Smartphones as Steady Companions

Device Use in Everyday Life and the Economics of Attention

Maximilian Heitmayer

A thesis submitted to the Department of Psychological and Behavioural Science of the London School of Economics and Political Science for the degree of Doctor of Philosophy, London, 05 February 2021

DECLARATION

I certify that the thesis I have presented for examination for the MPhil/PhD degree of the London School of Economics and Political Science is solely my own work other than where I have clearly indicated that it is the work of others (in which case the extent of any work carried out jointly by me and any other person is clearly identified in it).

I warrant that this authorisation does not, to the best of my belief, infringe the rights of any third party.

I declare that my thesis consists of 114359 words.

STATEMENT OF CO-AUTHORED WORK

In confirm that Paper 2 presented in Appendix B was jointly co-authored between Dr. Marina Everri, who contributed 40% of the work, Dr Paulius Yamin-Slotkus, Prof. Saadi Lahlou, and me who each contributed 20% of the work.

I confirm that Paper 4 presented in Appendix D was jointly co-authored with Professor Saadi Lahlou and I contributed 90% of the work.

I confirm that Paper 6 presented in Appendix F was jointly co-authored with Professor Saadi Lahlou and I contributed 70% of the work.

ABSTRACT

This thesis investigates smartphone use in naturally occurring contexts with a dataset comprising 200 hours of audio-visual first-person recordings from wearable cameras, and self-confrontation interview video footage (N = 41 users).

The situated context in which smartphone use takes place has often been overlooked because of the technical difficulty of capturing context of use, actual action of users, and their subjective experience simultaneously. This research project contributes to filling this gap, with a detailed, mixed-methods analysis of over a thousand individual phone engagement behaviours (EB).

We observe that (a) the smartphone is a key structuring element in the flow of daily activities. Participants report complex strategies on how they manage engaging with or avoiding their devices. (b) Unexpectedly, we find that the majority of EB (89%) are initiated by users, not devices; users engage with the phone roughly every five minutes regardless of the context they are in. (c) A large portion of EB seems to stem from contextual cues and an unconscious urge to pick up the device, even when there is no clear reason to do so. d) Participants are surprised about, and often unhappy with how frequently they mindlessly reach for the phone.

Our in-depth analysis unveils several overlapping layers of motivations and triggers driving EB. Monitoring incoming notifications, managing time use, responding to social pressures, actually completing a task with the phone, design factors, unconscious urges, as well as the accessibility of the device, and most importantly its affordance for distraction all contribute to picking up the phone. This user drive for EB is used by providers to feed the attention economy. So far, keeping the smartphone outside of the visual field and immediate reach has appeared as the only efficient strategy to prevent overuse.

CONTENTS

TABLES & FIGURES

ACKNOWLEDGEMENTS

SAADI LAHLOU

FRED BASSO

UICHOL KIM

DARIO KRPAN

BRADLEY FRANKS

SONIA LIVINGSTONE

PAULIUS YAMIN

MARINA EVERRI

MARTA ENTRADAS

CHAMPA HEIDBRINK

GIULIA PRESTI

& ALL MY PARTICIPANTS

- THANK YOU

1. INTRODUCTION

The smartphone is one of the most, if not the most successful invention of the past decades. Within a time frame of less than 20 years, it has become almost impossible for a large share of people on this planet to live without one. Smartphones are a powerful tool for productivity, social facilitation, and entertainment, and are tightly interwoven with our work lives and our social lives. For many users, the phone's alarm is the first thing they hear in the morning and the phone's screen is the last thing they see at night. Smartphones have, thus, become a steady companion in the lives of many users.

The explosion of the uses and users of smartphones in recent years has also brought it into the limelight of scientific attention, and the body of work investigating the interaction of smartphone users and their devices continues to grow exponentially. While technical and design research has focused mostly on how users interact with their devices, studies based on the uses & gratifications literature (E. Katz, Blumler, & Gurevitch, 1973) have focused on the why. Other literature has also begun to investigate the psychological side of smartphone use, including effects on the self-image, social and time pressure, as well as dependency and even addiction.

At the onset of this PhD, we saw the existing research and realised that there are currently two major problems associated with the way smartphone use is being studied: First, research is often only 'seeing with the eyes of the device'. The commonly used server- or app-logging methods can reliably collect massive amounts of data, but that data is limited to the sensors of the smartphone (accelerometer, GPS, device-log, etc.). What happens around the screen is usually a complete black box. We maintain that the context users are situated in is crucially important for smartphone use. For example: Is the user alone or in company? Is she at work or at home? And what internal and external factors make her pick up the phone? This systematic oversight of situated context is a highly problematic shortcoming of the literature.

Second, when research is trying to see with the eyes of users and takes into account interviews and user-reports, they are actually only seeing with *the memory* of users. It is well-known that participants almost never remember the full course of activity and also often misremember information when they are asked to reconstruct their actions (Heptonstall, 2015; Nosulenko & Samoylenko, 2001). Participants are furthermore subject to pressures around social desirability when it comes to being on the phone 'too much', which can also affect what they are willing to share, and even what they perceive in the first place (Araujo, Wonneberger, Neijens, & de Vreese, 2017; Boase & Ling, 2013). Unsurprisingly, several studies show that self-report and logging data do not correlate well (Boase & Ling, 2013; Junco, 2013; Kobayashi & Boase, 2012; Scharkow, 2016). The only way to overcome this problem lies in a detailed, situated ethnographic approach, which allows for a "thick description" of how smartphone use plays out in naturally occurring contexts (Geertz, 1973).

We believe first-person video, and the Subjective Evidence-Based Ethnography (SEBE) method in particular (e.g. Le Bellu, Lahlou, Nosulenko, & Samoylenko, 2016), is the only way to address this gap, as it documents objectively what happens on the device, while also taking into account the subjective experience of users, and the situated context they are in. Only with such detailed *in situ* data, will we ultimately be able to disentangle the inconclusive and sometimes contradicting findings that self-report and logging data produce independently. There are a handful of projects who have used first-person video to study smartphone use already and produced really promising results (B. Brown, McGregor, & Laurier, 2013; B. Brown, McGregor, & McMillan, 2014; Everri, 2017; Figeac & Chaulet, 2018; Gouveia, Karapanos, & Hassenzahl, 2018; Licoppe & Figeac, 2013, 2018). Adding on top a discussion of the video material with participants has allowed us to incorporate their thoughts and opinions into the research, which has improved the quality of the data obtained even further. This dissertation, therefore, went out on a massive 'ethnographic quest' to document the everyday lives of users with their smartphones using miniature, wearable first-person cameras, to capture on film all kinds of different activities that they engage in, and to gather their commentary on these observational materials and our interpretations. We did so in order to gain clarity on how smartphone users actually engage with their devices in naturally occurring contexts, and in the hopes of being able to bring some clarity to contrasting findings in the extant literature and to address some of its shortcomings

But we did not find at all what we expected: neither the socio-psychological, nor the technical narratives seem to be able to give a sufficient account of why people reach for their phones, and much of what we observed in the first-person video material our participants gathered, as well as the feedback they provided on these materials in the interviews, often did not reproduce and even contradict what was previously assumed in the literature. Thus, rather than being able to validate existing approaches and judge which ones seem to take precedence in which moments, we ran into difficulties to maintain a lot of existing models altogether. The interaction between user and device appears to be initiated by users, not by devices, in the vast majority of cases, which challenges the narrative of the disruptiveness of the phone. The numbers on duration and frequency of interactions with which users engaged with their devices we observed do not properly fit the usual patterns of dependency or (behavioural) addiction, which challenges the literature on the addictiveness of smartphones and problematic smartphone use. An unexpected amount of smartphone use (both to our participants and to us) was triggered by contextual cues and even appeared automatic and unconscious at times and, lastly, in a substantial share of cases, neither we, nor our participants were able to provide a definitive explanation for why they were using the phone in that moment, despite the thick and detailed data we have gathered, which suggests that this thesis has only been the starting point for a highly relevant and complex line of inquiry.

This thesis is organised in the following way:

The overall research carried out for this thesis over the course of the last four years produced six research projects that were written up in the form of Papers intended to satisfy the requirements to be submitted to peer-review. These Papers are presented in Appendix A to F. Paper 2, 3 and 4 have been published already, and Papers 1 and 5 have been submitted for review.

Paper 1 presents a theoretical discussion of the decisions individuals make regarding the use of their time and their attention, and explores how the concept of the attention economy, which emerge in the late 1990s could be developed to an actual economy with attention as its currency. This paper also connects the allocation of attention and the experience of time pressure to the literature around smartphone and social media use, and, thus, lays the theoretical foundations for this thesis.

Paper 2 emerged from a collaborative project on the ethics of visual research, and particularly the use of video-ethnographic techniques, which both informed and was informed by the research carried out for this project, recognising the importance of a proactive and well-considered approach to ethics and participant privacy.

Paper 3 discusses the use of smartphones at the workplace. Contextual differences between work and leisure activities appeared as a key tension line for participants between different levels of engagement with the smartphone and their perceived appropriateness, as well as the uses for the device. Moreover, most participants mentioned the influence of the phone on their ability to work, both in positive and in negative ways, which warranted a more detailed analysis of the role of the phone in work contexts.

Paper 4 focuses on one of the key findings emerging from the discussions with participants while viewing their first-person perspective recordings, which is the 'pressure to be available', and the disruptions to their daily lives that led to overuse they felt their smartphones are causing. This paper therefore zooms in on the nature of disruption and compares the perception of participants with the actual behaviours recorded on tape. Importantly, we find that notifications initiate smartphone interactions much less frequently than participants believe.

Paper 5 discusses the shortest smartphone interactions we observed in our sample. For a sizeable amount interactions, participants engage with their devices for a very short time only, and without even fully unlocking the device. 'Locked' use of smartphones, consciously or unconsciously, appeared to serve as a structuring element that featured prominently, particularly when participants were multitasking or switching between activities. This Paper therefore investigates in which contexts, and after which cues locked use occurs and provides a typology of different contextual 'causes' of locked use.

Paper 6 then extends the discussion of contextual antecedents for locked smartphone use and applies them to our full sample of smartphone interactions to determine what drives smartphone use. To do so we test three hypotheses (appetite, addiction, habit). Although we do not find conclusive evidence for either of the three hypotheses, our findings strongly draw into question the notion of smartphone addiction and accessibility of the device appears to be a crucial factor to understand smartphone use. This Paper, thus, opens up several routes for further research.

For the main body of this thesis, the findings from the individual Papers were combined into a single narrative to improve clarity for the reader, and to highlight the overall research narrative of this research project. Chapter 2 discusses the general theoretical background revolving around attention allocation and more broadly the economics of attention, as well as different potential drivers of smartphone use. Chapter 3 then presents the state of the art of empirical research on smartphone use. Based on this discussion, chapter 4 and 5 outline the gap in the literature which this thesis aims to address and formally present the general research questions guiding this research. Chapter 6 presents and discusses the methodology employed for this thesis. Chapter 7 reports the overall qualitative findings emerging from the Replay-interviews, and chapter 8 reports the different quantitative analyses carried out for this thesis. Chapter 9 then provides a general discussion of all findings emerging from this research project. Chapter 10 discusses the limitations of this thesis, and chapter 11 looks ahead and outlines suggestions for the next research steps to be taken. Chapter 12, finally, discusses lessons learned both for the methodology and the field in general and provides some concluding remarks.

Further to the individual Papers, the Appendix contains the ethics approval form (G) and the coding frames from the qualitative and quantitative coding of the data (I). We also want to particularly highlight Appendix (H) which contains a link to video samples of Subfilms and Replay-interviews that convey the nature of the research data we have been dealing with more clearly.

2. THEORETICAL FRAMEWORK

This thesis rests on two theoretical pillars. First, we will provide a social-psychological and economic discussion of attention and how contemporary society is increasingly becoming an attention economy. Second, we will provide an account of what are potential drivers of smartphone use rooted in ethological and social-psychological theories of human activity.

2.1 ATTENTION

2.1.1 THE CONCEPT OF ATTENTION

The importance of the attention of others, and the pressure contemporary society exerts on the attention of its inhabitants minds is well established in the literature: Veblen's work on the leisure class traces how attention to detail, and wasting attention on details translate into power and status through conspicuous consumption (Veblen, 2007). Simmel and Giddens talk about the toll life in large agglomerations takes on our attention (Giddens, 1990; Simmel, 2016), and Rosa's work on social acceleration draws heavily on how attention is affected, even colonised, by technologies and societal conditions, and how channelling attention into the right things to create *resonance* offers a potential solution to these problems (Rosa, 2016a, 2016b). Looking more specifically towards media, Horkheimer & Adorno have provided one of the earliest, and still today most relevant accounts of the 'industrial' production of media content, and the distracting effects for the attention of the public this creates. They argue that it is the media's express purpose to capture the attention of the people to divert it from political matters, and to generate conformity amongst audiences; repetition and uniformity of content are the means to achieve this (Horkheimer & Adorno, 1988). Debord further develops their argument and contends that the commodity itself has become a 'spectacle' and that the staging of economic exchanges has moved to the centre of society (Debord, 1995).

This cursory overview of the use of attention in seminal scientific literature shows how variedly and widely the concept of attention is used for the study of society, and how many pressures on her attention the individual may encounter in her daily life. For this research project, understanding clearly what exactly it is the individual is ‘spending’ when it comes to using the phone, using social media, or *not* using them will be necessary. We therefore believe it is appropriate to take the time to discuss what attention actually is and how it has been approached by the literature, to then formulate a working definition of the concept that is to be used in the following. Let us begin by looking at some definitions:

- The Merriam-Webster defines attention as “the act or state of applying the mind to something”, or “a condition of readiness for such attention involving especially a selective narrowing or focussing of consciousness and receptivity” (“Attention,” 2020a).
- The Oxford dictionary says attention is “notice taken of someone or something; the regarding of someone or something as interesting or important”, or “The mental faculty of considering or taking notice of someone or something” (“Attention,” 2020b).
- In his *Principles of Psychology*, William James famously and courtly concluded that “everyone knows what attention is”, and ever since, it has been treated as this self-explanatory, experiential or mental state which does not require further discussion (James, 2006). Nevertheless, perhaps aware how unsatisfactory it would be for his readership to be left with an ‘it is what it is’, James adds: “It is the taking possession of the mind, in clear and vivid form, of one out of what seem several simultaneously possible objects or trains of thought” (James, 2006).

This cursory look at definitions of attention from dictionaries and the extant literature shows that they have in common three general elements that seem to make up the core concept:

1. Attention is a mental state or a mental faculty

2. Attention requires readiness and receptivity of the mind

3. Attention is an act of selection of something, or of something taking possession of the mind

Following James, while everyone may know what attention is on an experiential level, when looking more closely at these definitions, different types of attention varying in nature and intensity appear to be subsumed under the umbrella term 'attention'. From everyday experience, we know that paying attention to someone or something can be an active, meaningful activity, like solving a Rubik's cube, as well as a passive, meaningless activity like staring at a news screen while waiting at the airport without really noticing what is being displayed. Awareness appears to be antecedent to attention; conversely, in order to speak of attention, it seems that a certain threshold of awareness has to be surpassed:

> *Attention occurs between a relatively unconscious narrowing phase, in which we screen out most of the sensory inputs around us (we are aware of many things, but not paying attention to them), and a decision phase, in which we decide to act on the attention-getting information. Without both phases, there is no attention. A causal relationship exists between awareness, attention, and action. For example, attention is a link in the decision-making chain prior to the decision to buy, move, or otherwise act. If you do not get to the point at which you are considering some kind of action, you really have not given an item your attention.* (Davenport & Beck, 2001)

Another approach distinguishes between contact, attention, and emotion:

> *Contact with content is therefore the catalyst for a chain reaction; it is necessary, yet not sufficient, for drawing attention, and if this attention is sustained and transforms into interest, it can arouse emotion, depending on the kind of content received. (Tassi, 2018)*

The idea of different 'stages' of attention is rather straightforward and even though it is mostly unconscious, everyone has anecdotal experience of it. If you try to look at everything that is within your visual field on your desk, you will inevitably lose focus of what is around it – unless you have a very tidy desk. The amount of sensory impressions that we can be aware of at the same time is biologically limited (Stróżak & Francuz, 2017).

This reading works well to describe situations like solving a Rubik's cube, or staring at an airport TV, but it does not really take into consideration the wilfulness (or forcedness in the airport situation) of these activities, nor their outcomes. To move attention beyond a purely passive capacity, these theories then tie attention to action or emotion. Nevertheless, the line between full attention and its antecedents would still remain fuzzy in many situations, which points towards the bigger issue at stake here: The problem with tying attention to action or emotion is that it tries to define attention *as experienced by the individual*. This may be intuitive, but at the same time sets up attention so that it can only be understood in relation to the person that is acting, and her subjective thoughts and actions. However, the 'raw material' that becomes either awareness or attention is constantly depleting from our stock with every moment that passes. Hence, whether you stare out of the window of a train apathetically, aware of your surroundings, or attentive to your surroundings, you inevitably expend the 'biological resource' that holds the possibility to become awareness, attention, or action. This biological resource is at the very centre of the economics of attention.

2.1.2 FROM THE ECONOMICS OF TIME TO THE ECONOMICS OF ATTENTION

Economic approaches to thinking about the use of time have implicitly used this understanding of the biological resource attention for several decades already: "Since the scarce resource of time must be spent, a basic problem of human existence is to spend it well, to use it to bring in the greatest return of happiness that can be achieved" (Sharp, 1981). At the same time, the utility that can be gained from spending a continuous amount of time on one thing may be decreasing, or even discontinuous when it turns into a displacement activity. The analogy between time (or attention) and money as a resource, further, ends when it comes to the ability to *not* use it, to store it, or to accumulate it: "While we are alive we are compelled to spend our store of hours. Other goods and services that may yield displeasure need not be acquired, or can be given away or remain unused. But time must be spent even if it produces boredom or unhappiness or pain" (Sharp, 1981). Thus, as time is available to everybody in a fixed and finite amount it can be a source of pressure, creating *time stress*. Time stress, like poverty, is a problem that arises from a lack of resources, but while the constraint on goods relaxes in a growing economy, time stress increases: With an increased availability of information, individuals will increasingly feel that their time does not suffice to consume everything they desire (Hamermesh & Jungmin, 2007). In support of this, several studies find that the experience of high time pressure is associated with depression (Roxburgh, 2004), lowered life-satisfaction (Hamermesh & Jungmin, 2007; Whillans, Dunn, Smeets, Bekkers, & Norton, 2017), and interpersonal conflicts both at work and at home (Höge, 2009). More generally, the research on time-use raises the question where the time-crunch and the struggle for attention originate.

While the focus of the literature often lies on understanding attention expenditure, it makes sense to start with the circumstances under which people receive and proactively attempt to attract attention first. In his treatise on metropolitan life, Georg Simmel argued that the uprooting of the individual from traditional social settings had two adverse effects that eventually set the stage for the attention economy: On one hand, people were liberated from the constraints of traditional societies, which gave them more freedom for self-expression. On the other hand, strong social ties are also a source of purpose and identity, the lack thereof possibly resulting in a loss of self-hood (Simmel, 2016). As a result, Simmel observed, individuals living in large cities developing the “strangest eccentricities, [...] specifically metropolitan extravagancies of self-distantiation, of caprice, of fastidiousness, the meaning of which is no longer to be found in the content of such activity itself but rather in its being a form of being different - of making oneself noticeable” (Simmel, 2016). Being emancipated from the constraints of traditional societies, the individual enters into a competition to be noticed and to forge a recognisable identity for herself: “There’s always something to see in cities. People dress for others, show off what they possess, make the most astonishing efforts to induce others to watch” [14, translation]. The wish to be famous and successful has therefore evolved into an end in itself (Lasch, 1984, 1987). And while the esteem an individual was held in by other others was traditionally rooted in her accomplishments, as well as her moral integrity, celebrities in modern society derive their reputation from the coherent, and often visually appealing, public identity they maintain, or just any other means by which they have managed to draw attention to themselves (their ‘front’, see (Goffman, 1959)). It can, thus, be argued that individuals in modern societies do not strive directly for power, fame, or wealth, but rather seek the public attention that usually comes with the possession of these things, which makes the economics of attention really also an economics of reputation (Ghosh, 1998; A. N. Smith & Fischer, 2020). In this sense, attention economics is something that humans are more or less hardwired to do, judging from the lifestyle of our early ancestors and the behaviour of our closest animal relatives (e.g. (Latour, 1996)).

Since this early foreshadowing of the competition for attention, technological progress has made the world a ‘global village’, essentially decoupling locality and temporality (Giddens, 1990). In such a society, “in which everything is moved by communication, nobody can defy the pressure to attract public attention. Otherwise, one is forgotten and lost” [41, translation]. Hence, two new complications in the struggle for attention arise: The competition for attention, first, expands exponentially with the growing number of people and devices that try to capture our attention. The individual is, thus, forced to be highly selective about what she directs her attention to, which information she consumes, and which she does not (Franck, 1998). And since social media are not just a tool to store and distribute information, but also a channel for communication between individuals, they have become a prime contributor to the constant stream of information individuals are subjected to. They are thus both a means to attract attention, as well as a reason why attention is becoming increasingly scarce.

The second complication is that it is much harder to filter out what is currently considered important with the increased amounts of diverse information available. The individual is then forced to use more of her attention to ‘be in the know’, and the freedom of choice offered by modern societies becomes constrained again by the need to attract attention (Münch, 1991). The important insight here is that external appreciation can only be acquired “wrapped in the attention” of others [14, translation]. If we need the attention of others to feel good about ourselves, while attention overall becomes both increasingly scarce and difficult to attract, a “fight for visibility” ensues (Schroer, 2014). Modern media, have thus created “centripetal attention structures that bottle celebrity, and celebrities, for sale” (Lanham, 2006): Since every individual needs to spend attention to understand what is required to attract attention (this applies in any field, politics, academics, fashion, art, restauration, sports), those ‘in the know’ are moved into the spotlight, become opinion-leaders, and eventually gain agenda-setting power. Hence, although information is overabundant and days are limited to 24 hours for everyone, an imbalance in the distribution of attention arises like in any other economy (Aigrain, 2006). The amount of attention that is 'being paid to' an individual depicts her entrepreneurial success in this new economy, and with the increasing relevance that social media play in society, the amount of attention being paid to an individual will have to be understood less metaphorically and more literally. This sets the stage for the accumulation of 'capital' in the attention economy.

2.1.3. ATTENTION AS A CURRENCY

We will now turn to how attention behaves as a currency, how it could be traded, and where and how the analogy between attention and other currencies falls short. Much like modern monetary currencies attention is not valuable in itself, only as a means to provide access to valuable things, in this case information. Unlike modern currencies, however, attention is inherently limited, it cannot be saved for later, and it is foregone if it is not spent 'wisely' – at least to date.[1] In this sense, attention as experienced by the individual should not be treated as a stock, but as a *flow* currency. Our stock of attention constantly empties and refills itself at the same time, with the maximum amount of attention we can hold at any given time determined by a biological limit that remains largely invariant for the individual (different bodily states like hunger or fatigue, as well as stimulants can of course temporarily influence this biological limit). While time use studies have attempted to document what individuals spend their attention on, the sheer size of the attention economy and the microtransactions that make it up have been made visible to full extent only through social media. Surely, the number of copies a newspaper sold, or the viewers who tuned into a TV programme hint at the underlying processes, but it is only with likes, views, and followers that the immediacy of the flow of attention from consumer to producer and the circularity of the system become evident. When watching a video on YouTube, every single viewer immediately contributes to the accumulated view count, which subsequently influences how many other viewers the video is suggested to. On Instagram, likes count social

[1] It is beyond the scope of this thesis to delve into the physiological aspects of this issue. For the research agenda of this thesis, a socio-psychological understanding of the nature and the limitations of attention is adequate. As a first point for the reader interested in examining the phenomena observed below from a neuro-biological or physiological viewpoint Lang's *limited capacity model of motivated message processing* may be interesting as a potential framework of analysis (Lang, 2000), and Strózak & Francuz' EEG studies on attention allocation show potential pathways for a way of measurement and empirical validation (Stróżak & Francuz, 2017).

approval as a hard currency for social comparison and the number of followers quantify a user's personal audience, i.e., the people who regularly pay attention to them (e.g. Hayes, Carr, & Wohn, 2016). By recording, storing, and making visible the attention users expend and receive instead of letting it dissipate at the end of the transaction, social media have found a way around the fleeting nature of attention. Whilst still unable to store or save up attention internally, in the original form of the flow currency, social media allow attention to accumulate and calcify externally. Of course, calcified attention is different from the flow attention we use in our lives; you cannot 'use' the attention that people paid to a photo you have taken to take yet another photo, but it can determine how many people will pay attention to the next photo you take, and how much someone might be willing to pay you to feature their product in it. This translation of flow attention into a digitally stored stock currency is the central mechanism of a true attention economy.

To understand the modalities of how exchanges in the attention economy take place, attention should be treated as a *symbolic currency* (Luhmann, 1975; Parsons, 1963). In its calcified form displayed as subscribers, followers, likes, etc., attention acts as a signifier of reputation and status that puts into evidence previous success in the attention economy, a) with the promise of attracting more attention in the future, and b) with the opportunity to 'exchange' it for other valuable resources, such as money. Parsons had theorised that money is a specialised language that enables its users to symbolically communicate meaning to one another. Money, he argued:

> *"[...] is a symbolic "embodiment" of economic value, of what economists in a technical sense call "utility." Just as the word "dog" can neither bark nor bite, yet "signifies" the animal that can, so a dollar has no intrinsic utility, yet signifies commodities that do, in the special sense that it can in certain circumstances be substituted for them, and can evoke control of relations with them in the special kind of process of social interaction we call economic exchange. This means that holders of objects of utility will, on occasion, be willing to relinquish control over them for money, and, conversely, holders of money will be able to acquire, by use of the money (its "expenditure"), control over objects of utility."* (Parsons, 1963)

Parsons called this class of symbolic signifiers *generalised media of communication*; Luhmann then employed the notion for his conceptualisation of systems theory (Luhmann, 1975, 1987, 1994). This approach divides society into subsystems such as the economy, the legal system, or the political sphere, which are understood to mostly revolve around themselves, using a specific symbolic currency as their transactional medium to reduce the complexity of internal relationships (Luhmann, 1975). This would be influence for the political system, expertise for the legal system, or money for the economic system (Luhmann, 1994). For exchanges between systems, one symbolic currency can normally be translated into another, either directly or indirectly; e.g. expertise into influence, or influence into money. As we have seen before, calcified attention like Instagram followers or views on YouTube videos symbolically communicate a system specific meaning and are a signifier of success or 'power' on the social networks or, more generally, in the public sphere. Attention can moreover be translated into other subsystem currencies like influence or money relatively easily, albeit not as easily as money. In that regard, attention behaves more like power or influence as the exchange resembles a credit or a loan on the attention that one has rather than giving away a specific quantity of it for something else (Ghosh, 1998). An exchange of calcified attention into political power or influence for example is relatively easy: a typical case would be a famous actor or singer raising awareness for a pro-environmental campaign or engaging in dialogue with a politician on Twitter. An illustrative example of an exchange of attention into money is product placement: Most content creators on the internet have accumulated their following through the content they produce. If they then start capitalising too much on this following and mostly use the attention of their followers to advertise products to them (and receive large reimbursements) rather than continuing to produce content, they will lose their following rather quickly. If they find the right balance, however, their following will likely accept the occasional advertisement and an exchange of audience attention for money is possible without a loss of calcified attention (i.e. followers).

Crucially, the number of views on YouTube or followers on Instagram directly influence how easily attention can be exchanged into other symbolic currencies and at which 'exchange rate'. The larger the following of an individual on social media, the more likely for example politicians are to engage with them if they comment on current matters, and the more a company would pay for a sponsorship. Because large amounts of calcified attention hold the promise of attracting attention in the future, individuals rich in calcified attention can also exchange the flow attention *of their audiences* into other generalised media of communication. Thus, people can take out a 'credit' on calcified attention, on one hand, by virtue of the signalling value of being able to attract attention again in the future (just like reputation or political power), and on the other hand, by acting as a channelling point for other people's attention, explicitly guiding their audiences in certain directions. This duality in the way in which the attention individuals receive can be spent makes the ways in which attention works as a currency highly complex and is the key to understanding transactions in the attention economy. The remaining question to clarify for attention as a currency is for which system attention is the symbolic currency. Tentatively, the modern, mediated public can be seen as an independent subsystem for public life in the sense in which the ancient Greeks understood the *agora*. Alternatively, attention might be a secondary currency for the economic system and eventually replace money. Lastly, given the influence attention has on all subsystems of society already, it might evolve into meta-currency that is indigenous to each part of society. It is too early to give a definitive answer in which of these routes, if any of them, the attention economy is heading. In many respects, however, a broader shift towards attention as the prime medium of exchange appears to be under way already. What we are witnessing could be a fledgling revolution in the societal mode of exchange and production. As Goldhaber suggested:

> *Attention transactions, which already are far more numerous than monetary transactions will come to dominate even further. So even if you have lots of money, you will find it less and less convenient or worthwhile to bother to use it. As a result, our deeply ingrained desire for monetary recompense will begin to fade as well.* (Goldhaber, 1997a)

Current developments on social media. Calcified attention as an indicator of quality or success has gained importance far beyond the realm of social networks and many of our daily choices are now guided by it, be it directly through our choices, or indirectly through what is available to choose from. Inversely, it is becoming increasingly difficult to participate in society without leaving digital traces that contribute to the attention capital of others, be it by reading an article, listening to a song, or reserving a table at a restaurant. It is furthermore becoming increasingly easy to exchange attention into money and other symbolic currencies, and in certain areas even necessary, with social media and particularly live streaming remaining and the spearhead of these developments. Money now “tracks attention”, meaning that those who manage to attract attention find it easy to make money as well, and those who do not will find themselves struggling to obtain money (Goldhaber, 2006). Moreover, the notion that attention may be the more convenient medium of exchange does not seem as incredibly distant as it did twenty years ago when the economics of attention entered the spotlight of research for the first time.

Recent developments around live streaming and social media in general provide clear indications that the attention economy is steadily extending its reach and its impact. We discuss these processes in more detail and provide an outlook on how the institutional framework of such an attention economy could look like in Paper 1 (see Appendix A). Here, we shall now turn towards the issue of measuring and quantifying attention, as well as how decisions around the allocation of attention affect the daily lives of individuals.

2.1.4 MEASURING ATTENTION

With the growing societal and, more importantly, economic importance of attention, accurately measuring the attention a product, a film or an individual receives becomes increasingly important. As hinted at in the previous section, time spent attending to an object or engaging in an activity is in many cases an imperfect proxy, especially when it is measured directly through the device the individual is paying attention to: Evidently, the television stays on even when the viewer is attending to the toilet instead and anecdotal experience tells us that commercial breaks are often regarded as a good opportunity to do so - which creates a problem for advertisers who pay a lot of money for airtime, and for broadcasters who monetise the attention of their audiences. While advertisers continue to develop ways of getting around this problem of course, the issue goes beyond the field of advertising and the TV as a medium.

Different traditions have developed different ways of measuring attention and making it palpable. While the literature on human attention and time use focuses on the individual who pays attention, attention paid to media is typically measured on the side of the broadcaster, who emits something or the object to which attention is paid. Falkinger for example, delineates an approach focusing on the number and the types of information sources that succeed in attracting the attention of people in competition with others. From his point of view, “it is not the processing of specific information content which matters for an individual’s attention level but the aggregate volume and strength of signals to which she or he is exposed” (Falkinger, 2008). These metrics are more or less analogous to those used for traditional mass media, such as radio or TV. It is questionable whether this approach is still adequate for the contemporary context where attention is taxed like never before in any given moment and multitasking with a variety of media devices is ubiquitous. The recent research agenda on measuring attention, hence, has been twofold. Research building on the traditional audience measurements uses new technologies and techniques to improve the accuracy with which the attention that is actually being paid to the object of attention can be measured. At the same time, research aimed at understanding media use and multi-tasking has begun to build the foundation necessary to understand the modalities of attention expenditure from the perspective of the individual.

First, focusing on the object of attention, several studies have begun to investigate the notion of attention as a currency. Wu & Huberman have studied the relationship between the novelty of news articles and the attention paid to them, as well as their performance over time (Wu & Huberman, 2007). Weng and colleagues use the performance of memes to measure the breadth and the intensity of attention users spend on social media (Weng, Flammini, Vespignani, & Menczer, 2012). Mocanu et al. focus on information consumption and collective attention. In their sample of 2.3 million facebook users, they find similarities in the attention patterns paid to pieces of information, irrespective of the quality of the respective piece (Mocanu, Rossi, Zhang, Karsai, & Quattrociocchi, 2015). Connected to this, Bakshy and colleagues find in a study with 1.6 million Twitter users that information pieces do not exclusively spread from influential accounts to less influential ones, but that also users who exert average or less-than-average influence can contribute to the larger attention patterns on social media (Bakshy, Mason, Hofman, & Watts, 2011). Lastly, Nelson & Webster have examined the diverse nature of audience currencies (Nelson & Webster, 2016). They find that the two current major ways of measuring attention, size and time spent, are uncorrelated in a large dataset on website traffic in the US (230 million unique visitors).

One study that deserves to be highlighted particularly is Byron Reeve's *marketplace for attention*. He and his colleagues proposed an E-Mail currency system as a solution for the increased volume communication that arises from the lowered costs for senders (Reeves, Roy, Gorman, & Morley, 2008). A plug-in to a standard email software was installed on 23 employees' computers in one department of a technology company. They were then each given a weekly allowance of 100 units of the synthetic currency, which they could attach to their messages in order to signal heightened importance. Reeves and colleagues found that the time until recipients read messages increased significantly when small amounts were attached to them, and decreased significantly for larger quantities, respectively, as compared to 'uncertain' messages without any amount of currency attached (Reeves et al., 2008). These findings suggest that a synthetic attention currency can help people successfully discriminate between important and unimportant information and direct their attention towards the flow of incoming information accordingly.

Second, focusing on the individual spending attention, research on multi-tasking and task switching investigates how often users switch between different tasks, screens, windows, etc., and how long their attention dwells on the respective items. The two main theoretical approaches to multitasking distinguish between dual-tasking, which focuses on two tasks being carried out at the same time (Schumacher et al., 2001), and task-switching, which focuses on performing multiple tasks step by step, and sequentially (Monsell, 2003). Overall, more studies have embraced the dual-tasking approach, although recently combined approaches have gained in popularity (S. H. Jeong & Hwang, 2016; Salvucci & Taatgen, 2008; Wallis, 2010; Yeykelis, Cummings, & Reeves, 2014).

Overall, multitasking involving the use of media has been connected to difficulties with concentrating on tasks (Baumgartner & Sumter, 2017; Cain & Mitroff, 2011; Ophir, Nass, & Wagner, 2009; Rosen, Mark Carrier, & Cheever, 2013; M. Shin, Webb, & Kemps, 2019; Uncapher et al., 2017) and to reductions in cognitive performance on tasks involving long-term and working memory (S. H. Jeong & Hwang, 2016; Lang & Chrzan, 2015; Sanbonmatsu, Strayer, Medeiros-Ward, & Watson, 2013; Uncapher, K. Thieu, & Wagner, 2016). In this vein, it is argued that this performance is not only affected by the level of the demand on the attention of users, but also by its qualitative nature. Dual processing theory thus argues that tasks which share the same information processing structures can be performed less efficiently compared to tasks that use two different processing structures (such as hearing and listening) (Wickens, 2002). Experimental studies confirm these conjectures, showing a generally negative effect of sensory interference on a variety of performed tasks (e.g. J. M. Bowman & Pace, 2014; L. L. Bowman, Levine, Waite, & Gendron, 2010; Fante, Jacobi, & Sexton, 2013; Hwang & Jeong, 2018; Jeong & Fishbein, 2007; Pool, Koolstra, & van der Voort, 2003; Yeykelis et al., 2014).

Another factor that has been found to affect users' ability to multitask is the hierarchy of the tasks performed. Studies generally find support for the intuitive notion that cognitive performance is lower for tasks that are perceived as secondary (L. Lin, Robertson, & Lee, 2009; Z. Wang, Irwin, Cooper, & Srivastava, 2015). Importantly, however, there seems to be an interaction between task hierarchy and sensory interference, amplifying the negative effect of interferences on tasks that are perceived as secondary (Hwang & Jeong, 2018).

A final factor that influences the performance of individuals engaging in multiple tasks is the level of control they have over the inputs they receive (Eveland & Dunwoody, 2001; S. J. McMillan & Hwang, 2002; Milheim & Martin, 1991). User control thus focuses on the degree of control users have to selectively direct their attention to specific elements, and whether they can influence the "pace and sequence" of the information they need to process (Eveland, 2003). Initial experimental research shows that the level of user control appears to exert and even stronger effect on cognitive processing than sensory interference (Hwang & Jeong, 2019; S. H. Jeong & Hwang, 2016).

Research into the frequency of these multitasking behaviours generally reports an increase in switches, and a reduction in time spent continuously on a single task.

Studies find that users switch to their phones from work activities every four to six minutes (Rosen et al., 2013; Yan, Chu, Ganesan, Kansal, & Liu, 2012), while the numbers for general use are slightly higher (Van Berkel et al., 2016; Visuri et al., 2017). Experimental research found that half of adolescents and one third of adults stay on their main task for less than two minutes before switching to another media activity (Baumgartner & Sumter, 2017). More generally, due to the reduction in continuous time spent on tasks and an increase in interruptions, it has been argued that the nature of how users engage with tasks has changed (Yeykelis, Cummings & Reeves, 2014, 2017). Paradoxically, strong media-multitaskers appear to be worse at switching between tasks effectively (Ophir et al., 2009).

Feeding these findings forward. the *Screenome* methodology has been developed to verify these findings with naturally occurring data. A software that takes screenshots in short intervals is installed on the participants' devices. These screenshots are bundled, uploaded to a repository, and then transformed into a searchable text databased by an AI based software, which allows for the unobtrusive collection of large amounts of naturally occurring data depicting actual use and activity flows. (Brinberg et al., 2021; Chiatti et al., 2018; Ram et al., 2020; Reeves et al., 2019). Applying this technique to multi-tasking and task-switching on PCs and smartphones, Yeykelis and colleagues find that switches between tasks on smartphones occurred every 19 seconds and were preceded by varying states of anticipatory arousal (measured through a skin-conductance wrist sensor) depending on the upcoming content, which suggests that users are actively considering the following activity while they are still engaged in the previous task (Yeykelis et al., 2014; Yeykelis, Cummings, & Reeves, 2018) . Overall, users spent less than 5 seconds on 1/5 of the content they viewed, and less than one minute on 75% of the content, which is much less than what was previously reported in the literature.

Further probing the nature of multitasking towards dual-tasking or task-switching, the authors found a similarly fast-paced switching for computer use, albeit the overall pace was slower than that of smartphone use. The findings produced in both studies give support to combined approaches suggesting that media experiences can considered as *threads* which run across traditional experiential boundaries (Salvucci & Taatgen, 2008). They furthermore challenge the idea that content creators determine the pace of user experiences and its impact; rather, users seem to actively tailor their own information streams and the "sum of the parts may produce a different whole when the partial experiences are combined" (Yeykelis et al., 2018).

Especially with mobile devices, however, switches do not occur randomly or through voluntary allocation of attention; instead, devices capture our attention by sending notifications. In a pioneering experimental study, Beja, Lanir, and Kuflik have examined the disruptiveness of notifications in a real-world context (Beja, Lanir, & Kuflik, 2015). They find that while the type of notification (audible, tactile, visual, etc.) did not affect perceived disruptiveness, perceived importance and most importantly context did. Overall, they conclude that "the perceived level of disruption is correlated to the level of attention that is required from the user in his or her current activity" (Beja et al., 2015). With these important pointers laid out, why users see certain things as relevant or not, and what is more, why they allow themselves to be interrupted or not in *non-experimental settings* becomes the next important point on the agenda.

To sum things up, we must conclude that to fully understand how users expend their attention on social media, we cannot simply rely on the convenience of the commonly used measures. It should be noted, however, that all of these studies have employed large-scale quantitative data, relying on exactly those measures drawn into question by Webster. To move forward I therefore propose to take a step back and examine user behaviour in a real-life context. While this method is of course much more laborious and time-consuming than harvesting large quantities of existing data from social media platforms, it will provide more reliable data on the modalities of people's use of attention. Only then, when we have understood the complexity of these transactions and their contexts will it make sense to try and devise more abstract measurements that allow the use of large-scale datasets.

2.1.5 SUMMARY

In this overview of the pertinent literature, we have discussed the theoretical foundations of the attention economy and recent developments that have increased its prevalence in our society. Attention, though definitions vary in their specifics, seems to be a mental state of receptivity, as well as an occupation of the mind with, or selection of something, at the core. Attention is one *form of expenditure* that our natural capacity to focus on things can take and thus lies on a continuum between unconsciousness and conscious mental effort, with several nuances in between.

With an overwhelming supply of information provided by contemporary society, attention, like time, is an increasingly scarce resource that needs to be spent selectively. Information technology and especially social media are one such means that allows a highly selective and individualised expenditure of attention. At the same time, they are main contributors to the stream of information that makes it impossible for users to pay attention to everything that is addressed at them. Attention thus becomes increasingly valuable, not just for individuals who have to expend it, but also for media, politicians, academics and marketers who have to attract it to move their messages or products, to name a few. Conversely, anything that is able to attract large amounts of attention is automatically regarded as desirable, valuable, or successful. Social media have therefore developed numerous indicators like view counts or likes that document and exhibit such 'success' as calcified attention, which can in turn be exchanged into other desirable commodities such as money or influence. Attention is thus under way to become a generalised medium of communication, a truly transactional currency.

This general theoretical framework sets the stage for the analysis of the ethnographic data on smartphone use collected for this thesis. It will be important to document how much the theorised processes are reflected in situated user-behaviours, and how much calculations around the efficient allocation of time, and the accumulation of digital attention currencies actually influence decision-making. Are such calculations indeed occurring? When? How? We must start by looking in detail into the moment where attention is captured, as operationalized by the EB (engagement behaviour) with the smartphone, and make explicit what are the mechanisms and factors underlying this EB. The SEBE methodology should enable us to gather a rich description of relevant behaviours such as multi- or dual-tasking, and further, to shed light on which behaviours take precedence in which context, which will then enable this research to translate theoretical considerations into practical approaches that can inform further research and design practice.

Understanding how users interact with their devices, and when and why they switch between different tasks, programs, or devices will be the first step to show how the attention economy influences people's overall behaviours and attitudes. Describing in a second step the psychological implications the constant pressure to attract attention and the desire to expend it wisely has on individuals living in the times of the attention economy will then enable this research to inform design practice and policy to improve the quality of the relationship between users and devices. Further, a discussion on raising awareness for these patterns of attention allocation, and ultimately *attention literacy* in the population can help remedy the adverse effects for society.

A shortened version of section 2.1 is currently under review at alt.chi 2021 as Paper 1 of this thesis (see Appendix A).

2.2 DRIVERS OF SMARTPHONE USE

Having looked at attention allocation and the attention economy in general, we will now turn to underlying biological drivers and psychological motives that may be underpinning individual choices around attention allocation with the smartphone.

Specifically, this section will explore the causes of the smartphone *Engagement Behaviour* (EB), that is, the act of initiating an interaction with the device, touching it, and looking at it. This definition is wider than smartphone *use*, because there are instances where the person touches and looks at the device, but leaves the screen locked, or simply fidgets with the phone. The main issue here, which is at the root of all research on overuse or *problematic smartphone use*, is that in many cases the EB is not intentional; it is 'mindless'. At least, that is what participants declare. We are therefore studying movements that are not the result of a decision-making process, where alternative possibilities are considered and weighed, but rather spontaneous, possibly involuntary, and sometimes even unconscious movements.

Such movements are in a bit of a grey zone in psychology, as it is difficult to get an account of conscious mental processes that led to the movement from participants, precisely because likely there weren't any. Current research in neuroscience has made considerable progress on the study of volition and of the precise moment when the decision to act, or the consciousness of motor command, takes place. To put it simply, there seems to be a gradual building up of a "readiness potential" in the moments preceding voluntary actions (Haggard, 2008, 2019). When a threshold is met, the movement is triggered. Interestingly, *consciousness* of the decision ('urge') to move occurs *after* the readiness potential started building up (Libet, 1985; Libet, Gleason, Wright, & Pearl, 1983).

Yet even these fine-grained models do not tell us why the readiness potential grows; that is what the *motive* for action is. When a stimulus is present, we attribute to it the cause of the action, with the hypothesis that the stimulus evokes some neural activity which in turns builds the response; this is well in line with almost a century of experimental research on conditioning (Pavlov, 1927; Skinner, 1938). At least, that is, when the stimulus is clearly identified as such. Determining what is actually the stimulus for an observed action is not trivial unless one can run a controlled experiment. Put simply, we assume that some difference in the context is the stimulus only because we see a response that seems correlated with that difference (stimulus-contrast: Andrew, 1963). To be sure, we should also check all the moments where the 'stimulus' happens and see if the 'response' appears, too. Alas, this is very difficult in practice, especially when the stimulus is not a visible event in the context, but rather an internal change within the person (such as getting bored). Let us examine some of the classic forms of actions that are in this grey zone of mindless behaviour.

2.2.1 PURELY INTENTIONAL USE

While we focus here on the contextual drivers of smartphone use that either directly cause EB or enable users to act upon their usage intentions, smartphone use can be "purely intentional", that is to say, without any external prompt or change in circumstances as well of course. While current research in neuroscience is working on understanding the biological indicators for volition (see above; Haggard, 2008, 2019), psychological literature has been exploring the different facets of agency, including intentionality, self-reactiveness, self-reflexiveness, and forethought (Bandura, 2001, 2006; Davidson, 1971; Feather, 1982; Locke & Latham, 1990). For smartphone interactions, forethought around things that need to be done with the phone, as well as reactive or reflexive thoughts around the phone, while intentional in nature, will usually not lead to immediate EB, which will later be discharged at an opportune moment, or the thought process itself will occur during such a moment when cognitive load is shifted from other activities. Purely intentional smartphone EB that leads from volition to immediate action without external cues or opportune moments arising is akin to pop-ups or intrusive thoughts that appear (Levinson, Smallwood, & Davidson, 2012; see Randall, Oswald, & Beier, 2014 for a review). For users, these moments will be experienced as self-interruptions driven by an idea that comes to their mind, or remembering something they wanted to do with their phones (for a detailed discussion of the experience of cognition, see Carlson, 1997). Initial research on mind-wandering in the context of technology and social media use further suggests that lack of interest in an ongoing task, as well as lower levels of working memory (Hollis & Was, 2016), but also the mere presence devices and systems allowing for hedonic use, like the smartphone and social media (Oschinsky, Klesel, Ressel, & Niehaves, 2019), can increase use of the device. Naturally, purely intentional EB is difficult to capture and describe, and we have encountered several issues in reconstructing these moments with our participants (see “proactive use”, chapter 8.3.1).

2.2.2 HABITS

Habits are “any regularly repeated behaviour that requires little or no thought and is learned rather than innate. A habit - which can be part of any activity, ranging from eating and sleeping to thinking and reacting - is developed through reinforcement and repetition.” (Encyclopaedia Britannica, 2021). The notion of habit involves a generic cause in its formation (repetition, reinforcement) but does not say much about the conditions for execution. We will assume here that habits are triggered in a specific context, which reproduces the conditions of habit formation. As smartphone EB happens between 10 and 200 times every day, and in our sample every five minutes (Heitmayer & Lahlou, 2021), we can assume it is frequent enough to become a habit. Nevertheless that “habit” can have been reinforced by several types of activities or stimuli: answering to a ringtone, checking for a notification, and many other things. Several “habits” may therefore in theory be underlying the EB. Due to this vagueness, the concept of habit may not be very useful here in terms of explanation, but we should be able to verify that the presence of the phone as a salient stimulus increases EB.

2.2.3 FIXED ACTION PATTERNS

Reaching for the phone has many characteristics of what used to be called in ethology a "fixed action pattern" (FAP). These actions are hardwired motor scripts that, when triggered by the appropriate stimulus, are executed to completion in an automated way, even if the stimulus disappears on the way ('endogenous running out'). These actions, unlike reflexes, can be complex sequences of movements and reaching out for the phone, thus, could be one. FAPs were classically described initially by Tinbergen and Lorenz for actions connected with nesting and mating in birds and fish (Lorenz & Tinbergen, 1970; Tinbergen, 1952). The term FAP has been abandoned as behaviours are, as we now know, plastic rather than fixed; but the automatic release of stereotyped behavioural patterns remains a fact. More generally, release of an automatic behaviour is usually a combination of internal drive and external stimulus: the presence of the stimulus releases the execution of the stereotyped sequence (Schleidt, 1974). This is relevant for smartphone use as the reach for the phone appears as an automatic sequence of actions.

2.2.4 THE HYDRAULIC THEORY

Interestingly in cases where the animal has not had the opportunity to execute the behaviour for a long time, the FAP can be executed *without stimulus*, which is called a "vacuum activity". This is believed to be caused by a gradual build-up of the motivation for that activity, in what Lorenz proposed as the "hydraulic model" (Lorenz, 1963). In this model, the "pressure to act" accumulates with time like in a hydraulic reservoir. The right stimulus opens the valve and the pressure to act is released as the action is executed. As a result, the consummation of the behaviour empties the pressure to act from the reservoir, which then starts filling up again until the next release. But if the pressure becomes too high in the reservoir, it may force the valve open and release the behaviour. For example, sparrows that have been deprived of hunting have been observed executing hunting behaviour "in vacuum", chasing, and pretending to eat, non-existent flies in their cage (Lorenz, 1937). The hydraulic theory seems to apply well to some basic drives where consummation extinguishes the drive (e.g. feeding, reproduction, suckling), and where the motivation to act grows with duration of deprivation. In addition, the withdrawal from drugs produces a similar effect of a growing desire to take a dose. The hydraulic theory suggests the individual has embodied a constant "need" to execute the behavioural sequence, and that need grows with time so deprivation will increase the desire to execute it. This may be relevant here as some users appear to feel an increasingly pressing urge to reach for the phone after some time, at least with lengthy deprivation (e.g. a workday).

2.2.5 APPETITE

But not all needs grow with time, and not all actions are stereotypic. FAPs and movements in vacuum can be seen as extreme cases of appetite, that is, the tendency to search for the stimulus of consummatory behaviour. This notion may be relevant here as reaching for the phone is a way to access what could be considered as consummatory behaviour: It allows getting social contact by accessing social networks or communicative apps, distraction from unwanted tasks or entertainment (e.g. by browsing videos or playing games), and reassurance of basic needs (reading the news, checking a stock portfolio, checking the weather forecast and the train service for the commute back home):

> *An appetite, so far as externally observable, is a state of agitation which continues so long as a certain stimulus, the appeted stimulus, is absent. When the appeted stimulus is at length received it releases a consummatory reaction, after which the appetitive behavior ceases and is succeeded by a state of relative rest, a state of satisfaction. The appetitive behavior serves to bring about the appeted situation by trial and error. The appetitive state includes a certain readiness to act. When most fully predetermined this has the form of a chain reflex. (...) The entire behavior of the human being is, like that of the bird, a vast system of cycles and epicycles, the longest cycle extending through life, the shortest being measured in seconds, each cycle involving the rise and*

> *the termination of an appetite. This view helps us to understand the laws of attention; for example, the law that attention cannot be held continuously upon a faint, simple stimulus. For as soon as such a stimulus is brought to maximum clearness, which constitutes the consummatory situation, the appetite for it is quickly discharged and its cycle comes to an end".* (Craig, 1917, p. 685)

In satisfying appetite we can control the execution of the behaviour and its modalities, but the availability of the stimulus and ease of access in the context are very important.

2.2.6 ADDICTION

Addiction is a step further in need than appetite. The individual feels an irrepressible need to perform the behaviour that releases the tension. While this definition could apply to any vital need (intake of air, food etc.) the term addiction is reserved to acquired behaviour that the individual could do without if she were not addicted, and especially drugs. As an example, the American Psychiatric Association defines substance abuse disorder as:

> *Substance use disorder (SUD) is complex a condition in which there is uncontrolled use of a substance despite harmful consequence. People with SUD have an intense focus on using a certain substance(s) such as alcohol, tobacco, or illicit drugs, to the point where the person's ability to function in day to day life becomes impaired. People keep using the substance even when they know it is causing or will cause problems. The most severe SUDs are sometimes called addictions.* (Colon-Rivera & Balasanova, 2020)

2.2.7 DISPLACEMENT

"Displacement activity" or "Displacement reaction" (Tinbergen & Iersel, 1947) are movements irrelevant to the situation that can be observed when the individual is torn between incompatible or opposite courses of action. For example, an animal alternating between the urge to attack and to escape, neither of which can be carried out, finally is driven by this tension to find an outlet in an irrelevant action (Tinbergen, 1952). Displacement activities in humans such as finger tapping, fidgeting, lower-body position changes, self-grooming, head-scratching, etc., can be easily observed in people who face stress or frustration, and can be interpreted as a spill over of energy that releases some of the tension experienced by the individual. Barash (1974) provides an insightful illustration of humans torn between the desire to stay and to flee. As he notes humorously: "Curiously, individuals of this species [Homo sapiens] are known voluntarily to submit themselves to situations of great conflict. One of the most notable (and amenable to study) of these situations commonly occurs in waiting rooms of dental offices". And the observed patients in a dental office waiting room indeed exhibited significantly more displacement activities than non-patients (e.g. those accompanying patients).

Displacement activities may therefore be relevant here as phone fidgeting seems to occur in situations where the direction which behaviour should take is unclear (boredom) or contradictory (such as when the individual is busy with a task they wish to escape).

2.2.8 COGNITIVE ATTRACTORS

One of the most puzzling phenomena in behavioural studies is that individuals often seem to do things they would prefer not to, although they actually have complete freedom to not do them. This is frequently the case in office settings, where workers get trapped doing Emails or wasting time in minor tasks, especially small routines, instead of doing what they consider important. Lahlou (2000, 2005) describes how individuals are led into a specific activity path by a combination of patterns in the context ("data") and corresponding representations in their mind ("lata") which, in conjunction, produce an automatic interpretation (in the musical sense of playing a sequence) of the context:

> *Cognitive attractor theory predicts that if a critical mass of data and connected lata are present, the drive for the corresponding activity spontaneously emerges (…) automatically, beyond the subject's will: "it just happens", just like a Gestalt imposes a pattern to perception*

> *when a sufficient portion of the pattern is present (...) The strength of attractors is a combination of three factors: pregnance (attraction of attention), value (attraction of desire) and cost to be completed (attraction of effort). (...) presence of the relevant data in the environment will change the probability of occurrence of a given activity. By affording a specific activity track, they will favour it over another possible activity. By evoking the associated lata, they may induce motivation for an activity in subjects among participants initially without motivation. (...) As long as the activity is fluid, with continuous coupling with the environment and adequate system response, chances are that the subject will continue on the same track. But if some obstacle or failure occurs, there may be a recomputation of "what to do" and some locally stronger attractor may take over. For example, in the course of some activity, Robert needs to send an e-mail to someone. He opens his mailbox to do so and sees a just-arrived message from his big boss. Chances are he will open the message, and get side-tracked.* (Lahlou, 2005)

This may be relevant here as the phone appears to be the most prominent cognitive attractor that users find around themselves. In moments where a break in the flow of activity occurs, users are particularly vulnerable to direct their attention to the smartphone and reach out for the device. This is in line with the notion of *valence* or *Aufforderungscharakter* as defined by Kurt Lewin:

> *It is common knowledge that the objects and events of our environment are not neutral towards us in our role of acting beings. Not only does their very nature facilitate or obstruct our actions to varying degrees, but we also encounter many objects and events which face us with a will of their own: they challenge us to certain activities. (...) A stairway stimulates the two-year-old child to climb it and jump down; doors, to open and to close them; small crumbs, to pick them; the chocolate and a piece of cake want to be eaten. (...) The intensity with which objects and events challenge us varies greatly. The shadings of such challenge range from "irresistible temptations", to which child as well as adult yields unthinkingly and against which self-control is little help if at all,*

> *to those which have the character of "command", to the weaker "urgings" and "attractions", which can be easily resisted and become noticeable only when the person tries to find something to do. The term "valence" comprises all these shadings".* (Lewin, 1926, 1999, p. 95)

The notion of valence has been abandoned because it changes with the state of the individual and is therefore not a very operational concept. Lewin himself noted that:

> *For instance, someone intends to drop a letter into a mailbox. The first mailbox he passes serves as a signal and reminds him of the action. He drops the letter. The mailboxes he passes thereafter leave him altogether cold. In general, the occurrence of the occasion (referent-presentation) as a rule has no effect once the intentional action has been "consummated".* (Lewin, 1926, 1999, p. 84)

Gibson suggested the notion of affordances (the actions the object allows the individual)[2], which do not change once the need of the individual is resolved (Gibson, 1982). In practice, the *Aufforderungscharakter* of the phone remains largely the same for users. The crux with smartphone, as our participants note, seems to lie in the fact that “it has everything” (P4) and, thus, provides the polyvalent affordance of “something to do” (P26). Let us note furthermore that the smartphone contains *per se* most of the components necessary for many types of small activities, without requiring anything beyond the user herself. This makes it a ready-to-use “installation” (Lahlou, 2017) for short activities. That characteristic, as we shall see later, is crucial.

2.2.9 THE INFLUENCE OF SIGHT AND REACH

The models above stress the importance of how available and easy to reach the triggering stimulus or object instrumental to the consummatory behaviour is in the environment. A highly interesting experiment on mindless consumption of hedonic food provides further qualification on this: Painter and colleagues investigated how

[2] “Roughly, the affordances of things are what they furnish, for good or ill, that is what they afford the observer (...) they are ecological, in the sense that they are properties of the environment relative to an animal (...) Affordances do not cause behaviour but constrain or control it. Needs control the perception of affordances (selective attention) and also initiate acts. An observer is not ‘bombarded’ by stimuli. He extracts invariants from a flux of stimulation.” (Gibson, 1982)

the visibility and the convenience of access influenced consumption and perceived consumption of a hedonic food (Painter, Wansink, & Hieggelke, 2002). Participants were given a closed container holding chocolates that was either placed on top of their desk, where it was convenient and visible, in a drawer, where it was convenient, but not visible, or on a shelf two meters away, so it was visible but participants had to leave the desk to obtain the candy. The mean consumption of candies was: 8.6 per day for visible and convenient, 5.7 for not visible, but convenient, and 3.0 for visible but inconvenient; and participants slightly overestimated their consumption of the visible candies, and underestimated their consumption of the non-visible ones (Painter et al., 2002). It appears we eat more hedonic food when it is “in sight and in reach”. This finding is in line with the observation that participants feel they are better able to manage their phone use when it is out of reach and our sight (Everri, 2017; Heitmayer, 2020; Heitmayer & Lahlou, 2021), but also reflects the surprise at how often they use their smartphone many participants expressed when they watched their own video footage.

2.2.10 SUMMARY

As we have seen, in the classic digital media literature, reaching for the phone tends to be classified as *problematic use*. This is mostly based on a negative evaluation by users themselves, but does not provide a clear explanation of how and why this behaviour occurs, except for ‘habit’ or ‘addiction’, which are descriptive rather than explanatory. The ethological literature provides descriptions and explanations of a wealth of seemingly similar behaviours, ranging from the automatic and irrepressible execution of hard-wired, stereotyped action scripts (FAP), over the loose coupling of an appetite in the individual, to the presence of an ‘attractive’ and easily reachable object triggering opportunistic satisfaction by consummatory behaviour.

The ‘cause’ of a behaviour can be attributed to an external stimulus, or an internal drive, or a combination of those. More generally, the behaviour will be more likely to emerge if there is a sufficient degree of internal motivation and an opportunity to execute it. The greater the motivation, the more salient the affordance and the easier the opportunity to execute the behaviour, the more likely it will occur.

Consciousness of these various components is not necessary for the behaviour to occur, as the interpretation can become automatic with reinforcement and create a shortcut from situation to action, where conscious decision-making is bypassed or occurs after the fact. Recent literature, following the remarkable review by (Stanovich & West, 2000), has popularized the difference between “system 1” processes (a variety of more or less automatic, associative, fast processes) vs “system 2” (slower, analytic, controlled) processes of reasoning involving higher cognitive functions. The EBs we study here are at best system 1 ; in fact there does not seem to be any reasoning here.

It is also suggested that some moments of the activity course, especially when a contradiction, obstacle, or the end of a step occur, are more prone to triggering mindless behaviour (see the discussion on valence and attractors above). Can we empirically determine if, between these various models, one or several are more relevant for smartphone reach? Assuming we are able to capture all the occurrences of such behaviour, we can hypothesize :

H1 (Smartphone use as satisfying appetite):

> If smartphone use is driven by appetite for something, or for phone use itself, we should observe many occurrences where individuals actively search for their phone when it is out of reach. We also expect to see an increased likelihood in smartphone use when users are idle (as the appetite would then have no other drive to compete with), and as a displacement action when they are distressed or frustrated (where smartphone use presents itself as a good, third option versus the conflicting pair).

H2 (Smartphone use as addiction):

> If smartphone use has become an addiction, we should observe a relative stable frequency of interactions over time for spontaneous (i.e. user-initiated) smartphone use, likely following a Poisson law. We also expect an increased likelihood of interactions the longer a user has not interacted with the smartphone (hydraulic theory; the urge for EB increases with time), an “intense focus” on the smartphone and in some cases an irrepressible urge for EB.

H3 (Smartphone use as pure habit triggered by availability):

> If smartphone use is influenced by ease of access, we should observe more frequent and longer interactions when the phone is visible and within reach. We should also observe participants choosing to interact with their phone over other activities in moments when their flow of activity is interrupted (cognitive attractors).

H1, H2 and H3 are not mutually exclusive; we will explore which one is the most likely, or whether some take precedence over the others.

An edited version of section 2.2 is part of Paper 6 of this thesis (see Appendix F).

3. THE STATE OF THE ART: SMARTPHONE USE

This chapter is intended to give the reader a general overview of the different branches in the field of studying smartphone use. The individual Papers reporting on the research that went into the different Papers presented in Appendix A-F will each provide a more detailed review of the literature pertinent specifically to the research agenda of the respective Paper. The diversity and the volume of studies focusing on ubiquitous mobile computing and human-computer interaction focusing on smartphones, that is to say, how users interact with their smartphones, has been steadily increasing throughout the last decade. However, the use of the smartphone has often not been studied as the exclusive object of interest, but in conjunction with the use of social media. While it is impossible to cover every area that is being investigated, we have identified 6 major research streams that discuss topics pertinent to this dissertation:

The first and oldest strand of research focuses on generally describing the *uses & gratifications* of smartphones, that is, how individuals use their devices and what they gain from this use. Pioneering work on the use of mobile phones already showed that the mobile phone was used to micro-coordinate social interactions and everyday tasks (Ling, 2004; Ling & Yttri, 1999), and a wide range of studies has subsequently investigated psychological motivations to use smartphones and social media (Baek, Cho, & Kim, 2014; Hayes et al., 2016; E. Katz et al., 1973; Leung & Wei, 2000; Oeldorf-Hirsch & Sundar, 2016; Papacharissi & Rubin, 2010; Whiting & Williams, 2013). In general, research shows that adolescents and young adults use their phones for communication, social facilitation and compensation, as well as for social comparison and for "lurking", i.e., online voyeurism (Grellhesl & Punyanunt-Carter, 2012; Ling, 2004, 2018; Ling & Pedersen, 2005; Pempek, Yermolayeva, & Calvert, 2009; Valkenburg, Schouten, & Peter, 2005). Smartphones are, thus, used to look up or fact-check information on the go, allowing for more flexibility in how and particularly when information is consumed (Church, Smyth, Bradley, & Cotter, 2008; Church, Smyth, Cotter, & Bradley, 2007; Kamvar & Baluja, 2006; Kamvar, Kellar, Patel, & Xu, 2009; Teevan, Karlson, Amini, Brush, & Krumm, 2011; Van Damme, Courtois, Verbrugge, & De Marez, 2015), and sometimes serving as a form of 'conversation enhancement' (Bertel, 2013; B. Brown, McGregor, & McMillan, 2015).

Several studies conclude, further, that the smartphone as an immediate access point to social media has become the main communication device for adolescents and young adults, which allows them to create a sense of belonging with their peers, to anchor themselves in their close social circle, and to connect with like-minded individuals around the world (Damásio, Henriques, & Costa, 2012; Ijsselsteijn, Baren, Lanen, Box, & Eindhoven, 2003; Ishii, 2006; Kaplan & Haenlein, 2010; Ling, 2004; Oksman & Turtiainen, 2004; Whittaker & Gillespie, 2013). As a consequence, this makes smartphones an important indicator for social status and a major tool for social and cultural adaptation (Damásio, Henriques, Teixeira-Botelho, & Dias, 2013; J. E. Katz & Sugiyama, 2006). Ultimately, this leads many users to feel that their smartphone has become a part of them (Walsh, White, & Young, 2008). As smartphones and social media have become a key tool to participate in social life for adolescents and young adults, they also appear to play an increasingly relevant role for self-expression and identity formation (Hogan, 2010; Kapidzic & Martins, 2015; Rangaswamy & Arora, 2016; Scott, Sinclair, Short, & Bruce, 2014; Throuvala, Griffiths, Rennoldson, & Kuss, 2019). Thus, studies find that adolescents users mimic, in both their on- and offline self-presentation, behaviours they have learned from media (Kapidzic & Martins, 2015).

Finally, as the lives of heavy communication technology users are characterised by tight, detailed schedules and time pressure, managing available time and combining multiple tasks are becoming routine activities closely linked to smartphones (Frissen, 2000). Smartphones have thus been found to be a means to pass time, fight boredom, and achieve flow for users (Leung, 2020; Zhou & Lu, 2011), as well as a way of coping with stress (Chiu, 2014; Panova & Lleras, 2016; Thomée, Härenstam, & Hagberg, 2011). Another major use of smartphones, lastly, which is not the focus of this thesis, but must be mentioned nonetheless, is mobile gaming (e.g. McCauley, Merola, & Gumbley, 2017; Wei & Lu, 2014). Interestingly, users spend 90% of their time on the top 20% of media and communication applications available, which indicates high levels of similarity in usage profiles across users (Jaemin Jung, Kim, & Chan-Olmsted, 2014). Furthermore, the general usage patterns observed in the literature seem to be relatively homogenous across different cultures (Panova, Carbonell, Chamarro, & Puerta-Cortés, 2020). While the majority of this research uses Interview or survey data, several studies have also begun to use video-ethnographic approaches (B. Brown et al., 2013, 2014; D. McMillan et al., 2017; Pizza, Brown, McMillan, & Lampinen, 2016).

The second strand looks at the influence of the smartphone on the daily lives of users. The overall consensus found amongst users is that smartphones have a significant impact on their daily routines, demanding large amounts of their attention (Arnold, 2003; Frissen, 2000; Hamermesh & Jungmin, 2007; Roxburgh, 2004), and that they regularly distract them from their current tasks (Iqbal & Horvitz, 2010; Kushlev, Proulx, & Dunn, 2016). Importantly, while most users explicitly acknowledge the overall benefits of owning a smartphone, the valence towards it is often quite negative, especially when it comes to its influence on social interactions (Turkle, 2015) and to creating social pressures (Pielot, de Oliveira, Kwak, & Oliver, 2014).

For adolescents and young adults, social media and the permanent access afforded by smartphone have become a dominating factor for the participation in their social life (Baym & Boyd, 2012; Boyd, 2007; Schroer, 2014; Turkle, 2015), and the increased and 'ritualised' contact with the closest friends via the smartphone contributes largely to the formation of a tightly knit in-group (Ling, 2018). The smartphone also helps users connect and maintain intimacy with their families and partners (Arminen & Weilenmann, 2009; Castelain-Meunier, 1997; Green, 2002; Licoppe, 2004; Wajcman, Bittman, & Brown, 2008), and can even create a sense of belonging among relative strangers in messaging groups (Dixon, 2017). Moreover, dating apps have changed how smartphone users find and interact with potential partners (Anzani, Di Sarno, & Prunas, 2018; LeFebvre, 2018; Licoppe, Rivière, & Morel, 2016; Rochat, Bianchi-Demicheli, Aboujaoude, & Khazaal, 2019; Sumter & Vandenbosch, 2019; Sumter, Vandenbosch, & Ligtenberg, 2017). Studies have, thus, found that success on dating apps was a source of self-worth validation (Sumter & Vandenbosch, 2019; Sumter et al., 2017), but also that communication on dating apps is geared towards initiating sexual encounters rather than personal connections (Licoppe et al., 2016). Dating app use has further been shown to both positively and negatively influence sexual health practices (Deogan, Jacobsson, Mannheimer, & Björkenstam, 2020; Eleuteri, Rossi, Tripodi, Fabrizi, & Simonelli, 2018; Hoenigl et al., 2020; Schäfer, 2020). While this topic goes beyond the scope of this paper, Anzani and colleagues provide an insightful review as a starting point (Anzani et al., 2018).

The specific effects of smartphone use on communication patterns have also been an object of study. While the amount of communication users engage in through their smartphones continues to increase steadily (Lenhart, 2012; Montag et al., 2015; Oksman & Turtiainen, 2004), it has been found that communication on social media depends on a variety of sociodemographic variables, as well as the user's internet skill level, and socialisation (Hargittai & Walejko, 2008; Mendelson & Papacharissi, 2007). Furthermore, communication on social media has developed from the mere exchanging of information to the coordination of activities in the physical world and to the recording and cataloguing of information (Humphreys, 2012). Importantly, colleagues and friends influence each other in how they use social media as communication tools (Bradner, Kellogg, & Erickson, 1999). It has further been investigated whether smartphone-mediated communication influences or replaces face-to-face communication (e.g. Kim, 2017; Verduyn, Schulte-Strathaus, Kross, & Hülsheger, 2021) with no conclusive evidence found yet. The case has been made, however, that the smartphone and the communication it affords is not just the medium, but also a constitutive part of our social relations (B. Brown, O'Hara, McGregor, & McMillan, 2018; Church & De Oliveira, 2013; O'Hara, Massimi, Harper, Rubens, & Morris, 2014). Instant messaging with the phone has, thus, been connected to playfulness, entertainment, and humour in social interactions (Jacucci, Oulasvirta, & Salovaara, 2007; Kurvinen, 2003; Lou, Chau, & Li, 2005; Perry & Rachovides, 2007; Salovaara, 2008) and particularly the use of emoticons for humour (S. H. Hsieh & Tseng, 2017; Huang, Yen, & Zhang, 2008; Lo, 2008; Luor, Wu, Lu, & Tao, 2010), but also to reduce ambiguity in conversations and to repair misunderstandings (Tagg, 2015) has received scientific attention.

However, the smartphone can also act detrimentally upon communication, distracting users from the activities they are engaged in and reducing how 'present' and involved they are in social interactions (Campbell, 2006; Paskewitz & Beck, 2021; Srivastava, 2005; Tindell & Bohlander, 2012; Tolmie, Crabtree, Rodden, & Benford, 2008; Turkle, 2015). In this vein, particularly *phubbing*, snubbing other people through the use of the phone, has been in the limelight of the research for a while now and studies unsurprisingly find that using the phone in the presence of others is often seen as a nuisance (e.g. Chotpitayasunondh & Douglas, 2016; Leuppert & Geber, 2020; Turkle, 2015).

The third strand of the research focuses on *problematic internet use*, which discusses the negative effects of smartphone overuse and compulsive usage patterns (Ezoe et al., 2009; Horwood & Anglim, 2019; Kuss, Van Rooij, Shorter, Griffiths, & Van De Mheen, 2013; Marengo et al., 2020; Steelman, Soror, Limayem, & Worrell, 2012). Especially habitual, routine patterns of smartphone interactions have been shown to lead to overuse (Davazdahemami, Hammer, & Soror, 2016; Oulasvirta, Rattenbury, Ma, & Raita, 2012; Walsh et al., 2008).

The literature has investigated problematic smartphone use in relation to a variety individual characteristics such as personality traits (Horwood & Anglim, 2018; Hussain, Griffiths, & Sheffield, 2017; Marengo et al., 2020; Takao, Takahashi, & Kitamura, 2009), emotional attachment-styles and anxiety (Baek et al., 2014; Contractor, Frankfurt, Weiss, & Elhai, 2017; Stanković, Nešić, Čičević, & Shi, 2021), as well as psychological dependency on the device (Chen et al., 2017; Kaviani, Robards, Young, & Koppel, 2020; King et al., 2013; G. Wang & Suh, 2018). Moreover, lack of self-control has been associated with problematic smartphone use (Davey, Nasser, & Davey, 2020; Lyngs, 2019; Lyngs et al., 2019), even though recent studies argue that attentional impulsivity rather appears to be the main driver (Cudo, Torój, Demczuk, & Francuz, 2020; Cudo, Torój, Misiuro, & Griffiths, 2020; Wegmann, Müller, Turel, & Brand, 2020).

Problematic phone use has further been linked to lowered cognitive functioning and procrastination (Ezoe et al., 2009; Lepp, Li, & Barkley, 2016; Rozgonjuk, Kattago, & Täht, 2018), problems with getting sufficient amounts of sleep (Edward Bernroider, Krumay, & Margiol, 2014; Stanković et al., 2021; M. X. Zhang & Wu, 2020), and even the risk of physical injury, particularly connected to driving (Bendak, Alali, Alali, & Alshehhi, 2019; Crisler et al., 2008; Hosking, Young, & Regan, 2009; Steelman et al., 2012), but also mobile gaming (Ayers et al., 2016; Faccio & McConnell, 2020).

Lastly, frequency of daily use and its development over time have been shown to be associated to smartphone addiction, and it was further found that reported usage time was significantly lower than measured usage time, suggesting that users might underestimate their own use (Y. H. Lin et al., 2015). Further attempts have, thus, been made to predict problematic smartphone use directly through the device (Y. H. Lin et al., 2015; C. Shin & Dey, 2013). For a systematic review on problematic internet use, see Busch & McCarthy (2021).

Another major stream of research, fourth, has looked at issues concerning *privacy*, detailing the concerns and strategies of users for both the software and the hardware they use (Ford, 2012; Litt, 2012; Livingstone, Ólafsson, Livingstone, Ólafsson, & Staksrud, 2011; Livingstone, Ólafsson, & Staksrud, 2013; Quinn, 2016; Vitak, 2012). Especially the use of social media and GPS-enabled devices create large amounts of incidental data and make the history of user's mediated actions accessible and searchable, theoretically by anyone and for all time to come. Therefore, many smartphone and social media users take their privacy and the different audiences they might reach (e.g. colleagues, personal friends, family) very seriously (Ford, 2012; Vitak, 2012). At the same time, the ability to target specific audiences is sometimes also used as a strategic tool to acquire or avoid a certain reputation in the eyes of a specific group of people (Quinn, 2016).

A specific concern in this area, although it is not the main focus of this thesis, is the safety of children and teenagers when they use smartphones and social media. Beyond a focus on problematic smartphone use in younger users (C. Koo, Wati, Lee, & Oh, 2011; R. Koo, 2014; Kormas, Critselis, Janikian, Kafetzis, & Tsitsika, 2011; Kuss et al., 2013; Leung, 2007), particularly the effect of access to the internet and smartphones on their daily lives (Boyd, 2007; Ling, 2004; Livingstone, 2004; Marwick & Boyd, 2014; Oksman & Turtiainen, 2004), as well as their safety and the protection of their rights (Baumgartner, Sumter, Peter, Valkenburg, & Livingstone, 2014; Holloway, Green, & Livingstone, 2013; Livingstone, 2008; Livingstone & Brake, 2010; Livingstone & Helsper, 2010; Livingstone, Mascheroni, & Murru, 2011; Livingstone, Ólafsson, et al., 2011; Livingstone et al., 2013; W. Shin, Huh, & Faber, 2012) have been investigated in previous work. Studies have, thus, focused on identifying potential risks to young users on the internet (Brake, 2014; Byrne & Burton, 2017; Helsper & Smahel, 2020; Livingstone, Bober, & Helsper, 2005; Livingstone & Brake, 2010; Livingstone & Helsper, 2010; Livingstone, Mascheroni, et al., 2011), and further also looked at the experience of risk-taking behaviours from the eyes of young users (Baumgartner et al., 2014; Kormas et al., 2011; Livingstone, 2008; Schouten, 2007; W. Shin et al., 2012). At the same time, both parents and children report that having a phone provides some reassurance that they can be reached or reach out if necessary, which can make the presence of the device beneficial for parent/child dyads (Ling, 2004; Ling & Yttri, 2002). On the other hand, the phone can also create tension between parents and children, as they afford children a space that evades control of their parents (Ling, 2005; Lohan, 1997), but at the same time also hold the potential to provide extensive surveillance capacities to parents (Everri, 2017, 2018; Massena, Everri, & Mancini, 2019; Sonck, Nikken, & de Haan, 2013; Zaman, Nouwen, Vanattenhoven, de Ferrerre, & Looy, 2016).

Looking at privacy from the hardware side, then, research has investigated different unlocking methods primarily to address issues like *shoulder-surfing* or *smudge attacks* to improve the privacy and security of users (Von Zezschwitz, De Luca, Janssen, & Hussmann, 2015; Von Zezschwitz, Dunphy, & De Luca, 2013; von Zezschwitz, Koslow, De Luca, & Hussmann, 2013). Interestingly, research indicates that about 35% of users do not add security barriers to their phones (Bruggen et al., 2013). Reasons users give for not locking the phone range from not caring about it or not having considered it, as well as thinking that there is nothing that needs to be protected, to worrying about the phone not being usable in an accident or in case it got lost, which would complicate returning it to the owner. More practical considerations also included ease of access and sharing the device with other users (Egelman et al., 2014; Harbach, De Luca, & Egelman, 2016; Harbach, De Luca, Malkin, & Egelman, 2016; Harbach, von Zezschwitz, Fichtner, Luca, & Smith, 2016).

Fifth, the influence of smartphone use on productivity, especially at the workplace, has been another object of study. Qualitative studies find that users associate smartphones with increased mobility and flexibility at work, an enhanced capacity to engage with colleagues and clients, as well as reduced uncertainty and fewer mistakes (Johnston et al., 2015; Khanna, Sambandam, Gul, & Mounasamy, 2015; Li & Lin, 2019; MacCormick, Dery, & Kolb, 2012). On the downside, this reliance on smartphones can turn into dependence, leading to anxiety, uncontrolled use, and ultimately decreases in productivity (Li & Lin, 2019). Quantitative evidence supports these perceptions, linking smartphone addiction to lowered work-related and non-work-related productivity and finding a negative relationship between total hours spent on the smartphone and total hours worked (Adamczyk & Bailey, 2004; Czerwinski, Cutrell, & Horvitz, 2000; Duke & Montag, 2017). It also suggests that employees use instant messaging to create distance between themselves and their superiors in difficult situations (Quan-Haase, Cothrel, & Wellman, 2005).

Another issue is cyberslacking, the personal use of devices at work (Lavoie & Pychyl, 2001; Mills, Hu, Beldona, & Clay, 2001). Cyberslacking becomes particularly problematic when it is triggered by dysphoric states or repetitive, boring tasks (Vitak, Crouse, & Larose, 2011). Messaging applications are one of the key tension lines between smartphones enhancing work and cyberslacking, with researchers suggesting to separate private and work conversations within individual apps (Y. Jeong, Jung, & Lee, 2020).

Smartphone use at work also increases the duration of smartphone use after work and reduces the emotional well-being of users (Cambier, Derks, & Vlerick, 2019; Derks, van Mierlo, & Schmitz, 2014; Duke & Montag, 2017; Van Laethem, van Vianen, & Derks, 2018). As people use their work phones at home or their private phones for work, job pressures can intrude into their private lives (Derks et al., 2014). This, together with the feeling of having to respond to work communication as soon as possible creates *telepressure* (Barber & Santuzzi, 2015). Responses to being constantly connected vary tremendously between, and fluctuate even within individuals (Cambier et al., 2019), making it difficult to recommend straightforward policies. Importantly, telepressure intrudes back into the workplace, increasing smartphone use at work and reducing perceived engagement (Van Laethem et al., 2018). Similarly, *nomophobia*, the feeling of discomfort related to not being reachable and potentially missing out on information when users do not have access to their devices has mixed effects on productivity (King et al., 2013). Workers high in nomophobia perceive themselves as more engaged and productive when they use the phone to enhance their work performance. On the other hand, these users also experience reduced levels of productivity, emotional stress, and exhaustion when they cannot check their device (G. Wang & Suh, 2018). Simply restricting the use of smartphones will, therefore, result in unintended consequences.

Frequent interruptions can also exacerbate the disruptiveness of smartphones as users need time to return to their previous task and make more errors completing them after having been interrupted (Borst, Taatgen, & van Rijn, 2015). An early study found that people only return to their previous work task in 40% of cases after an interruption (O'Conaill & Frohlich, 1995). More recently, it was shown that tasks interrupted externally were more likely to be resumed, and resumed faster than the ones users self-interrupted (Mark, Gonzalez, & Harris, 2005), with observational research suggesting that users interrupt themselves about as often as they get interrupted (V. M. González & Mark, 2004). External interruptions furthermore significantly increase subsequent self-interruptions in following hours, suggesting that certain environments condition people to self-interrupt (Dabbish, Mark, & González, 2011). Workers who are constantly interrupted seem to adapt their working style to their experience and one study found that interrupted work was performed faster than uninterrupted work (Mark, Gudith, & Klocke, 2008). However, interrupted workers also experience more stress, time pressure, and effort, as well as a higher workload and frustration (Mark et al., 2008, p. 110). Importantly, workers with high levels of self-control experienced significant costs when blocking software was installed on their devices as interruptions serve as structuring elements and breaks for them (Mark, Czerwinski, & Iqbal, 2018).

Finally, a sixth strand of research has investigated how users feel about the messages they receive and why and when smartphones and particularly notifications are being perceived as disruptive by users (Lenhart, 2012; Reeves et al., 2008; Walsh et al., 2008). Many studies show that the pressure to be 'constantly available' (Frissen, 2000) or the fear of missing out ("fomo"; Fitz, Kushlev, Jagannathan, Lewis, & Paliwal, 2019) can affect well-being and interpersonal relationships (e.g. Höge, 2009; Sbarra, Briskin, & Slatcher, 2019). Research has thus investigated variations in the perceived and actual 'disruptiveness' of notifications in the field, conditional on various hardware, software, and some environmental factors. Research has found that place is an important mediator of the disruptiveness of notifications (Do, Blom, & Gatica-Perez, 2011; Exler, Braith, Schankin, & Beigl, 2016; Oulasvirta, Tamminen, Roto, & Kuorelahti, 2005; Yuan, Gao, & Lindqvist, 2017). Quite logically, it seems that users are happy to be interrupted when they are waiting or idle (e.g. at bus stations or whilst queuing for food), while disruptions in places such as the cinema or the library are not acceptable (Exler et al., 2016). Moreover, when users are in “nomadic contexts”, i.e. on the move or in places with a short duration of stay, they are more likely to use their phones for micro-coordination of their schedules or with other people (Do et al., 2011). Studies have further found a positive correlation between the perceived level of disruption and the amount of attention demanded by the activity users are engaged in. Notifications are thus regarded as most disruptive while users are working on, or finishing up tasks, and least disruptive when they are idle (Mehrotra, Pejovic, Vermeulen, Hendley, & Musolesi, 2016). Research has furthermore found a negative correlation between the perceived importance of a notification and the perceived level of disruption (Beja et al., 2015). This is also reflected in the finding that system messages or messages from subordinates are perceived as most disruptive, whereas messages from friends and family are considered least disruptive, particularly when users are enacting a private rather than a work-related role (C. Anderson, Heinisch, Ohly, David, & Pejovic, 2019; Mehrotra et al., 2016). Moreover, the day and time when notifications are delivered (Morrison, Xiong, Higgs, Bell, & Chalmers, 2018; Visuri et al., 2017; Westermann, Wechsung, & Möller, 2016) and the mood users are in (Yuan et al., 2017) seem to play a relevant role for interruptibility as well, with users being more interruptible when they are in an unpleasant mood and response time to notifications being the lowest on Fridays.

As an outflow of this, a large body of research focuses on the technological side of the issue, aiming at designing and testing different intelligent notification systems that ameliorate their disruptiveness and overall negative effects on attention, productivity, and well-being of users (see Mehrotra & Musolesi, 2017 for an overview). One straightforward solution is to automatically bundle notifications to reduce the volume of disruptions, for which three batches a day seem to be the right balance between staying on top of incoming messages, not eliciting fomo, and not getting interrupted too much (Exler et al., 2017). Similarly, determining appropriate break points in between activities so that notifications don't actually interrupt the user can reduce frustration about incoming messages (Iqbal & Bailey, 2007, 2008; Okoshi, Nozaki, et al., 2016; Okoshi, Tokuda, & Nakazawa, 2016; Pejovic & Musolesi, 2014; Weber et al., 2017). Another approach is to adapt notifications that users receive to the situation. While a classic study has investigated this idea by adding additional information about the call to the generic 'ring' of the phone (Milewski, 2006), recent applications have employed user preferences and machine learning to automatically detect and silence unwanted calls based on the devices' sensors and usage data (De Russis & Monge Roffarello, 2017; Fisher & Simmons, 2011; Oh, Jalali, & Jain, 2015; Schulze & Groh, 2014, 2016; J. Smith, Lavygina, Ma, Russo, & Dulay, 2014; J. Smith, Lavygina, Russo, & Dulay, 2014).

A third approach tries to develop systems that offer more and different types of notifications or give users entirely new ways of responding to notifications to help them cope with disruptions better. While vibrations and sounds are the easiest to perceive for users (Exler et al., 2017), the binary default choice that most devices afford (e.g. vibration or audible) seems to be appropriate for only 45% of situations; by adding visual or LED flashes, acceptance of notifications increased by 60% (Lopez-Tovar, Charalambous, & Dowell, 2015). It has further been shown that using external devices leveraging the peripheral vision of users results in more accurate and overall less disruptive delivery (L. Jones, McClelland, Thongsouksanoumane, & Girouard, 2017; K. Kobayashi & Yamada, 2013; Rasmussen, Troiano, Petersen, Simonsen, & Hornbæk, 2016). Lastly, giving users more options to respond to notifications than simply 'opening' them (Banovic, Brant, Mankoff, & Dey, 2014) and different gestures or other haptic interactions (Mayer, Lischke, Woźniak, & Henze, 2018) can increase engagement with ongoing tasks and make device interactions more efficient.

4. THE GAP IN THE LITERATURE: SMARTPHONE USE IN CONTEXT

The review of previous empirical studies has revealed that particularly the instrumental uses of social media have been well-researched. The existing literature has also analysed the effect of specific character traits of smartphone and social media users on online behaviour and usage patterns, as well as the feedback to the user's psyche. Finally, the disruption caused by smartphones and specifically the notifications they send have received some attention.[3] But while understanding the impact of smartphone use on life outcomes for individual users is important, understanding how the use of the device and the context around it look like in the first place is necessary as a prior step to drawing meaningful conclusions on the impact of smartphone use.

Though the merging of physical and digital environments, and the resulting hybrid spaces have received some initial theoretical attention (e.g. Eagle & Pentland, 2006; de Souza e Silva, 2006), the bulk of the literature focuses on the device itself and the moments when the interaction is performed. It further often relies on elements of self-report, which are dependent on participants' memory, and research that studied actual smartphone use has at times relied on controlled, experimental settings. (e.g. Bogunovich & Salvucci, 2011; L. L. Bowman et al., 2010; De Russis & Monge Roffarello, 2017). While these studies of course provide indications, it is not straightforward to generalise this to naturally-occurring behaviour. In short, while on-screen activity and perceptions of on-screen activity are well studied, how screen use inserts itself into off-screen activity is less well understood.

Some researchers have therefore begun to advocate for the use of *in situ* or *in vivo* techniques that gather naturally occurring data of smartphone use from real world contexts, which allow for a richer description of the phenomenon. Generally speaking, there have been two ways in which research has approached collecting such data, smartphone-logging and audio-visual recording.

[3] It is important to mention here that the vast majority of participants in the cited studies and experiments were recruited from US-American universities, which creates major problems for the generalisation of results, and is a larger problem in the social sciences (Arnett, 2008; Henrich, Heine, & Norenzayan, 2010).

4.1 SMARTPHONE-LOGGING

Logging is a powerful and convenient technique, as it uses the device itself to record usage. It can, thus, collect large amounts of trace and logging data generated by the device to draw inferences on user behaviour. To do so, researchers either use the phone's internal process log, or, more commonly, install a software on the user's device that tracks the processes on the phone and sometimes even around it with the help of the phone's sensors (GPS, microphone, etc.). This allows for a relatively easy and unobtrusive data collection process (although logging software can sometimes affect the performance or the battery life of the device), and moreover enables researchers to obtain longitudinal data from a large pool of users (Do et al., 2011; Dumais, Teevan, Jeffries, Russell, & Tang, 2014). Logging methods have thus been used to study various usage practices.

Firstly, early studies document menu navigation as well as descriptive information around phone calls (Demumieux & Losquin, 2005), texting (Froehlich, Chen, Consolvo, Harrison, & Landay, 2007), and mobile internet access patterns (Adar, Teevan, & Dumais, 2008; Cui & Roto, 2008). Further work then proceeded to describe the general patterns of smartphone use with a variety of logging apps and methods (Ahn, Wijaya, & Esmero, 2014; Böhmer, Hecht, Schöning, Krüger, & Bauer, 2011; Brinberg et al., 2021; Deng et al., 2019; Do et al., 2011; Hiniker, Patel, Kohno, & Kientz, 2016; I. Kim et al., 2019; Shah, Upasini, & Sasidhar, 2020; Tossell, Kortum, Shepard, Rahmati, & Zhong, 2012). While most of these studies focus on generally describing usage patterns and behaviours, some studies have looked more specifically at the amount of information smartphone users are exposed to (Petersen & Böhmer, 2018), and individual differences between healthy and problematic smartphone users (Ahn et al., 2014), and have investigated specific categories of smartphone use such as gaming (Tonetto et al., 2021), or specific age groups such as teenagers (I. Kim et al., 2019; Ram et al., 2020; Shah et al., 2020).

Secondly, studies have looked at the app-launching behaviours of users, documenting which apps are being used in conjunction, for how long, and at which specific times (Böhmer et al., 2011; Hang, De Luca, Hartmann, & Hussmann, 2013; Morrison et al., 2018; Yan et al., 2012). Interestingly, Böhmer and colleagues find, that in about half of all cases in which participants engage with their device they use some form of communication application first (Böhmer et al., 2011). Based on these general descriptives of context and user behaviours, a software has been able to predict whether the phone was going to be used for instrumental purposes or for diversion and entertainment (Hiniker et al., 2016). And while logging data for specific app categories can be used to predict personality traits (Stachl et al., 2020, 2017), the relationship between smartphone use and well-being, is not yet clear from the data (Johannes et al., 2020; Katevas, Arapakis, & Pielot, 2018).

Smartphone-logging has moreover been used to make sense of mobile search patterns and news consumption (Carrascal & Church, 2015; Church et al., 2008, 2007; Cui & Roto, 2008; Kamvar & Baluja, 2006; Kamvar et al., 2009; Van Damme et al., 2015). Early studies found that search queries on mobile phones were shorter and more similar to each other compared to searches on stationary machines (Church et al., 2007; Kamvar & Baluja, 2006); with the increased popularity of the smartphone, these differences disappeared however (Kamvar et al., 2009). More recent work has shown that mobile search is associated with longer use and more apps used per session, and that certain apps are more likely to be used in connection with mobile searches; photography apps, for example, are used to look at screenshots taken during the search (Carrascal & Church, 2015).

Thirdly, beyond studying the use of the device, the fact that the phone has become a constant companion for many users also opens up the possibility to researchers to use the phone as a means to study other elements of the lives of users that can be captured with logging applications (e.g. Böhmer et al., 2011; Froehlich et al., 2007; Nguyen-Huu, Song, & Lee, 2018).

Gonzalez and colleagues, for example, have used the GPS sensors of smartphones to track the movement and travel patterns of users, finding that movement trajectories of users actually exhibit a large amount of spatial and temporal regularity, and identifying several simple movement patterns that humans tend to follow and frequently visited locations they return to (M. C. González, Hidalgo, & Barabási, 2008). Böhmer and colleagues intersected application use with time and GPS data, showing that users were more likely to engage with multimedia elements on their smartphones when they were travelling faster than walking speed, and that map and travel application use increases in the early afternoon hours when they were commuting from work, while weather apps were being used the most in the morning before leaving the house (Böhmer et al., 2011).

Other studies have used smartphone logging to look at pedestrian movement patterns in malls (Lee, Min, Yoo, & Song, 2013; Ocaña et al., 2021) or in traffic (Jha, Tiwari, Mohan, Mukherjee, & Banerjee, 2017), as well as behaviour while driving (Khan, Khusro, & Alam, 2019; Mahboob, Iqbal, Farman, Khan, & Wasi, 2018; Mahfouz, Muslukhov, & Beznosov, 2016) or using public transport (Zhao, Ghorpade, Pereira, Zegras, & Ben-Akiva, 2015). Ahlström and colleagues provide a comparative overview of smartphone use during the different modes of participating in traffic (Ahlström, Wachtmeister, Nyman, Nordenström, & Kircher, 2020). Smartphone-logging has further been explored as a means to study the physical activity of users (Foster, Gielen, Beattie, & Goodwill, 2014; Shah et al., 2020; Stromback, Huang, & Radu, 2020) or chronic health issues (S. L. Jones et al., 2021).

Researchers have, fourthly, used device-logging methods in combination with experimental manipulations to monitor the progress and the outcomes of field experiments or design trials (Loid, Täht, & Rozgonjuk, 2020; Luo et al., 2019; Mazzella & Testa, 2016). Studies have also combined log data with user feedback to facilitate the design process and improve the performance of smartphone applications (Henze, Poppinga, & Boll, 2010; D. McMillan, Morrison, Brown, Hall, & Chalmers, 2010) and notifications (Mehrotra & Musolesi, 2017; Mehrotra et al., 2016; Oh et al., 2015; Pielot et al., 2014), medical devices such as hearing aids (Andersson, Andersen, Christensen, & Neher, 2021; Christensen, Saunders, Porsbo, & Pontoppidan, 2021; Pontoppidan & Christensen, 2019), and other connected devices such as smartwatches (Nguyen-Huu et al., 2018; Visuri et al., 2017).

Lastly, logging has also been used to inform the design of hardware factors. A study by Henze and colleagues, for example, used logging to record tapping and swiping gestures on the phone's touchscreen to improve the device's performance (Henze, Rukzio, & Boll, 2011). Logging studies have also been widely used to make sense of the battery life of smartphones, and to describe the general charging patterns users have adopted (Banerjee, Rahmati, Corner, Rollins, & Zhong, 2007; D. Ferreira, Ferreira, Goncalves, Kostakos, & Dey, 2013; P. Ferreira, McGregor, & Lampinen, 2015; Froehlich et al., 2007; Khan, Khusro, Ali, & Ud Din, 2016). Based on this large scale data on charging behaviour, one study developed and tested an adaptive energy management system that balances device performance and user experience with battery lifetime (Banerjee et al., 2007), and another project developed an interactive battery interface that supports users in managing the battery life of their devices (D. Ferreira et al., 2013). Having conducted additional participant interviews based on logging data, one study has further been able to qualify the practices of caring for the battery of their device, and provide an insight into the various strategies users have developed to avoid running out of charge (P. Ferreira et al., 2015).

Smartphone-logging is a powerful technique, which allows researchers to capture longitudinal usage data from large amounts of users in an efficient manner. It, thus, is very well suited to describe long-term behavioural patterns at the individual and population level. It is, however, limited, to observing what can be recorded with the smartphone's sensors. Many contextual elements around the user and her device, and especially other humans she may interact with, cannot be studied in a straightforward manner with logging techniques. Consequently, audio-visual recording techniques are being used to fill in these gaps, and to add nuance to the patterns uncovered with logging and trace data.

4.2 AUDIOVISUAL RECORDING

With technological advancements around small, portable cameras in the early 2000s, applications of collecting audio-visual materials for the ethnographic study of human activity began to develop (Berry et al., 2007; K. M. Brown, Dilley, & Marshall, 2008; Cherry, 2005; Hodges, Berry, & Wood, 2011; Lahlou, 1998, 1999a, 1999b, 2000a, 2000c, 2006, 2007c, 2007a, 2007b, 2010; Lahlou, Nosulenko, & Samoylenko, 2002, 2009; Mark, Christensen, & Shafae, 2001; Oulasvirta et al., 2005; Wood, Fleck, & Williams, 2004). While there have been some early technology transfers between teams (e.g. Lahlou introduced the subcam to Gloria Mark, Christian Licoppe, and others), similar systems developed independently, for example in Australia with the early work of Mary Omodei with head-mounted cameras (McLennan, Holgate, Omodei, & Wearing, 2006; Omodei, Wearing, & McLennan, 1997), which unfortunately did not have much local follow-up. The problem with these pioneer works is that devices did not exist off-the-shelf and were prototypes - and the quality of data depends crucially on the form factor and quality of the devices, as well as of the protocols. Until now, good subcams still have to be custom-made; the ones used in this research for example were assembled with 3D printers at the LSE.

These techniques provided an interesting addition to the suite of available tools for data collection, enabling researchers to view activities and subjective experiences from the eyes of their participants, and they moreover allowed capturing these experiences in situated, naturally-occurring moments and made them reusable for later analysis. For the use of smartphones, this is particularly relevant as it allows studying how usage plays out naturally, and how the device interacts with, and inserts itself into the other activities of users.

In an early study using first-person video for the study of smartphone use, Brown and colleagues put forward that their observations make a strong case for the notion that the value of the 'mobility' of portable devices arises precisely from the fact that their use can be interwoven with the daily lives of users and their interactional practices (B. Brown et al., 2013; Luff & Heath, 1998). A large amount of studies has, thus, used video-ethnographic techniques to look at the use of smartphones in situations of mobility such as driving (Ahmed et al., 2016; Arminen & Weilenmann, 2009; B. Brown & Laurier, 2012; Licoppe & Figeac, 2013; Mondada, 2012), public transport (Figeac & Chaulet, 2018; Licoppe & Figeac, 2014, 2018), and pedestrian walking (B. Brown et al., 2013; Laurier, Brown, & McGregor, 2016; D. McMillan, McGregor, & Brown, 2015). These studies often investigated multiactivity and particularly patterns of gaze switching between the smartphone and the environment when users were on the move. One study thus observed how the smartphone is used to fill in periods of waiting when users were on the move (e.g. commuting, waiting at a red light), but also highlighted the 'temporal mismatches' that still occur, as activities often do not seamlessly flow into each other in 'messy' urban environments (Licoppe & Figeac, 2013). Looking at public transport in specific, another study finds similar, recurring patterns of gaze switching for smartphone use and further highlights the specific situational cues and determinants such as switching between trains on the underground, but also sitting or standing on the train during the commute that influence the way in which users engage with their devices (Figeac & Chaulet, 2018). Other studies have focused on the different ways in which users navigate with their phones (Laurier et al., 2016), and the troubles and additional embodied wayfinding skills required for effectively using maps on the smartphone, as well as the associated gestures and search patterns that surround navigation with the smartphone (B. Brown et al., 2013; D. McMillan et al., 2015).

Building on these studies on mobility, the use of smartwatches and fitness trackers, which often are often connected to the smartphone, has been investigated as well (Gouveia et al., 2018; D. McMillan et al., 2017; Pizza et al., 2016). Like smartphones, smartwatches are embedded in the daily lives of users and offer a wide range of activities. And while the frequency of use of smartphones and smartwatches is similar, interactions with the smartwatch are, unsurprisingly, significantly shorter than those with the phone (D. McMillan et al., 2017). Furthermore, because the smartwatch is worn, not held in the hand, the embodied experience of the two devices differs. Smartwatches have, thus, been found to be more convenient to use than smartphones, as they do not need to be searched for or picked up, and they were perceived as less disruptive when they deliver notifications compared to smartphones for that reason (Pizza et al., 2016). Further research extended these findings to the activity tracking function of smartwatches and other wearables, again highlighting their convenience, but also showing that users were more conscious or worried about what constitutes 'enough' physical activity, and how their daily performance compared to their average level of activity (Gouveia et al., 2018).

Focusing more on interpersonal relationships, then, video-ethnographic methods have also been used to study the impact of smartphones on conversation and social relationships overall (Arminen & Weilenmann, 2009; B. Brown et al., 2015; Everri, 2017, 2018). Research has thus looked into how the use of smartphones is used to share and exchange information between users, but also to create intimate connections between multiple parties and their ongoing activities (Arminen & Weilenmann, 2009). Everri, has moreover investigated the positive effects of the communal use of the smartphone in families to connect to a distant family member (Everri, 2018). On the other hand, this research has also uncovered the potentially detrimental effects of smartphone use on family relations and communication patterns, and how the smartphone use of adolescent users was guided by both external and self-control to mitigate their impact (Everri, 2017, 2018; Massena et al., 2019).

Lastly, while this goes beyond the scope of this dissertation, research has also looked into using video-ethnographic techniques and smartphones in healthcare provision (e.g. Gurrin et al., 2013).

4.3 THE NEXT STEPS

Research using smartphone-logging, as well as audio-visual techniques have begun to lay a foundation to develop our understanding of how naturally-emerging smartphone use plays out in everyday life. So far, logging approaches have been more developed, providing insights into large scale trends of smartphone use across participants. However, while this research can record some elements of the context surrounding smartphone use, it is usually mostly concerned with the smartphone interaction itself. Focusing on the action is of course intuitive and reinforced by techniques that gather data from the phone itself. But there are problems associated with using the device that is being studied as the main means of data collection. Ultimately, this can lead to device-centric research, neglecting what happens before and after the interactions, and particularly when the phone is 'in the mix' but not the main focus of attention. This strikingly contrasts with the reality of smartphone use, where context plays a major role in the experience and nature of users' interactions with their devices. And while off-screen context is difficult to record, research using audio-visual techniques has begun to provide empirical evidence of what actually happens in situated contexts when users interact with their devices, particularly in contexts of mobility.

This research is very labour-intensive and therefore at an early stage still. Taking into consideration the pressures around attention allocation and multi-tasking, of which smartphones are a major driver, it is evident that a systematic study of the situated use of smartphones in everyday contexts is necessary to document the relevant access behaviours, triggers, patterns, and the psychological processes guiding them. Without paying attention to what is actually happening on the ground, research is vulnerable to providing inadequate analyses of the modalities of smartphone use and, thus, bound to jump to conclusions based on an incomplete picture - and in many cases, to offer inadequate or altogether inappropriate solutions. Moreover, while both logging and audio-visual studies have sometimes added interviewing techniques to their method of data collection, in many cases participants have not been given the opportunity to provide detailed commentary on their own data to allow for a triangulation of the findings, which has been found to be crucial during the use of SEBE for the success of such approaches (Lahlou, 2011; Lahlou, Le Bellu, & Boesen-Mariani, 2015).

5. RESEARCH QUESTIONS

Based on the previous discussion of theoretical and existing empirical literature, as well as the gaps identified in the current research landscape, we contend that, while this kind of research is intricate and labour-intensive, there is a need for a basic, video-ethnographic account of what users do with their phones in naturally-occurring settings to ground and verify previous findings, and to reliably inform and enable further research with methodologies that are less heavy and more scalable in terms of data collection. The relevant questions are: What is the context around smartphone use? What are users doing before they reach for their smartphone? What is happening in parallel and afterwards? There is a crucial difference between viewing a photo of receipts alone at night in a study while filing one's tax return and viewing a photo from last year's hiking trip together with friends at a restaurant. Moreover, how do users perceive their use of smartphones and how do they manage their daily use? Do these perceptions match up with the empirical data collected, and how do users react when they are confronted with their actual behaviours? If there are any discrepancies, what are they? Are they systematic? And what do users make of them?

This research project will seek to address these questions, and provide detailed insights into how the use of smartphones plays out in the daily lives of users. We therefore formulate the following overarching research questions that will guide the research work carried out for this thesis:

> **RQ1:** When, where, and how do users interact with their smartphones? What is their perception of this use?
>
> **RQ2:** How do smartphones influence the daily lives of users? Does the phone affect their existing routines and habits? Have users developed routines and habits specific to the smartphone?
>
> **RQ3:** Why do people pick up their phones? What are the drivers of smartphone use? How do empirical findings match with the hypotheses formulated in section 2.2.9?

6. RESEARCH DESIGN

Gathering data on media use is not nearly as straightforward as it seems and systematic errors due to self-report measurements have been a topic of discussion for quite a while now (Niemi, 1993; Prior, 2009; Schwarz, 2007). The field's general reliance on self-report data has made it susceptible to participants misremembering and consciously or unconsciously misreporting their media use, and in general it appears that heavy users under- and light users overreport their behaviours (Deng et al., 2019).

Advancements in technology and the increasing amounts of digital traces the use of media creates now allow for a comparison of self-report data with such logged and digital trace data. Studies thus find that self-report measures are overall dissatisfactory when trying to measure the use of media (Junco, 2013; Scharkow, 2016) and smartphones (Boase & Ling, 2013; T. Kobayashi & Boase, 2012). Specifically, these studies conclude that self-report measures "only moderately correlate with actual behavior, they vary more widely than actual behaviour, and they are prone to overreporting" (Boase & Ling, 2013). Apart from general situational factors, social desirability also seems to be an important factor that influences the reporting of specific behaviours judged good or bad by relevant social groups (Araujo et al., 2017; Boase & Ling, 2013). It was further found that these reporting errors create big issues for inferences relating media and smartphone use to socio-demographics, and while the effect of age appears to be somewhat robust, "effects of gender, income, household size and employment status are not" (De Reuver & Bouwman, 2015). More recently, however, a study showed that the bias in self-report data is more likely to create false negatives than false positives, that is to say, research using self-report data is likely to find smaller or non-significant effects around media use compared to what is actually happening in the real world (Jones-Jang et al., 2020).

As computing power keeps increasing on an exponential scale, and with the problems surrounding self-report data becoming better understood, research using logging and digital trace data has grown tremendously over the past decade, especially since the discourse around 'big data' has taken centre stage in research in general (see Karikoski, 2012; Stieglitz, Mirbabaie, Ross, & Neuberger, 2018 for an overview of the development of the field). This trend towards large datasets based on user profiles has made traditional analysis techniques inapplicable and sparked debates on the automation of topic discovery and data retrieval (Chinnov, Kerschke, Meske, Stieglitz, & Trautmann, 2015), as well as the automation of data analysis using artificial intelligence technologies (Chiatti et al., 2018). While these techniques promise spectacular new insights, substantially new and different results are still to come. Moreover, while quantitative studies on social media using log-data seem to make less errors due to measurement, they are dependent on the information that is being recorded by the sensors of the device and, thus, still very much confined to the boundaries of the (admittedly ever-growing) screens of users' smartphones. As hinted at in chapter 4, this makes logging and digital trace techniques susceptible to systematic bias when it comes to context variables that are not recorded by the device, or when users apply different settings around notification and display-timeout settings to their devices (Falaki et al., 2010; Hintze, Findling, Muaaz, Scholz, & Mayrhofer, 2014); we discuss these problems in more detail in Papers 3 & 4 (Appendix C & D).

Overall, it appears that a substantial ethnographic effort to understand the motivations of users and the context they find themselves in needs to be undertaken before researchers can confidently rely on findings from large-scale quantitative data sources based on self-report, digital traces, and server-log protocols. This chapter will outline the approach on data collection we have taken for this thesis in detail.

6.1 METHODOLOGY

This thesis employed a mixed-method research methodology that widely relies on the Subjective Evidence-Based Ethnography (SEBE) protocol. With the technological advances in the area of portable digital video devices in the late 1990s and 2000s also came new investigation techniques and methodological approaches to working with such data (Goldman, Pea, Barron, & Derry, 2007; Hollan & Hutchins, 2009; R. D. Pea, 2007; Pink, 2011a). The most important insight from this work was the shift from treating video as 'objective reality' to an understanding of video as dependent on the subjective perspectives of its viewers and producers

(Pink, 2011a). These new techniques therefore aimed at understanding different perspectives on visual material and facilitating the collaborative analysis and interpretation of such material between researchers and participants (Hollan & Hutchins, 2009; Lahlou, 2011; R. D. Pea, 2007). SEBE was initially developed as a means to study work activities, cognition, and more specifically the use of information (Lahlou, 1999b; Lahlou, Nosulenko, & Samoylenko, 2012; Le Bellu et al., 2016; Nosulenko & Samoylenko, 2009), with a particular eye towards the design of augmented environments and training of workers, but has since been applied to a variety of other contexts such as high stakes nuclear power plant operation (Fauquet-Alekhine, 2016; Fauquet-Alekhine & Lahlou, 2017), policing (Phelps, Strype, Le Bellu, Lahlou, & Aandal, 2018; Rieken & Lahlou, 2010; Stangeland, 2016), shopping (Gobbo, 2015), eating habits and food choices (Bruns, Heitmayer, Boesen-Mariani, & Lahlou, 2019; Lahlou, Urdapilleta, Pruzina, & Catheline, 2012; Leppämäki, 2004; Vrabcová, 2015), parenting and family communication (Everri, 2017, 2018), hospital care (Dieckmann, Clemmensen, & Lahlou, 2019; Dieckmann et al., 2017), home automation and sustainability (Cordelois, 2010; Mutinelli, 2017), and virtual worlds (Evans, 2015; Evans S., 2012). These various different applications of SEBE have shown how versatile it is for the study of human activity. It has further become clear that participants are ‘experts of being themselves’, as they are usually much better able to analyse and explain the nuances of their personal lived experience than an external observer can. Nevertheless, it is also evident that while SEBE is versatile, it also requires additional methodological work for each different context prior to the research to accommodate the different lives of participants, the different situations they record, and the different purposes of the research that is being conducted. The ethical issues and the relation between researchers and participants have also been given detailed attention (Everri, Heitmayer, Yamin-Slotkus, & Lahlou, 2020; Lahlou, 2011; Lahlou et al., 2015; Le Bellu, Lahlou, & Nosulenko, 2010).

At the basic level, SEBE consists of three phases: First, participants are given unobtrusive, miniature cameras worn at eye-level “Subcams”, (Lahlou, 1999b, see *fig. 1*) to gather first-person audio-visual material, “Subfilms”. This enables participants to go about their lives naturally, without being disrupted or distracted, while gathering complete data on their daily experiences (first person perspective,

fig. 1 **A researcher wearing the Subcam. The camera weighs only 7 grams and can be mounted on a pair of research glasses or the participant's own (here); it has about 3 hours of autonomy with the internal, and several days with an external battery.**

wide angle, stereo sound recordings). In the second step, the Replay-interview, participant and researcher watch the Subfilms together and discuss salient moments. Here, participants can explain and reflect on what is happening in the tape, and they can feed into (and object to) interpretations by the researcher and suggest alternatives based on solid data as they relive their experiences. Crucially, these interviews usually unearth things that went unnoticed by participants in the course of the action, because the tapes can be rewound, slowed down, and stopped. Most importantly, reviewing one's own first-person perspective recording elicits accurate remembrance of actions, intentions, and emotions – similar to re-enactment or an access to episodic memory (Lahlou, 2011; Tulving, 2002). This grounds introspective investigation in all elements of the context of action which are made visible on the video. Finally, the researcher is left with many hours of situated first-person videos and a set of interviews that can be analysed with quantitative and qualitative techniques (see Appendix C for the participant information sheet and the Subcam manual and Appendix H for examples of Subfilms and Replay-interviews).

For the study of smartphone use, SEBE is particularly relevant as it allows, unlike stand-alone interviews or any form of smartphone-log method, to document the merging and the interaction of the physical and the digital environments users find themselves in, and both their online and offline behaviours in real-time. As discussed above, interviewees often misremember their actual behaviours when it comes to smartphone and social media use. It is, further, not otherwise possible to obtain information on habits or activities that the participant has not consciously taken note of (e.g. quickly checking the phone for notifications while moving it from a table in the pockets of one’s pants). The SEBE technique, on the other hand, enables the researcher to obtain data on complex, every day, multi-media processes, even if the participant may not notice them herself at first.

Similar to ethno-mining approaches (e.g. Aipperspach et al., 2006; K. Anderson, Nafus, Rattenbury, & Aipperspach, 2009), SEBE is particularly relevant for the study of device use as it allows, unlike stand-alone interviews or any type of server- or smartphone-log method, to document the interaction of the physical and the digital environments users find themselves in, as well as both their online and offline behaviours. In the field, wearable video has been shown to provide insightful accounts of the use of smartphones (B. Brown et al., 2013, 2015; Licoppe & Figeac, 2013) and smartwatches (D. McMillan et al., 2017; Pizza et al., 2016). Moreover, supporting interviews with logging and trace data has proven to be effective in supporting recall (P. Ferreira et al., 2015) and in contextualizing usage behaviours in “wider webs of activities” (K. Anderson et al., 2009; Rattenbury, Nafus, & Anderson, 2008). The Replay-interview presents a useful addition to these approaches as the rich, first-person audio-visual material participants record leverage multimodal episodic memory in the interviews and enable participants to give detailed accounts of their activity, the context surrounding it, and their cognitive and emotional experience, see (Lahlou, 2011) and (Glăveanu & Lahlou, 2012) for a detailed discussion. Particularly for this research, it is important that, unlike log-data or interviews, SEBE captures online and offline behaviour in interaction, thus addressing the lack of contextual information from which the commonly used methods suffer.

6.2 SAMPLING & CASE SELECTION

The basis of this thesis is a "typical case" sample of young adult ICT users (Boehnke, Lietz, Schreier, & Wilhelm, 2010). While the sample has been generated through snowball-sampling, interested candidates were selected to create a sample generally balanced in terms of gender, as well as aiming for diversity in terms of country of origin, occupation, and educational background where possible. While the first real smartphones became available in the early to mid-2000s as a professional device, the smartphone's mass-appeal and its rapid spread roughly coincides with the release of the first iPhone in 2007. Similarly, many of today's largest social media platforms like facebook, Twitter or Instagram[4] became popular in the 2000s and quickly attained "significant cultural resonance" among teenagers (Boyd, 2007). Consequently, today's young adults are the first generation that was exposed to social media during the formative years of their lives before adulthood. Arnett has shown that during this phase of *emerging adulthood*, individuals "examine the life possibilities open to them and gradually arrive at more enduring choices in love, work, and worldviews" (Arnett, 2000; Erikson, 1968). This dissertation will therefore focus on *young and emerging adults between 20 and 29*. To preclude any gender-specific bias, we have paid attention to creating a balanced sample in terms of gender. Given the large amount of labour involved in collecting and analysing this data, we aimed for a sample size between 35 and 40 participants to have a sufficiently large, but still manageable amount of data. Participants have been recruited in the Greater London area, United Kingdom, but several participants lived or made their recordings in other European cities.

6.3 RESEARCH ETHICS

The SEBE lab research group run by Prof. Lahlou constantly works on the development of the protocols for SEBE. Part of the work on this dissertation has contributed to a collaborative project on research ethics for video-ethnographic methods with Dr. Marina Everri, Dr. Paulius Yamin and Prof. Saadi Lahlou. The goal of this project was to refine the SEBE technique, make sure it complies with

[4] In the English-speaking world. See for example VKontakte or Sina Weibo for popular networks in other languages that became in the mid- to late 2000s.

the highest ethical standards and the European Union's General Data Protection Regulation (GDPR) which came into effect in May 2018 and, more importantly, to produce useable and transferable guidelines for other applications and users. We have presented the results of this project at the conference Ethnography with a twist at the University of Jyväskylä, Finland in February 2019. The resulting Paper has been published as a book chapter and is enclosed to this dissertation (Paper 2, see Appendix B). This section draws on the research underlying this publication.

The privacy of participants and the high ethical standards of research at the London School of Economics and Political Science were an important concern for this dissertation, and we have relied on the stringent ethical guidelines of the SEBE protocol, ensuring the protection of the privacy of participants and maintaining their full control over the data throughout the research process. (Everri et al., 2020; Jonassen, 2016; Lahlou, 2011; Lahlou et al., 2015). The Ethical approval by the LSE Research Ethics board was granted on 08.11.2017 (see Appendix G for the Ethics Approval Form).

Pre-formatted checklists distributed by institutional ethics boards that usually are to be filled out prior to data collection neither enable researchers to react adequately to issues arising while the research is being conducted, nor do they enable ethics boards to ensure adherence to institutional and general ethical standards (Cox et al., 2014; Gubrium, Hill, & Flicker, 2014). Moreover, achieving truly 'informed' consent with check-lists and by handing out paper forms prior to data collection, which is the standard procedure for most academic institutions (Gubrium et al., 2014; Lenette et al., 2018), is not possible either, as unexpected sensitive events might occur during recording *after* informed consent was obtained, or events only *appear* sensitive after the fact. We have therefore approached ethics and consent as an ongoing process that continued throughout and beyond data collection.

All video recordings were anonymised and encrypted using pseudonyms on a hard disk drive to ensure confidentiality. As soon as possible after original or derived data is created or collected it must be accompanied by sufficient information to identify what it is, who created it, when, and its sensitivity. This information is further needed to guarantee anonymization and to be able to account for any requests made by participants or the cast. The researcher will keep the data and destroy them after the usual time (5 years). Participants will get no royalties from the use of the films, which are only intended for scientific purposes. However, before the data left the hands of the participants, they were encouraged to review the material and blur or delete anything they wished, or abandon parts or all of the recordings altogether, and they were also offered technical assistance to do so if needed. Participants were explicitly, and repeatedly, reminded about this prior to data collection, after data collection, prior to the Replay-interview and after the Replay-interview so that the participants could rightly feel completely safe and in full control of their data. No participant made use of this option. Furthermore, participants were asked about their opinions of the SEBE procedure in the debrief, and their feedback was incorporated into the ongoing research.

In general, researchers who use or create data in the process of their research have a responsibility to manage the data they create effectively and securely, whether original or derived. Primary responsibility for design and implementation of effective research data management lies with the researcher. We therefore asked the participants to get in touch with the cast - these are people who are recorded on the Subfilm because they interact with the participant or they enter the recording - where possible, to obtain their consent (e.g. Everri, 2017; Kelly et al., 2013). By experience, most people appearing in the cast are identifiable and accessible to the participants. For those people, who refused consent or could not be identified, we blur faces and distort or mute speech (replaced by subtitles) if they appear in parts of the video material that are being used for the publication and communication of this research.

Lastly, participants were given both mail and phone contact data of the researcher and the supervisor in case they felt uncomfortable about the procedure, wanted to express their feelings, or had urgent questions regarding their participation. None of the participants made any urgent request to the researcher or reported finding themselves in a difficult or dangerous situation because of their research participation. Participants were also offered to receive a copy of their Subfilm material and a research report, as a token of appreciation for their participation. In case they decided they wanted to keep a copy of the Subfilms, they were given a full explanation of the legal limitations to and the potential implications of sharing some of this data in full or in parts, as outlined in the guidelines produced for Paper 2 of this dissertation (Appendix B).

6.4 DATA COLLECTION

Data collection took place in the UK in 2018 and 2019 with the majority of participants being residents of the Greater London area, generating an international, but mainly European sample of n=41 participants.[5] Participants were recruited through mailing lists at the London School of Economics and Political Science, and through snowball-sampling. Two thirds of participants were university students, and one third (14) were working. The age of participants ranged from 21 to 29 years with 46% being female. The majority of our participants used Apple iOS devices (78%), six used Android on Samsung devices (15%), with one participant each using a Sony, Motorola, or Huawei device running Android.

Participants have been asked to wear their subcam on at least three consecutive days, collecting at least 5 h of video material. Participants have furthermore been instructed to only wear the camera in situations in which they felt comfortable and could forget about wearing it. Allowing participants to self-select when to wear the Subcam results in more natural behaviours, while also protecting their privacy, and it gives each individual the opportunity to document the parts of their lives they deem the most relevant. As part of the protocol, participants were regularly reminded they can delete data if they feel they have recorded something undesired, and we offered assistance for doing so. No participant used this opportunity. This has generated a data corpus spanning a breadth of activities and locations like commuting, working in the office, attending lectures at university, going to the supermarket or the museum, or spending time with friends and family (see Figure 2). Throughout we observe a rather even spread of Subfilms recorded at home, at work, and outside.

[5] UK (12), Italy (5), Germany (5), France (3), India (3), Latvia (3), America (2), Russia (2), Colombia (1), Czech Republic (1), Iran (1), Netherlands (1), Singapore (1), Spain (1), Sweden (1).

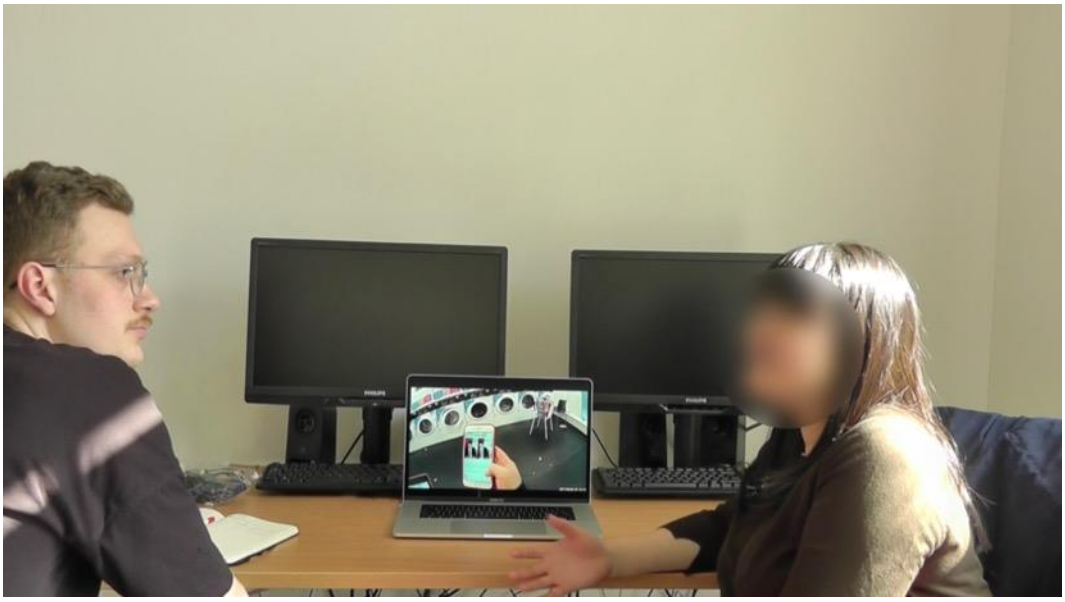


fig. 2 **Example of a Replay-interview. A participant comments on her Subfilm (on the laptop screen) to the investigator; here her use of the phone in the launderette (frame extracted from the recording of the RIW).**

Replay-interviews lasted between 50 and 90 minutes and were conducted no more than two weeks after participants collected the subfilm material (see *fig. 2*). During the interviews, we watched the subfilms together with our participants. At the beginning of the interviews, we let the tapes play for a few minutes to get participants acquainted with the experience of re-watching moments from their own lives from a first-person perspective, and discussed with participants where they

were in the subfilm, what day it was, and which activity they had recorded with the subcam, as well as their general goals and motifs. This interview-technique focusing on the activity of users and based on Russian Activity Theory (Le Bellu et al., 2016; Nosulenko, Barabanshikov, Brushlinsky, & Rabardel, 2005) has been found to be very effective for understanding the moments caught in the subfilm material. Once participants had become comfortable with the general format of the interview, we encouraged them to ‘take control’ of the video tapes by fast-forwarding the material and walking us through their experience. At every instance during which they interacted with their smartphones in the subfilms, we then stopped the tape and discussed the specific context of the situation, what participants were doing with their phones, why they were doing this, and what their motivations and goals were to interact with the device in this specific moment. Here, the SEBE technique showed one of its main strengths, as we needed to rewind the videos and watch the smartphone interaction as well as the moments prior to it multiple times on many occasions to be able to reconstruct together what participants were doing, and why. We, thus, both observed instances in which the researcher misinterpreted the participant's actions, and participants were able to clarify the researchers mistake with the videos, as well as vice versa for instances where participants initially misremembered or didn't remember the smartphone interaction correctly, and re-watching the moments multiple times over enabled them to recall their original goals and motivations.

The interviews from the initial phase of data collection (n=37) discussed smartphone use as it was naturally emerging from the Subfilm material and, thus, covered a broad range of topics around smartphone use reported in chapter 7. After having gained a general picture of empirical observations and participant interpretations of contextual smartphone use, we carried out a second round of Subcam data collection and Replay-interviews in November and December 2020 (n=4) to discuss moments in which it was unclear from the Subfilms why participants picked up the phone in more detail with them (proactive use; see section 8.3.1). The average amount of Subfilm data collected per participant was about 4.5 hours, and Replay-interviews lasted 74 minutes on average. Overall, the data corpus comprises over 200 hours of video material.

6.5 QUALITATIVE DATA ANALYSIS

SEBE generates large amounts of video footage of situated and natural participant behaviour. To address the complex questions raised in the theoretical discussion, data analysis took place in two steps, with a qualitative technique being applied to the Replay-interview footage, followed by a quantitative examination of the Subfilm data.

The Replay-interviews have been transcribed literally and prepared for analysis using *directed Qualitative Content Analysis (QCA)*. These transcripts make up a large corpus of complex, qualitative data, which needs to be structured and reduced to become manageable and comprehensible. QCA is perfectly suited to analyse such data, since it does not aim to fully describe the material. Rather, the goal of

QCA is to carve out salient topics and unearth emerging ideas from the data corpus in a circular process, and to describe them in a coherent and systematic way (Mayring, 2000, 2015; Schreier, 2014), to generate valid and replicable results that are “divorceable from the authority of the researcher” (Krippendorff, 1980, p. 18). Thus, QCA will be adopted in combination with SEBE, as a method of analysis that minimises the risk of the researcher making biased inferences from participants’ responses, based on his own usage patterns. Nevertheless, this directed approach to QCA also allows the researcher to build upon and further develop existing theory (Mayring, 2000, p.4). Moreover, it does not stipulate the prerequisite of an ‘unbiased mind’, often given for inductive, naturalistic research, which can hardly be assumed, given that the researcher has consulted the pertaining literature before carrying out the research (H. F. Hsieh & Shannon, 2005), and further alleviating the pressure of the problem of abduction (Frankfurt, 1958). Emerging topics can thus be supplemented with codes derived from the previous discussion of the literature.

6.6 QUANTITATIVE DATA ANALYSIS

In addition to the qualitative analysis of the interviews, the results from the Qualitative Content Analysis was supplemented by a quantitative analysis of the Subfilm data. Following the design commonly used in time use studies (Aguiar, Hurst, & Karabarbounis, 2012), the smartphone activities that took place in the Subfilms were coded quantitatively to show trends, patterns and differences amongst participants. For every instance during which participants used their smartphones on tape, we recorded duration, time elapsed since last phone interaction, location, type of interaction, the context they were in (e.g. working at the office, commuting), whether there was a notification (and if so, what type) and the nature of the activity.[6] Overall, this resulted in a dataset of N = 1,130 unique smartphone interactions. The specific variables that were recorded and the corresponding statistical analyses are reported in the respective Papers in Appendix C, D, E and F.

[6] Unfortunately, the Subfilms for three participants were corrupted in the transfer process after the interview, resulting in an N = 34 for the quantitative analyses.

Adding these quantitative measures will support the triangulation of results as suggested in previous applications of SEBE (Le Bellu et al., 2016). It will furthermore allow to compare the findings of this dissertation to results from the existing literature and to formulate testable hypotheses, so that other researchers can easily build upon the findings of our research.

After analysing the Replay-interviews and coding the general descriptive variables of locked smartphone use in our Subfilm sample, we took a closer look at the moments immediately prior to the smartphone interactions our participants recorded in the Subfilm. Based on participant comments in the Replay-interviews, our qualitative analysis, and the contextual factors captured in the Subfilms, we classified the individual instances of locked use in our sample into 8 different categories of 'contextual antecedents' (These categories reflect how different instances of smartphone use arise from the flow of activity of participants. After an initial round of coding the videos, a framework of coding instructions was produced (see Appendix A2), and 25% of the videos were double-coded independently two more times by two researchers. In the first round of double-coding, we found an inter-coder reliability of 81% (Krippendorff's $\alpha = 0.74$) (Krippendorff, 2011). We then updated the coding instructions and merged two categories because of overlap, which resulted in a 94% agreement for the second round of coding (Krippendorff's $\alpha = 0.91$). The remaining mismatches were reviewed jointly by coders and resolved. The entire dataset then was recoded based on the new coding instructions one final time.

7. GENERAL QUALITATIVE ANALYSIS

The Subcam footage shows a wide variety of activities participants engaged in with their smartphones. Unsurprisingly, smartphones are the most common way for all participants to access social media, followed by tablets. Stationary computers and laptops were used less often for social media activities, which can be explained by the fact that most participants used their computers for their main 'work' tasks while accessing social media at the same time through another device. Smartphones have therefore been described as a steady companion and as "a communication tool, not a work tool" (P7). Apart from that, most participants use their devices in a variety of different situations, e.g. as a camera, (stop-)watch, navigation device, e-book reader, or calendar, but also as a light pad for drawing and copying, or even as a mirror. It is evident from both the Subfilm material, and the participants comments that they view smart devices and especially smartphones as versatile tools for work and leisure, and possibly as an extension of the body: "So, the phone's really wonderful. It has everything" (P4; see *fig. 3*).

From the general Qualitative Content Analysis of the Replay-interviews, five substantive categories with two to four subcategories, respectively, emerged. The first category, *platform characteristics*, comprises general descriptions of and characteristics participants ascribed to the different social media and communication platforms they commonly used, such as facebook, Instagram, or WhatsApp. The second category, *picking up the phone*, presents participant descriptions of the motivations and their thought-processes around picking up their devices. The third category, *notifications*, focuses specifically on participants' preferences for and responses to receiving notifications on their devices. The fourth category captures the different *usage habits & strategies* participants have developed to engage with, or avoid their phones. Lastly, *managing the use of time*, the fifth category, describes how participants structure and manage their use of time & attention throughout the day with the help of their smartphone. The coding frame is accessible online via Appendix H.

fig. 3 **Various instances of ICT use (top left to bottom right): Snapchat during a break from studying, looking up public transport on the go, Tablet and Smartphone while doing laundry, reading messages after coming home from grocery shopping.**

7.1 PLATFORM CHARACTERISTICS

The data show that participants make significant differentiations between the social media platforms they use, both theoretically and practically. For this reason, *platform characteristics* pays detailed attention to the specifics of the use of the most important social media platforms the participants used. For reasons of comparability and parsimony, both WhatsApp and E-Mail have been included in this category. Both constitute smartphone use with high intensities and overlap significantly with the two most important social medias, facebook and Instagram, when it comes to communicating and sharing.

WhatsApp has emerged as the main messaging and communication tool from the data, being used much more frequently than other messengers, texts or phone calls (for that matter, phone calls were routinely conducted as VoIP calls through WhatsApp if at all). Participants have thus described it as their 'first go-to' when they pick up the phone, and as 'live communication' used for shorter messages. WhatsApp was also often used for group chats and coordinating group activities, as well as for sharing photos, videos and other social media content. Interestingly, for several participants this led to the impression that taking up contact through WhatsApp means 'contacting someone personally'.

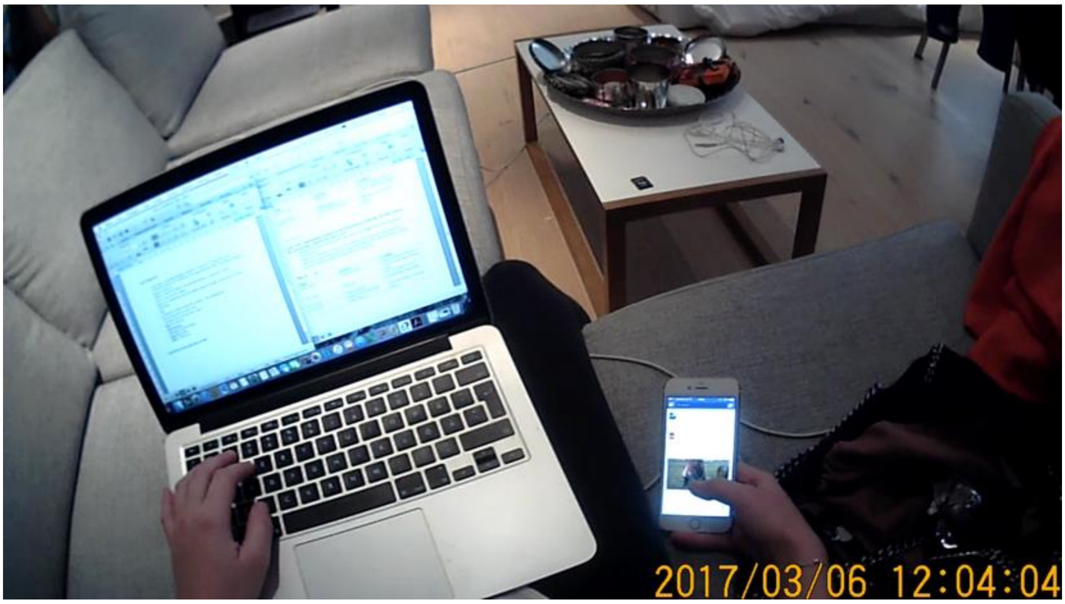


fig. 4 **A participant using facebook on the smartphone while working on the computer**.

Facebook was widely regarded as a source of a broad range of news and information by the participants. These range from light entertainment and distractions, such as music, pictures, and videos, to tutorials, recipes, and life-hacks, as well as more serious political news and articles. In that regard, facebook has also been described as a means to 'settle in' into the day or as a distraction before commencing an activity. At the same time, facebook enables users to share content, which turns the facebook wall into a means to "catch up with what is going on in my friends' lives" (P4). On the other hand, this can also be seen as a drawback since "facebook doesn't have a filter and everybody can say what they want, and sometimes not all the people have interesting stuff to say, let's put it this way" (P3). Furthermore, several participants used facebook as a business tool for their freelance work (illustration, DJing, photography, etc.), or even professionally as an advertising tool for their employer. Lastly, facebook is also often used as a birthday and event calendar, and as a means to communicate with other people, particularly with friends and family that are not in close geographical proximity.

Instagram, similarly to facebook, has been described as a source of information and leisure by the participants. Content available on Instagram, however, is seen as more casual, trivial, and even 'unintelligent'. Following the nature of the platform, participants are more focused on visual content (photos, short videos) on Instagram and consult it when they are looking for distraction and light entertainment "without much text" (P3). The content users hereby expect to see ranges from memes and funny photos, art, artistic photography and fashion, to snapshots from the private lives of friends, family and celebrities, as well as photos of beautiful or sexy people. Compared to facebook, where desired content was characterised as interesting and topical, content on Instagram reflected what participants ‘enjoy’ or ‘like personally’.

Finally, *E-Mail* was widely regarded as a more formal means of communication. Sending E-Mails enables participants to share longer messages and more precise information, provides an easily traceable history of a conversation, and was often used for communication with people that participants were less familiar with. The participants, thus, generally said that they spent more time composing an E-Mail and paid more attention to grammar and spelling than on WhatsApp or facebook, which led to a comparison between writing E-Mails and sending letters. But also receiving E-Mails reflected the formal nature of the medium: Several participants had subscribed to newsletters and executive summaries of newspapers, parties, universities or think tanks. Moreover, E-Mails from employers or universities were given “highest priority” and described as “needing to be checked asap” by the participants (P17).

This consideration of the different platforms and communication tools the participants of this study use exhibits a clear duality between work and leisure, formal and informal, both for how they share and communicate information, and for how they consume it. WhatsApp appears to be the most important communication tool for private and social activities, while E-Mail still is the go-to tool for important and more formal communication. Similarly, Instagram is regarded as a source of personal leisure and entertainment, while facebook also provides relevant and topical information outside of the users’ personal preferences, with some participants adding newsletters received through E-Mail as a third, even more formal layer.

fig. 5 **Various instances of smartphone use revolving around food. Top left to bottom right: Watching a video while cooking. Sending a photo of the cooking food via Snapchat. Texting another person to join while having lunch with colleague. Scrolling through social media while eating.**

7.2 PICKING UP THE PHONE

First, when asked about why they picked up their phones, participants usually reported it feeling natural or automatic, and even unconscious "like when you cough and put your hand over your mouth" (P24). Moreover, participants often exhibited genuine surprise at the intensity of their use:

> *I wouldn't consider myself someone who isn't attached to their phone much. But seeing this has made me realise that I don't even remember picking it up- I think I use it a lot more than I let myself believe. It's really interesting for me to see how much I use it and how much I rely on it.* (P27)

Participants also reported how frustration or boredom with the ongoing activity led their minds to 'drift off', and to eventually pick up the phone or switch to their social media. This commonly applies to unenjoyable work tasks but also to other activities that were perceived as non-rewarding, like cooking, cleaning, or commuting.

Second, engagement with one social media platform usually triggered a chain of subsequent engagements with other platforms, characterised as getting 'caught in the loop', which led many participants to spend more time on the phone than they wanted as social media suggested further content to them:

> *And I tell myself those lies. You know, like 'I'm gonna finish this video and then I'm going back to work'. But then I keep scrolling like 'No, just one more video.'* (P3)

On one hand, this can be attributed to a 'lingering' loop pattern that entails participants cycling through apps, and different functions (e.g. Instagram feed and Instagram stories) after finishing an activity on the phone, even though there are evidently no new notifications:

> *It happens often when I've just been on my phone. I wasn't just using it to procrastinate, I was actually using it to do something that was useful. But then, it's just something that there's like this feedback loop, you know, and you have to... continue.* (P12)

On the other hand, most participants had routine orders in which they accessed their social media apps. In combination with automatic pick-ups, this induces participants to go about their routines while they figure out why they picked up their phones in the first place:

> *Here I actually check the time and then go about my routine. So, WhatsApp, Email, the important things, and then faffing. Probably wanted to check the weather or something like this and I usually go on Instagram or facebook. I pick it up for something, then I forget what I wanted to do and check all the things, my routine, and then I remember, ah yeah, I wanted to check the weather.* (P19)

A third, striking finding is that almost all participants pick up the phone, unlock it, play around with it and then put it back without any evident purpose ('fidgeting'). This often also includes opening and closing apps without an evident purpose and even typing. Fidgeting is user-initiated and happens without any prompt from the smartphone. Most participants could not give a reason for their behaviour beyond stating that it felt natural to regularly check the phone. A few participants also reported that fidgeting with apps on the touchscreen felt relaxing or therapeutic.

Overall, picking up the phone seems to be widely automatic and habitualised, with participants often ending up with their phone in hand without intending to do so, or longer than they had originally intended.

7.3 NOTIFICATIONS

All participants described varying *preferences on receiving* notifications for different settings. Strategies for achieving the right level of 'distance' include muting the phone, putting it out of reach, or turning off notifications for specific apps, but also harsher measures such as switching off the phone, leaving it at home, wearing earplugs, and even handing over passwords for social media accounts to friends. Most participants differentiated between work-settings, in which the phone should not make lights or noises, and leisure settings, in which it can. For the work-setting, participants justified their choices by arguing that it would be harder to concentrate when the phone constantly made noises, and that it "would be embarrassing when the phone went off in a meeting, etc." (P2). Especially with regard to newspapers and other non-social-media apps, some participants mentioned that they want to receive the information contained in the notifications, but that they did not need it immediately. Lastly, while most participants reported that they had edited which applications or pages could send them notifications, three participants reported that they had not changed the notification pre-sets and had instead "arranged with how the phone works" (P8).

> *Actually, that's something important from my housemate. All chats are silenced except for this one. If it's something that I haven't pre-programmed as important then the phone isn't even going to vibrate.* (P19)

When talking about notifications, participants often mentioned the social pressure of constantly *being available* having a negative impact on their well-being. Apart from this pressure being "mentally tiring" (P19), participants specifically highlighted others getting mad at them for not responding promptly:

> *Realistically how long is it going to take you? I'm never in a situation where I just can't answer my phone you know? There's this expectation*

> *that you're going to be on your phone. People literally say to me: 'Why didn't you text me back because I know you had your phone on you?'. And I just say: 'Yeah, you're right, I probably could have to be honest. I just chose not to for once, you know.'* (P21)

Particularly group chats were characterised as sources of 'information overload' and distress. Notably, for several participants this pressure extended into sleeping hours:

> *No, I never turn it off. Only at night sometimes. But sometimes I get paranoid and think what if something happens back home? I want to be reachable, but I feel I should turn it off more because you don't get that sense of freedom. It's a nice feeling to be unreachable.* (P28)

Another issue with notifications were the different levels of *urgency to respond*, depending on the nature of the message and who sent it. Overall, participants agreed that most notifications are unimportant and do not need to be responded to quickly. One frequently mentioned exception to this were notifications connected to coordinating offline activities:

> *Things that require immediate responses are, I don't know. It's 12:45, I have a lunch date for 1pm and I get a notification: 'I need ten more minutes'. Then I'd write: 'Yeah sure, no problem'* (P25).

Similarly, Emails and other work-related notifications were generally regarded as high priority, not only demanding a quick response, but also turning other notifications into distractions and nuisance. Particularly client-facing messages demanded immediate responses:

> *I tend to put off my standard deadlines because it's always less urgent than dealing with an annoying client who's breathing down your neck like 'I need it now'.* (P11)

In contrast, even though participants generally agreed that group chats were a source of distress and most messages in them rather unimportant, longer absence from a conversation was cited as a reason to respond: "So, it's because there have been a few messages and I have been silent for a while" (P4). Linking this to the previously discussed pressure of being available, while there seem to be notifications that are more urgent in nature than others, social pressure appears to drive perceived urgency of notifications as well.

Finally, all participants characterised notifications as *disruptions*. In the Subfilm material, receiving a notification almost always led the participants to immediately interrupt their current activities and attend to their phones. Several participants also reported having a folder for 'disruptive' apps on their phone. A striking example of this disruptiveness can be seen in the Subfilm material of P1, who had spent about an hour cooking dinner and then turns to her phone as soon as the food is plated. After fifteen minutes of the food getting cold and not having eaten, she exclaimed in the interview: "I just don't get it, even though I'm so hungry I'm still on my phone" (P1). In our discussions, participants took an almost fatalistic view on interactions with their smartphones:

> *Usually I just have my phone on the table and I won't look at it. Hopefully nobody messages me but if they do then I will.* (P26)

> *I try and put it a bit away but obviously if a message pops up then I want to answer right away. Not that I always do but I want to.* (P36)

> *I just feel like anytime someone messages me it just sets off a stream of 'oh I can do this, this and that' you know? It's not ideal, which is why I'll let my phone die or put it in a different room because I feel like once you pick your phone up you've got one notification, then you have ten of them.* (P21)

Interestingly, some users were aware that their notifications might distract others, particularly work colleagues, within earshot:

> *I have my phone on my notebook cuz sometimes it's going to buzz, and I don't want people to hear it, but I also don't want to turn it off completely in case there's something important. It kinda muffles the sound, cuz on the table it goes like "naa, naa" and I get a bit embarrassed.* (P11)

The disruptiveness of smartphones at the workplace became especially evident when other disruptions were present too. When a ringing phone, an incoming Email or talking colleagues interrupted participants, they usually picked up their phones. This was most salient in open-plan offices where ambient noise levels tend to be high ("Ok, too much talking around me. I can't do any work. So, facebook." P12). Adjusting notification settings, thus, was often not sufficient to regulate engagement with a device to the desired level. In fact, most participants were annoyed with how regularly they check their phone for messages. In that context, the phone has been poignantly described as a 'vice' that is pleasurable to indulge in, but needs to be avoided to attain daily goals (P19).

From the descriptions of the participants, notifications emerge as one of the most important triggers of smartphone usage, both when they are noticeable by the senses, and, as discussed above, when participants routinely check their muted phones. They furthermore appear to be both desired as sources of information, as well as undesired as disruptions. Hence, participants appear to be caught in a double bind where having the phone in a place or setting that makes notifications noticeable to the senses renders it impossible not to engage with them immediately, and when notifications are not noticeable social pressure and a backlog of things to deal with accumulate. As one participant sums up:

> *A lot of the apps that I have on there, I've switched off the notifications. Which means that I'm not hassled as much. But I find myself checking more regularly to see whether something's come up.* (P29)

7.4 USAGE HABITS & STRATEGIES

To manage the intellectual tension between the different demands and desires around engaging or disengaging with the phone, participants report a nuanced mixture of intentional strategies and unintentional habits that have developed over time.

All participants cited avoidance strategies that helped them to not attend to their phone. The avoidance strategies participants reported can be broadly categorised as either 'software' and 'hardware' approaches. Software strategies focused on adjusting the phone's settings to specific situations. Usually, this entailed having multiple sets of notification settings for specific contexts. Most participants differentiated between work-settings, in which the phone should not make lights or noises, and leisure settings, in which it could. The exact settings varied greatly between participants with all three common forms of notifications (tactile, visual, audible) being described as either the least or the most disruptive by some.

Hardware strategies were aimed to alter the physical connection participants had with their phones. These include moderate approaches such as turning the phone facing downwards or putting it out of immediate reach, but also switching off the phone, hiding it under a pillow, wearing earplugs to not hear the phone, and even leaving it at home when going to work or university. Most of these strategies, again, exhibited a fatalistic view on smartphone interactions and ultimately sought to address a perceived lack of self-control on the side of the participants. As one participant described:

> *I use my phone a lot yeah, but I try to plan in advance to avoid hurdles. If I just go ahead with my day it's difficult to control myself but if I plan in advance then; you silence the chats or a particular one.* (P19)

Moreover, social aspects were described as drivers of avoidance strategies, both for work and leisure contexts. At work, participants said that they wanted to appear focused and hard-working, and that it "would be embarrassing when the phone went off in a meeting, etc." (P6). Especially with regard to newspapers and other non-social media apps, some participants mentioned that they want to receive the information contained in the notifications, but that they did not need it immediately. For leisure contexts, most participants described people who used their smartphones during social occasions as annoying and conversations in which people were on their phones as 'slightly lacking', since people got absorbed in their smartphones: "I would say that when I see something that actually matters online and I need to concentrate, some of my responses are... just fillers" (P27). Hence, several participants also saw this as an opportunity for impression management or to set a positive example: "It's like, the way I want to be seen by others and I want to control that, I don't want to be seen in a different way. I want to be this guy who pays attention" (P18).

On the other hand, participants also reported engagement strategies that enabled them to interact with their phones when they wanted and, at times, while carrying out other tasks. Reflecting the dilemma of having to check the phone and wanting to focus on other things, most participants exploited natural breakpoints between activities and actively created short mental breaks in order to 'engage to not engage'. Participants thus used the phone when they knew their computers were loading for some time, while they were waiting for water for a tea to boil or when they were walking from one place to another. Participants also used their phones to fill gaps in between activities: "There's no notifications on my phone. I'm just going on it because I'm awkwardly standing in line" (P27). Moreover, checking the phone was also cited as "one of the first things to do when coming home" (P5), and one participant had even dedicated a specific hour of the day for using social media without feeling bad about it for her "recreation and mental health" (P4).

Several participants furthermore described that they check all apps and notifications and reply to all unanswered messages in preparation of putting the phone aside for another task: "I try to get rid of the messages before I work, so I can focus. Otherwise, it is in the back of my mind" (P7). At the same time, particularly when their current task was either very stressful or dull, participants allowed themselves to check the phone to give their minds a little break, and as an excuse to take time off working. Finally, several participants stated that they sometimes leave the phone face up on the table when they want to be distracted, to 'take their mind off things', or 'slowly fade out work in the evening':

> *It's something to look forward to when I open Instagram or facebook. When I have my phone in my hand I know that I have access to that now. I feel like I'm obliged to look through some kind of social media. I don't know how it is for other people, but it is something that I've ingrained in myself.* (P24)

We also found specific routines that pertained to going to bed or waking up. In this context, smartphones and social media were described as a tool that helped participants to wake up ("a light that wakes up your eyes"; P17) and to fall asleep. At the same time, participants also switched off the phone or even left it in another room for the night to prevent themselves from going on it ("Otherwise, I'm always reaching over when I can't sleep or whatever"; P37).

A particularly interesting finding was that one participant would go to the bathroom if he had to respond to a message while in company:

> *It's going to sound weird but what I do is, I go to the bathroom. Because that's socially acceptable. Sometimes I also use it but often I just go there and reply to messages for 5 minutes. I'm not rude in front of people as I'm using the toilet, but I'm not.* (P18)

Once more, this highlights the dilemma of social expectations around smartphone use. On one hand, the physically present people expect him to not use his phone, on the other, those who are not expect him to check his notifications.

7.5 MANAGING THE USE OF TIME

All participants described *managing their use of time* through the phone, both for work and for leisure. Participants use asynchronous conversations through chat to do multiple things at the same time as "full attention is not needed" (P18) and to stall for time while figuring out responses. Similarly, participants often multitasked with their devices to use their time most effectively, for example while being on a long conference call. They also frequently used short phone breaks to plan their schedules, from the bus ride to an appointment, to a night out with friends. In addition to that, participants commonly multitasked with their phones during routine activities in the Subfilms, such as 'blind walking', preparing beverages or food, and preparing the laundry.

Smartphones were further used to *pass time*, for example while waiting for friends or commuting to "make it feel like time is going faster" (P24). Low levels of engagement in work tasks and other activities that were perceived as non-rewarding led participants to take their phones "looking for something to do with it" (P8). While most participants clearly considered this 'completely unnecessary' and a 'waste of time', they reported that they enjoyed being able to distract themselves whenever they wanted to at the same time, and one participant poignantly said: "I do it for a purpose, so it's okay, it's not just a waste of time" (P4).

Most participants check all apps and notifications in preparation of putting their phone aside to *settle into a task*: "I try to get rid of the messages before I work, so I can focus. Otherwise, it is in the back of my mind" (P7). Similarly, participants described that 'getting into the flow' with work depended on their surroundings ("It's like the atmosphere has changed now. You know, sometimes there's this 'ebb and flow' while working. I also think I was more focused because people before me were working as well", P4), and the presence of the smartphone ("If I really want to get into the flow, the smartphone needs to be gone", P5).

Though most participants described feeling pressed for time during work, they usually allowed themselves to check their phones during short breaks:

> *But my thought process is like I don't have enough time to take an actual full-time break, I don't have enough time to go outside or read a book. So, I'll only allow myself 2 minutes and really it's the only thing that I can do in that time. It'll be like I've been typing for a while and I can feel my attention dropping and I know if I just stop for like two minutes, I can carry on.* (P24)

The smartphone is, thus, routinely cited as a means, or even an excuse to take a break from an ongoing activity, either as "a break in a long task, or in between a series of short tasks" (P1). At the same time, participants acknowledged that their break time could be spent differently, and breaks often become longer than planned:

> *Sometimes that time for easing your mind would be better spent just stretching instead of going on facebook. Because it gets you in a loop. Like, 'I'm gonna be here for five seconds. Oh, but this video is fun. Okay, I'm gonna see just one more video. Okay wait, this video is funny and down here, another video that I wanna see. And I'm gonna see those two videos and then I'll go back to work...' And then five seconds turn into five or ten minutes.* (P3)

fig. 6 **Various smartphone activities while being outside. Top left to bottom right: Paying for a coffee with the phone. Walking the dog and taking a photo. Texting with friend to confirm what to buy at the supermarket. Showing photos to a friend on the bus.**

Participants also used their phones to *structure the flow of activity*. Phones, thus, helped to 'fill in' unproductive spaces between activities:

> *I'm waiting for the machine to do a calculation and I want to use this break time efficiently, so I'm checking maps to figure out how to get to the event tonight.* (P28)

Similarly, participants use the phone to organise their private lives during work to help with nomophobia:

> *I'm gonna send a message to one of the groups and see if someone wants to do something. It's awesome. Because you know, in ten minutes you can make up a plan and enjoy the night. Which would be harder if you don't have your device.* (P17)

But distractions were also welcomed under certain circumstances. Many participants mentioned being more lenient with themselves and 'wanting to be distracted' after completing a task, or when the workday comes to an end ("Mentally, it's like: Oh, it's five! You've worked so much, you can be on the phone", P7). This depended on the type of work participants were doing, and could even carry on into the next day:

> *It depends on how interesting and close to my goals the things I'm doing are. If I finished or delivered something and the day after I'd go to work, I'd be really distracted and would probably use my phone more. Here I was doing an analysis and it was really difficult to distract me.* (P19)

Participants also enjoyed being able to briefly distract themselves whenever they want, and suggested that they evaluate these distractions based on the utility they gain:

> *But here I reach out for the phone and social media for a purpose, so it's okay, it's not just a waste of time.* (P4)

> *I feel like I'm scrolling for a long time, and I haven't found anything interesting. Which means that I have been wasting my time and start feeling guilty. At least I should be getting something interesting, otherwise it's obvious that I am not using my time wisely.* (P3)

7.6 DISCUSSION OF THE QUALITATIVE ANALYSIS

This analysis of the Replay-interviews shows the important role that smartphones play in the lives of young adults. While being engaged in a 'non-smartphone' line of activities, the smartphone always remains salient at a baseline, and occasionally intrudes in the other activities, both by 'making itself noticeable' through notifications, and by participants actively reaching for their phones for numerous different reasons, as elucidated above. More generally, it figures that participants are indeed in constant negotiation of how and where to spend their attention, as anticipated in the theoretical discussion. These negotiations were driven by self-regulatory goals revolving around the concept of *managing time wisely and efficiently.* As the supply of content and activities they could spend their time with greatly exceeds the resources they have available, participants appeared quite aware, both explicitly and implicitly, that their attention is a limited resource.

A closer look at the usage habits of participants revealed that most switches seem to occur from routines and habitualised behaviours. These routines consist of a mixture between intentional strategies and unintentional habits that have developed over time and can be generally separated into strategies that help participants avoid using the phone if they do not wish to do so, and engage with it when it is desired. When asked about these strategies and habits, most participants reported that they feel they use the phone too much and the phone has been described as a 'vice' which is pleasurable to indulge in, but which at the same time needs to be avoided to attain the daily goals.

At the end of the interviews we asked participants whether they had noticed anything in their behaviour they weren't aware of before (when this had not arisen naturally from the conversation already). Generally, the answers to this question were mixed, with some participants stating they thought they use the phone less than what appeared on recording (usually paired with negative valence), and some saying they saw what they expected (usually with neutral valence). The majority of participants, however, were surprised at the frequency with which they checked the phone, and the automaticity with which this occurred:

> *It's just this automatic thing. I don't remember getting my phone out. When I see that moment, I don't remember doing that [...] I feel as if to feel normal I have to have my phone next to me and I'm surprised that I keep checking it.* (P28)

As a methodological side note, this lack of awareness by the users of their own automatic behaviour illustrates and emphasizes the caveats about excessive reliance on user reports to understand the use of smartphones discussed in section 6.1. While we expected some differences between behaviour and awareness, we (and our participants) were struck by their amplitude. The quantitative analysis following in the next chapter will illustrate this further.

Lastly, all participants were quite enthusiastic about the SEBE-technique. When prompted in the Replay-interviews, they reported that they enjoyed being able to re-live their experiences, and that they discovered behaviours they had not been aware of before. All participants furthermore concluded that the Subfilm material they had gathered constituted an accurate and representative depiction of their behaviour, with many of them reporting that after wearing the camera for a short time, they were not conscious of it anymore ("Did you see that? If I had thought about the camera at that time, I wouldn't have thrown around the shampoo bottle like this!", P5). However, some participants, all of whom do not wear glasses regularly, reported that they were conscious about the camera at times ("The embodied way of the glasses is hard to miss", P4).

As a side note, this suggests that there is some interesting potential in the use of SEBE as a therapeutic tool to address smartphone overuse, at least to help users become mor aware of their behaviour and what triggers it.

8. GENERAL QUANTITATIVE ANALYSIS

After the qualitative analysis of the Replay-interviews, the Subfilms were coded quantitatively to triangulate participant comments with empirical observations of their actual smartphone use. Every time participants used their smartphones on tape, we recorded duration, time elapsed since last phone interaction, location, type of interaction, where the phone was in the physical space, the context they were in (e.g. working at the office, commuting), whether there was a notification (and if so, what type), and the nature of the activity (what they were doing with their phone and which apps they were using). When users switched between apps or functionalities within one continuous session of using the phone, we coded this as multiple interactions. Overall, this resulted in a dataset of N=1,130 smartphone interactions.

8.1 FINDINGS

We observe that smartphone interactions lasted 64.4s on average in our sample. Note that this value is affected by several substantially longer phone sessions caught on tape; 25% of interactions lasted 8s, and 50% 23s or less. The same picture emerged for the time elapsed between smartphone interactions, which averaged at 290.5s, with 25% of intervals between use being 40s, and 50% being 137s or less. Using these averages, our findings purport that participants engage with their phones for 10 minutes every hour in a ‘one minute every five minutes’ pattern (note that data collection was limited to waking hours of course).

The most frequent smartphone activity we observed in our sample was using WhatsApp, a popular messaging app in most of Europe, followed by the lock screen check, i.e., briefly activating the phone screen without unlocking all of the phone’s functionalities, and Instagram. Phone calls, text messages, and maps only made up about 1% each of the total sample (see *fig. 7*).

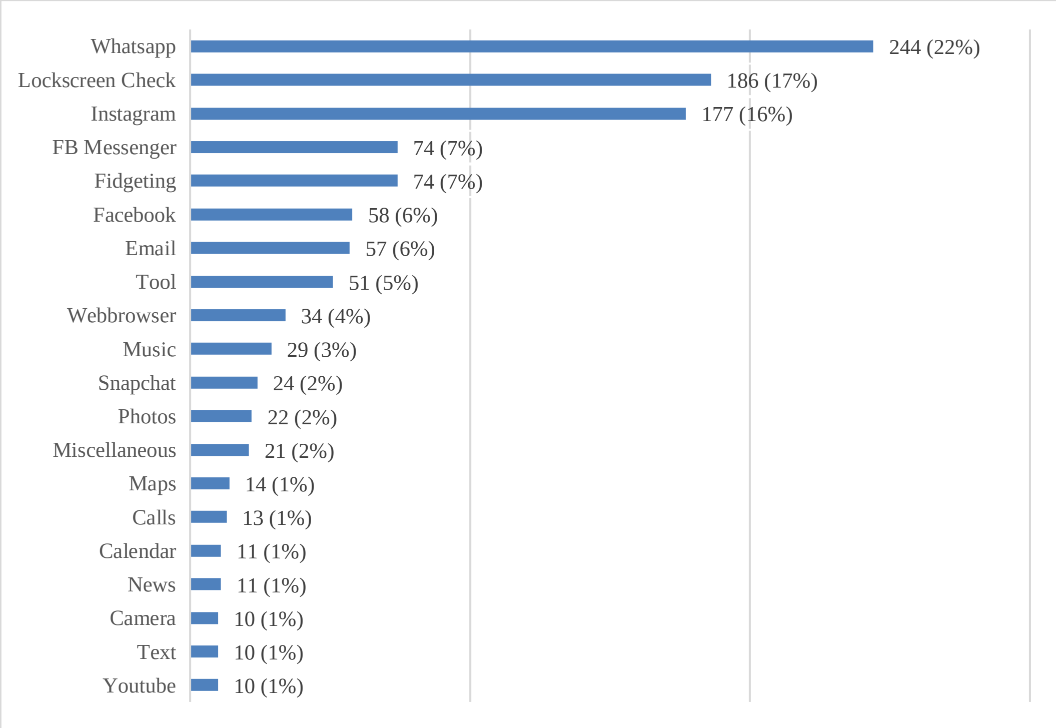


fig. 7 **Observed smartphone activity categories by frequency (Activities with a frequency <1% have been excluded).**

We then further investigated the relevant issues that emerged from the qualitative analysis using ANOVAs.[7] We find that smartphone interactions last longer when users were interacting with their phones before, compared to when they come from a non-smartphone activity (104s vs. 46s; β= 58.71, SD = 9.36, p < .001). This confirms the idea that users can get caught in a loop when they engage with their smartphones for longer sessions that include multiple apps. Furthermore, while the type of activity participants were engaged in did not significantly influence time between pickups, its influence on the duration of the smartphone interaction was highly significant. For example, interactions with Facebook (β = 113.74, SD = 19.73, p < .001), Instagram (β= 63.11, SD = 12.01, p < .001), as well as the phone's web browser (β = 199.15, SD = 25.17, p < .001) lasted significantly longer than other activities. These apps are prime examples for endless scrolling and getting caught in the loop as described by participants.

[7] Note that while the ANOVA is relatively robust, due to the nature of user behaviour the data is skewed and the Bartlett's/ Brown-Forsythe tests were significant, which warrants further investigation of the findings, for example with a larger dataset generated through server-logs. We have further controlled these findings using non-parametric tests such as the Kruskal-Wallis H test and Fisher's exact test, although it is worth noting that also non-parametric measures come with their problems as they are unfortunately prone to create type II errors, which we are worried about here. Nevertheless, the findings remain the same regardless of the method of analysis used in this case.

Our results also indicate that phone interactions last longer when users are alone as compared to being in company (β = 22.46, *SD* = 8.84, *p* = .011). Interestingly, the effect on time elapsed since last pick up is only marginally significant (β = -58.68, *SD* = 29.94, *p* = .05). This suggests that the overall notion that being on the phone is considered rude or undesirable when one is in company leads participants to spend less time on the phone, yet they still seem to feel the need to regularly check it.

Moreover, we find that the location users are in significantly influences the duration of smartphone interactions ($F(10, 1118) = 3.2$, $p < .001$), but not the time elapsed between interactions ($F(10, 616) = 1.46$, $p = .151$). Unsurprisingly, testing specifically for home and work as locations, we find that phone interactions last longer when users are at home (β = 42.53, *SD* = 8.77, $p < .001$) and shorter when they are at work (β = -36.02, *SD* = 10.29, *p* = .005), but even in these specific comparisons, we did not find a significant effect for time elapsed between interactions ($F(1,625) = 1.73$, $p = 0.189$ and $F(1,625) = 3.43$, $p = .065$, respectively). Further controlling for instances in which participants worked from home; they spent less time on their phones, as compared to other activity contexts at home (β = -59.05, *SD* = 16.94, *p* = .001), which suggests that the activity seems to matter more than the activity context. Overall, this again suggests that, while participants seem to engage in longer phone sessions in the comfort of their home and shorter sessions while at work, the intervals in which they check the phone are not affected by their location.

Most importantly, however, we observed that participants had their phones in silent mode or located out of noticeable distance in the vast majority of cases as 89% of interactions were user-initiated. Of the 11% of the interactions that were initiated by a notification, 59% were visual only, as compared to sound, vibration or a combination of these. In contrast, every sixth smartphone interaction in our sample was a lock screen check. These lasted 5.2s on average and entailed either returning to the previous activity, fidgeting with the phone briefly when no new notifications were available, or reading or skimming through notifications in case there were any. Again, only 15.6% of these brief checks were initiated through notifications, with 63% of them being visual only (for a detailed discussion of lock screen checks, see Paper 5, Appendix E).

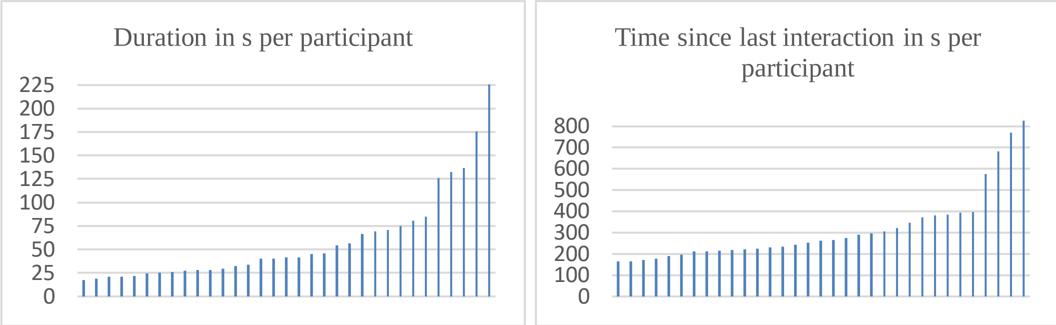


fig. 8 **Mean duration of smartphone interaction and mean time since last smartphone interaction in s per participant.**

Moreover, interactions initiated by users lasted longer on average than those initiated by devices (67s vs. 43s), suggesting that participants respond to prompts when their phones are calling their attention, but actively engage with them when they pick them up out of their own initiative. While this is aligned with the qualitative analysis, the observed difference is not significant in our sample ($F(1, 1127) = 2.73$, $p = .095$), suggesting further investigation is necessary.

When participants were working, significantly less interactions were initiated by the phone compared to when they were not working (7% vs 17%, $F(1,1128) = 26.49$, $p < .001$). Given that the intervals between smartphone interactions do not vary between working and non-working contexts, users actually self-interrupt more to attend to their phones while working, which is in line with previous research. In situations where notifications were not muted, there was no significant difference in response time across working and non-working activities ($F(1, 101) = .08$, $p = .078$). This evidence corroborates our participants' statements about regularly checking the phone out of habit, rather than being 'called upon' by the phone.

Lastly, we also controlled for differences between participants. Looking at individual participants we observe relatively homogenous usage patterns in our sample that lead us to believe the general findings adequately depict individual experiences (see *fig. 8*). For duration of interaction, roughly half of participants ranged between 20 and 30s, the other half between 40 and 85s with five outlier cases over 120s on the high end. While it is difficult to directly compare individual cases because of the unique composition of situations participants have recorded, one initial pointer for the source of these differences may be that the participants with significantly higher average durations recorded much more interactions that took place in public transport or at home (between 83% and 100% compared to 54% on average in the sample) than the rest of the sample, which we have found to be locations that are conducive to longer use. For time since last interaction a similar picture emerges with half of the individual means ranging between 165s and 250s, and the other half between 250s and 400s with four outliers at the high end again. Just as in our previous analyses, we did not observe any systematic variation from other participants in activities participants engaged in or locations they were in that can explain these outliers. It appears, again, that intervals between smartphone interactions depend on habits and internal motivations, not external influences.

8.2 DISCUSSION

Overall, smartphone use appears to be fast-paced and embedded into the other activities occurring in the flow of the daily lives of the participants. We find that interactions lasted 64.4s with 290.5s intervals between them on average, giving a 'rhythm of smartphone interaction' of roughly one minute every five minutes. These numbers reproduce the findings of Yan and colleagues (Yan et al., 2012), but are much lower than what two other studies have found (Van Berkel et al., 2016; Visuri et al., 2017). This shows, on a positive note, that SEBE is suited to deliver adequate and reliable quantitative data on the behaviour smartphone user. On the other hand, there still seem to be differences in the numbers researchers in the field obtain, and, more generally, both the 'lower' and 'higher' numbers for time between interactions reported in the literature are rather low in absolute terms.

As suggested in the literature, we also find that location and context influence how much users interact with their phones. Crucially, however, while participants usually reported being more on their phone when they were in leisure and less when they were in work settings, the quantitative analysis reveals that it is only the duration of smartphone interactions that is shorter when participants are working, while the intervals between interactions remain unchanged. The same picture emerges for being in company, which again only results in a reduction in duration of interactions, not a change in frequency. This suggests that participants were sincere when they expressed that they find it rude to be on the phone when other people are around, and that they do try to be on their phone less when they want to be productive, but it is also clear that participants underestimate just how routinised, habitualised and 'automatic' frequent smartphone interactions have become in the flow of their daily activities.

This initial analysis has uncovered some alarming numbers regarding the duration, frequency, and the situational invariance with which users interact with their devices. Especially the automatic and regular interactions that participants had described in the interviews appear to be resting on deeply internalised habits that withstand most contextual influences. It, thus, becomes very clear how important situated data on smartphone use really is, as the context in which the interaction with the device takes place appears to be crucial for how the nature of the subsequent interaction with the device unfolds.

But it is also clear that just looking at whether or not a notification had triggered the interaction, how long it was, or the location participants were in only scratches the surface. To truly take context into account, and this has not been done in the literature so far, a detailed analysis of the situations and actions immediately preceding the interaction with the smartphone, and of how different antecedents may lead to different outcomes in terms of app use and activities that users engage in on their devices appeared necessary. We have, thus, in a second step, reviewed the Subfilms once more and analysed the moments immediately preceding smartphone interactions in our sample in detail. We present this analysis in the next section.

9. MULTI-DEVICE USE WITH THE SMARTPHONE

After this general analysis of smartphone use, we now focus on situations in which participants used multiple devices at the same time, both to understand differences between multi-device use and single-device use, and to describe and analyse patterns and usage habits for the various contexts and assemblages of different devices we have observed in our sample. It is important to note here that we did not observe single use of other devices than the smartphone, or multi-device use that did not involve the smartphone in some way in our sample, which will be discussed further below.

9.1 QUANTITATIVE ANALYSIS OF MULTI-DEVICE USE

To look at the use of the smartphone in combination with other devices, we reviewed the subfilm data once more as a first step and recorded whether participants were using the smartphone only, or whether they were using multiple devices at the same time, for every instance of smartphone use we observed in our sample. We then investigated the relationships between single- and multi-device use with other key variables of smartphone interactions using non-parametric tests (Fisher's exact test and the Kruskal-Wallis H test where appropriate).

9.1.1 ANALYSIS

Our participants engaged in multi-device use with smartphones in a variety of contexts and situations, and in various different assemblages of devices in our sample. Overall, 60.4% of smartphone use in our sample occurred in multi-device settings; in the remaining 39.6% of instances, smartphones were used without other devices. Of this use of the smartphone in conjunction with other devices, roughly three quarters occurred in conjunction with a computer (74%), 12.6% with a television set, and 7.5% with a tablet. On rarer occasions, participants used three devices at the same time: in 4.2% of cases participants were using two phones and a computer, in 1.8% of cases, they used their phone, a television set and a computer (see *fig. 9*).

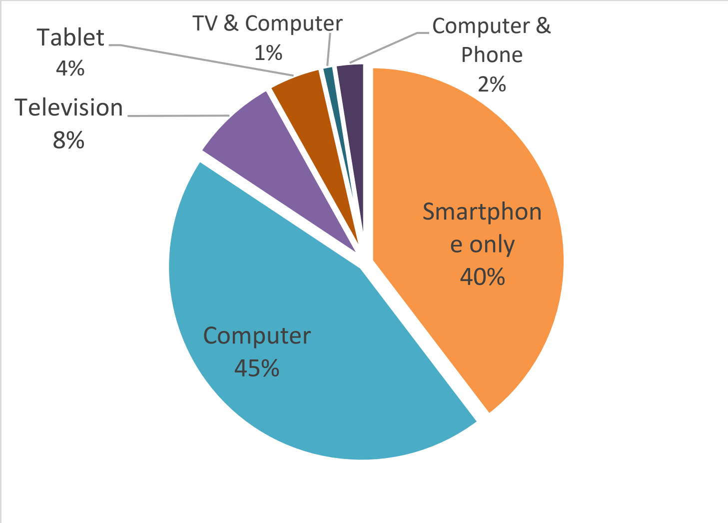


fig. 9 **Proportion of smartphone use in combination with other devices in our sample**

First, we tested for a relationship between the duration of smartphone interactions as well as the time since users had last interacted with their phones and multi-device use. We did not observe a significant difference for the duration of use (32s vs 34s, $H(1) = .578$, $p = .447$). For time since last interaction, however, the results are highly significant with the mean interval between interactions being 27s longer when participants were using other devices as well (148s vs 175s, $H(1) = 6.457$, $p = .011$). We further, do not observe a difference in the number of apps used per smartphone use session between individual smartphone and multi-device use (1.44 vs 1.36, $H(1) = .436$, $p = .509$).

Second, we find a significant interaction between notifications and multi-device use in our sample ($p < .001$). While 7.1% (37/518) of interactions were initiated by notifications when participants were not using another device, 13.3% (105/789) of interactions follow notifications when users were using another device as well.

Third, we looked at the influence of the location participants were in on multi-device use. Multi-device use occurred significantly less when participants were in public transport (5.8% (3/52) vs. 62.6% (786/1255), $p < .001$) or when they were outside (13.5% (10/74) vs. 63.2% (779/1233), $p < .001$), and significantly more when they were at work (86.5% (238/275) vs. 53.4% (551/1032), $p < .001$), but we did not observe a significant difference in multi-device use when participants were at home compared to other contexts (61.7% (481/779) vs. 58.3% (308/528), $p = .119$). Regardless of the location, when participants were working, they were much more likely to be using multiple devices (compared to when they were not 91.5% 482/627 vs. 39.4% (307/780, $p < .001$).

Fourth, we have also looked at the association between the most common uses of the phone and applications used in our sample and multi-device use. We do not observe a significant differences in the use of messaging apps such as WhatsApp (20.8% (108/518) vs. 21.7% (171/789), $p = .388$), or facebook messenger (6.8% (35/518) vs. 5.8% (46/789), $p = .285$); social media apps such as facebook (5.6% (29/518) vs. 5.3% (42/789), $p = .461$) or Instagram (16.2% (84/518) vs. 14.4% (114/779), $p = .214$); as well as Email (4.2% (22/518) vs. 6.1% (48/789), $p = .093$), the web browser (4.4% (23/518) vs. 3% (24/789), $p = .120$), and tool apps (e.g. weather, Shazam; 3.3% (17/518) vs. 4.9% (39/789), $p = .094$). The only significant difference between single- and multi-device smartphone use we observed were brief lock screen checks, which occurred more often when participants were using more than one device 12.7% (66/518) vs. 19.6% (155/789), $p = .001$).

9.1.2 DISCUSSION

Our quantitate data show that smartphone interactions do not differ in length between single and multi-device use. We further do not find a difference in the frequency of use for any of the most common uses of the phone in our sample such as messaging and social media apps, or the use of the device as a tool. This suggests that the actions and activities people engage in with their phone remain largely the same whether participants used the phone on its own or in combination with other devices.

We do observe, however, that the intervals between instances of smartphone use were significantly longer when participants were using other devices at the same time. In conjunction with the finding that multi-device use is much more likely to occur when participants were working and significantly less when they were on the move, it appears that this relates to the fact that the majority of our participants were either knowledge workers or students. As mentioned in previous chapters, participants often use the phone to manage their schedules and other parts of their life during short breaks of their main work activity. Consequently, the longer intervals between smartphone use in contexts of multi-device activity can be attributed to situations in which participants were using their phone intermittently while focusing on their work on a computer or tablet.

In this context, it is also not surprising that we observed slightly more instances of brief smartphone interactions and locked smartphone use (see Appendix E for a detailed discussion) when participants were engaging with more than one device, and that notifications were more likely to lead to interactions in these moments. Again, participants frequently use brief lock screen checks as well as notifications to stay up to date on incoming information on their phones while being engaged in another activity. When working with another device such as a computer or a tablet, but also when watching TV, participants usually place their smartphone visibly and accessibly next to themselves, which increases the likelihood of notifications to be noticed, and the opportunities to engage with the phone when an opportune moment occurs in the flow of their activity.

9.2 QUALITATIVE ANALYSIS OF MULTI-DEVICE USE WITH THE SMARTPHONE

Having provided a general quantitative description of our observations, we then turned to the interview data, and the situated moments of multi-device use our participants have recorded with the subcams more closely. We have observed various complex assemblages and kinds of distributed device use in the subfilms that provide a nuanced picture of multi-device use both in terms of the use of devices, and in the way participants combine the use of multiple devices and switch between them. Generally speaking, we have observed three modes of multi-device use in our data: 1) multi-device work, 2) multi-device entertainment, and 3) mixed use of devices for different purposes. In the following, we present an analysis of these three modes based on the subfilm data and the replay interviews, and we illustrate this with three individual journeys of multi-device use our participants engaged in.

fig. 10 **Various instances of multi-device use during work (top left to bottom right): Sharing a photo of a document with a colleague while writing, coordinating a meeting with friend while reading, using the phone as a calculator, recording a video-conferencing call with a smartphone.**

9.2.1 MULTI-DEVICE-WORK

As we found in our quantitative analysis, multi-device use was much more likely to occur in our sample when participants were working. This is not surprising given that the majority of our participants were either students or knowledge workers. Consequently, many of them used a computer or a tablet as their main tool for work, and their smartphone to supplement their work, or to manage other aspects of their lives, as discussed in chapter 8. *Figure 10* shows some examples of this. The smartphone was often used as a simple means to communicate with work colleagues in our sample. Messaging apps like WhatsApp and Facebook messenger seem to have superseded Email for communication with close colleagues, often also because they directly integrate the capacity to record multi-media content and share it with multiple people (see *fig. 10,* top left). Moreover, these uses of the smartphone as a tool and multi-media recording device were utilised beyond messaging, and the phone thus acted as a recording device, note pad, calendar, calculator, etc. while participants engaged with their main work activities on another device (see *fig. 10*, bottom row). Finally, smartphones also afforded participants to take short breaks to coordinate their lives with others while they were working, as discussed in detail in chapter 8 (see *fig.10,* top right). It is important to note that we did not observe use of the phone as the locus of the main work activity with other devices being used to supplement the activity in our sample.

Figure 11 gives an overview of a session of multi-device work. In this sequence lasting roughly 1.5 hours, P12 is working on a laptop at a large co-working desk with two smartphones placed visibly and facing up, as well as several notepads and journals, a water bottle, and a tub of lip balm besides the laptop. Phone A is the participant's private phone and phone B is her work phone; both devices are muted, but their screens light up when notifications arrive. In the interview, P12 mentioned that this is a typical way of how she would arrange her desk space and that she scatters her things widely so nobody sits next to her and distracts her while she is working.

The sequence starts with P12 setting up her workspace and waking her laptop (1). She then briefly checks phone B and proceeds to her first work goal, filing receipts from a business dinner with her employer to be reimbursed for her expenses. To do so, she arranges the receipts on the desk and sends a photo from phone A to phone B (2). This is an interesting solution to quickly move images from her phone to her computer she has developed: rather than opening the image on phone B, she proceeds to log into WhatsApp on her computer to access it directly on the machine where she needs them (3). Unfortunately, a problem with the file occurs and it does not download properly so that she moves back and forth between phone A and the laptop several times trying to fix the issue before deciding to email the photo to herself. This solves the problem and she proceeds to file the receipts, which takes about 15 minutes (4). In the interview, P12 remarked that she was frustrated with the filing process and the duration of it: "I'm still doing receipts here, it's incredible. It takes ages to do that, but I need to get paid back, and I actually have to do this quite often".

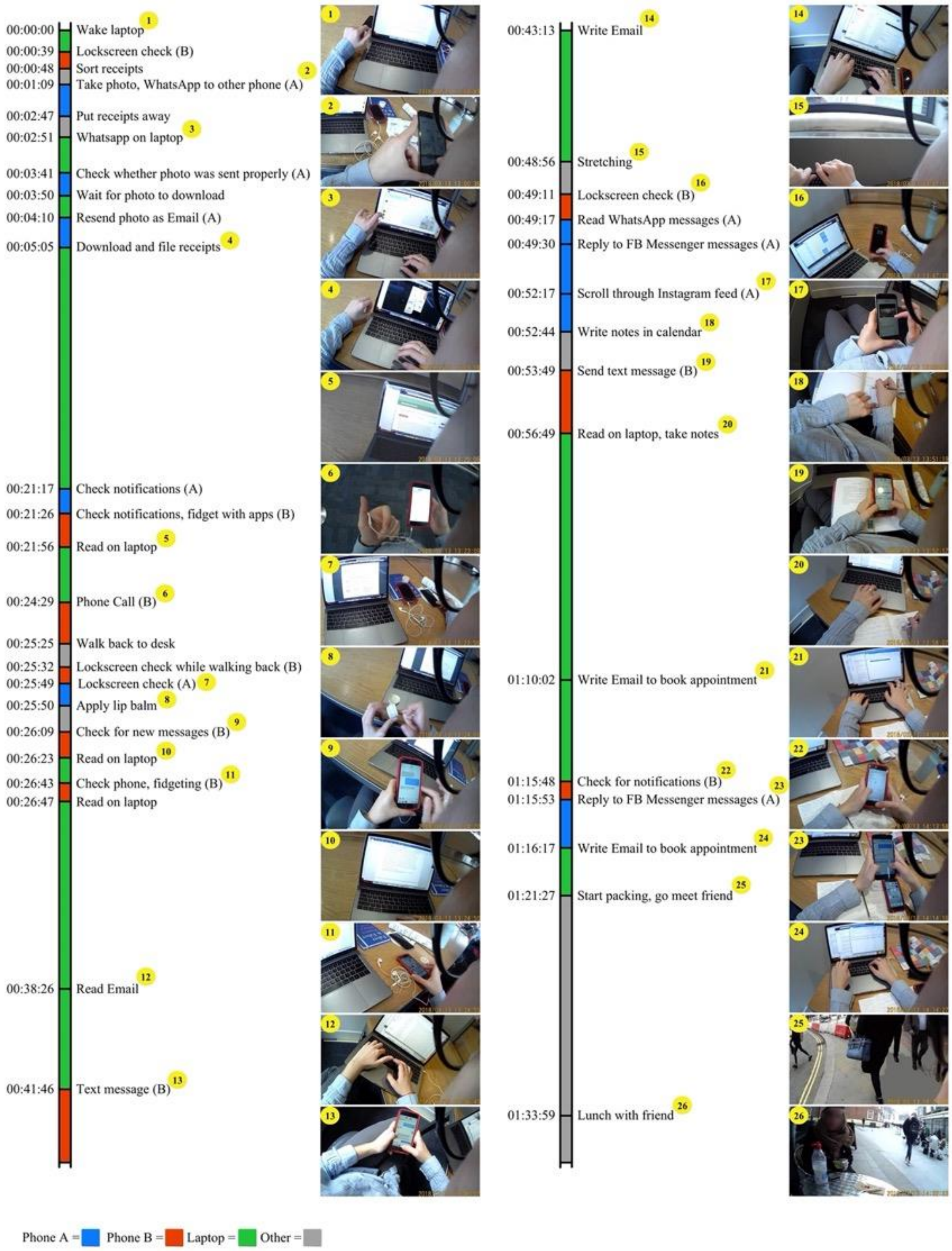


fig. 11 **Timeline of a 1.5h session of multi-device work at an office.**

After filing the receipts, she proceeds to check phone A for notifications first and then phone B with which she is fidgeting for a while by playing around with the apps on the touch screen. P12 exhibited surprise about this in the interview:

> *"I don't know why I just did that! It happens often when I've just been on my phone. So I wasn't just using it to procrastinate, I was actually using it to do something that was useful, but then, there's just this feedback loop, you know, and you have to... linger a bit".*

She then proceeds to read a document on her laptop (5). After about 2.5 minutes, she notices that the screen of her work phone (B) lights up because she has missed a call. She immediately gets up from her seat and tries to return the call (6). This action fails, however, because the caller had supressed their number, and it takes her a minute to realise that she will not be able to return the call. Upon sitting down when returning to her desk, she checks phone A (7), applies some lip balm (8), and continues reading on her laptop while intermittently checking phone B to see whether a text message or another call arrives ("I'm wondering who the hell called so I'm checking. Pointless! Pointless!").

After about 12 minutes of focused reading, she switches to reading and replying to her Emails for about 5 minutes (12, 14; "I get quite a few Emails, so I should probably check them now"). She then takes a break, stretching and looking out of the window for a moment (15) before picking up her private phone (A) and replying to a message from a friend who is asking her to have lunch together. P12 agrees and briefly scrolls through her Instagram feed (17).

She then takes some notes (18) and replies to a text message on phone B (19), before reading on her laptop and taking notes on a notepad for about 15 minutes (20) and writing an Email to book an appointment for about 5 minutes (21). In the interview, she commented on this longer period of focus on the computer: "Here I'm focused because I'm about to go for coffee, and I want to get as much work done as I can since I'm about to leave". After that P12 checks phone B for notifications, before picking up phone A (22, 23; "It's always, like, if I look at one [phone] it's hard not to look at the other I guess"). On her private phone she finds that her friend has sent her several messages saying that she arrived at the location. P12 responds to her friend, apologising for being late and assuring her friend she will be there soon (23). Nevertheless, she then returns to her Email for about 5 more minutes before packing up her things and meeting her friend for lunch (26), which ends the sequence recorded on the subfilm. In the interview, P12 commented:

> *See, I have three messenger Notifications from my friend, she's like "Where are you?" And I go, "Hi, I just typed an E-Mail, I'll be right there". And then I keep on writing that E-Mail and then I was late (laughs). It takes so long, but I wanted to get this done.*

An interesting observation throughout the sequence is that P12 used WhatsApp and Facebook messenger to communicate with her personal phone (A), and calls and text messages when she is using her work phone (B). As suggested by many of our participants, social media apps seem to constitute a more personal form of communication than the traditional phone affordances that use the cellular network.

9.2.2 MULTI-DEVICE ENTERTAINMENT

We also observed many instances in which participants were using multiple devices for entertainment, leisure, and any other non-work related activities. This usually occurred when participants were in their or someone else's private home. Like for multi-device work, participants often use the phone for brief moments but in regular intervals in these situations while a computer, laptop, or TV provided the main source of entertainment and was in the focus of their attention. In these cases, the phone was commonly used for communication, for example to get feedback from a friend on a piece of furniture the participant intended on buying (see *fig. 12*, top right), or it provided some distraction or additional information, as when one of our participants used his phone to look up further news on a story from the sports segment of a show he was watching that had just ended (see *fig.12*, bottom left).

However, the smartphone sometimes is also the main focus of attention during multi-device entertainment, usually with another device playing video or music in the background. An illustrative example of this is shown in the bottom right image of *fig. 12*. The participant is watching cartoons with her son, both waning to spend time with him and monitoring the content that was being consumed. Because the show itself was not interesting to her, her personal focus remained on the smartphone mostly, on which she was scrolling through Instagram.

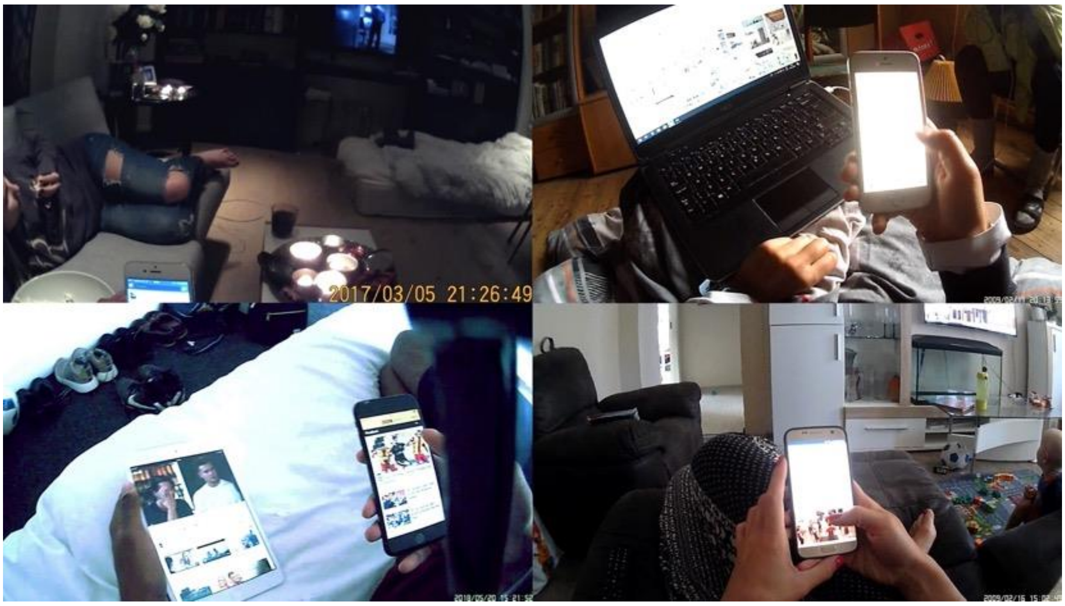


fig. 12 **Various instances of multi-device use for entertainment (top left to bottom right): Scrolling through facebook while watching a movie, replying to messages while doing online-shopping on a computer, reading news on a phone while watching a video on a tablet, scrolling through Instagram while watching TV with a child.**

Figure 13 depicts a sequence of multi-device use for entertainment. In this sequence lasting just under 2 hours, P15 is having dinner while watching Netflix on a laptop at a desk at home, using his smartphone to access social media and to play games at the same time. The laptop is playing sound through the internal speakers. The smartphone is muted, but has a flashing light displaying new notifications and is sometimes placed next to the laptop on the desk, but mostly held in hand by the participant. P15's desk is quite cluttered and in the interview he commented:

> *My room is not exactly big, and I'm not the best at organising stuff. I usually don't care what goes where, but I would clear out some space for the laptop because I don't want anything falling on my lap while I'm sitting there. And at the end of the day I know where things are - on my desk.*

The sequence starts with P15 finishing up reading a document on his laptop (1). He then logs into his Netflix account on the laptop and begins watching a show while eating dinner for roughly 9 minutes (2). After washing his hands (3), P15 then picks up the phone and checks his Emails and WhatsApp messages with Netflix playing in the background before he eventually proceeds to playing various games on his smartphone (4, 5). In the interview, he commented:

> *It's crazy, I haven't played that game in a while now. I used to play this game all the time but now I play Sudoku and haven't touched this one since. So it sort of shows how quickly I've moved along and how my interests have shifted in gaming as well.*

The interview was conducted 11 days after the participant began filming, supporting these sentiments. P15 continues to play games for about 35 minutes with multiple episodes of the show he is watching playing on the laptop in the background, before eating a bit more (6) and smoking his vape. When he returns to his phone, he turns to Instagram for about 8 minutes, watching stories first and then scrolling through the feed after answering a brief phone call with his brother (7). He then puts the phone away and vapes while watching Netflix on his laptop. Interestingly, he uses the phone to look up an experiment that is mentioned in the show he watches (8; "The Big Bang Theory" which revolves around the lives of several physicists). In the interview, P15 commented: "They were mentioning a psychological experiment and I thought, hey, that's something in my area, so I looked it up."

He then continues to watch the show and refills his humidifier (9). The recording was filmed during summer and the participant noted: "I usually change into these clothes when I'm home [shorts, t-shirt] and I turn on the humidifier because it's extremely hot and dry in my room". After that, he switches between replying to messages from his friends (10), watching the show (11), and vaping for about 15 minutes. Finally, he plays games on his phone for about six more minutes (12) before switching to facebook and watching videos (13): "So, facebook is a lot of sports for me. I recently have become into snooker, and since then I've been sort of expanding my knowledge of it. Football is very common, too, especially here in the UK." This is where the recorded sequence ends.

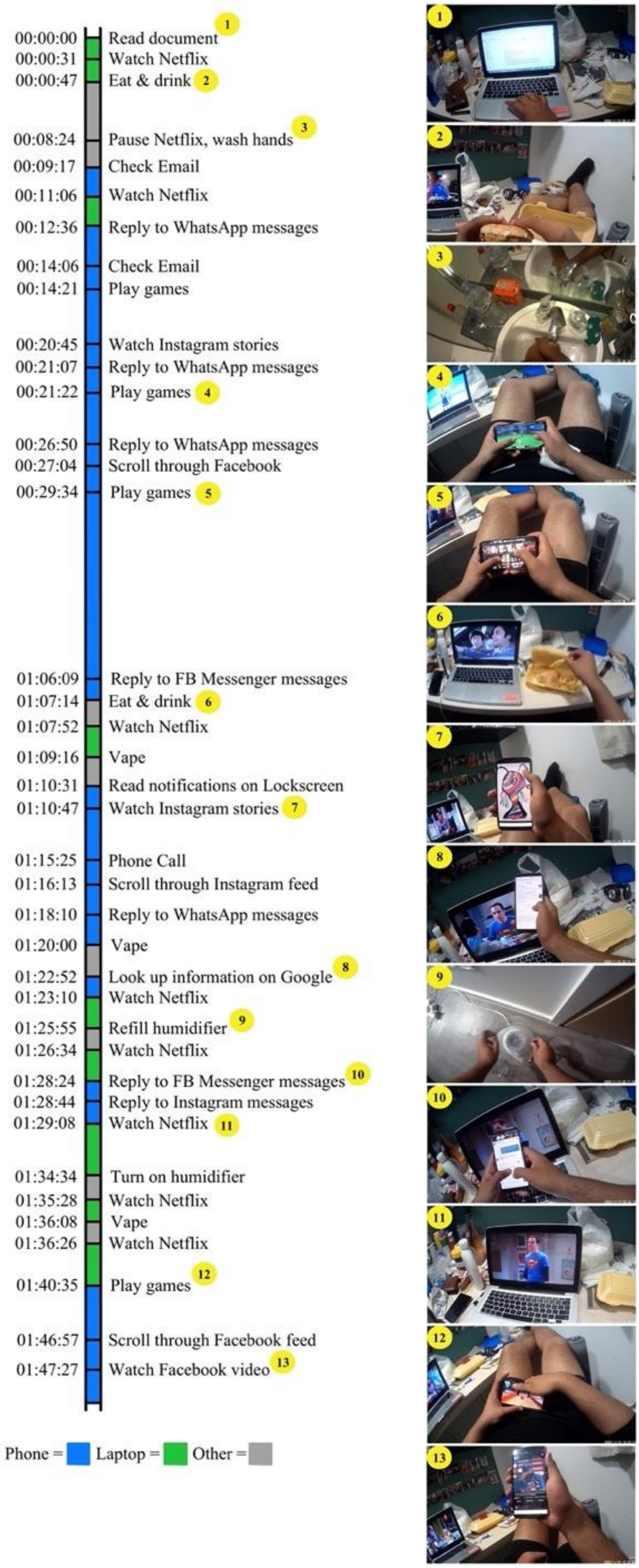


fig. 13 **Timeline of a 2h session of multi-device entertainment at home.**

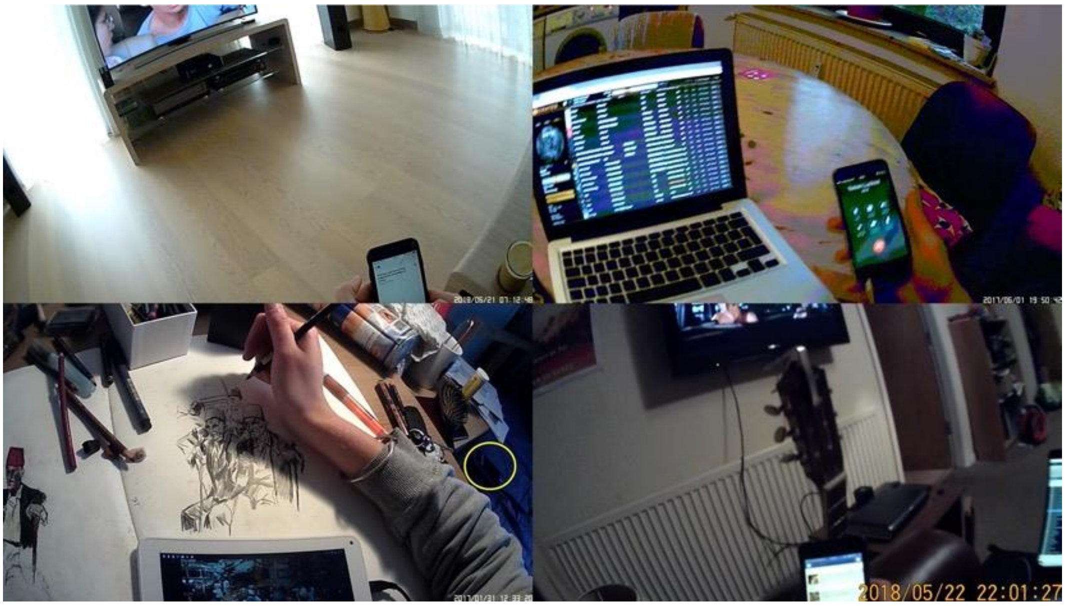


fig. 14 **Various instances of mixed multi-device use (top left to bottom right): Replying to an Email while watching TV, business call while browsing music, listening to music on the phone while copying images from a tablet, Replying to messages on the phone while working on a laptop and watching a film on the TV.**

9.2.3 MIXED MULTI-DEVICE USE

Finally, we also observed instances of multi-device use in which some devices served work, and some devices served entertainment purposes. Naturally, the lines between work and entertainment are not perfectly clear-cut. Overall, mixed use most commonly occurred with the work device being the main focus of attention and another device providing entertainment or distraction in the background. Typical situations comprised participants using their phone to play music (see *fig. 14*, bottom left), or a TV playing a film in the background (bottom right), while participants were working. We did, however, also observe the use of the phone as the main work tool in mixed settings: *Figure 14* shows one participant answering work Emails while watching TV on his sofa (top left), and another participant browsing a music streaming service on his laptop during a work call, intermittently muting his microphone to preview songs (top right). The intensity of work during mixed-use moments tended to be lower compared to multi-device work, with mixed use often occurring when participants were working after hours or from home.

Figure 15 depicts a sequence of mixed multi-device use for entertainment and for work. In this sequence lasting about 1 hour, P40 is working on her sofa in her living room in the evening. She uses a laptop for work, a television for entertainment, and her smartphone for both work and entertainment. The smartphone is muted completely and does not deliver any type of notification ("I think it's 11 p.m., it automatically goes on do not disturb mode where everything is just, basically I won't receive any notifications). When asked about the use of three devices at the same time, P40 commented:

> *So I do it to supplement the news and other stuff that's going on. That is what usually happens, because I find it extremely hard to focus on one thing. I find myself more comfortable when I sort of distribute my attention for some reason. I don't know if that makes sense, but that really contributes to my productivity somehow.*

The sequence starts with P40 hanging up her laundry (1) and sitting down on her sofa where her phone was lying. She then begins her smartphone session by watching Instagram stories for about two minutes, before turning to a news app (2). After about 11 minutes, she turns on her television and tunes into the news:

> *This is where I get really deep into the news. It's the end of the day, I'm trying to see what has happened today in the world. And there was this thing that happened with a journalist in Iran today, I don't know why I was so obsessed with this, but I found it quite interesting and had to see everything.*

P40 continues to watch the news on her television for about five minutes with two short interruptions of using the phone to read a news article and to look at some photos (3) for about one minute each. In the interview, she commented:

> *I'm actually looking at pictures of the document I'm working on at the moment. I sent the first draft to my father to ask for his opinion as a general reader. And what he did was that, well, he's from another generation. So he had actually printed out the document and made some edits with a pen and sent me photos of it. Which is a bit funny, but I mean I can't really - he's from another generation.*

After this, she fully focuses on the television for about ten minutes. P40 then picks up her laptop about halfway into the entire sequence and begins to work on a document with the television playing in the background (5).

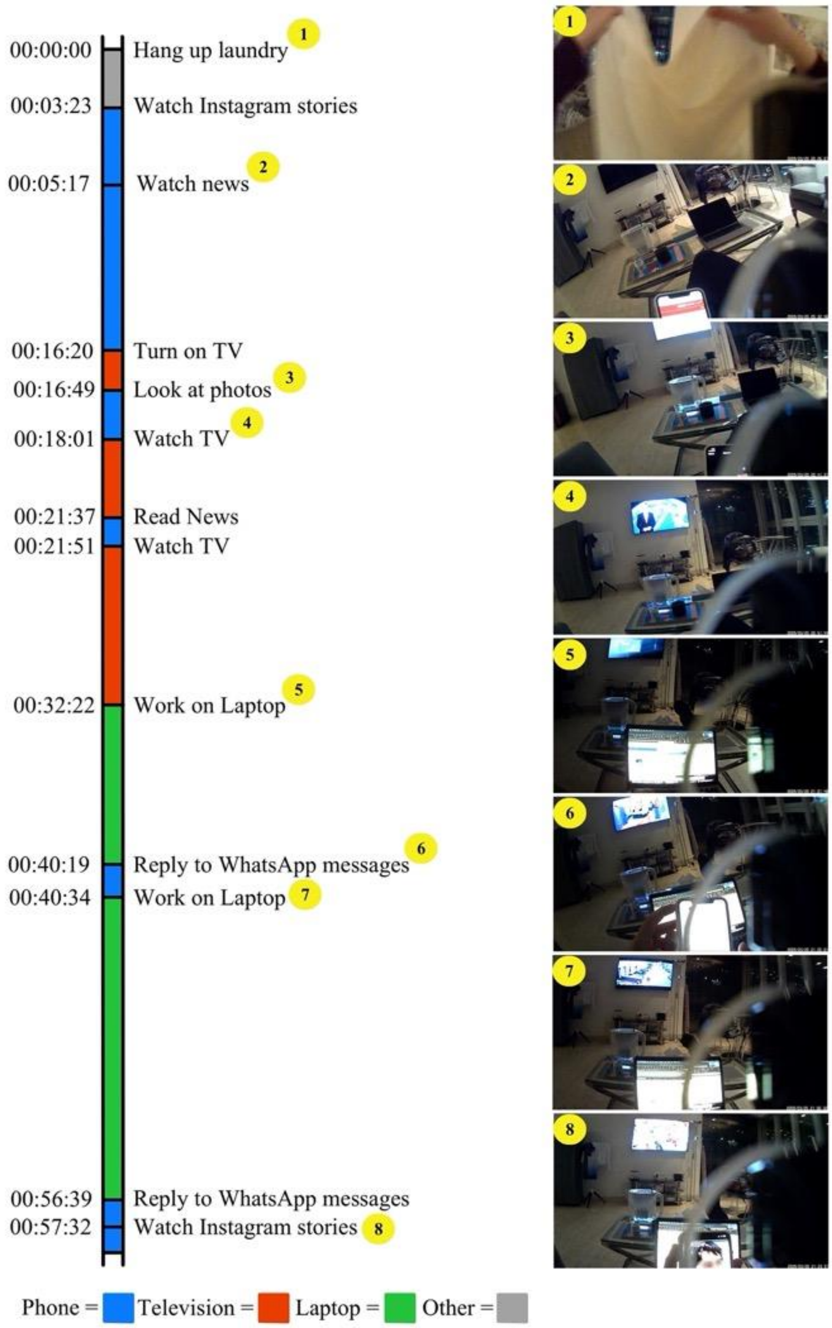


fig. 15 **Timeline of a 1h session of mixed multi-device use at home.**

After about 8 minutes, she replies to some WhatsApp messages and puts the phone down next to her with her photos opened.

> *OK, so here I'm a little bit tired, but I don't want to finish work yet. I just need a few minutes. If I put down the laptop and get up, it's going to be a longer break than I intend for it to be. So I'm not going to get up. I just need like a few minute break. And so what's there for a few minute break? My phone is there and Instagram is there. And I'm not*

> *really a social media person, I don't really enjoy it. So usually scrolling through social media is like a two minute, three minute thing for me. So I think 'OK, that that sounds great'. And I pick up my phone and go on Instagram to have a really short break.*

This continues for about 15 minutes before the sequence ends with P40 taking a deep breath and picking up the smartphone to reply to more messages on WhatsApp, and to watch stories on Instagram (8), which is where the recording ends:

> *Apparently I need another break. I think I'm finished with editing the essay. So if you hear me do that [breathing], that's definitely the cue that I need a break, which is why I reach out to get my phone and go to Instagram.*

9.3. DISCUSSION

Multi-device use of the smartphone in combination with other devices made up about 60% of all instances of smartphone use in our sample. We have observed many different moments of multi-device use, and it is very evident that the role the individual devices play in different situations varies greatly. While TVs were used exclusively for entertainment and mostly in the background, computers, tablets and smartphones fulfilled a variety of work, leisure, and entertainment functions. Unlike the interpretation our quantitative findings would suggest, multi-device use with the smartphone does not always revolve around another device with the smartphone acting as a supplementary or communication tool; we frequently observed other devices supplementing the smartphone as the main focus of activity as well.

Strikingly, we did not observe single-device use of other devices than the smartphone. The closest other devices got to being used 'on their own' in our data is in situations where the smartphone was used only briefly when participants checked for notifications in longer intervals. Nevertheless, within one session of device use or activity like watching a film or working on a laptop, participants always used the smartphone in our sample eventually. This opens up an interesting discussion of what constitutes 'using a single device', or the minimum-threshold for multi-device use. From our observations, we are inclined to argue that even if the phone is used once or twice during one instance of the use of another device, this should be considered multi-device use, because the smartphone nevertheless remains salient through its mere presence, and the possibility of notifications being delivered constitutes one of the key uses of the smartphone; that is, monitoring incoming information. In a way, this analysis of multi-device use has not only shown that the smartphone always tends to be in the mix, but also that in contexts of multi-device use, and particularly work, not using the smartphone (in a physical sense) can still constitute using the smartphone (in a general sense) and often this is precisely its use for participants.

Typical assemblages of devices during multi-device work are a computer or a tablet on a desk with a smartphone next to it plus other notebooks or relevant tools. It is to be noted, however, that we did not observe the phone as the locus of the main work activity with other devices being used to supplement the activity in work contexts in our sample, only in instances of mixed use. This may be simply attributed to hardware factors; the smartphone tends to have a smaller screen, less powerful information input technology, as well as less storage and computing power than computers or tablets (although this may change in the future). Consequently, when participants want to fully engage in work, they do so on a device they consider more capable than the smartphone. However, this may also have to do with the learned and embodied way of using the device and a resistance to using the phone for work, either because the phone is not perceived as a capable work tool per se, or because people believe they are unable to accomplish as much on the phone as on a computer, for example ('I need a real keyboard'). Whether this resistance to using the phone as a work tool is due to technological shortcomings of the device, or only stems from the representations requires additional investigation, and could be an interesting route for design to further integrate form factors. Since the phone has already found widespread use as a work tool in other professions, and given that our sample mostly contains knowledge workers and students, looking more closely at this group and drawing comparisons to professions who have successfully integrated the device into their work can be instructive.

We also observe different patterns of engaging with multiple devices at the same time, mainly dual-tasking and task-switching. Multi-device work tends to go along with task-switching between different threads of activity that participants pick up, leave, and return to intermittently (see Yeykelis et al., 2014, 2018 for a detailed discussion). In this context, different devices attract the attention of users (through a notification for example), but also the context and natural break points in the flow of activity can lead to switches between activities and devices (see *fig. 11*, 15). Further illustrative examples of this can be seen in Figure 11 between (6) and (11), when P12 is trying to figure out who has called her while returning to work, or (14) and (20), where she alternates between writing an Email, reading a document, organising lunch with her friend, and using the phone to take a small break.

Multi-device entertainment, on the other hand, tends to be more associated with dual-tasking, with one medium taking slight precedence over the other, but also often entails task-switching. Unsurprisingly, participants tend to focus more on interactive devices like smartphones and tablets while background devices tend to play some form of media that can be consumed passively. In this vein, we also observe that the 'first' interaction with the phone after entering an entertainment context is often relatively long and participants tend to 'exhaust' all apps they can engage with or check. This is underlined by P26 who commented in her interview:

> *Yeah, I go through all the apps and check what's there, but because I've already seen everything I'm back on track. Nothing new. I always think I'm the first one to see things on Instagram because I'm scrolling and refreshing.*

Figure 13 illustrates this pattern, with P15 using the smartphone for just under an hour in one intensive usage session (5) before focusing on the laptop again and returning to an alternating pattern between activities and devices again, which more closely resembles task-switching (6). Note that in this case Netflix is playing on the laptop throughout the entire sequence, and the phone and other objects and activities come in and out of focus. This finding of the phone being used until participants have exhausted both novelty and entertainment also echoes participant sentiments of the phone as a 'vice' they indulge in (P19), and the positive anticipation to "having access to what's on the phone" (P24). On a side note, we observed that aimless scrolling and fidgeting with the smartphone often occurs when the phone is the secondary focus of attention but participants keep it in their hands while engaging with another device.

Mixed use is equally associated with both task-switching between threads of activities and dual-tasking in our sample, depending on the specific context, with the 'entertainment' device playing media for passive consumption in the background being the secondary focus of attention, but drawing in participants when there is a particularly interesting passage (such as a song or news segment).

Overall, we therefore observe that multi-device use, and particularly the smartphone, plays an important role in helping users to transition between different activities. In *fig. 15*, P40 is doing laundry (1), then uses the phone and the TV for entertainment (news; 2, 4), but also starts having a look at the photos her father sent her which are relevant to her work (3). This marks the point where she slowly begins to transition from entertainment with the television and her smartphone to fully working with her phone and the laptop (5). Commenting on this moment in the interview, P40 said:

> *I'm not sure why I pick it up exactly, but yeah, I basically use it as a transition phase from leisure mode to work mode here.* (P40)

Similarly, P12 uses her phone when she switches from filing receipts to reading (see *fig. 11*, 4, 5), and from writing an Email to reading again (14, 20). Multi-device use also allows users to take a break from a work screen - with another screen, which may seem a bit paradoxical at first:

> *This is why I really enjoy having multiple sort of screens on, because every now and then I can take a break from what I'm doing. And since I live alone and that can get quite depressing. I sometimes have the TV on and take short breaks from the screen that I'm working on. Yeah, sometimes I take a break from it with my phone, sometimes it's with the TV, really depends. (P25)*

> *It's eleven already, but I wanted to get some more work done. Usually by midnight I'm going to bed. So, I thought walking around might help because I was just tired, and I went to my iPad for a bit to read.* (P4)

It, thus, appears that the notion of 'needing a break from the screen', which has been mentioned by the majority of our participants, and also has gained general acceptance in everyday language use may actually be a bit more nuanced than it initially appears. As we observed that our participants are usually happy to engage with another device during that time, the narrative of 'relaxing the eyes' or 'getting away from the machine' may not be applicable to many of those screen breaks.

Instead, work takes place on the computer and is located in the machine; the 'screen' seems to have become synonymous with work for our participants. This has interesting implications in turn for how they think about taking breaks: Rather than taking a break from work, because one does not want to work or is tired of it, one has to take a break to get away from the screen, which is something that almost follows from biological necessity. In this way, it is much easier to justify taking breaks during work, to cope with cognitive dissonance around achieving work targets, and even to rationalise procrastination. Clearly, however, this does not seem to be the case, as participants are able to engage with another device's screen during these breaks without any problems. This finding around 'needing a break from the screen' is therefore especially relevant when it comes to smartphone overuse based on habitual engagement patterns, as well as reduced work productivity.

Overall, we observe multi-device use as complex usage patterns with participants engaging with various different assemblages of devices throughout their daily lives. The smartphone often plays the role of a transitional device that allows managing different threads of activity our participants were engaged in intermittently. The combination of different devices and their affordances enable users to perform more complex work tasks involving analogue and digital activities and materials (P12 filing receipts, see *fig.* 11, P40 receiving physical notes, see *fig.* 15), but also to get smaller tasks done on the go and in non-work contexts (see *fig. 14*).

During multi-device use in leisure or mixed contexts, we also observed the strength of the smartphone as a cognitive attractor, where it usually captured the full attention of participants until they had exhausted their interest in the device before they returned to a pattern of intermittent interactions with the smartphone. Other devices only provided ‘background’ ambience until participants were finished with using the phone, and we observed several instances, in which participants proceeded to rewind a movie or show that had been playing, because they had not caught what was happening:

> *I actually remember I was checking and I missed like basically the entire first scene. So I had to put the film back to a certain point. It’s just a passing thing I am used to do with the phone. Which is annoying because I should be focused on the film, on the action.* (P39)

10. CONTEXTUAL ANTECEDENTS OF SMARTPHONE USE

We now focus on the contexts and causes of smartphone interactions in our sample. Based on the previous qualitative and quantitative analyses, we have coded the 774 unique situations immediately prior to the instances in which participants picked up their phones in our sample into 10 different categories (*archetypes*) based on the immediate contextual antecedents and triggers, which we will discuss in the following (see *fig. 16*). This analysis is taken from Papers 5 and 6 (see Appendix E and F).

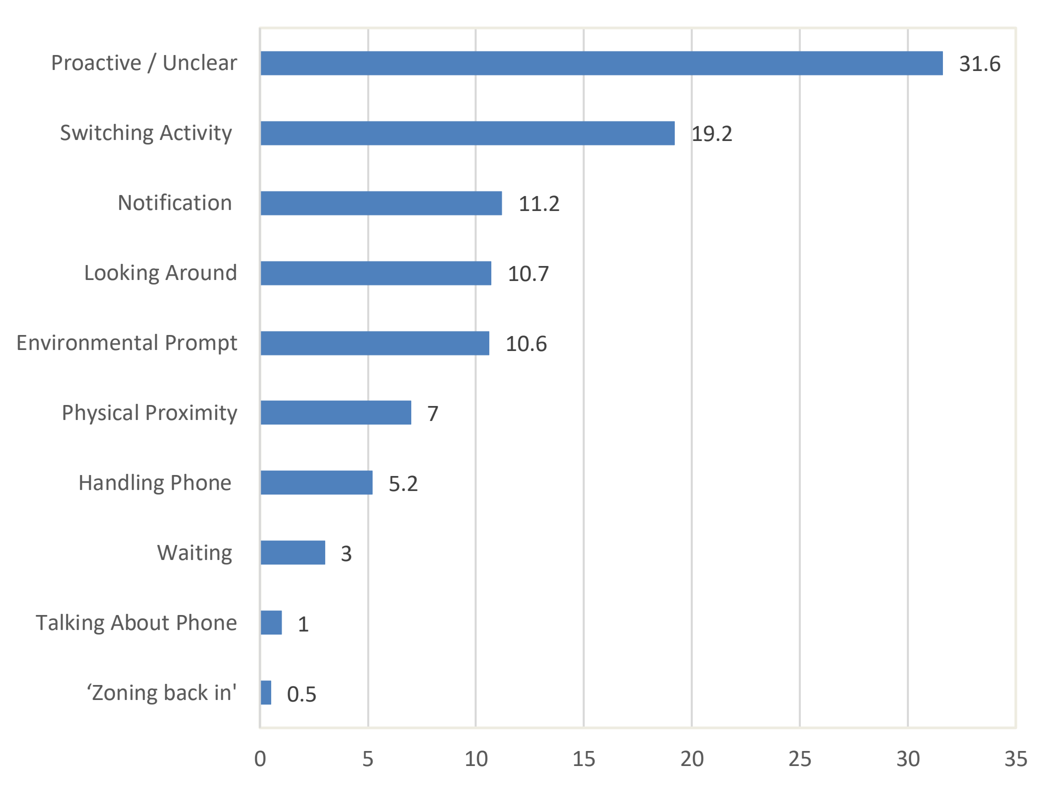


fig. 16 **Ten different types of contextual antecedents to smartphone use (n=774).**

10.1 TYPES OF CONTEXTUAL ANTECEDENTS

10.1.1 PROACTIVE PICKUPS

For roughly a third of the interactions in our sample (31.6%), we did not observe any contextual cue that led participants to pick up their phone. In these situations, participants interrupted the flow of their current activity out of their own motivation and proactively picked up the phone. We also did not observe an extended "build-up phase" prior to the interaction. This archetype represents interactions that are fully driven by the whim of participants and must also encompass instances where thinking about the phone intrudes into participants minds, as well as habitualised checking behaviours. It is of course not possible to look inside the head of participants, but for some instances of proactive pickups, participants were able to give us a clear reason, as expected, while SEBE provides us with detailed, contextual data:

> *I remember that day I was really tired. And I was just thinking about things that I had to do. And then, [watching] the film is part of work, but I was kind of losing time, it just took two hours basically not working. Well, working, but not like other work. And so yeah, I think I was thinking about things I had to do and emails to reply to and um, I don't know why I picked up the phone during this particular scene, but I wasn't engaged with the thing.* (P39)

Nevertheless in the majority of cases that we classified as *proactive pickups;* participants did not know themselves why they interacted with their phone:

> *So I looked at my phone and didn't do anything. I have no idea what I did. I just went and had a look.* (P41)

10.1.2 SWITCHING ACTIVITY

Participants also often used their smartphones when they switched from one activity to another, such as sending out an Email, switching to a different software, finishing cutting vegetables or tidying up the room, but also when there were natural breakpoints within activities such as finishing writing a paragraph in an Email, or turning the page of a book while reading.

> *It's just a moment where I don't think. But it's also curiosity, what are my friends doing? But not even that... Yeah it is almost automatic: 'Ok. Break, drink, [pretends to pick up phone]. Nothing interesting happening, [pretends to put phone back down], focus.'* (P17)

Curiously, we observed that participants inhaled and exhaled deeply when they have finished their first activity, before they pick up the phone, and after finishing using the phone, before starting the following activity almost every time they used their devices during a switch. These breathing patterns seem to be markers of a release of cognitive load or a cesura in the flow of activity and warrant further investigation. The same type of “sigh” has been observed in another SEBE study when participants pass the threshold of their home when coming back after a day at work and was interpreted as a sign of relaxation (Cordelois, 2010).

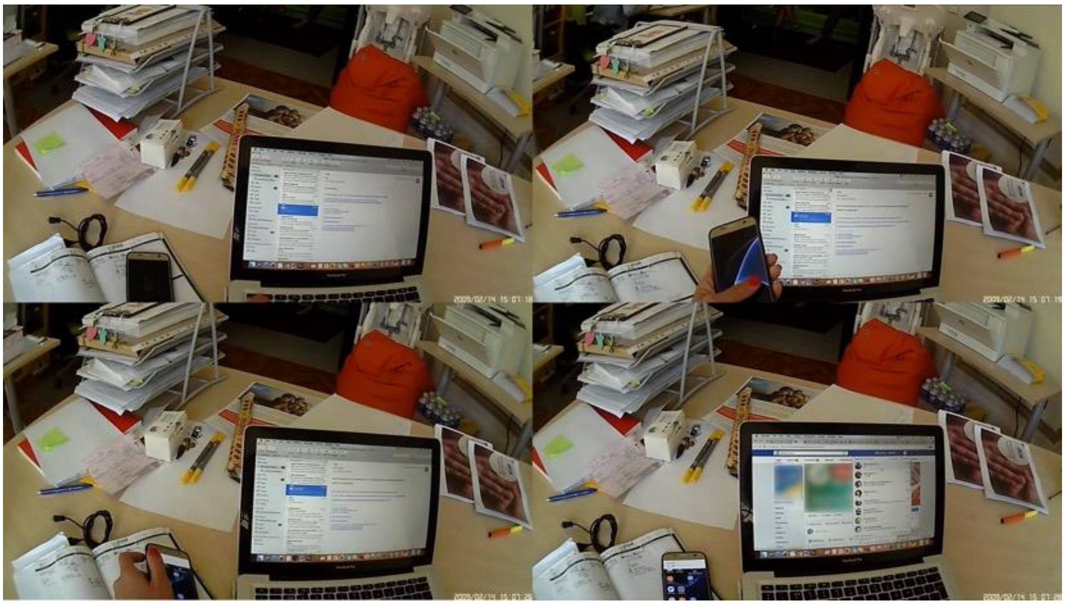


fig. 17 **A participant finishing working on an Email on their laptop and using their phone before switching to facebook on the laptop (top left to bottom right).**

10.1.3 NOTIFICATIONS

Notifications were the third most common precursor to smartphone interactions in our sample (11%). Receiving a notification in our sample immediately leads participants to interrupt their current activities, often moving the device into their visual fields with an illustrative jolt of the head.

> *I try and put it a bit away but obviously if a message pops up then I want to answer right away. Not that I always do but I want to.* (P26)

> *I checked it again here, for the same stupid reason. Because a notification could be anything. Could be WhatsApp, Telegram, facebook...* (P28)

These interactions exemplify the perceived disruptiveness of the smartphone when it does indeed relay notifications to the users. As discussed above, notifications arrive in the form of sounds, vibrations, and visual only (i.e. the screen lighting up), the latter of which made up 65.8% of all notifications observed in the sample.

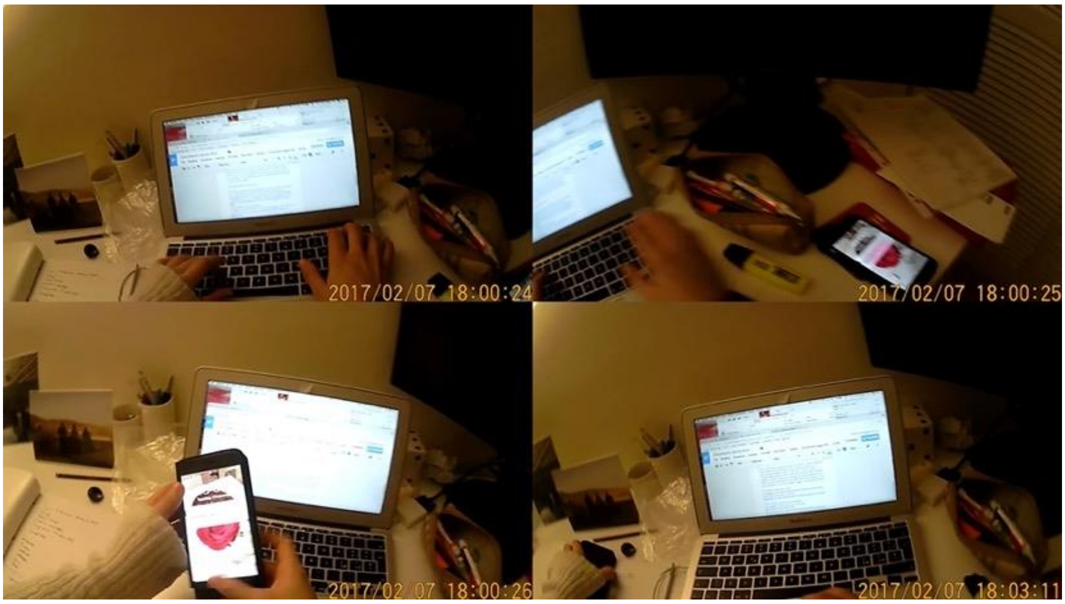


fig. 18 **A notification disrupting work on a laptop (top left to bottom right). The participant immediately turns their head towards the phone and picks it up when the device's screen lights up (see time stamps of frame 1-3). The participant then returns to their original task 2min and 46s after the interruption.**

10.1.4 LOOKING AROUND

Another common trigger of smartphone use was the device simply moving into the visual field of participants when they were looking or walking around, or sitting down with the phone within arm's reach (see *fig. 19*). In cases where participants are looking around as a precursor to smartphone use, they either do not have an immediate main task they are currently pursuing, or they are moving their heads while being engaged in another task (i.e. repositioning oneself on a chair, getting a cooking ingredient from a shelf) which then moves the phone into vision and allows it to intrude into the flow of activity.

10.1.5 ENVIRONMENTAL PROMPT

Sometimes the situation or the environment itself that participants found themselves in called for a use of the phone. Typically, the phone functioned as a tool in these interactions, for example when participants used their phones as a stopwatch to time an event, to find a song that was playing in the radio with Shazam, or to take a photo. Similarly, paying with the phone or showing a digital ticket or boarding pass were instances of environmental prompts.

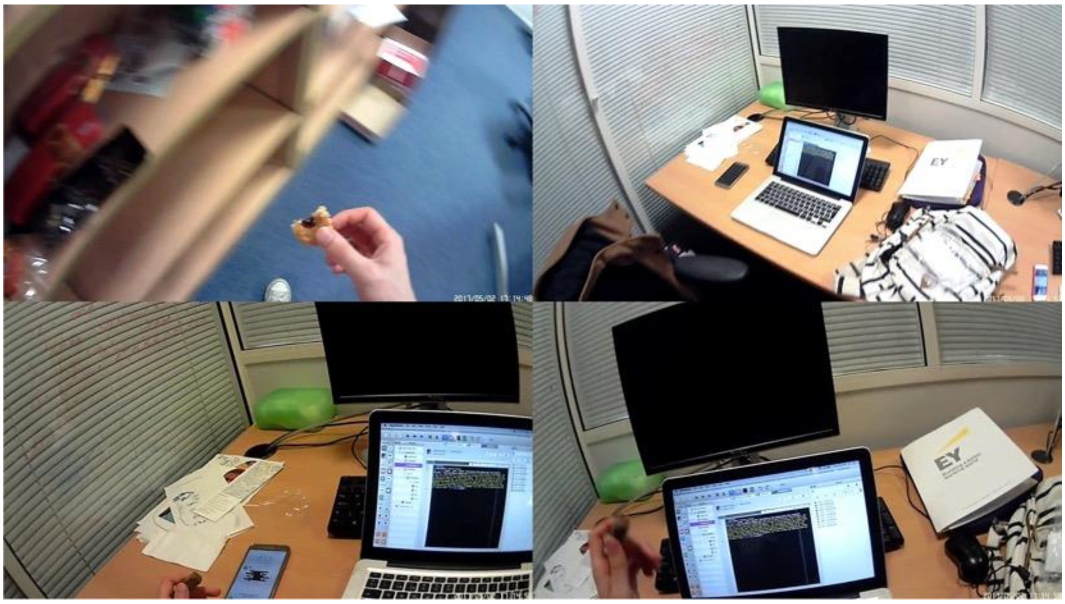


fig. 19 **A participant fetching a biscuit and checking their phone after sitting back down (top left to bottom right).**

10.1.6 PHYSICAL PROXIMITY

Another common trigger of smartphone interactions was participants moving closely by the phone, or interacting with objects in close physical proximity to the device. Illustrative examples were picking up or putting down a mug or a tv remote in close physical proximity to the phone, which led participants to interact with their devices. Similarly, stretching or scratching oneself often triggered smartphone interactions as participants were moving their hands already and had caused an interruption in their current activity.

10.1.7 HANDLING PHONE

Another situational trigger that led participants to interact with their devices was when they were handling their phone as physical objects without the intention of using it. Typical cases comprise rearranging objects on the desk and, thus, moving the phone, picking up the phone to place it in a bag or pocket, or connecting the phone to a charging device (see *fig. 20*). Naturally, smartphone use that follows after handling the phone is highly conducive to fidgeting as there is not a clear, immediate purpose for interacting with the device properly, as compared to moving it around as an object in surrounding space.

fig. 20 **Checking the phone prior to connecting it to the charger.**

10.1.8 WAITING

Brief periods of idleness, typically while participants were waiting for their computers to load or launch something, but also everyday activities such as queueing for a coffee or waiting for a bus, were antecedents to smartphone use in our sample. Interactions following from waiting further reflect the sentiments expressed by participants around optimising the use of their time in situations where they have nothing else to do. Moreover, one participant described that they checked their phone because they did not want to *look like* they have nothing else to do:

> *"I'm just going on it because I'm awkwardly standing in line."* (P27)

10.1.9 'ZONING BACK IN' AND TALKING ABOUT PHONE

The last two groups of antecedents we observed in only make up a small percentage of our sample, partly also because they are difficult to observe. Nevertheless, we found it important to report on these as well. On a few occasions, participants had 'zoned out' for a moment, e.g. stared onto a wall or out of a window being completely idle, or fully fell asleep (which we have only been able to capture on tape once). Once they returned from that idleness, usually marked by a shaking of the head and heavy breathing, participants immediately checked their phones, both as a clock but also to see whether messages had arrived. Yet, in none of these cases, even where notifications had arrived, did they fully interact with their phones immediately. Instead, they took a moment to fully get back to their senses before interacting with their phones in an unlocked state. These findings resonate with participant comments on the intimate relationship between the phone and sleep: For example, it was mentioned that “the phone is the first thing I check after I wake up” (P18) and “the light of the phone helps waking up the eyes” (P10). Again, these findings also hint at the compulsive nature of *fomo* that leads participants to interact with their devices. Lastly, when phones or apps were mentioned in a conversation, both as a general topic (“Have you heard that the WhatsApp servers were down all over Europe for 30 minutes yesterday?”) or the user’s own device in specific (“Should I send them a text and ask if they want to grab a drink tonight?”), participants picked up and checked their phones.

10.2 ANALYSIS OF CONTEXTUAL ANTECEDENTS

After identifying the different contextual causes of smartphone use, we coded the 774 unique instances of picking up the smartphone in our sample once more and assigned them to the respective archetypes. We then investigated the relationships of the different archetypes with other key variables of smartphone interactions using non-parametric tests (Fisher’s exact test and the Kruskal-Wallis H test where appropriate).

Firstly, testing the influence of contextual antecedents and being at home, we only observed a significant interaction between waiting and being at home (p = 0.001). Unsurprisingly, participants were using their phones more while they were waiting for something when they were not at home (4.8%, 20/409) compared to when they were (0.8%, 3/366). In addition to that, using the phone because participants were moving in proximity to the phone occurred significantly more often when they were at home (8.7% (32/366) vs. 5.4% (22/409), p = .045).

Testing further the influence of context on smartphone interactions during work (at home or at the workplace) we find that proactive interactions occur significantly less when participants were working (10.4% (63/347) vs. 42.5% (182/428), $p < .001$). On the other hand, contextual factors that bring the phone into the awareness of the users appear to be more likely to lead to smartphone interactions while participants were working: switching between tasks (27.4% (95/347) vs. 12.6% (54/428), $p < .001$) and notifications (19% (66/347) vs. 4.9% (21/428), $p < .001$) were more likely to be antecedent to smartphone use while participants were working.

When participants were alone, notifications were more likely to lead to an interaction (14.2% (55/387) vs. 8.2% (32/388), $p = .006$). Similarly, proximity use also occurred more when participants were alone (9.6% (37/387) vs. 4.4% (17/388), $p = .003$).

When the phone was not in the visual field of users, participants picked their phones up proactively significantly more compared to when it was visible (64.6% (62/96) vs. 26.9% (180/669), $p < .001$). This was especially the case in waiting situations when the phone was not visible; then users reached for the phone more often (10.4% (10/96) vs. 1.9% (13/669), $p < .001$), On the other hand, notifications (12.7% (85/669) vs. 2.1% (2/96), $p < .001$) and situational cues like moving in proximity to the device (7.9% (53/669) vs. 1% (1/96), $p = .005$), looking around (97.5% (78/669) vs. 2.1% (2/96), $p = .001$), and switching between activities (20.9% (140/669) vs. 6.25% (6/96), $p < .001$) led to significantly more interactions when the device was visible.

Not a single interaction was initiated by notifications in our sample when the phone was not easily accessible to participants (0% (0/51) vs. 12.2% (87/714), $p = .002$). Similar to visibility, switching between activities is also more likely to lead to interactions when the phone is within the reach of users (20% (143/714) vs. 5.9% (3/51), $p = .006$). When the phone is not within the immediate reach of participants, handling the device 19.6% (10/51) vs. 4.2% (30/714), $p < .001$) and environmental prompts (25.5% (13/51) vs. 9.5% (68/714), $p = .001$) led to more interactions.

Testing for the effect of the different antecedents of smartphone use we observe on duration of use, we find that proactive use appears to increase mean duration of smartphone use sessions by 79s ($H(1) = 4.589$, $p = .032$). Similarly, waiting increased the duration of interactions by 26s ($H(1) = 8.084$, $p = .005$). When participants were merely handling the phone, on the other hand, the duration of interactions was 78s shorter (H (1) = 14.53, $p < .001$). Note that although notifications appeared to have a negative effect, reducing the duration of interaction of sessions by 58s, which is in line with previous findings, this finding is highly insignificant ($H(1) = 1.055$, $p = .3043$). Participants handling the device as a physical object, moving it to the side to make place for a mug on a desk for example, or to connect it to a charger, unsurprisingly leads to locked use and often shorter interactions (9.7% (18/186) vs. 3.7% (22/589), $p = .002$).

We then turned to the different apps and activities that participants engaged in with their phones, and how these were influenced by the context prior to the interaction. WhatsApp (the most commonly used instant messaging app in Europe at the time of this study) follows more often after notifications (22.4% (41/183) vs. 7.8% (46/592), $p < .001$), and when participants were waiting (6% (11/183) vs. 2% (12/592), $p = .009$. Conversely, when environmental cues solicit smartphone interactions (1.6% (3/183) vs. 13.3% (79/592), $p < .001$), or when participants were handling the phone (.5% (1/183) vs. 6.6% (39/592), $p < .001$), WhatsApp was less likely to be used.

Just like WhatsApp, use of the facebook messenger is also significantly more often preceded by notifications (21.6% (11/51) vs. 10.5% (76/724), $p = .02$; 13.7% of all notifications) and follows less often after environmental prompts (2% (1/51) vs. 11.1% (81/724), $p = .02$).

Instagram, on the other hand, follows less often both after notifications (1.6% (1/64) vs. 12.1% (86/711), $p = .003$) and environmental prompts (3.1% (2/64) vs. 11.3% (80/711), $p = .024$), but more when participants are switching tasks (29.7% (19/64) vs. 18.3% (130/711), $p = .024$) and going for the phone proactively (42.2% (27/64) vs. 4% (28/711), $p = .041$).

fig. 21 **Various instances of tool use following after environmental prompts (top left to bottom right): Tuning a guitar, paying for a coffee, taking a phone of a dog fetching a ball, Timing a work task.**

Similarly, the use of Email on the smartphone is more likely to occur when participants are switching between different activities (34.4% (11/32) vs. 18.6% (138/743), p = .029). Participants use their phones as tools, i.e., camera, stopwatch, navigation, etc. significantly less when there is a notification (0% (0/34) vs. 11.7% (87/741), p = .016), they are switching tasks (0% (0/34) vs. 20.1% (149/741), p <.001) or they are picking up the phone proactively (14.7% (5/34) vs. 32.4% (240/741), p = .019). On the other hand, tool use follows more after environmental prompts than after all other contextual antecedents combined (64.7% (22/34) vs. 8,1% (60/741), p < .001, see *fig. 21*). On a similar note, participants use the phone's browser significantly more often proactively than other categories (60% (12/20) vs. 30.9% (233/755), p < .001).

Fidgeting follows less after notifications (1.8% (1/57) vs. 7.8% (56/718), p = .008) or environmental prompts (1.8% (1/57) vs. 11.3% (81/718), p = .011). Conversely, when participants switch between activities, fidgeting is more likely to occur (31.6% (18/57) vs. 18.2% (131/718), p = .014). The majority of fidgeting behaviours we observed followed after proactive use (35.1%) and after switching activity (31.6%). *Figure 22* provides a summary of the interactions between antecedents and contexts participants are in directly prior to the interaction with the smartphone, and the ways in which they use them.

Antecedent of EB	More associated with	Less associated with
Proactive	Web browser, (Instagram), Long Duration	Tool App, Phone Visible, Working
Switching Activity	Email, Instagram, Fidgeting, Phone Visible, Phone Accessible, Working,	Tool App
Notification	WhatsApp, facebook Messenger, Visible, Accessible, Working, Being Alone,	Instagram, Tool App, Fidgeting
Looking around	Phone Visible	Being Alone
Environmental Prompt		WhatsApp, facebook Messenger, Instagram, Phone Accessible
Proximity	Phone Visible, Being Alone	
Handling Phone	Fidgeting	WhatsApp, Accessible
Waiting	WhatsApp	Phone Visible, Being Alone

***fig. 22* Effects of antecedents to device interactions on activities and characteristics of smartphone use.**

10.3 DISCUSSION OF THE ANALYIS OF CONTEXTUAL ANTECEDENTS

Participants used their phones more when they were waiting for something outside their home. This is mostly because interactions outside of the house can cause delays more often (queueing, waiting for public transport, etc.), and may to a certain degree also be due to the fact that periods of waiting in the house can be compensated more easily with other activities because the environment is rich and less socially controlled (e.g. going to take a snack from the fridge is not possible when queuing for the bus).

We also find that participants use their phones significantly less proactively when they are working, but contextual and situational cues are more likely to lead to interactions. This sits well with the previous discussion of cognitive attractors; as participants have a primary goal already, they will find themselves "looking for something to do" less often. As discussed previously, contemporary work, especially with computers is characterised by fragmented diaries and repeated task-switching as discussed in section 2.1.4 (Bogunovich & Salvucci, 2011; Yeykelis et al., 2018). It is therefore not surprising that task switching, which appears to leave participants vulnerable to pick up their phones, occurs more often when participants are working. The finding that notifications led to more interactions while participants were working compared to when they were not, on the other hand, does not appear intuitive at first sight given that participants overall report they do not want the phone to send notifications during work to not be interrupted, but also to avoid annoying colleagues or being embarrassed in front of them. We found two potential explanations for this in the data: 1) In work settings where participants cannot monitor their phones proactively regularly because they are absorbed in other tasks, the experience of *fomo* and the worry of not being able to stay on top of incoming notifications may be stronger. We thus observed that in the majority of cases, participants had their phones lying face up on their desks while working with sounds and vibrations muted, but the screen lighting up when a notification arrived. This way, incoming notifications were received immediately without risking embarrassment or bothering others. Moreover, given that the phone often stays in the same setting when participants are not working, and they do not normally have their phone in vision, they are less likely to take note of incoming notifications in these cases. 2) In some instances, participants also use their phone for activities related to work and therefore monitor incoming notifications.

When participants were alone, interactions with the device are initiated by the device significantly more often, which may be attributed to the fact that they allow their phones to send notifications when they do not disturb other people, but also because being in company of other people usually means that participants have other main objectives. Similarly, proximity to the device and looking around also triggered interactions more frequently, when participants were alone, which suggests that they keep the phone out of immediate reach and move it around less when they are in company, which is in line with strategies to avoid engaging with the phone too much when they are with other people that are cited by participants. Moreover, users appear to be monitoring their environment more when other people are around, and once they are disconnected from their main task, the strength of the phone as a cognitive attractor captures their attention. In a similar vein, higher distraction and noise levels may lead participants to look around more.

Regarding accessibility, it appears that when the phone is not visible, contextual and environmental cues trigger EB with the phone less, and participants may divert their attention elsewhere. On the inverse, when the phone is not visible, participants are more likely to pick up their devices proactively. When participants have their phone out of immediate reach, they seem to focus more on the activity they are engaged in, as situational cues like breaks in the flow of activity, again, lead to significantly less interactions compared to when the phone is within reach. Notifications did not lead to interactions at all when participants had their phone out of reach, which is intuitive given that most participants keep their phone in a setting where it does not make sounds, but is still very 'noticeable' in close proximity. When the smartphone is out of reach, participants picked it up more to deal with an issue arising from the context (looking up something, tool apps) or to move the device to another place (typically charging it).

Looking at the duration of smartphone use, more different interactions with the device in one session significantly increase the duration of use, especially when participants go beyond a single interaction, which is in line with our findings around cognitive attractors and getting caught in the loop (see Paper 3 & 4). We also observe that duration of smartphone use is longer when participants interact with their devices proactively and when they are waiting for something, but shorter when they are only handling the device as a physical object. The time between different interactions, however, remains the same regardless of the different triggers that cause the interaction. While it is intuitive that participants would interact with the device for shorter periods of time when they are moving it to the side to make place on their desk for a mug for example, or to connect it to a charger, and longer when they are waiting, as this use is quite literally intended to occupy time in these situations, the finding regarding proactive use is quite alarming overall. Given that it captures the interactions in our sample for which it was not possible to determine an environmental or situational cue that could have led participants to pick up the phone, it appears that proactive use depicts deeply internalised checking behaviours. We have further controlled for the number of different apps or interactions within a session and did not find a significant difference between proactive smartphone use and the other categories. In other words, when participants pick up the phone out of internal, and possibly habitual, motivation, smartphone use lasts 1 minute and 20 seconds longer on average compared to when an environmental cue solicits the interaction.

We also found that different contextual triggers of smartphone use influenced the activities participants engage in with their phones. WhatsApp was used more frequently after notifications and when participants were waiting, but less after environmental cues or when participants were handling the device. This makes sense intuitively as it is the main communication app for participants (49.2% of all notifications received in our sample were received through this app alone). Similarly, when people are bored or idle, WhatsApp usually offers a variety of options from messages to reply to, to sending out new messages to friends and family. Environmental prompts usually call for tool uses of the phone like the camera or maps (see below). Moreover, because WhatsApp usually leads to longer interactions as they require reading and responding to messages, participants are less likely to open up the app when they are just picking up the phone to move it into another place. The same holds true for facebook messenger. Again, messaging tools send more notifications than other apps and their use is rarely called upon by environmental cues.

Use of Instagram, on the other hand, is less frequently triggered by environmental prompts or notifications, but more when participants pick the phone up proactively or during breaks in the flow of activity, which is consistent with participant descriptions of their use of the app as aimless and distraction-seeking. Instagram seems to plug itself in when users are reorienting their attention and looking for distraction from an ongoing activity. Especially the finding regarding proactive use is concerning again, as Instagram has been described as major source of ‘getting caught in the loop’ and spending too much time with the device (see Paper 4, Appendix D), and proactive use is further associated with longer smartphone interactions in our sample. Overall, it appears that smartphone use is less goal-oriented, more distraction-seeking and longer when clear contextual prompts are absent and participants engage with their phones proactively.

The use of Email on the smartphone is also more likely to occur during breaks in the flow of activity, as participants do indeed seem to make use of their phones during brief breaks to check their inboxes and make sure they stay on top of incoming messages. The finding that participants use the phone’s web browser proactively more often warrants further investigation, also because the overall prevalence of its use is relatively low, but may allude to the fact that use of the phone's browser is highly diverse and can serve both entertainment/distraction and tool purposes.

Tool use is most likely to follow after environmental prompts, but participants engage in it less proactively, when they are switching tasks, or after notifications, which, again, is intuitive. Tool apps do not normally send notifications (0 in our sample) or promise distraction during breaks, but are used as a response to a specific demand that arises from the situation like looking up the next bus, setting a timer while cooking, taking a picture or using a tuning app to check the pitch of an instrument (see *fig. 21*).

Fidgeting, finally, is less likely to occur after notifications or environmental prompts, but more when participants are switching tasks. Given that notifications and environmental prompts come with clear objectives, it is not surprising that users fidget less after these triggers. Conversely, when participants switch between activities there is no clear objective scaffolding the situation which opens the gate to unconsciously interact with the device in the 'mental orientation phase' in the gap before a new task is begun.

10.4 DRIVERS OF SMARTPHONE USE

Having taken a look at our quantitative observations on smartphone use in general, and the contextual influences that cause, we now turn to the hypotheses formulated in section 2.2.9 and try to tease out what drives smartphone use. To do so, we look at the patterns of duration of smartphone interactions, time between interactions and number of interactions per usage session in relation to contextual factors. We provide a visual analysis of the data first, and then control with Kruskal-Wallis H tests and Poisson regressions as suggested in Schleidt (1974, p. 193).

The relationship between time since the last smartphone interaction and the duration of the session appears a bit unclear. The visual analysis suggests that duration of use might be shorter, the more time elapsed since the last interaction (see *fig. 23a*), but this pattern is not statistically significant ($H(310) = 292.834$, $p = .75$). Further controlling for the pattern following a Poisson law, we do not find a statistically significant association ($\chi 2(1) = 1.61$, $p = .204$). The visual analysis of the relationship between the duration of sessions and the number of interactions in the previous session (*fig. 23b*) seems to suggest that the more interactions in the previous session, the lower the duration of the current one, but this pattern is, again, not statistically significant ($H(8) = 5.955$, $p = .652$). Further controlling for the pattern following a Poisson law, we do not find a statistically significant association ($\chi 2(1) = 1.61$, $p = .204$). The relationship between the duration of sessions and the time until the next session is a bit less clear again (*fig. 23c*). The visual analysis suggests that longer usage is followed by more interactions sooner than shorter interactions, but this pattern is, again, not statistically significant ($H(312) = 316.13$, $p = .424$), and finally controlling for the pattern following a Poisson law, we do not find a statistically significant association ($\chi 2(1) = 1.61$, $p = .204$).

We have also investigated these three associations specifically for proactive smartphone use. We do not find an effect of the time since the last smartphone interaction ($H(118) = 111.832$, $p = .643$), or the number of activities in the previous session ($H(8) = 5.955$, $p = .652$) on the duration of smartphone use, as well as the duration of the previous sessions on the time until the next interaction ($H(55) = 51.422$, $p = .612$) for proactive use in our sample. Finally, we also do not observe a significant effect of proactive use on the time since the last smartphone interaction in general ($H(1) = 1.324$, $p = .25$).

Turning towards visibility and accessibility, we observe that accessibility seems to influence the duration of use (21s vs. 28s; $H(1) = 4.266$, $p = .039$), but not the time between interactions ($H(1) = 2.692$, $p = .101$), while visibility does not seem to influence the duration of use ($H(1) = 1.531$, p = .216), but the time since last interaction (273s vs 201s; $H(1) = 4.955$, $p = .026$). We did not observe more proactive use when the phone was accessible (31.4% (224/714) vs. 35.3% (18/51), $p = .33$). However, proactive use occurred more when the smartphone was not visible (26.9% (180/669) vs. 22.4% (64.5), $p < .001$). This last result is rather mechanical, as there will be less situational cues when the phone is not in sight.

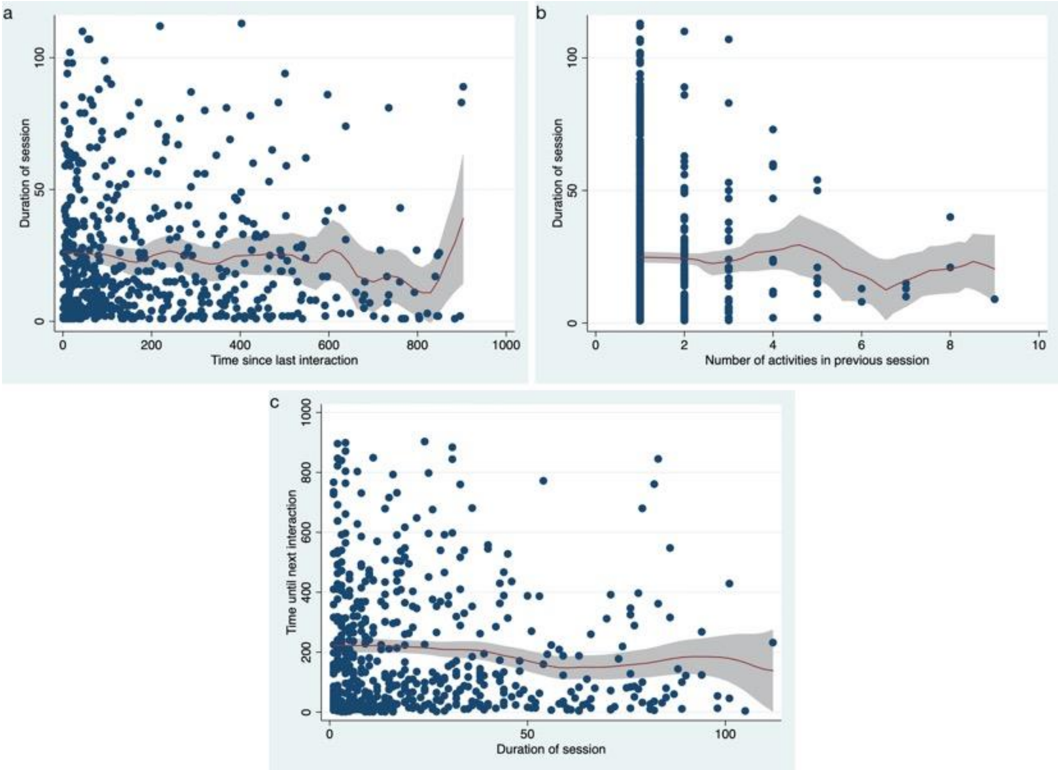


fig. 23 **Scatterplots of the relationship between (a) time since last smartphone interaction and duration of session, (b) number of activities in previous session and duration of session, (c) duration of session and time until next smartphone interaction. The red lines depict smoothed graphs of a kernel-weighted (Epanechnikov) local polynomial regression fitted to the data, the grey shaded areas depict the 95% confidence intervals.**

10.5 DISCUSSION OF HYPOTHESES: WHAT DRIVES SMARTPHONE USE?

While many of the responses to contextual antecedents we observe appear deeply habitualised and automatic, for about 30% of all interactions we did *not* observe any distinguishable environmental or situational cues. We therefore took this proactive use as a starting point for our analysis of the internal drivers of smartphone use. Even in discussions with our participants, we were unable to reconstruct the reasons for the interaction for a large portion of proactive use and the motivation to interact with the phone seems to come from within the users themselves. These behaviours need to be studied in more detail, as they represent what participants refer to when they speak about automatic and *unconscious* interactions. From the descriptions of our participants, it appears that they can usually remember or reconstruct the interaction itself quite well, but not the reason why they picked up the device:

> *And sometimes I would check the phone just as an automatic gesture. Because I realize a lot of times this is not a conscious thing like: "Oh, I want to check this notification or I just want to go to Instagram or whatever". I don't know, it's just a passive thing that I do.* (P39)

> *I think it's an easy, or automatic… like when you have a cough and you put your hand to your mouth- it's something like that.* (P24)

Hence, smartphone use appears to occur automatically overall, and users do not seem to pick up their phones 'intentionally' in the full sense of the term in the majority of situations. This supports the notion that picking up the smartphone use may be a FAP, over which participants have little agency once triggered. But that does not account for what is the trigger.

Proactive smartphone use being longer than other types of use would suggest that appetite may be relevant for smartphone interactions. Appetite as a driver of smartphone use also sits well with the notion that patterns of engagement with the device may follow a Poisson law, which is further reflected in the varying engagement and avoidance strategies for different contexts our participants report (e.g. working vs. being at home), which are discussed in more detail in Paper 3 & 4 (see Appendix C & D).

We did not observe any relationship between different antecedents of smartphone use and the intervals between interactions, which makes a case for a hydraulic explanation: Environmental cues and other causes, as well as feelings of fomo may not be as salient for participants until a certain threshold (i.e. time away from the phone) is reached again. Similarly, if an opportune moment to interact with the phone does not arise from context, participants end up picking up their devices proactively. Yet, we do not observe an increased likelihood of proactive (or any other type of) smartphone use when users have not interacted with their smartphones for longer periods of time or when the previous interaction was short, which contradicts hydraulic explanations or addiction.

The finding that participants tend to pick up their phone when they are waiting or idle, builds the case for smartphone use as a displacement activity. Participants further report that they sometimes use their phones to ease their mind:

> *I don't know why I did that. I literally just looked to the right, unlocked my phone, locked it again. And I cannot tell you what time it was because I didn't look, it's just a bit evasive, I think. Because it's a mechanism. It's something that I do when I'm bored or something that I do if I need to, like, change my mind, you know. If I'm a bit stressed or so, I'll watch a video or something like that. I guess my hypothesis is that, yes, if I'm in a situation where I feel a bit observed or scrutinized or like at work, when we're having a meeting about something and I'm not really sure what to answer to some questions, my eyes might dart down, and I might look at my phone because it is a bit of a pacifier.* (P42)

The phone, thus, appears to have the affordance to "distract", that is, to offer a different, new, track of activity when the task at hand is finished, and when there is a conflict between activities (e.g. the individual being torn between two possible activities, or not wanting to continue the current task because it is boring, stressful, or exhausting). The affordance of course is the more salient if the phone is in sight, present in peripheral attention, or in the focus of attention.

Similar to the study on the consumption of hedonic foods (Painter et al., 2002), we also find support for explanations focusing on the availability of the phone. The time between smartphone interactions was 72s shorter in our sample when the phone was in the visual field of participants, and the duration of smartphone interactions was 7s longer on average when the phone was within arm's reach of participants. Looking at the different antecedents to smartphone use, visibility appears to play a large enabling role for environmental cues like switching activities, looking around, or proximity use, but also use following notifications, and proactive use, are more prevalent. When the phone is not immediately accessible to participants, they do not appear to notice notifications and, thus, pick up their device at all. This supports the sentiments of participants that placing the device somewhere else helps them to engage with it less:

> *Sometimes I get it farther away from me as much as I can to not get distracted as much.* (P28)

> *If it's next to my bed at night I'm literally going to be on it all the time. Even if I wake up, you know how you sometimes wake up in the middle of the night? For example when I'm in a hotel and the socket is next to the bed, I'm always reaching over when I can't sleep or whatever. So overnight, I always keep my charger outside of my room.* (P37)

> *On Saturday afternoons, I practice for my bar exam and I only got to the library for that. Then I actually leave the mobile phone at home to fully focus.* (P32)

Participants seem to have an intuitive understanding that reducing the accessibility of the device can help them regulate their phone use. But just facing the device downwards on the table to not notice the screen lighting up, or moving it a bit farther away on the desk does not create sufficient 'distance' between the device and the user. Moreover, environmental cues, like for visibility, are less likely to lead to smartphone interactions when the phone is not easily accessible. In these situations, moving the phone into a different location (often charging it), or when it is needed as a tool is more likely to make people get up and fetch the device.

It is important to note though that the participants keep their devices visible and accessible in the overwhelming majority of cases (the phone was neither visible nor accessible before only 2% of the smartphone interactions we observed). Hence, further investigation into the effect of visibility and accessibility of the device in a controlled setting, and formally controlling and testing the perceptions of users, will be necessary to confirm these effects and to see where participants direct their attention to when they these contextual cues occur while the phone is not visible and/or accessible. Nevertheless, visibility and particularly accessibility appear to be a highly promising route for further investigations into effective ways to reduce smartphone use.

Even though we observe a stable frequency of interactions, we cannot confirm the predictions of reservoir theory and therefore have to reject H2 (smartphone as addiction), especially since we did not find any evidence of an 'urge' to use the phone, or an 'intense focus' on phone EB, nor expressions of intense satisfaction or relief after EB. And while the findings for visibility and accessibility are in line with predictions, we can only partially confirm the expected patterns. Therefore, even though nothing in our data immediately contradicts H1 and H3, active searching and accessibility alone can only provide an insufficient explanation for variations in motivation and causes of smartphone use in situations where contextual cues trigger interactions, and bearing in mind that participants do keep their phones readily accessible at most times.

We have explored in depth the rich, ethnographic data on smartphone use SEBE has generated in our attempt to explain what drives smartphone use in naturally occurring contexts. For the interactions triggered by the phone, we naturally find intuitive responses, modulated by the context and social acceptability (e.g. shorter duration in company). This is both trivial and consistent with the literature, although the finding about duration, but not intervals being shorter is novel.

When looking at the other antecedents of EB, we find that the very presence of the device in the field of perception and its accessibility matter, and in some cases are enough to trigger EB. While this shows positive modulating by the availability of the device, it does not clearly enable us to favour one of the three hypotheses (H1, H2, H3) about the nature of the mechanism driving EB per se.

Indeed, we find evidence for parts of all three possible explanations that emerged from the literature, but no single explanation appears cogent or comprehensive on its own. The data, moreover, does not allow us to give either hypothesis precedence over the others for all situations. For any given smartphone interaction, there seem to be many overlapping motivations and drives pulling and pushing participants simultaneously. If anything, smartphone use appears to look more like eating candy, than like smoking cigarettes as an urging addiction. If it has some similarities to cigarettes, it is (except for some extreme cases perhaps where there is actually addiction to some functions of the smartphone) more because the cigarette can also act as an affordance for distraction. This is well described by one of the participants:

> *I'm a smoker. It's kind of similar to that a little bit. Sometimes I get an urge to smoke, but most of the time I kind of want to smoke because I'm idle. Like, if I'm waiting for a bus, then I'll have a cigarette. I don't really get, like, a strong nicotine urge because I know how those feel. Like sometimes I'll get a strong nicotine urge. But then, you know, I'm just waiting for the bus and I'm like, when the fuck is it going to come?*

> *And so I just I'm like: "You know what? I probably have ten minutes". So I roll myself a cigarette. And that's kind of the same thing. I think with the phone, it's not so much that I feel compelled to do it. At least I don't feel like it's that. But it's definitely a mechanism, you know, certainly there is a habit there. And I'm like: "Oh, I'm bored." There is something that I know I can do when I'm bored, but then I think I'm fairly aware of it, so.* (P42)

Smartphone users interact with their devices to satisfy their appetite for communicative and social needs, as well as for distraction and displacement (inter alia). And while interacting with the device appears to be 'scratching an itch' for participants, this does not conclusively lead to the automatic or hydraulic discharge of such behaviours in the sense of fixed action patterns, and even less in the sense of addiction.

11. GENERAL DISCUSSION

The findings from the individual projects this thesis consists of have provided a detailed and multi-faceted insight into how smartphone use unfolds in naturally occurring contexts. Smartphone use appeared as highly habitualised with a 'rhythm of smartphone interactions' of roughly one minute every five minutes and the vast majority of interactions (89%) in our sample being user-initiated. On one hand, these findings make a strong case for EB being generally user-driven rather than device-driven, which has relevant implications for our understanding of how smartphone users perceive disruption. On the other hand, we also observe that environmental cues and contexts scaffold the behaviour of our participants and influence both the way they interact with their devices and what they do with them. It appears that the disruptiveness of smartphones is not of a physical or sensory nature, but a result of internalised routines and habits of users, as well as social pressures, and the availability of the device. These patterns become especially evident when the phone is used in combination with other devices, which show clear switching patterns that are influenced by the context and the devices used. Importantly, we find that the majority of smartphone interactions are triggered by ubiquitous environmental cues, which go mostly unnoticed by users and are the reason why smartphone interactions are described as unconscious and automatic by them. But we also find that about 30% of smartphone interactions are initiated proactively by users without any evident external cause, and even when we probed specifically about these types of use, we were not able to ascertain a clear reason for the interactions. It, thus, emerges that the smartphone is a major *cognitive attractor* for users, and that users have an *appetite* for their devices (often the distraction the device affords) that hinges upon the accessibility of the device.

Overall, there are four areas of findings emerging from our research project; the conflicting desires to engage with, but not be disrupted by the phone, the phone as a tool for managing productivity and time allocation, the drivers of smartphone use, as well as the importance of conducting in situ research when it comes to the study of user behaviour.

11.1 CONFLICTING DESIRES

Firstly, we observed a strong tension between the desire to engage with smartphones to obtain information and communicate with others, and the desire to focus and avoid frequent distractions in participants. To deal with this tension, participants have described various habits to us that help them achieve the desired ‘distance’ to their devices. Yet, the data shows that contexts are blurry and motivations to engage with or avoid the phone overlap. In this vein, notifications, while being seen as important for managing urgent work and ‘life admin’ tasks, mostly emerge as disruptions and sources of social pressure, both when they are noticed by the senses and when participants actively check their phones for updates. It appeared almost impossible for participants to not immediately interrupt their current activities and attend to their phones when they noticed a new notification with their senses. They therefore often switched off notifications or limited access to the phone (sometimes they are able to push back the interaction in time a bit if the notification interrupts the task at an inconvenient time; see *fig. 24*).

While, generally speaking, the more demanding the task, the less participants wanted to receive notifications, when tasks became too intense or difficult, they actually welcomed notifications as a means for escapism. Settling into work was usually preceded by dealing with notifications and then switching them off. Switching them back on helped participants transition back into their private lives and often occurred before participants completely stopped working. But our quantitative findings have also revealed that participants seem to prefer restricting the access to their phones or muting them, as only 11% of interactions were preceded by a notification being delivered from the phone. In situations in which notifications were turned off, however, participants reported the social pressure of being available and the worry of missing something important as becoming increasingly more pressing as time elapsed, ultimately leading them to check their phones (“I think we’re constantly conscious of thinking that someone might have sent a message”; P29), which is in line with the predictions of telepressure and nomophobia. Most participants consequently appear to have adopted the fatalistic view that their phone disrupting the flow of other activities one way or another just cannot be avoided.

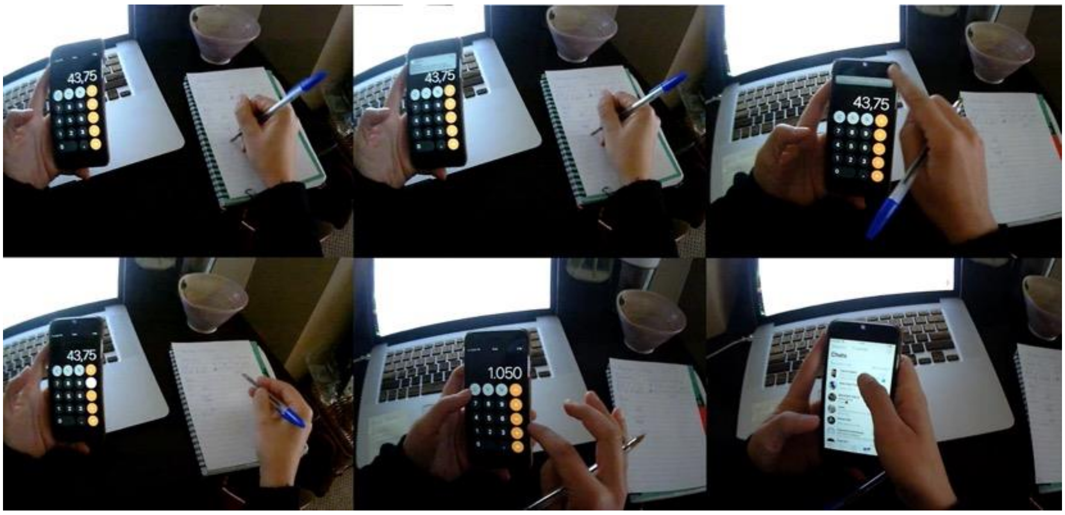


fig. 24 **A Participant dismisses a notification that interrupts doing a calculation with phone, finishes the calculation and immediately checks the notification after the task is done.**

Another emergent finding that participants highlighted is the danger of getting caught in the loop. Many users seem to find it difficult to only use their phones briefly, and to only do what they originally intended to do with it. Moreover, certain apps that feature a 'feed' that allows for continuous scrolling through information (or similar features) were described as especially attention-grabbing, often leading users to spend much more time on their phone than they originally intended. In line with the qualitative findings, the quantitative analysis revealed that duration of smartphone use was shorter when participants received notifications compared to when they self-interrupted. Thus, smartphone use appears to be more purpose-driven when users receive notifications, and more distraction-seeking when it is self-initiated. Smartphone interactions also lasted longer when participants had their phones in hand already, suggesting that going beyond a single, brief smartphone interaction tends to trigger longer phone sessions. In line with this, we find that use of apps that allow scrolling through a newsfeed or watching stories (particularly Instagram and facebook, but also the web browser) was indeed longer on average than other phone activities. The analysis of antecedents of smartphone use in our sample further revealed that proactive checking increased the overall duration of interactions, and was more likely to lead to the use of Instagram. This suggests that users are correct in assuming they are running the risk of getting caught in the loop when they engage with their device: they get trapped in a "cognitive attractor" (Lahlou, 2007a) that provides (small) amounts of satisfaction at a low cost with a high salience of the stimulus.

We did, however, observe that phone interactions were shorter, and proportional use of ‘time-consuming’ apps like Instagram or Facebook was lower when participants were working. This suggests a more task-oriented approach to smartphone use while working, compared to a focus on discovery and distraction in non-working contexts and is connected to the previous finding around notifications. However, the intervals between smartphone interactions remain statistically invariant across every association we tested except for visibility of the device. Hence, though participants use their phones in a more focused manner while working, they cannot resist the urge to check their phones every five minutes. This urge to interact with the phone in such frequent intervals stands as one of the key findings of this research and appears to be both cause and effect of the patterns of EB we observed.

This connects to the most curious finding of this research, fidgeting, which does not only appear to be unconscious at the moment when the device is being picked up, but also often while participants are aimlessly interacting with the screen of the device. Fidgeting behaviours surprised both participants and researchers during the Replay-interviews, and we have no conclusive explanation for them, especially given the duration of some instances, and the pervasiveness across individuals we observed. Several comments made by our participants hint at potential explanations:

> *Yeah, here I was just looking for something to do on my phone.* (P8)

> *It’s kinda therapeutic to just like [gestures swiping fingers over a phone] move the things on the phone and play around with it.* (P3)

> *Well, I know I took it out there. I'm just fidgeting. Again, it's this thing, my partner got up to go get the cheese and the pepper that we needed to eat the pasta. And so I guess at that moment there is somebody doing something for me. I feel useless. So I take out my phone to let the moment pass. And I mean, you can see on the screen, right? I'm not really looking at anything on the phone or, say, I wasn’t checking my notifications because it was a very tough week of work and I was ruminating over some emails or whatever and checking if I had gotten an answer. I can tell you for sure, because I do this quite often, that I'm*

> *not really looking at anything in particular, I'm just letting the moments go by.* (P42)

Fidgeting appears to be a displacement activity when users are waiting for something or trying to avoid a situation, but it also appeared to be truly unconscious and embodied on some occasions, which points toward the intimacy of the relationship users reported with their device, such as the feeling that it is an extension of the body. More broadly speaking, fidgeting provides support to the notion that some smartphone activities have become FAPs, and that users may have developed an appetite for interaction with the device per se. On the other hand, the smartphone seems to attract unconscious fidgeting to the device rather than other objects (see *fig. 25* and the example video clip provided in Appendix H), which further underlines that smartphones are a major cognitive attractor for participants (Lahlou, 2007a).

11.2 TIME MANAGEMENT AND ATTENTION ALLOCATION

From our analyses, the smartphone also emerged as the central logistical tool that participants use to structure their days and to manage professional and private activities. Participants, thus, engage with their smartphones during natural breaks in the flow of their activities to stay aware of the notifications that go unnoticed and respond to arising issues or adjust their schedules if necessary. At the same time, checking the smartphone is also used proactively as a means to create breakpoints during activities to manage cognitive load, and to monitor incoming notifications. For this, locked use played a particularly important role as it enables participants to stay aware of incoming notifications with a brief glance, and with a lower risk of getting caught in the loop and using the phone longer than originally intended.

The findings around time management and productivity connect our empirical observations back to the theoretical discussion around attention allocation and time pressure, and show that the mechanisms of the attention economy figure prominently in the daily lives of participants. While participants use their phones to manage their time efficiently both through conscious strategies and unconscious habits they have developed, it is also the ‘gate’ which gives them virtually limitless

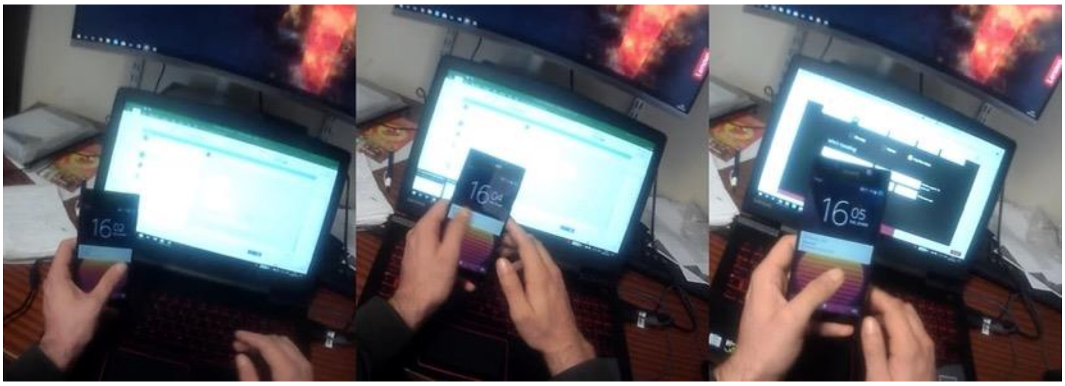


fig. 25 **Repeated checking of the smartphone while waiting without doing anything (*fidgeting*). Link to video clip in Appendix H.**

opportunities to spend attention, and through which distractions continuously flood in. Especially social pressures to be active and reachable suggest that the phone often demands more attention than users want to invest in it. But also the sheer amount of information that participants always have available at their fingertips can be a distraction, to which many comments of our participants give testimony:

> *It's really useful when you're alone and kind of bored. Like mentally bored. Because it's updated so frequently, there's just so much to see. It can be very addictive. I know a friend, who had to change her password to facebook and now her sister manages her page, so she wouldn't be distracted and can't get access to it.* (P4)

It is therefore difficult to judge whether the phone is a net-contributor to time and attention pressure, or whether it does indeed allow participants to streamline the activities of their daily lives and increase efficiency and productivity. It is certain, however, that the phone as the 'most personal' device users interact with in their daily lives will play a central role in the accumulation and exchange of attention currencies in the attention economy as it increasingly plays the dual role of being the device through which people both pay and receive attention.

However, let us also note in passing here that the effectiveness of attention capture by the smartphone in the moments where users are vulnerable to distraction is not purely accidental. An army of hardware designers, app developers, and social media companies are investing a lot of time and effort into making the smartphone and its affordances so irresistible to the users, to increase their engagement with the device and ultimately resell as much of their attention as possible in the attention economy.

Attention literacy, thus, does not only pertain to the area of mental health and well-being, but will also play an important role for the economic viability of many current and future business models, and may, similar to the discussion on privacy and data protection, become a highly political issue.

As the smartphone continues to gain in importance in the everyday lives of users and has already consolidated many different devices and objects of daily use (computer, calendar, camera, music player, etc.), it will be interesting to see how the form factor and the functionalities of the device continue to develop, and several further steps which will have a significant impact on the relationship between user and device are already under way (e.g. medical tool/health monitor, wallet and identification, wearable technologies).

11.3 DRIVERS OF SMARTPHONE USE

Our analysis of the contextual antecedents of smartphone use has shown that the majority of the usage habits we observed in the Subfilm material and that participants described are actually triggered by environmental cues, either arising from the physical surroundings of the user, or from the flow of activity they are engaged in. Surprisingly, external interruptions that break the continuous flow of activity and divert the focus of participants from their current activity, as well as notifications each only cause about 10% of all smartphone interactions. We therefore find that the narrative of the 'disruptive phone' does not hold up to closer examination. Similarly, the story of the fragmented, hectic life that constantly sends interruptions and temptations toward the individual, who, with her mind and attention taxed in such a way, picks up the phone as an anchoring point can only be part of the story.

From our observations, smartphone use appears tightly interwoven with the other activities we engage in in our daily lives, with brief interactions and lock screen checks enabling participants to manage their schedules, messages, and incoming information while being engaged in other activities, and longer interactions allowing them to take care of social connections and consume a variety of information they consider important, as well as distract and entertain themselves. It is in the breakpoints within, or the switches between other major activities where participants naturally reach out to the phone, and it is precisely because these cues (e.g. the need to stretch one's body) are so subtle and the actions come natural to participants that they tend to go unnoticed by participants.

Importantly, it is still somewhat unclear what really constitutes purely intentional use and how it is experienced by users. For about 30% of all interactions we did not observe any distinguishable environmental or situational cues. Even in a second round of data collection that focused exclusively on proactive use, we were unable to reconstruct the reasons for the interaction for a large portion of it. These behaviours need to be studied in more detail, as they represent what participants refer to when they speak about automatic and *unconscious* interactions. From the descriptions of our participants, it appears that they remember the interaction itself and their reasons quite well, but not the reason why they pick up the device. It is, thus, the initiation of the interaction that seems to take place 'unconsciously', which is why it will be relevant to take this finding to a laboratory setting and look at proactive use in more detail, perhaps also using physiological measures.

We have tested three general hypotheses; smartphone use as satisfying appetite, smartphone use as addiction, smartphone use as habit triggered by availability. From our data, we were not able to fully support any of these three hypotheses, or come up with a single, comprehensive model that works in all cases. The data and the statements of our participants seem to support the idea that several overlapping mechanisms are at play simultaneously:

- There is reactive behaviour: users reach for the phone when there are notifications. In only very few instances they do not, for social reasons. They also react to contextual cues and breaks in the flow of their ongoing activity.

- There are, indeed, uses of the phone as a displacement activity, as made explicit by participant comments (*I'm trying to concentrate on the statistics here, but every few minutes I check my phone. Can someone take me out of my misery?*, P18).

- Accessibility does trigger phone use, especially in 'moments of vulnerability' where external cues leave participants unfocused for a moment or trigger automatic engagement behaviours.

- There even are occasions where the users reach for the phone without any prompts, and do not even 'consume' (behaviour in vacuum), such as fidgeting or short proactive glances.

These findings confirm that phones are cognitive attractors and that participants have an appetite to interact with their devices and that a combination of internal drive, opportunism, and external stimulation seem to be at play. This probably relies on the extrinsic rewards that smartphone use produces (entertainment, social grooming). Thus looking into smartphone use from a neurological angle, and particularly into dopamine response (see Haynes, 2018; Parkin, 2018; Weinschenk, 2012), as well as controlling our findings regarding visibility and accessibility under experimental conditions is required in a next step. Moreover, the literature on mind wandering and intrusive thoughts is starting to build-up evidence in relation to the origin of smartphone and social media usage, which will be instructive for the theoretical understanding of purely intentional engagement behaviours that are not driven by contextual cues.

In general, we believe it is problematic to speak of addiction when it comes to smartphones; if smartphone use needs to be likened to other pleasures we overindulge in, it appears more appropriate to think of it as eating candy, than as smoking cigarettes. It is difficult to tease out these different hypotheses since, as said above, we find some evidence in favour of each, but no conclusive evidence that would favour one over the other; there may be several reasons. The first is that participants may have acquired, between subjects, different embodied propensions for EBs: some may only have a mild habit, others some degree of addiction. For example, they could be addicted to gaming, porn, or social networking and use the phone for this - although no such behaviour appeared in our sample. Then they could, within subject, perform EBs for different causes at different times. This is obvious when comparing notifications and proactive use; but it may also be the case within different types of proactive use; and we saw that the same participants can indeed explain different occurrences of EB differently. Finally, as mentioned earlier, the hypotheses we investigated are not mutually exclusive, and one single EB may have multiple causes - as it frequently is in human behaviour.

11.4 SITUATED RESEARCH

Taking a bit of a bird's eye perspective, the fourth and final area of findings highlights the importance of taking into account situated context when we study user behaviour. It has become very clear from the research carried out for this thesis that users do not take conscious note of many of their interactions with the smartphone, for example, and that they greatly underestimate how much and how regularly they use their devices in the flow of their daily lives, which has massive implications for how self-report data on smartphone use should be handled. Moreover, the finding that 89% of interactions are initiated by users, but also the prevalence of fidgeting, and the different antecedents of smartphone use would have been impossible to observe with device-log or self-report data.

Using situated qualitative methods and moving the user back to the centre of the stage in a field that is dominated by technology-centric approaches is paramount, not just to provide a full picture of user behaviour to better understand it, but also to allocate resources and research work efficiently. For example, our findings on habitual smartphone use, and that the majority of smartphone interactions is initiated by users, suggests that research trying to manipulate hardware factors to make notifications and devices in general less disruptive is not aiming at the right target. Yet, this is exactly what the majority of research in this area is trying to do. This is, of course, driven by findings from smartphone-log and recall-interview studies that have not taken into account context, and therefore not provided a full picture for software and hardware designers to work from.

We believe that situated, video-ethnographic methods are, currently, the only way to really understand how human-computer interaction plays out in naturally occurring contexts and are, therefore, a crucial step for basically any area of research trying to understand how users interact with devices. While these methods are labour intensive and often entail complex preparations and planning, they appear as the most reliable first step of approaching a research question without running the risk of relying on incomplete assumptions, jumping to conclusions too quickly, and potentially setting a misguided agenda for an entire emerging strand of the literature.

12. LIMITATIONS

Overall, this application of SEBE to unconstrained, real-world contexts for the study of smartphone use has proven to be very successful overall and built a strong case for the use of ethnographic mixed-method research to understand device use and to test whether experimental or quantitative findings replicate in naturally occurring contexts, or to shed light on existing contrasting findings (Banovic, 2016; Church, Ferreira, Banovic, & Lyons, 2015; Wilson & Mackay, 2011).

Nevertheless, there are many limitations to the method that became evident throughout the process and we have gained many insights that can help improving the usefulness of this technique in future applications. SEBE is a highly labour-intensive technique that, while collecting large amounts of data, ultimately results in a small-n study (41 participants in this case), and therefore cannot claim the same levels of generalisability that other studies that require a comparable and often significantly smaller amount of work can. We therefore believe that SEBE should always be the first step 'only' in a line of research that attempts to understand user and device interactions and deeper underlying motivations in minute detail.

On a practical level, future work is required to streamline the process of quantitative coding. Especially developing actionable inter-coder reliability strategies will significantly reduce the workload on individual researchers and improve the quality of results. It should also be explored how SEBE can be combined with automated large-scale methods of data collection, that allow to record the activities that are not recorded with the Subcams (as participants mostly will not be able to wear their cameras for full days), and further reduce the workload of the quantitative analysis. In that vein, exploring how the ethnographic, *in situ* part of SEBE can be combined with logging or experimental approaches already at the time of drafting the general research plan is prudent.

While quantitative approaches using device and application logs would not have been able to obtain some of the findings of our study, they produce more reliable data on usage patterns, which is needed to consolidate the evidence we have found. This, in combination with the mixture of conforming and contrasting results from previous studies substantiates the case for replication of smartphone use studies that has been argued in the mobile HCI community in recent years (Banovic, 2016;

Church et al., 2015; Wilson & Mackay, 2011). It is important to bear in mind that, while the differences in results may be due to the different study populations, there also might be a gradual shift in usage occurring over the years, which is then reflected in differences between the ‘snapshots’ that individual studies take.

Finally, while SEBE allows a much more detailed look into the subjective experiences of users, we have not assessed which specific notifications participants had activated or disactivated, and the influence of changing the devices’ notification settings on perceived disruptiveness. While this would be highly insightful, it is very difficult to reliably record in naturally occurring contexts as most people change these settings situationally (e.g. while waiting for a call); a more streamlined approach using SEBE in a slightly more controlled environment may be suited better to investigate these questions. Nevertheless, the key point remains that participants feel the phones *interrupt* them, when they actually *self-interrupt* in the majority of cases, whether different types of notifications are turned on or off.

13. NEXT STEPS

The findings this thesis has produced have been able to address several important questions around the nature and the underlying motivations of smartphone use, but as so often with research, and especially ethnographic explorations, they have also raised many further questions. On a very positive note, however, our findings also point out several clear and actionable pathways for future investigation for a variety of topics and fields, ranging from the economics of attention, to motivations and drivers of smartphone use, and intervention and design recommendations to address overuse and problematic smartphone use. Specifically, we see six avenues for future research building upon the findings from this thesis:

A first potential avenue of research should investigate empirically how the attention economy develops, and especially how it plays out on live-streaming platforms. As this field of research is only in its infancy and mostly based on interviews with streamers (Johnson & Woodcock, 2019; Woodcock & Johnson, 2019b, 2019a), SEBE will be a highly interesting addition to the study of live-streaming. Here, it will be key to study the relationships between live streamers and their audiences, as well as between audience members through an ethnographic lens to explore and better understand their nature. Further documenting how attention- and monetary transactions play out in naturally occurring contexts, but also documenting the entire, complex installation around the live-stream feed itself will not only be necessary to properly understand user behaviour, but may also be able to prevent the field from being affected by methodological issues similar to how the research around 'disruptive' smartphone notifications was. Live-streaming holds a wide range of opportunities and given the length of the feeds and the more passive form of engagement with the device compared to playing games oneself for example, we expect to find that the live-streaming installations of users are highly complex environments of multimedia interactions, using multiple devices, different constellations of people and spaces, and different levels of intensity of use. From a theoretical angle, taking a look at existing scholarship on TV and radio consumption, multitasking, and the level of engagement with the medium will be instructive.

A second potential avenue should further explore the drivers of smartphone use in controlled, experimental settings to clarify and confirm the influence of contextual antecedents, and the influence of the accessibility of the device on the patterns of device interactions. The three hypotheses formulated in this thesis (smartphone use as satisfying appetite, smartphone use as addiction, smartphone use as habit triggered by availability), and the interaction model proposed in Paper 4 (see Appendix E, *fig. 7*) should be the starting point for such investigations. This would constitute an excellent opportunity to further explore the use of first-person cameras for experimental methodologies. It would also enable researchers to develop a more nuanced understanding of intentionality and contextual drivers of smartphone use. The current model based on our observations leaves relatively little room for intentional and task-driven use of the device. Nevertheless, users experience many uses of their device as purposeful and goal-oriented. We were agnostic towards this when we started this research, which was simply trying to see when and why people pick up their phones, and were more interested in the details of what triggers the EB, whatever the reason. Interestingly, and as one can see in the detail of smartphone use described in our qualitative sections, we found that a lot of interactions consist of tasks that would not have existed before smartphones became ubiquitous (browsing Instagram, checking for notifications on various social networks and apps, games…). Specifically, these activities would not exist without the phone affordance. And this raises the question of what causes them. Of course there are some tasks that are unambiguously intentional, such as making a phone call, but detailed analysis has shown that the difference between internal and external triggers is difficult to tease out; often it is both. In other words, the question here is not about whether the EB is intentional or not, but why it occurs (or is triggered) at that specific moment and in that specific context: Why call now? Why browse Instagram at that specific moment? It appears that a deeper investigation of the subtle differences between environmental cause and subjective intentionality will prove as an immensely fruitful field of research, not just for smartphone or device use, but for human activity in general.

A third avenue should look in more detail at the nature, and the extreme levels of fidgeting we observed. Although it proved difficult to record and participants were often unable to provide much further insight, future research on fidgeting needs to tease out the internal, automatic motivators of this behaviour and the ecological factors that trigger it. It also needs to confirm whether the phone is actually the most common target object of fidgeting, and, if so, why this is the case. Our analysis of multi-device use suggests that fidgeting may potentially be attributed to situations in which participants are dual-tasking with their devices, rather than task-switching. In situations where participants are focusing on another device or activity but are still close to the device, or perhaps even hold it in their hands, seem to be particularly conducive to fidgeting. Future research could try to elicit these behaviours by exposing participants to sudden switches in background ambience that draw their attention, while they are engaged with their phones, and possibly other objects that can be manipulated and provide haptic feedback. For this line of inquiry, again, situated video-ethnographic approaches like SEBE that capture the first-person sensory experience of participants are indispensable.

A fourth avenue of research should try and connect the findings on high-frequency, user-initiated (and often locked) EBs with the recently emerging literature on the role of dopamine for smartphone use. Several researchers and industry professionals suggest that smartphones and social media leverage the dopamine response, which gets users addicted to a feedback loop (Haynes, 2018; Parkin, 2018; Weinschenk, 2012), but there is no solid confirmation of this relationship yet (Ley, 2017). This research is particularly relevant to the ongoing discussion on the ‘addictiveness’ of smartphones, and can potentially settle a long-standing debate. Monitoring the blood pressure, dopamine and cortisol levels of users, and other vitals across different users and situations, and especially investigating differences in these markers for the main different contexts when users are engaging with their devices while they are working or in leisure situations, as well as when they are rapidly switching between tasks and devices, or sequentially engaging with different activities for longer periods of time would provide an insightful addition to the current state of the literature.

A fifth avenue should clarify and test how the findings around the engagement and avoidance strategies of users and the internal and external drivers of smartphone use can inform research on hardware and software design, as well as how they can be applied to interventions for problematic smartphone use. The findings around the perceived disruptiveness of notifications and proactive smartphone checking behaviours make it very obvious that solely manipulating hardware factors will often not be sufficient to deliver the desired changes in user behaviour. Similar to the rationale of this thesis which has emphasised the importance of paying attention to users and contexts, both device and intervention design will have to move the users and their actions to the centre stage. The observations made in this thesis and the discussions with the participants suggest that while the problematic elements of smartphone use originate in user behaviours, so do the successful strategies that enabled participants to maintain the right 'distance' to their devices in different situations. A first, actionable path would be to build on our findings regarding the accessibility and the visibility of the device; it appears that strategies to not engage with the phone would be even more successful if this distance were quite literally larger. Experimental work could, thus, use similar designs to Painter and colleagues' candy consumption study (2002) to manipulate the accessibility and visibility of the smartphone in controlled settings, also taking into account different contexts and multi-device assemblages. In this line of research, it will be particularly interesting to try and determine the right 'distance' to the device to reduce disruptions, but also not to elicit fomo for various contexts and assemblages of devices.

A sixth avenue, finally, should develop the concept of attention literacy further. We propose that internet literacy should be understood in a more nuanced way: While most educational and research programs to date focus on improving the understanding of and training audiences on what could be called content literacy (i.e. how to not get one's credit card data stolen, or worse, groomed), future research should also focus on attention literacy (i.e. when and how to spend ones attention wisely, and how to maintain a desired level of intensity of use of the smartphone and communication technology in general) in specific situations. Attention literacy is the key that will enable users to make more informed and conscious choices on when and how to use these undoubtedly powerful tools, and when not to. Further investigating smartphone use in situated contexts and co-creating behavioural interventions based on the existing successful strategies appears to be the way forward to help users gain adequate levels of attention literacy. *Glanceable display* or *Slide to X approaches*, for example, that leverage the often-automatic behaviours around taking short mental breaks and checking the phones are an illustrative example for such approaches drawing on naturally emerging behaviours. A starting point could be the previously tested *glanceable display* approach, e.g. changing the background of the lock screen to include a reminder to use the phone less or regularly display metrics based on usage statistics (see for example “Screen Time” on iOS). Another straightforward application of this could be an unlocking choice that allows users to choose a time for when they receive a reminder that their ‘break time’ is over (e.g. 1, 3, or 5 minutes), or to choose between different HIT or survey tasks to complete during the break depending on their length.

Moreover, systems that enable users to distinguish between different types of notification delivery for different applications and to easily prioritise them over each other in specific moments appear especially promising for developing a healthy practice of attention allocation, and could leverage findings on decreasing the overall disruptiveness of notifications, for example around batching, predicting appropriate breakpoints, and offering different and new types of notification delivery. Users could, thus, distinguish between information that they want ‘forced’ upon them, be gently alerted to, and information that only needs to be included in the ‘digest’ the next time they check their lock screen to manage their notifications (see Paper 5 for a detailed discussion).

14. CONCLUSIONS

This thesis has allowed us to take a detailed look at the personal lives of smartphone users with their devices. We have observed how the phone acts as a necessary tool to fulfil professional duties and as a source of distraction preventing those professional duties from being carried out, but also how it keeps participants company and takes their mind off of worrisome thoughts or simple boredom when there was nothing else to keep them occupied. The smartphone helps users to keep track of and manage their schedules, to navigate the physical and social world around them, and to stay in touch with friends and family. And, through the Replay-interviews, an unprecedented glimpse into the inner workings and mechanisms at play when they interact with their phones, we saw how users feel about the device itself, their use of it, and how much of this use they were actually aware of.

For many users, the smartphone is indeed the first thing they see in the morning and the last thing they see at night - and continuous interactions with it are interspersed with all other activities of the day. *How many times have you checked your phone while reading this document?* The phone is probably the single object with which we interact with the most throughout our days: first and foremost, of course, because it is always present, both because we keep it in close physical proximity, and because it continuously occupies a portion of our mind. As we have seen, this preoccupation of the mind of users is highly complex and rooted in the fear of missing out on important information, the belief that the phone could potentially usefully contribute to the situation we find ourselves in, and the worry that the phone might interrupt us in a crucial moment and hinder us from achieving our daily goals.

Our findings also suggest that users have a multi-faceted and polyvalent relationship with their smartphones that is based on a variety of explicit desires and strategies and implicit drives and habits, both to engage and disengage with the smartphone that overlap in most cases and co-determine how the use of it plays out. Most interestingly, perhaps, smartphone use is driven by the user’s desire to interact with the device, its availability, and a variety of contextual cues that allow the phone to intrude into the minds of users and the activities they are engaged in much more than the device pushing itself onto the user with sounds or vibrations. Phones are major cognitive attractors and users have an appetite to interact with their devices. We therefore suggest that the narrative of the disruptive phone is not correct. This thesis has furthermore built up strong evidence that it is not correct to speak of smartphone addiction when talking about problematic smartphone use either, as the behavioural patterns we observe contradict what one would expect to see if picking up the smartphone were similar to other behavioural or even substance addictions.

We have also shown how important it is to conduct a solid ethnographic analysis of contextual, naturally occurring user behaviours before pursuing the 'intuitive' route, both in design and in research. And while we have not been able to come up with a single, comprehensive model of what drives smartphone use that works on every occasion, it has become abundantly clear that the key to striking a successful balance between engaging with the smartphone without overusing it or being disrupted lies within the users, not within their devices.

Lastly, as many smartphone routines and habits have become deeply internalised, automatic and mutually reinforcing, it will require substantial effort to find the right behavioural levers, and a committed effort on the side of the participants, to increase attention literacy and effect significant change in usage patterns, especially when it comes to using the phone less frequently. Adding to this difficulty is the fact that a whole industry is working behind the smartphone to attract the user into various apps, to catch her attention, and to resell it in the attention economy; and there are sophisticated systems keeping the user "caught in the loop" and in a state of fomo, leveraging social motives, gamification etc. This industry is working hard to increase the affordance for distraction of the phone, and an important part of the intense use of the device we observed is to be credited to this industry. Nevertheless, we do not believe in Luddism and the smartphone will probably go down in history as one of the most important inventions of mankind - but it is also important to not allow the corporations behind the design of devices and software to overly feed on our appetite for distraction.

This thesis rests on the shoulders of our participants, who have willingly shared with us some very private moments of their lives and contributed invaluably to our research, both by spending many hours recording Subfilm material, and by giving their important insights and interpretations in the Replay-interviews. We therefore leave the final words to them:

> *I'd say when I'm bored I use my phone more intensively. And when I have a lot on my hands or don't want to be distracted, then I'd exclude it a bit more. But I never experience my phone as a burden or nuisance, it's more of a partnership (laughs). And otherwise I never have the feeling that my phone is 'holding my reigns' or so. I mean I always have the choice to use the thing or to put it away, to pursue those notifications or not, uhm, and it is also nice to receive messages and so it's a really harmonic relationship, between my phone and me.* (P10)

> *After watching the recordings with you, I feel like I rely on my phone for more than I think I do. And honestly, I don't really like it. I would like to be a lot more independent. But it is what it is. It has become a companion. I mean, especially for a person who's living all by herself. And as you can see in the recordings, apparently she's obsessed with having multiple screens and monitors and people, digital people, digital viewings of people all around her! Maybe because I can't get real people around me, I don't know. But there's something about it that just feels nice.* (P40)

> *It's just this thing. It's so extremely familiar to somehow have new messages all the time, and then when you don't... I mean in the past you maybe had 10 text messages a day or so. And now, I had a look, I have a traffic of 200 messages a day, you can go calculate that for the minutes in a day. And so, the absence of notifications creates this feeling: "There's got to be something!," and then you go and see if you have read a message but haven't replied to it yet. Hands down though, if you were to get rid of all the unimportant messages, you'd probably be back to the original 10 messages a day.* (P5)

> *WhatsApp and these social networks give you the opportunity to be in direct contact with people, without having to be in actual contact with them. You know, you don't have to go and spend an hour in a bus to meet with them, you just can talk about whatever. And you don't have*

to have your whole attention there. Having the opportunity of having human contact without the downside and the costs of commuting, buying stuff, because whenever you're with people you're buying stuff: "Let's get beer. Let's get food. Let's pay for this museum.", you know, for everything you're using money. So, this is kind of a good way for introverts to have human contact when you don't want to be around a lot of people. (P3)

And I know that sometimes I look at my phone for no reason, very often, actually. I'm not really prompted because most of the time I have my phone on, silent. So I don't really... I just look at my phone when I look at my phone, I guess. (P42)

REFERENCES

Aarsand, P. (2016). Children's media practices: Challenges and dilemmas for the qualitative researcher. *Journal of Children and Media*, *10*(1), 90–97. https://doi.org/10.1080/17482798.2015.1121894

Aarsand, P., & Forsberg, L. (2010). Producing children's corporeal privacy: Ethnographic video recording as material-discursive practice. *Qualitative Research*. https://doi.org/10.1177/1468794109356744

Abowd, G. (2013). I-Corps: The Lock Screen Query (LSQ): Using the Unlock Interaction on Mobile Devices to Gather Relevant Information.

Adamczyk, P. D., & Bailey, B. P. (2004). If not now when?: the effects of interruption at different moments within task execution. *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems*. https://doi.org/10.1145/985692.985727

Adar, E., Teevan, J., & Dumais, S. T. (2008). Large scale analysis of web revisitation patterns. In *Conference on Human Factors in Computing Systems - Proceedings*. https://doi.org/10.1145/1357054.1357241

Aguiar, M., Hurst, E., & Karabarbounis, L. (2012). Recent Developments in the Economics of Time Use. *Annual Review of Economics*. https://doi.org/10.1146/annurev-economics-111809-125129

Ahlström, C., Wachtmeister, J., Nyman, M., Nordenström, A., & Kircher, K. (2020). Using smartphone logging to gain insight about phone use in traffic. *Cognition, Technology and Work*. https://doi.org/10.1007/s10111-019-00547-6

Ahmed, S. I., Dhareshwar, A., Bidwell, N. J., Karachiwala, B., Zade, H., Cedrick, T. N., … O'Neill, J. (2016). Peer-to-peer in the workplace: A view from the road peer-to-peer in the workplace: A view from the road. In *Conference on Human Factors in Computing Systems - Proceedings*. https://doi.org/10.1145/2858036.2858393

Ahn, H., Wijaya, M., & Esmero, B. (2014). A systemic smartphone usage pattern analysis: Focusing on smartphone addiction issue. *International Journal of Multimedia and Ubiquitous Engineering*, *9*(6), 9–14.

Aigrain, P. (2006). Diversity, attention and symmetry in a many-to-many attention society. *First Monday*, *11*(6). https://doi.org/https://doi.org/10.5210/fm.v11i6.1337

Aipperspach, R., Rattenbury, T., Woodruff, A., Anderson, K., Canny, J., & Aoki, P. (2006). *Ethno-Mining: Integrating Numbers and Words from the Ground Up. Technical Report UCB/EECS-2006-125*. Berkeley.

Aly-Tovar, R., Bacache-Beauvallet, M., Bourreau, M., & Moreau, F. (2020). Why would artists favor free streaming? *Journal of Cultural Economics*. https://doi.org/10.1007/s10824-019-09358-z

American Anthropological Association. (2001). *AAA Guidelines for the* *evaluation of ethnographic visual media*.

Anderson, C., Heinisch, J. S., Ohly, S., David, K., & Pejovic, V. (2019). The impact of private and work-related smartphone usage on interruptibility. In *UbiComp/ISWC 2019- - Adjunct Proceedings of the 2019 ACM International Joint Conference on Pervasive and Ubiquitous Computing and Proceedings of the 2019 ACM International Symposium on Wearable Computers*. https://doi.org/10.1145/3341162.3344845

Anderson, K., Nafus, D., Rattenbury, T., & Aipperspach, R. (2009). Numbers Have Qualities Too: Experiences with Ethno-Mining. *Ethnographic Praxis in Industry Conference Proceedings*. https://doi.org/10.1111/j.1559-8918.2009.tb00133.x

Andersson, K. E., Andersen, L. S., Christensen, J. H., & Neher, T. (2021). Assessing real-life benefit from hearing-aid noise management: Ssq12 questionnaire versus ecological momentary assessment with acoustic data-logging. *American Journal of Audiology*. https://doi.org/10.1044/2020_AJA-20-00042

Andorka, R. (1987). Time Budgets And Their Uses. *Annual Review of Sociology*. https://doi.org/10.1146/annurev.soc.13.1.149

Andrew, R. J. (1963). The Origin and Evolution of the Calls and Facial Expressions of the Primates. *Behaviour*, *20*(1–2), 1–109. https://doi.org/10.1163/156853963x00220

Andrews, S., Ellis, D. A., Shaw, H., & Piwek, L. (2015). Beyond self-report: Tools to compare estimated and real-world smartphone use. *PLoS ONE*. https://doi.org/10.1371/journal.pone.0139004

Anzani, A., Di Sarno, M., & Prunas, A. (2018). Using smartphone apps to find sexual partners: A review of the literature. *Sexologies*. https://doi.org/10.1016/j.sexol.2018.05.001

Araujo, T., Wonneberger, A., Neijens, P., & de Vreese, C. (2017). How Much Time Do You Spend Online? Understanding and Improving the Accuracy of Self-Reported Measures of Internet Use. *Communication Methods and Measures*. https://doi.org/10.1080/19312458.2017.1317337

Arminen, I., & Weilenmann, A. (2009). Mobile presence and intimacy-Reshaping social actions in mobile contextual configuration. *Journal of Pragmatics*. https://doi.org/10.1016/j.pragma.2008.09.016

Arnett, J. (2000). Emerging adulthood: A theory of development from the late teens through the twenties. *American Psychologist*, *55*(5), 469–480. https://doi.org/10.1037/0003-066X.55.5.469

Arnett, J. (2008). The Neglected 95%: Why American Psychology Needs to Become Less American. *American Psychologist*. https://doi.org/10.1037/0003-066X.63.7.602

Arnold, M. (2003). On the phenomenology of technology: The “Janus-faces” of mobile phones. *Information and Organization*.

https://doi.org/10.1016/S1471-7727(03)00013-7

Association of Social Anthropologists of the UK and the Commonwealth. (2011). *Ethical Guidelines for Good Research Practice*.

Atkinson, P. (2009). Ethics and ethnography. *Twenty-First Century Society*. https://doi.org/10.1080/17450140802648439

Attention. (2020a). In *Merriam-Webster.com*. Retrieved from https://www.merriam-webster.com/dictionary/attention.

Attention. (2020b). In *Oxford Dictionary*. Retrieved from https://www.lexico.com/definition/attention

Ayers, J. W., Leas, E. C., Dredze, M., Allem, J. P., Grabowski, J. G., & Hill, L. (2016). Pokémon GO-A new distraction for drivers and pedestrians. *JAMA Internal Medicine*. https://doi.org/10.1001/jamainternmed.2016.6274

Baek, Y. M., Cho, Y., & Kim, H. (2014). Attachment Style and its Influence on the Activities, Motives, and Consequences of SNS Use. *Journal of Broadcasting and Electronic Media*, *58*(4), 522–541. https://doi.org/10.1080/08838151.2014.966362

Bakshy, E., Mason, W. A., Hofman, J. M., & Watts, D. J. (2011). Everyone's an influencer: Quantifying influence on twitter. In *Proceedings of the 4th ACM International Conference on Web Search and Data Mining, WSDM 2011*. https://doi.org/10.1145/1935826.1935845

Bandura, A. (2001). Social cognitive theory: An agentic perspective. *Annual Review of Psychology*. https://doi.org/10.1146/annurev.psych.52.1.1

Bandura, A. (2006). Toward a Psychology of Human Agency. *Perspectives on Psychological Science*, *1*(2), 164–180. https://doi.org/10.1111/j.1745-6916.2006.00011.x

Banerjee, N., Rahmati, A., Corner, M. D., Rollins, S., & Zhong, L. (2007). Users and batteries: Interactions and adaptive energy management in mobile systems. In *Lecture Notes in Computer Science (including subseries Lecture Notes in Artificial Intelligence and Lecture Notes in Bioinformatics)*. https://doi.org/10.1007/978-3-540-74853-3_13

Banks, M. (2011). *Visual Methods in Social Research*. *Visual Methods in Social Research*. https://doi.org/10.4135/9780857020284

Banovic, N. (2016). To Replicate or Not to Replicate? *GetMobile: Mobile Computing and Communications*, *19*(4), 23–27. https://doi.org/10.1145/2904337.2904346

Banovic, N., Brant, C., Mankoff, J., & Dey, A. K. (2014). ProactiveTasks: The short of mobile device use sessions. In *MobileHCI 2014 - Proceedings of the 16th ACM International Conference on Human-Computer Interaction with Mobile Devices and Services*. https://doi.org/10.1145/2628363.2628380

Barash, D. P. (1974). Human Ethology: Displacement Activities in a Dental

Office. *Psychological Reports*, *34*(3), 947–949. https://doi.org/10.2466/pr0.1974.34.3.947

Barber, L. K., & Santuzzi, A. M. (2015). Please respond ASAP: Workplace telepressure and employee recovery. *Journal of Occupational Health Psychology*. https://doi.org/10.1037/a0038278

Bauer, J. S., Consolvo, S., Greenstein, B., Schooler, J., Wu, E., Watson, N. F., & Kientz, J. A. (2012). ShutEye: Encouraging awareness of healthy sleep recommendations with a mobile, peripheral display. In *Conference on Human Factors in Computing Systems - Proceedings*. https://doi.org/10.1145/2207676.2208600

Baumgartner, S. E., & Sumter, S. R. (2017). Dealing with media distractions: an observational study of computer-based multitasking among children and adults in the Netherlands. *Journal of Children and Media*. https://doi.org/10.1080/17482798.2017.1304971

Baumgartner, S. E., Sumter, S. R., Peter, J., Valkenburg, P. M., & Livingstone, S. (2014). Does country context matter? Investigating the predictors of teen sexting across Europe. *Computers in Human Behavior*, *34*, 157–164. https://doi.org/10.1016/j.chb.2014.01.041

Baym, N. K., & Boyd, D. (2012). Socially Mediated Publicness: An Introduction. *Journal of Broadcasting and Electronic Media*, *56*(3), 320–329. https://doi.org/10.1080/08838151.2012.705200

BBC. (2019). Editorial Guidelines on privacy.

Beja, I., Lanir, J., & Kuflik, T. (2015). Examining Factors Influencing the Disruptiveness of Notifications in a Mobile Museum Context. *Human–Computer Interaction*. https://doi.org/10.1080/07370024.2015.1005093

Beller, J. (2006). Paying attention. *Cabinet Magazine*, (24).

Bendak, S., Alali, A. K., Alali, N. M., & Alshehhi, M. M. (2019). Is the use of mobile phones while driving reaching alarming rates? A case study. *Transportation Letters*. https://doi.org/10.1080/19427867.2017.1409458

Bentham, J. (1791). *Panopticon or the inspection house*. *Postscript*.

Berry, E., Kapur, N., Williams, L., Hodges, S., Watson, P., Smyth, G., … Wood, K. (2007). The use of a wearable camera, SenseCam, as a pictorial diary to improve autobiographical memory in a patient with limbic encephalitis: A preliminary report. *Neuropsychological Rehabilitation*. https://doi.org/10.1080/09602010601029780

Bertel, T. F. (2013). “It’s like I trust it so much that I don’t really check where it is I’m going before I leave”: Informational uses of smartphones among Danish youth. *Mobile Media and Communication*. https://doi.org/10.1177/2050157913495386

Bessenhof, G. R. (2006). Can the Media affect us? Social Comparison, Self-Discrepancy, and the Thin Ideal. *Psychology of Women Quarterly*, *30*, 239–

251.

Blazek, M., & Hraňová, P. (2012). Emerging relationships and diverse motivations and benefits in participatory video with young people. *Children's Geographies*. https://doi.org/10.1080/14733285.2012.667917

Boase, J., & Ling, R. (2013). Measuring Mobile Phone Use: Self-Report Versus Log Data. *Journal of Computer-Mediated Communication*. https://doi.org/10.1111/jcc4.12021

Boehnke, K., Lietz, P., Schreier, M., & Wilhelm, A. (2010). Sampling: The selection of cases for culturally comparative psychological research. In *Cross-Cultural Research Methods in Psychology*. https://doi.org/10.1017/CBO9780511779381.007

Bogunovich, P., & Salvucci, D. (2011). The effects of time constraints on user behavior for deferrable interruptions. In *Conference on Human Factors in Computing Systems - Proceedings*. https://doi.org/10.1145/1978942.1979404

Böhmer, M., Hecht, B., Schöning, J., Krüger, A., & Bauer, G. (2011). Falling asleep with Angry Birds, Facebook and Kindle: A large scale study on mobile application usage. In *Mobile HCI 2011 - 13th International Conference on Human-Computer Interaction with Mobile Devices and Services*. https://doi.org/10.1145/2037373.2037383

Borst, J. P., Taatgen, N. A., & van Rijn, H. (2015). What Makes Interruptions Disruptive? https://doi.org/10.1145/2702123.2702156

Bowman, J. M., & Pace, R. C. (2014). Dual-Tasking Effects on Outcomes of Mobile Communication Technologies. *Communication Research Reports*. https://doi.org/10.1080/08824096.2014.907149

Bowman, L. L., Levine, L. E., Waite, B. M., & Gendron, M. (2010). Can students really multitask? An experimental study of instant messaging while reading. *Computers and Education*. https://doi.org/10.1016/j.compedu.2009.09.024

Boyd, D. M. (2007). Why youth (heart) Social network sites: the role of networked publics in teenage social life. *MacArthur Foundation Series on Digital Learning – Youth, Identity, and Digital Media*. https://doi.org/10.1162/dmal.9780262524834.119

Bradner, E., Kellogg, W. A., & Erickson, T. (1999). The Adoption and Use of 'Babble': A Field Study of Chat in the Workplace. In *ECSCW' 99*. https://doi.org/10.1007/978-94-011-4441-4_8

Brake, D. R. (2014). Sharing our lives online: Risks and exposure in social media. *Sharing Our Lives Online: Risks and Exposure in Social Media, 8151*(March), 1–193. https://doi.org/10.1057/9781137312716

Brinberg, M., Ram, N., Yang, X., Cho, M. J., Sundar, S. S., Robinson, T. N., & Reeves, B. (2021). The idiosyncrasies of everyday digital lives: Using the Human Screenome Project to study user behavior on smartphones. *Computers in Human Behavior*. https://doi.org/10.1016/j.chb.2020.106570

British Sociological Society. (2017). *Ethics Guidelines and Collated Resources for Digital Research*.

Brown, B., & Laurier, E. (2012). The normal, natural troubles of driving with GPS. In *Conference on Human Factors in Computing Systems - Proceedings*. https://doi.org/10.1145/2207676.2208285

Brown, B., McGregor, M., & Laurier, E. (2013). iPhone in Vivo: Video Analysis of Mobile Device Use. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems* (pp. 1031–1040). New York, NY, USA: ACM. https://doi.org/10.1145/2470654.2466132

Brown, B., McGregor, M., & McMillan, D. (2014). 100 days of iPhone use: Understanding the details of mobile device use. In *MobileHCI 2014 - Proceedings of the 16th ACM International Conference on Human-Computer Interaction with Mobile Devices and Services*. https://doi.org/10.1145/2628363.2628377

Brown, B., McGregor, M., & McMillan, D. (2015). Searchable Objects: Search in Everyday Conversation. In *Proceedings of the 18th ACM Conference on Computer Supported Cooperative Work and Social Computing* (pp. 508–517). New York, NY, USA: ACM. https://doi.org/10.1145/2675133.2675206

Brown, B., O'Hara, K., McGregor, M., & McMillan, D. (2018). Text in talk: Lightweight messages in co-present interaction. *ACM Transactions on Computer-Human Interaction*. https://doi.org/10.1145/3152419

Brown, K. M., Dilley, R., & Marshall, K. (2008). Using a head-mounted video camera to understand social worlds and experiences. *Sociological Research Online*. https://doi.org/10.5153/sro.1818

Bruenger, D. (2019). *Create, Produce, Consume*. *Create, Produce, Consume*. Berkeley: University of California Press. https://doi.org/10.1525/9780520972735

Bruggen, D. Van, Liu, S., Kajzer, M., Striegel, A., Crowell, C. R., & Arcy, J. D. (2013). Modifying Smartphone User Locking Behavior Categories and Subject Descriptors. *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems (CHI '13)*. https://doi.org/10.1145/2501604.2501614

Bruns, A., Heitmayer, M., Boesen-Mariani, S., & Lahlou, S. (2019). Dietary habits in advanced age. An investigation of food choice drivers, approaching to figh malnutrition among the elderly in the UK. In *Ethnography with a Twist*. Jyväskylä.

Busch, P. A., & McCarthy, S. (2021). Antecedents and consequences of problematic smartphone use: A systematic literature review of an emerging research area. *Computers in Human Behavior*. https://doi.org/10.1016/j.chb.2020.106414

Byrne, J., & Burton, P. (2017). Children as Internet users: how can evidence better inform policy debate? *Journal of Cyber Policy*.

https://doi.org/10.1080/23738871.2017.1291698

Cahn, E. (1999). Time dollars, work and community: From “why?” to “why not?” *Futures*. https://doi.org/10.1016/S0016-3287(99)00009-9

Cahn, E. (2001). On LETS and time dollars. *International Journal of Community Currency Research*.

Cahn, E., & Rowe, J. (1996). *Time Dollars: The New Currency that Enables Americans to Turn their Hidden Resource—Time—Into Personal Security and Community Renewal*. Chicago, IL: Family Resource Coalition of America.

Cain, M. S., & Mitroff, S. R. (2011). Distractor filtering in media multitaskers. *Perception*. https://doi.org/10.1068/p7017

Cambier, R., Derks, D., & Vlerick, P. (2019). Detachment from work: A diary study on telepressure, smartphone use and empathy. *Psychologica Belgica*. https://doi.org/10.5334/pb.477

Campbell, S. W. (2006). Perceptions of mobile phones in college classrooms: Ringing, cheating, and classroom policies. *Communication Education*. https://doi.org/10.1080/03634520600748573

Carlson, R. (1997). *Experienced Cognition*. Mahwah, NJ: Erlbaum.

Carrascal, J. P., & Church, K. (2015). An in-situ study of mobile app & mobile search interactions. In *Conference on Human Factors in Computing Systems - Proceedings*. https://doi.org/10.1145/2702123.2702486

Carroll, K. (2009). Outsider, insider, alongsider: Examining reflexivity in hospital-based video research. *International Journal of Multiple Research Approaches*. https://doi.org/10.5172/mra.3.3.246

Carroll, K., & Mesman, J. (2018). Multiple Researcher Roles in Video-Reflexive Ethnography. *Qualitative Health Research*. https://doi.org/10.1177/1049732318759490

Castelain-Meunier, C. (1997). The paternal cord: Telephone relationships between ‘non-custodian’ fathers and their children. *Reseaux, 5*(6), 161–176.

Chakraborty, A., Paranjape, B., Kakarla, S., & Ganguly, N. (2016). Stop Clickbait: Detecting and preventing clickbaits in online news media. In *Proceedings of the 2016 IEEE/ACM International Conference on Advances in Social Networks Analysis and Mining, ASONAM 2016*. https://doi.org/10.1109/ASONAM.2016.7752207

Chen, B., Liu, F., Ding, S., Ying, X., Wang, L., & Wen, Y. (2017). Gender differences in factors associated with smartphone addiction: A cross-sectional study among medical college students. *BMC Psychiatry*. https://doi.org/10.1186/s12888-017-1503-z

Cherry, S. (2005). Total recall. *IEEE Spectrum*. https://doi.org/10.1109/MSPEC.2005.1526902

Chiatti, A., Cho, M. J., Gagneja, A., Yang, X., Brinberg, M., Roehrick, K., … Giles, C. L. (2018). Text extraction and retrieval from smartphone screenshots: Building a repository for life in media. In *Proceedings of the ACM Symposium on Applied Computing*. https://doi.org/10.1145/3167132.3167236

Chinnov, A., Kerschke, P., Meske, C., Stieglitz, S., & Trautmann, H. (2015). An overview of topic discovery in Twitter communication through social media analytics. In *2015 Americas Conference on Information Systems, AMCIS 2015*.

Chiu, S. I. (2014). The relationship between life stress and smartphone addiction on taiwanese university student: A mediation model of learning self-Efficacy and social self-Efficacy. *Computers in Human Behavior*. https://doi.org/10.1016/j.chb.2014.01.024

Chotpitayasunondh, V., & Douglas, K. M. (2016). How "phubbing" becomes the norm: The antecedents and consequences of snubbing via smartphone. *Computers in Human Behavior*. https://doi.org/10.1016/j.chb.2016.05.018

Christensen, J. H., Saunders, G. H., Porsbo, M., & Pontoppidan, N. H. (2021). The everyday acoustic environment and its association with human heart rate: Evidence from real-world data logging with hearing aids and wearables. *Royal Society Open Science*. https://doi.org/10.1098/rsos.201345

Church, K., & De Oliveira, R. (2013). What's up with WhatsApp? Comparing mobile instant messaging behaviors with traditional SMS. In *MobileHCI 2013 - Proceedings of the 15th International Conference on Human-Computer Interaction with Mobile Devices and Services*. https://doi.org/10.1145/2493190.2493225

Church, K., Ferreira, D., Banovic, N., & Lyons, K. (2015). Understanding the Challenges of Mobile Phone Usage Data. In *Proceedings of the 17th International Conference on Human-Computer Interaction with Mobile Devices and Services* (pp. 504–514). New York, NY, USA: Association for Computing Machinery. https://doi.org/10.1145/2785830.2785891

Church, K., Smyth, B., Bradley, K., & Cotter, P. (2008). A large scale study of European mobile search behaviour. In *MobileHCI 2008 - Proceedings of the 10th International Conference on Human-Computer Interaction with Mobile Devices and Services*. https://doi.org/10.1145/1409240.1409243

Church, K., Smyth, B., Cotter, P., & Bradley, K. (2007). Mobile information access: A study of emerging search behavior on the mobile Internet. *ACM Transactions on the Web*. https://doi.org/10.1145/1232722.1232726

Cicourel, A. (1964). *Method and Measurement in Sociology*. Oxford: Free Press of Glencoe.

Clark, A., Prosser, J., & Wiles, R. (2010). Ethical issues in image-based research. *Arts & Health*. https://doi.org/10.1080/17533010903495298

Collom, E. (2007). The Motivations, Engagement, Satisfaction, Outcomes, and

Demographics of Time Bank Participants: Survey Findings from a U.S. System. *International Journal of Community Currency Research*.

Colon-Rivera, H., & Balasanova, A. (2020). What is a Substance Use Disorder? In *American Psychiatric Organisation*. Retrieved from https://www.psychiatry.org/patients-families/addiction/what-is-addiction

Consolvo, S., Klasnja, P., McDonald, D. W., Avrahami, D., Froehlich, J., Legrand, L., … Landay, J. A. (2008). Flowers or a robot army?: Encouraging awareness & activity with personal, mobile displays. In *UbiComp 2008 - Proceedings of the 10th International Conference on Ubiquitous Computing*. https://doi.org/10.1145/1409635.1409644

Consolvo, S., McDonald, D. W., Toscos, T., Chen, M. Y., Froehlich, J., Harrison, B., … Landay, J. A. (2008). Activity sensing in the wild: A field trial of UbiFit Garden. In *Conference on Human Factors in Computing Systems - Proceedings*. https://doi.org/10.1145/1357054.1357335

Contractor, A. A., Frankfurt, S. B., Weiss, N. H., & Elhai, J. D. (2017). Latent-level relations between DSM-5 PTSD symptom clusters and problematic smartphone use. *Computers in Human Behavior*. https://doi.org/10.1016/j.chb.2017.02.051

Cordelois, A. (2010). Using digital technology for collective ethnographic observation: An experiment on “coming home.” *Social Science Information*, *49*(3), 445–463. https://doi.org/10.1177/0539018410371266

Cox, S., Drew, S., Guillemin, M., Howell, C., Warr, D., & Waycott, J. (2014). Guidelines for Ethical Visual Research Methods. *Visual Research Collaboratory*.

Craig, W. (1917). Appetites and Aversions as Constituents of Instincts. *Proceedings of the National Academy of Sciences of the United States of America*, *3*(12), 685. https://doi.org/10.1073/PNAS.3.12.685

Crisler, M. C., Brooks, J. O., Ogle, J. H., Guirl, C. D., Alluri, P., & Dixon, K. K. (2008). Effect of wireless communication and entertainment devices on simulated driving performance. *Transportation Research Record*. https://doi.org/10.3141/2069-07

Crogan, P., & Kinsley, S. (2012). Paying attention: Toward a critique of the attention economy. *Culture Machine*.

Csikszentmihalyi, M. (2008). Flow: The psychology of optimal performance. In *Optimal experience: Psychological studies of flow in consciousness*. https://doi.org/10.1017/CBO9781107415324.004

Csikszentmihalyi, M. (2012). The flow experience and its significance for human psychology. In *Optimal Experience*. https://doi.org/10.1017/cbo9780511621956.002

Cudo, A., Francuz, P., Augustynowicz, P., & Stróżak, P. (2018). The Effects of Arousal and Approach Motivated Positive Affect on Cognitive Control. An ERP Study. *Frontiers in Human Neuroscience*.

https://doi.org/10.3389/fnhum.2018.00320

Cudo, A., Torój, M., Demczuk, M., & Francuz, P. (2020). Dysfunction of Self-Control in Facebook Addiction: Impulsivity Is the Key. *Psychiatric Quarterly*. https://doi.org/10.1007/s11126-019-09683-8

Cudo, A., Torój, M., Misiuro, T., & Griffiths, M. D. (2020). Problematic Facebook Use and Problematic Video Gaming among Female and Male Gamers. *Cyberpsychology, Behavior, and Social Networking*. https://doi.org/10.1089/cyber.2019.0252

Cui, Y., & Roto, V. (2008). How people use the web on mobile devices. In *Proceeding of the 17th International Conference on World Wide Web 2008, WWW'08*. https://doi.org/10.1145/1367497.1367619

Czerwinski, M., Cutrell, E., & Horvitz, E. (2000). Instant Messaging and Interruption: Influence of Task Type on Performance. *Proceedings of OZCHI 2000*. https://doi.org/10.1016/S1361-3723(02)01112-0

Dabbish, L., Mark, G., & González, V. M. (2011). Why do i keep interrupting myself?: Environment, habit and self-interruption. In *Conference on Human Factors in Computing Systems - Proceedings*. https://doi.org/10.1145/1978942.1979405

Damásio, M. J., Henriques, S., & Costa, C. (2012). Belonging to a community: The mediation of belonging. *Observatorio*.

Damásio, M. J., Henriques, S., Teixeira-Botelho, I., & Dias, P. (2013). Social activities and mobile Internet diffusion: A search for the Holy Grail? *Mobile Media and Communication*. https://doi.org/10.1177/2050157913495690

Davazdahemami, B., Hammer, B., & Soror, A. (2016). Addiction to mobile phone or addiction through mobile phone? In *Proceedings of the Annual Hawaii International Conference on System Sciences*. https://doi.org/10.1109/HICSS.2016.186

Davenport, T., & Beck, J. (2001). *The Attention Economy: Understanding the New Currency of Business.* Boston: Harvard Business School Press.

Davey, A., Nasser, K., & Davey, S. (2020). Gender differential for smart phone addiction and its predictors among adolescents: Assessing relationship with self control via sem approach. *Journal of Indian Association for Child and Adolescent Mental Health*.

Davidson, D. (1971). Agency. In R. Binkley, R. Bronaugh, & A. Marras (Eds.), *Agent, Action, and Reason* (pp. 3–37). Toronto: University of Toronto Press.

de Laat, S. (2004). Picture Perfect (?): Ethical Considerations in Visual Representation. *Nexus*.

De Reuver, M., & Bouwman, H. (2015). Dealing with self-report bias in mobile Internet acceptance and usage studies. *Information and Management*. https://doi.org/10.1016/j.im.2014.12.002

De Russis, L., & Monge Roffarello, A. (2017). On the Benefit of Adding User Preferences to Notification Delivery. In *CHI EA '17 Proceedings of the 2017 CHI Conference Extended Abstracts on Human Factors in Computing Systems* (pp. 1561–1568). https://doi.org/10.1145/3027063.3053160

Dearman, D., & Truong, K. N. (2012). Evaluating the implicit acquisition of second language Vocabulary using a live Wallpaper. In *Conference on Human Factors in Computing Systems - Proceedings*. https://doi.org/10.1145/2207676.2208598

Debord, G. (1995). The Society of the Spectacle. *Society*.

Demumieux, R., & Losquin, P. (2005). Gather customer's real usage on mobile phones. In *ACM International Conference Proceeding Series*. https://doi.org/10.1145/1085777.1085828

Demuth, C., & Fatigante, M. (2012). Comparative qualitative research in cultural psychology: Challenges and potentials. *Zeitschrift Für Qualitative Forschung*, *13*(1–2), 13–37.

Deng, T., Kanthawala, S., Meng, J., Peng, W., Kononova, A., Hao, Q., … David, P. (2019). Measuring smartphone usage and task switching with log tracking and self-reports. *Mobile Media and Communication*. https://doi.org/10.1177/2050157918761491

Deogan, C., Jacobsson, E., Mannheimer, L., & Björkenstam, C. (2020). Meeting Sexual Partners Online and Associations With Sexual Risk Behaviors in the Swedish Population. In *Journal of Sexual Medicine*. https://doi.org/10.1016/j.jsxm.2020.08.001

Derks, D., van Mierlo, H., & Schmitz, E. B. (2014). A diary study on work-related smartphone use, psychological detachment and exhaustion: Examining the role of the perceived segmentation norm. *Journal of Occupational Health Psychology*. https://doi.org/10.1037/a0035076

Derry, S. J., Pea, R., Barron, B., Engle, R. A., Erickson, F., Goldman, R., … Sherin, B. L. (2010). Conducting video research in the learning sciences: Guidance on selection, analysis, technology, and ethics. *Journal of the Learning Sciences*. https://doi.org/10.1080/10508400903452884

Dieckmann, P., Clemmensen, M. H., & Lahlou, S. (2019). Understanding Medication Dispensing as Done in Real Work Settings – Combining Conceptual Models and an Empirical Approach. In *Working Across Boundaries*. https://doi.org/10.1201/9780429274978-9

Dieckmann, P., Patterson, M., Lahlou, S., Mesman, J., Nyström, P., & Krage, R. (2017). Variation and adaptation: learning from success in patient safety-oriented simulation training. *Advances in Simulation*. https://doi.org/10.1186/s41077-017-0054-1

Dixon, N. (2017). Stranger-ness and Belonging in a Neighbourhood WhatsApp Group. *Open Cultural Studies*. https://doi.org/10.1515/culture-2017-0046

Do, T. M. T., Blom, J., & Gatica-Perez, D. (2011). Smartphone usage in the wild:

A large-scale analysis of applications and context. In *ICMI'11 - Proceedings of the 2011 ACM International Conference on Multimodal Interaction*. https://doi.org/10.1145/2070481.2070550

Doctorow, C. (2003). *Down and Out in the Magic Kingdom*. *Distribution*.

Duffy, B. E. (2017). *(Not) getting paid to do what you love: Gender, social media, and aspirational work*. *(Not) Getting Paid to do what You Love: Gender, Social Media, and Aspirational Work*. https://doi.org/10.1080/15295036.2018.1433310

Duke, É., & Montag, C. (2017). Smartphone addiction, daily interruptions and self-reported productivity. *Addictive Behaviors Reports*. https://doi.org/10.1016/j.abrep.2017.07.002

Dumais, S., Teevan, J., Jeffries, R., Russell, D. M., & Tang, D. (2014). Understanding user behaviour through log data and analysis. In *Ways of Knowing in HCI*. https://doi.org/10.1007/978-1-4939-0378-8_14

Easton, J. (2020, May 14). Almost 4 billion hours watched as live streaming industry benefits from lockdown. *Digital TV Europe*.

Edward Bernroider, W. N., Krumay, B., & Margiol, S. (2014). Not Without my smartphone! impacts of smartphone addiction on smartphone usage. In *Proceedings of the 25th Australasian Conference on Information Systems, ACIS 2014*.

Egelman, S., Jain, S., Portnoff, R. S., Liao, K., Consolvo, S., & Wagner, D. (2014). Are you ready to lock? Understanding user motivations for smartphone locking behaviors. In *Proceedings of the ACM Conference on Computer and Communications Security*. https://doi.org/10.1145/2660267.2660273

Eglinton, K. A. (2013). Between the Personal and the Professional: Ethical Challenges When Using Visual Ethnography to Understand Young People's Use of Popular Visual Material Culture. *Young*. https://doi.org/10.1177/1103308813488793

Eleuteri, S., Rossi, R., Tripodi, F., Fabrizi, A., & Simonelli, C. (2018). Sexual health in your hands: How the smartphone apps can improve your sexual wellbeing? *Sexologies*. https://doi.org/10.1016/j.sexol.2018.04.004

Ellis, D. A., Davidson, B. I., Shaw, H., & Geyer, K. (2019). Do smartphone usage scales predict behavior? *International Journal of Human Computer Studies*. https://doi.org/10.1016/j.ijhcs.2019.05.004

Entradas, M., & Bauer, M. (2019). Kommunikationsfunktionen im Mehrebenensystem Hochschule. In B. Fähnrich, J. Metag, S. Post, & M. Schäfer (Eds.), *Forschungsfeld Hochschulkommunikation*. Wiesbaden: Springer VS.

Erikson, E. (1968). *Youth: Identity and crisis*. *New York, NY: WW*.

Evans S. (2012). Virtual Selves, Real Relationships: An Exploration of the

Context and Role for Social Interactions in the Emergence of Self in Virtual Environments. *Integrative Psychological and Behavioral Science*, *46*(4), 512–528. Retrieved from http://ovidsp.ovid.com/ovidweb.cgi?T=JS&PAGE=reference&D=emed10b&NEWS=N&AN=22933055

Evans, S. (2015). Virtual Selves in Virtual Worlds: Towards the Development of a Social Psychological Understanding of the Self in Contemporary Society, (September), 697.

Eveland, W. P. (2003). A “mix of attributes” approach to the study of media effects and new communication technologies. *Journal of Communication*. https://doi.org/10.1093/joc/53.3.395

Eveland, W. P., & Dunwoody, S. (2001). User control and structural isomorphism or disorientation and cognitive load? Learning from the web versus print. *Communication Research*. https://doi.org/10.1177/009365001028001002

Everri, M. (2017). *Adolescents, parents, digital media: looking for the pattern that dis/connects. MSCA final research report.*

Everri, M. (2018). La comunicazione familiare nell’era digitale. In L. Fruggeri (Ed.), *Famiglie d’oggi. Quotidianità, dinamiche e processi psicosociali* (pp. 151–182). Rome: Carocci.

Everri, M., Heitmayer, M., Yamin-Slotkus, P., & Lahlou, S. (2020). Ethical challenges of using video for qualitative research and ethnography. In A.-K. Koistinen, T. Lähdesmäki, & V. Čeginskas (Eds.), *Ethnography with a Twist. Methodological and Ethical Challenges and Solutions in Contemporary Research*. Milton Park: Routledge.

Exler, A., Braith, M., Schankin, A., & Beigl, M. (2016). Preliminary Investigations About Interruptibility of Smartphone Users at Specific Place Types. In *Proceedings of the 2016 ACM International Joint Conference on Pervasive and Ubiquitous Computing: Adjunct* (pp. 1590–1595). New York, NY, USA: ACM. https://doi.org/10.1145/2968219.2968554

Exler, A., Dinse, C., Günes, Z., Hammoud, N., Mattes, S., & Beigl, M. (2017). Investigating the Perceptibility Different Notification Types on Smartphones Depending on the Smartphone Position. In *Proceedings of the 2017 ACM International Joint Conference on Pervasive and Ubiquitous Computing and Proceedings of the 2017 ACM International Symposium on Wearable Computers* (pp. 970–976). New York, NY, USA: ACM. https://doi.org/10.1145/3123024.3124560

Ezoe, S., Toda, M., Yoshimura, K., Naritomi, A., Den, R., & Morimoto, K. (2009). Relationships of personality and lifestyle with mobile phone dependence among female nursing students. *Social Behavior and Personality*. https://doi.org/10.2224/sbp.2009.37.2.231

Faccio, M., & McConnell, J. J. (2020). Death by Pokémon GO: The Economic and Human Cost of Using Apps While Driving. *Journal of Risk and Insurance*. https://doi.org/10.1111/jori.12301

Falaki, H., Mahajan, R., Kandula, S., Lymberopoulos, D., Govindan, R., & Estrin, D. (2010). Diversity in smartphone usage. In *MobiSys'10 - Proceedings of the 8th International Conference on Mobile Systems, Applications, and Services*. https://doi.org/10.1145/1814433.1814453

Falkinger, J. (2007). Attention economies. *Journal of Economic Theory*. https://doi.org/10.1016/j.jet.2005.12.001

Falkinger, J. (2008). Limited attention as a scarce resource in information-rich economies. *Economic Journal*. https://doi.org/10.1111/j.1468-0297.2008.02182.x

Fante, R., Jacobi, L. L., & Sexton, V. D. (2013). The effects of instant messaging and task difficulty on reading comprehension. *North American Journal of Psychology*.

Fauquet-Alekhine, P. (2016). Risk Assessment for Subjective Evidence-Based Ethnography Applied in High Risk Environment. *Advances in Research*. https://doi.org/10.9734/air/2016/21597

Fauquet-Alekhine, P., & Lahlou, S. (2017). The Square of PErceived ACtion Model (SPEAC Model) Applied in Digital Ethnography for Work Activity Analysis: Performance and Workers' Perception. *Current Journal of Applied Science and Technology*. https://doi.org/10.9734/cjast/2017/34985

Feather, N. (1982). *Expectations and Actions: Expectancy-Value Models in Psychology*. Hillsdale, NJ: Erlbaum.

Fehr, E., & Gächter, S. (2000). Fairness and retaliation: The economics of reciprocity. *Journal of Economic Perspectives*. https://doi.org/10.1257/jep.14.3.159

Fehr, E., & Gächter, S. (2002). Altruistic punishment in humans. *Nature*. https://doi.org/10.1038/415137a

Ferreira, D., Ferreira, E., Goncalves, J., Kostakos, V., & Dey, A. K. (2013). Revisiting human-battery interaction with an interactive battery interface. In *UbiComp 2013 - Proceedings of the 2013 ACM International Joint Conference on Pervasive and Ubiquitous Computing*. https://doi.org/10.1145/2493432.2493465

Ferreira, D., Goncalves, J., Kostakos, V., Barkhuus, L., & Dey, A. K. (2014). Contextual experience sampling of mobile application micro-usage. In *MobileHCI 2014 - Proceedings of the 16th ACM International Conference on Human-Computer Interaction with Mobile Devices and Services*. https://doi.org/10.1145/2628363.2628367

Ferreira, P., McGregor, M., & Lampinen, A. (2015). Caring for batteries: Maintaining infrastructures and mobile social contexts. In *MobileHCI 2015 - Proceedings of the 17th International Conference on Human-Computer Interaction with Mobile Devices and Services*. https://doi.org/10.1145/2785830.2785864

Figeac, J., & Chaulet, J. (2018). Video-ethnography of social media apps' connection cues in public settings. *Mobile Media and Communication*. https://doi.org/10.1177/2050157917747642

Fisher, R., & Simmons, R. (2011). Smartphone interruptibility using density-weighted uncertainty sampling with reinforcement learning. In *Proceedings - 10th International Conference on Machine Learning and Applications, ICMLA 2011*. https://doi.org/10.1109/ICMLA.2011.128

Fitz, N., Kushlev, K., Jagannathan, R., Lewis, T., & Paliwal, D. (2019). Batching smartphone notifications can improve well-being. *Computers in Human Behavior*, 1–23. https://doi.org/10.1016/j.chb.2019.07.016

Flewitt, R. (2005). Conducting research with young children: Some ethical considerations. *Early Child Development and Care*. https://doi.org/10.1080/03004430500131338

Ford, S. M. (2012). The Mother-in-Law Effect: Managing the Publicity of Personal Content Online. *Journal of Broadcasting and Electronic Media*, *56*(4), 550–561. https://doi.org/10.1080/08838151.2012.732143

Fortin, P. E., Huang, Y., & Cooperstock, J. R. (2019). Exploring the use of fingerprint sensor gestures for unlock journaling: A comparison with slide-to-X. In *Proceedings of the 21st International Conference on Human-Computer Interaction with Mobile Devices and Services, MobileHCI 2019*. https://doi.org/10.1145/3338286.3340135

Foster, L., Gielen, M., Beattie, M., & Goodwill, S. (2014). Real-time monitoring of user physical activity and position in an outdoor public space. *Lecture Notes in Computer Science (Including Subseries Lecture Notes in Artificial Intelligence and Lecture Notes in Bioinformatics)*. https://doi.org/10.1007/978-3-319-13102-3_19

Fournier, S., & Eckhardt, G. M. (2019). Putting the Person Back in Person-Brands: Understanding and Managing the Two-Bodied Brand. *Journal of Marketing Research*. https://doi.org/10.1177/0022243719830654

Franck, G. (1998). Ökonomie der Aufmerksamkeit: Ein Entwurf. *Edition Akzente*.

Franck, G. (1999). Scientific communication - A vanity fair? *Science*. https://doi.org/10.1126/science.286.5437.53

Frankfurt, H. G. (1958). Peirce’s Notion of Abduction. *The Journal of Philosophy*. https://doi.org/10.2307/2021966

Frissen, V. A. J. (2000). ICTs in the Rush Hour of Life. *The Information Society, 16*(1), 65–75. https://doi.org/10.1080/019722400128338

Froehlich, J., Chen, M. Y., Consolvo, S., Harrison, B., & Landay, J. A. (2007). MyExperience: A system for in situ tracing and capturing of user feedback on mobile phones. In *MobiSys’07: Proceedings of the 5th International Conference on Mobile Systems, Applications and Services*. https://doi.org/10.1145/1247660.1247670

Frost, M., Doryab, A., Faurholt-Jepsen, M., Kessing, L., & Bardram, J. E. (2013).

Supporting disease insight through data analysis: Refinements of the MONARCA self-assessment system. In *UbiComp 2013 - Proceedings of the 2013 ACM International Joint Conference on Pervasive and Ubiquitous Computing*. https://doi.org/10.1145/2493432.2493507

Geertz, C. (1973). Thick description: Toward an interpretive theory of culture. In *Interpretation of Cultures*.

Gelbart, B., Barfield, C., & Watkins, A. (2009). Ethical and legal considerations in video recording neonatal resuscitations. *Journal of Medical Ethics*. https://doi.org/10.1136/jme.2008.024612

Ghosh, R. A. (1997). Economics is dead, long live economics! A commentary on Michael Goldhaber's "The attention economy. *First Monday*. https://doi.org/10.5210/fm.v2i5.529

Ghosh, R. A. (1998). Cooking pot markets: An economic model for the trade in free goods and services on the Internet. *First Monday*. https://doi.org/10.5210/fm.v3i2.580

Gibson, J. J. (1982). Notes on affordances. In E. Reed & R. Jones (Eds.), *Reasons for realism. Selected Essays of James J. Gibson* (pp. 401–418). London: Lawrence Erlbaum Associates.

Giddens, A. (1990). *The consequences of modernity*. Stanford, Calif.: Stanford University Press.

Glăveanu, V. P., & Lahlou, S. (2012). Through the Creator's Eyes: Using the Subjective Camera to Study Craft Creativity. *Creativity Research Journal, 24*(2–3), 152–162. https://doi.org/10.1080/10400419.2012.677293

Glăveanu, V. P., & Lahlou, S. (2012). Through the Creator's Eyes: Using the Subjective Camera to Study Craft Creativity. *Creativity Research Journal*. https://doi.org/10.1080/10400419.2012.677293

Gobbo, A. (2015). *The making of consumer decisions: Revisiting the notions of evaluation and choice by reconstructing consumer habits through subjective evidence based ethnography. PhD Thesis.* London School of Economics and Political Science.

Goffman, E. (1959). *The Presentation of Self In Everyday Life (1959). Contemporary sociological theory, 46-61.* https://doi.org/10.2307/258197

Goldhaber, M. (1997a). The attention economy and the net. *First Monday*. https://doi.org/10.5210/fm.v2i4.519

Goldhaber, M. (1997b). What's the Right Economics for Cyberspace? *First Monday*. https://doi.org/10.5210/fm.v2i7.537

Goldhaber, M. (2006). The value of openness in an attention economy. *First Monday*. https://doi.org/10.5210/fm.v11i6.1334

Goldman, R., Pea, R., Barron, B., & Derry, S. (Eds.). (2007). *Video research in the learning science*. Mahwah, NJ: Lawrence Erlbaum Associates, Inc.

González, M. C., Hidalgo, C. A., & Barabási, A. L. (2008). Understanding individual human mobility patterns. *Nature*. https://doi.org/10.1038/nature06958

González, V. M., & Mark, G. (2004). “Constant, constant, multi-tasking craziness”: Managing multiple working spheres. In *Conference on Human Factors in Computing Systems - Proceedings*.

Gouveia, R., Karapanos, E., & Hassenzahl, M. (2018). Activity tracking in vivo. In *Conference on Human Factors in Computing Systems - Proceedings*. https://doi.org/10.1145/3173574.3173936

Green, N. (2002). On the Move: Technology, Mobility, and the Mediation of Social Time and Space. *The Information Society*, *18*(4), 281–292.

Grellhesl, M., & Punyanunt-Carter, N. M. (2012). Using the uses and gratifications theory to understand gratifications sought through text messaging practices of male and female undergraduate students. *Computers in Human Behavior*. https://doi.org/10.1016/j.chb.2012.06.024

Gubrium, A., & Harper, K. (2016). *Participatory Visual and Digital Methods*. *Participatory Visual and Digital Methods*. https://doi.org/10.4324/9781315423012

Gubrium, A., Hill, A., & Flicker, S. (2014). A situated practice of ethics for participatory visual and digital methods in public health research and practice: A focus on digital storytelling. *American Journal of Public Health*. https://doi.org/10.2105/AJPH.2013.301310

Gurrin, C., Qiu, Z., Hughes, M., Caprani, N., Doherty, A. R., Hodges, S. E., & Smeaton, A. F. (2013). The smartphone as a platform for wearable cameras in health research. *American Journal of Preventive Medicine*. https://doi.org/10.1016/j.amepre.2012.11.010

Hadlington, L., White, H., & Curtis, S. (2019). “I cannot live without my [tablet]”: Children’s experiences of using tablet technology within the home. *Computers in Human Behavior*. https://doi.org/10.1016/j.chb.2018.12.043

Haeckling, M. (2013). Challenges of conducting ethical video-based classroom research. Retrieved from http://ro.ecu.edu.au/ecuworkspost2013/839

Haggard, P. (2008). Human volition: towards a neuroscience of will. *Nature Reviews Neuroscience*, *9*(12), 934–946. https://doi.org/10.1038/nrn2497

Haggard, P. (2019). The Neurocognitive Bases of Human Volition. *Annual Review of Psychology*, *70*(1), 9–28. https://doi.org/10.1146/annurev-psych-010418-103348

Hamermesh, D. S., & Jungmin, L. (2007). Stressed out on four continents: Time crunch or yuppie kvetch? *Review of Economics and Statistics*. https://doi.org/10.1162/rest.89.2.374

Hamilton, W. A., Garretson, O., & Kerne, A. (2014). Streaming on twitch: Fostering participatory communities of play within live mixed media. In

Conference on Human Factors in Computing Systems - Proceedings. https://doi.org/10.1145/2556288.2557048

Hang, A., De Luca, A., Hartmann, J., & Hussmann, H. (2013). Oh app, where art thou? On app launching habits of smartphone users. In *MobileHCI 2013 - Proceedings of the 15th International Conference on Human-Computer Interaction with Mobile Devices and Services*. https://doi.org/10.1145/2493190.2493219

Harbach, M., De Luca, A., & Egelman, S. (2016). The anatomy of smartphone unlocking a field study of android lock screens. In *Conference on Human Factors in Computing Systems - Proceedings*. https://doi.org/10.1145/2858036.2858267

Harbach, M., De Luca, A., Malkin, N., & Egelman, S. (2016). Keep on lockin' in the free world: A multi-national comparison of smartphone locking. In *Conference on Human Factors in Computing Systems - Proceedings*. https://doi.org/10.1145/2858036.2858273

Harbach, M., von Zezschwitz, E., Fichtner, A., Luca, A. De, & Smith, M. (2016). It's a Hard Lock Life: A Field Study of Smartphone (Un)Locking Behavior and Risk Perception. *SOUPS '14: Proceedings of the Tenth Symposium On Usable Privacy and Security*.

Hardt, M., & Negri, A. (2004). *Multitude: War and democracy in the age of empire*. *Penguin Books*.

Hargittai, E., & Hsieh, Y. li P. (2010). Predictors and consequences of differentiated practices on social network sites. *Information Communication and Society*, *13*(4), 515–536. https://doi.org/10.1080/13691181003639866

Hargittai, E., & Walejko, G. (2008). The participation divide: Content creation and sharing in the digital age. *Information Communication and Society*, *11*(2), 239–256. https://doi.org/10.1080/13691180801946150

Haumann, E. (2020). Foucault and the Connected City: How Information and Communication Technologies Influence Urban Governance and Citizenship. *Informa*, *13*, 194–207.

Hayes, R. A., Carr, C. T., & Wohn, D. Y. (2016). One Click, Many Meanings: Interpreting Paralinguistic Digital Affordances in Social Media. *Journal of Broadcasting and Electronic Media*, *60*(1), 171–187. https://doi.org/10.1080/08838151.2015.1127248

Haynes, T. (2018). Dopamine, Smartphones & You: A battle for your time. Retrieved September 10, 2019, from http://sitn.hms.harvard.edu/flash/2018/dopamine-smartphones-battle-time/

Heath, C., Hindmarsh, J., & Luff, P. (2017). Access, Ethics and Project Planning. In *Video in Qualitative Research: Analysing Social Interaction in Everyday Life*. https://doi.org/10.4135/9781526435385.n2

Heitmayer, M. (2020). Smartphones at the Workplace: An in situ Mixed-Method Study on Smartphone Use During Intellectual Work. In *The Asian*

Conference on Psychology & the Behavioral Sciences 2020 Official Conference Proceedings (pp. 31–50). Tokyo. Retrieved from https://papers.iafor.org/submission55826/

Heitmayer, M., & Lahlou, S. (2021). Why are smartphones disruptive? An empirical study of smartphone use in real-life contexts. *Computers in Human Behavior*. https://doi.org/10.1016/j.chb.2020.106637

Helsper, E. J., & Smahel, D. (2020). Excessive internet use by young Europeans: psychological vulnerability and digital literacy? *Information Communication and Society*. https://doi.org/10.1080/1369118X.2018.1563203

Henrich, J., Heine, S. J., & Norenzayan, A. (2010). The weirdest people in the world? *Behavioral and Brain Sciences*. https://doi.org/10.1017/S0140525X0999152X

Henze, N., Poppinga, B., & Boll, S. (2010). Experiments in the wild: Public evaluation of off-screen visualizations in the Android Market. In *NordiCHI 2010: Extending Boundaries - Proceedings of the 6th Nordic Conference on Human-Computer Interaction*. https://doi.org/10.1145/1868914.1869002

Henze, N., Rukzio, E., & Boll, S. (2011). 100,000,000 Taps: Analysis and improvement of touch performance in the large. In *Mobile HCI 2011 - 13th International Conference on Human-Computer Interaction with Mobile Devices and Services*. https://doi.org/10.1145/2037373.2037395

Heptonstall, B. (2015). *Cognitive de-biasing strategies in medicine: a subjective evidence-based ethnography approach. MSc Thesis.* London School of Economics and Political Science.

Hill, M. S. (1985). Patterns of Time Use. In F. Juster & F. Stafford (Eds.), *Time, Goods and Well-Being* (pp. 133–176). Ann Arbor: Survey Research Center. Retrieved from file:///C:/paper/AllPapers/1-MKTG/Hill 1985 - Chapter.pdf

Hilvert-Bruce, Z., Neill, J. T., Sjöblom, M., & Hamari, J. (2018). Social motivations of live-streaming viewer engagement on Twitch. *Computers in Human Behavior*. https://doi.org/10.1016/j.chb.2018.02.013

Hiniker, A., Patel, S. N., Kohno, T., & Kientz, J. A. (2016). Why would you do that? Predicting the uses and gratifications behind smartphone-usage behaviors. In *UbiComp 2016 - Proceedings of the 2016 ACM International Joint Conference on Pervasive and Ubiquitous Computing*. https://doi.org/10.1145/2971648.2971762

Hintze, D., Findling, R. D., Muaaz, M., Scholz, S., & Mayrhofer, R. (2014). Diversity in locked and unlocked mobile device usage. In *UbiComp 2014 - Adjunct Proceedings of the 2014 ACM International Joint Conference on Pervasive and Ubiquitous Computing*. https://doi.org/10.1145/2638728.2641697

Hintze, D., Findling, R. D., Scholz, S., & Mayrhofer, R. (2014). Mobile device usage characteristics: The effect of context and form factor on locked and unlocked usage. In *12th International Conference on Advances in Mobile*

Computing and Multimedia, MoMM 2014. https://doi.org/10.1145/2684103.2684156

Hodges, S., Berry, E., & Wood, K. (2011). SenseCam: A wearable camera that stimulates and rehabilitates autobiographical memory. *Memory*. https://doi.org/10.1080/09658211.2011.605591

Hoenigl, M., Little, S. J., Grelotti, D., Skaathun, B., Wagner, G. A., Weibel, N., … Smith, D. M. (2020). Grindr users take more risks, but are more open to Human Immunodeficiency Virus (HIV) Pre-exposure prophylaxis: Could this dating app provide a platform for HIV prevention outreach? *Clinical Infectious Diseases*. https://doi.org/10.1093/cid/ciz1093

Hogan, B. (2010). The Presentation of Self in the Age of Social Media: Distinguishing Performances and Exhibitions Online. *Bulletin of Science, Technology & Society, 30*(6), 377–386. https://doi.org/10.1177/0270467610385893

Höge, T. (2009). When work strain transcends psychological boundaries: An inquiry into the relationship between time pressure, irritation, work-family conflict and psychosomatic complaints. *Stress and Health*. https://doi.org/10.1002/smi.1226

Hollan, J. D., & Hutchins, E. L. (2009). Opportunities and Challenges for Augmented Environments: A Distributed Cognition Perspective. In S. Lahlou (Ed.), *Designing User Friendly Augmented Work Environments. From Meeting Rooms to Digital Collaborative Spaces.* (pp. 269–289). London: Springer. https://doi.org/10.1007/978-1-84800-098-8_9

Hollis, R. B., & Was, C. A. (2016). Mind wandering, control failures, and social media distractions in online learning. *Learning and Instruction*. https://doi.org/10.1016/j.learninstruc.2016.01.007

Holloway, D., Green, L., & Livingstone, S. (2013). Zero to eight: Young children and their internet use. *EU Kids Online*, (August), 36. https://doi.org/10.1186/1479-5868-10-137

Holst, A. (2019). Number of smartphone users worldwide from 2016 to 2021 (in billions).

Horkheimer, M., & Adorno, T. W. (1988). *Dialektik der Aufklärung. Philosophische Fragmente*. *Theodor W Adorno Gesammelte Schriften Bd 3*.

Horvitz, E., Koch, P., & Apacible, J. (2004). BusyBody: creating and fielding personalized models of the cost of interruption. *Proceedings of the 2004 ACM Conference on Computer Supported Cooperative Work - CSCW '04*. https://doi.org/10.1145/1031607.1031690

Horwood, S., & Anglim, J. (2018). Personality and problematic smartphone use: A facet-level analysis using the Five Factor Model and HEXACO frameworks. *Computers in Human Behavior*. https://doi.org/10.1016/j.chb.2018.04.013

Horwood, S., & Anglim, J. (2019). Problematic smartphone usage and subjective and psychological well-being. *Computers in Human Behavior*. https://doi.org/10.1016/j.chb.2019.02.028

Hosking, S. G., Young, K. L., & Regan, M. A. (2009). The effects of text messaging on young drivers. *Human Factors*. https://doi.org/10.1177/0018720809341575

Hsieh, H. F., & Shannon, S. E. (2005). Three approaches to qualitative content analysis. *Qualitative Health Research*. https://doi.org/10.1177/1049732305276687

Hsieh, S. H., & Tseng, T. H. (2017). Playfulness in mobile instant messaging: Examining the influence of emoticons and text messaging on social interaction. *Computers in Human Behavior*. https://doi.org/10.1016/j.chb.2016.12.052

Huang, A. H., Yen, D. C., & Zhang, X. (2008). Exploring the potential effects of emoticons. *Information and Management*. https://doi.org/10.1016/j.im.2008.07.001

Humphreys, L. (2012). Connecting, Coordinating, Cataloguing: Communicative Practices on Mobile Social Networks. *Journal of Broadcasting and Electronic Media*, *56*(4), 494–510. https://doi.org/10.1080/08838151.2012.732144

Hussain, Z., Griffiths, M. D., & Sheffield, D. (2017). An investigation into problematic smartphone use: The role of narcissism, anxiety, and personality factors. *Journal of Behavioral Addictions*. https://doi.org/10.1556/2006.6.2017.052

Hutchby, I., O'Reilly, M., & Parker, N. (2012). Ethics in praxis: Negotiating the presence and functions of a video camera in family therapy. *Discourse Studies*. https://doi.org/10.1177/1461445612457487

Hwang, Y., & Jeong, S. H. (2018). Multitasking and task performance: Roles of task hierarchy, sensory interference, and behavioral response. *Computers in Human Behavior*. https://doi.org/10.1016/j.chb.2017.12.008

Hwang, Y., & Jeong, S. H. (2019). The role of user control in media multitasking effects. *Media Psychology*. https://doi.org/10.1080/15213269.2019.1659152

Ijsselsteijn, W. a., Baren, J. Van, Lanen, F. Van, Box, P. O., & Eindhoven, M. B. (2003). Staying in Touch Social Presence and Connectedness through Synchronous and Asynchronous Communication Media. In *Proceedings of the International Conference on Human-Computer Interaction (HCI'03)*.

Iqbal, S. T., & Bailey, B. P. (2007). Understanding and Developing Models for Detecting and Differentiating Breakpoints During Interactive Tasks. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems* (pp. 697–706). New York, NY, USA: ACM. https://doi.org/10.1145/1240624.1240732

Iqbal, S. T., & Bailey, B. P. (2008). Effects of Intelligent Notification Management on Users and Their Tasks. In *Proceedings of the SIGCHI*

Conference on Human Factors in Computing Systems (pp. 93–102). New York, NY, USA: ACM. https://doi.org/10.1145/1357054.1357070

Iqbal, S. T., & Horvitz, E. (2010). Notifications and awareness: A field study of alert usage and preferences. *Proceedings of the 2010 ACM Conference on Computer Supported Cooperative Work - CSCW '10*, 27–30. Retrieved from http://portal.acm.org/citation.cfm?doid=1718918.1718926%5Cnhttp://dl.acm.org/citation.cfm?id=1718918.1718926

Ishii, K. (2006). Implications of mobility: The uses of personal communication media in everyday life. *Journal of Communication*. https://doi.org/10.1111/j.1460-2466.2006.00023.x

Jacucci, G., Oulasvirta, A., & Salovaara, A. (2007). Active construction of experience through mobile media: A field study with implications for recording and sharing. In *Personal and Ubiquitous Computing*. https://doi.org/10.1007/s00779-006-0084-5

James, W. (2006). *The principles of psychology. The principles of psychology.* https://doi.org/10.1037/11059-000

Janlert, L. E., & Stolterman, E. (2017). The Meaning of Interactivity—Some Proposals for Definitions and Measures. *Human-Computer Interaction*. https://doi.org/10.1080/07370024.2016.1226139

Jeong, S. H., & Fishbein, M. (2007). Predictors of multitasking with media: Media factors and audience factors. *Media Psychology*. https://doi.org/10.1080/15213260701532948

Jeong, S. H., & Hwang, Y. (2016). Media Multitasking Effects on Cognitive vs. Attitudinal Outcomes: A Meta-Analysis. *Human Communication Research*. https://doi.org/10.1111/hcre.12089

Jeong, Y., Jung, H., & Lee, J. (2020). Cyberslacking or Smart Work: Smartphone Usage Log-Analysis Focused on App-Switching Behavior in Work and Leisure Conditions. *International Journal of Human-Computer Interaction*. https://doi.org/10.1080/10447318.2019.1597574

Jha, A., Tiwari, G., Mohan, D., Mukherjee, S., & Banerjee, S. (2017). Analysis of pedestrian movement on Delhi roads by using naturalistic observation techniques. *Transportation Research Record*. https://doi.org/10.3141/2634-14

Johannes, N., Meier, A., Reinecke, L., Ehlert, S., Setiawan, D. N., Walasek, N., … Veling, H. (2020). The relationship between online vigilance and affective well-being in everyday life: Combining smartphone logging with experience sampling. *Media Psychology*. https://doi.org/10.1080/15213269.2020.1768122

Johinke, R. (2020). Social production as authentic assessment: Wikipedia, digital writing, and hope labour. *Studies in Higher Education*. https://doi.org/10.1080/03075079.2020.1750192

Johnson, M. R., & Woodcock, J. (2019). "And Today's Top Donator is": How

Live Streamers on Twitch.tv Monetize and Gamify Their Broadcasts . *Social Media + Society*. https://doi.org/10.1177/2056305119881694

Johnston, M. J., King, D., Arora, S., Behar, N., Athanasiou, T., Sevdalis, N., & Darzi, A. (2015). Smartphones let surgeons know WhatsApp: An analysis of communication in emergency surgical teams. *American Journal of Surgery*. https://doi.org/10.1016/j.amjsurg.2014.08.030

Jonassen, Z. (2016). Good Practices of Replay Interviewers: An Explorative Study of their Understanding of the Interview Setting, Attitude, and Behaviour, 1–118.

Jones-Jang, S. M., Heo, Y.-J., McKeever, R., Kim, J. H., Moscowitz, L., & Moscowitz, D. (2020). Good News! Communication Findings May be Underestimated: Comparing Effect Sizes with Self-Reported and Logged Smartphone Use Data. *Journal of Computer-Mediated Communication*. https://doi.org/10.1093/jcmc/zmaa009

Jones, L., McClelland, J., Thongsouksanoumane, P., & Girouard, A. (2017). Ambient Notifications with Shape Changing Circuits in Peripheral Locations. In *Proceedings of the 2017 ACM International Conference on Interactive Surfaces and Spaces* (pp. 405–408). New York, NY, USA: ACM. https://doi.org/10.1145/3132272.3132291

Jones, S. L., Hue, W., Kelly, R. M., Barnett, R., Henderson, V., & Sengupta, R. (2021). Determinants of Longitudinal Adherence in Smartphone-Based Self-Tracking for Chronic Health Conditions: Evidence from Axial Spondyloarthritis. *Proceedings of the ACM on Interactive, Mobile, Wearable and Ubiquitous Technologies*. https://doi.org/10.1145/3448093

Junco, R. (2013). Comparing actual and self-reported measures of Facebook use. *Computers in Human Behavior*. https://doi.org/10.1016/j.chb.2012.11.007

Jung, Jaemin, Kim, Y., & Chan-Olmsted, S. (2014). Measuring usage concentration of smartphone applications: Selective repertoire in a marketplace of choices. *Mobile Media and Communication*. https://doi.org/10.1177/2050157914542172

Jung, Jisu, Nour, M., Allman-Farinelli, M., & Kay, J. (2017). Harnessing the “ambience” of the mobile-phone lockscreen for ultra-lite logging. In *ACM International Conference Proceeding Series*. https://doi.org/10.1145/3152771.3152774

Kamvar, M., & Baluja, S. (2006). A large scale study of wireless search behavior: Google mobile search. In *Conference on Human Factors in Computing Systems - Proceedings*.

Kamvar, M., Kellar, M., Patel, R., & Xu, Y. (2009). Computers and iPhones and mobile phones, oh my! A logs-based comparison of search users on different devices. In *WWW’09 - Proceedings of the 18th International World Wide Web Conference*. https://doi.org/10.1145/1526709.1526817

Kapidzic, S., & Martins, N. (2015). Mirroring the Media: The Relationship

Between Media Consumption, Media Internalization, and Profile Picture Characteristics on Facebook. *Journal of Broadcasting and Electronic Media*, *59*(2), 278–297. https://doi.org/10.1080/08838151.2015.1029127

Kaplan, A. M., & Haenlein, M. (2010). Users of the world, unite! The challenges and opportunities of Social Media. *Business Horizons*, *53*(1), 59–68. https://doi.org/10.1016/j.bushor.2009.09.003

Karikoski, J. (2012). Handset-Based Data Collection Process and Participant Attitudes. *International Journal of Handheld Computing Research*. https://doi.org/10.4018/jhcr.2012100101

Karmakar, M., Banshal, S. K., & Singh, V. K. (2020). Does presence of social media plugins in a journal website result in higher social media attention of its research publications? *Scientometrics*. https://doi.org/10.1007/s11192-020-03574-7

Katevas, K., Arapakis, I., & Pielot, M. (2018). Typical Phone Use Habits: Intense Use Does Not Predict Negative Well-Being. *ArXiv*.

Katz, E., Blumler, J. G., & Gurevitch, M. (1973). Uses and Gratifications Research. *Public Opinion Quarterly*, *37*(4), 509. https://doi.org/10.1086/268109

Katz, J. E., & Sugiyama, S. (2006). Mobile phones as fashion statements: Evidence from student surveys in the US and Japan. *New Media and Society*. https://doi.org/10.1177/1461444806061950

Kaviani, F., Robards, B., Young, K. L., & Koppel, S. (2020). Nomophobia: Is the fear of being without a smartphone associated with problematic use? *International Journal of Environmental Research and Public Health*. https://doi.org/10.3390/ijerph17176024

Kelly, P., Marshall, S. J., Badland, H., Kerr, J., Oliver, M., Doherty, A. R., & Foster, C. (2013). An ethical framework for automated, wearable cameras in health behavior research. *American Journal of Preventive Medicine*, *44*(3), 314–319. https://doi.org/10.1016/j.amepre.2012.11.006

Khan, I., Khusro, S., & Alam, I. (2019). Smartphone Distractions and its Effect on Driving Performance using Vehicular Lifelog Dataset. In *1st International Conference on Electrical, Communication and Computer Engineering, ICECCE 2019*. https://doi.org/10.1109/ICECCE47252.2019.8940697

Khan, I., Khusro, S., Ali, S., & Ud Din, A. (2016). Daily life activities on smartphones and their effect on battery life for better personal information management. *Proceedings of the Pakistan Academy of Sciences: Part A*.

Khanna, V., Sambandam, S. N., Gul, A., & Mounasamy, V. (2015). "WhatsApp"ening in orthopedic care: a concise report from a 300-bedded tertiary care teaching center. *European Journal of Orthopaedic Surgery and Traumatology*. https://doi.org/10.1007/s00590-015-1600-y

Kim, I., Kim, R., Kim, H., Kim, D., Han, K., Lee, P. H., … Lee, U. (2019). Understanding smartphone usage in college classrooms: A long-term measurement study. *Computers and Education*. https://doi.org/10.1016/j.compedu.2019.103611

Kim, J. H. (2017). Smartphone-mediated communication vs. face-to-face interaction: Two routes to social support and problematic use of smartphone. *Computers in Human Behavior*. https://doi.org/10.1016/j.chb.2016.11.004

King, A. L. S., Valença, A. M., Silva, A. C. O., Baczynski, T., Carvalho, M. R., & Nardi, A. E. (2013). Nomophobia: Dependency on virtual environments or social phobia? *Computers in Human Behavior*. https://doi.org/10.1016/j.chb.2012.07.025

Kobayashi, K., & Yamada, S. (2013). Shape changing device for notification. In *UIST '13 Adjunct Proceedings of the adjunct publication of the 26th annual ACM symposium on User interface software and technology* (pp. 71–72). https://doi.org/10.1145/2508468.2514715

Kobayashi, T., & Boase, J. (2012). No Such Effect? The Implications of Measurement Error in Self-Report Measures of Mobile Communication Use. *Communication Methods and Measures*. https://doi.org/10.1080/19312458.2012.679243

Kobie, N. (2019). The complicated truth about China's social credit system.

Koo, C., Wati, Y., Lee, C. C., & Oh, H. Y. (2011). Internet-addicted kids and South Korean government efforts: Boot-camp case. *Cyberpsychology, Behavior, and Social Networking*. https://doi.org/10.1089/cyber.2009.0331

Koo, R. (2014, April 9). Higher Chances of Cyber-bullying among Smartphone-Dependent Teenagers. *The Korea Bizwire*. Retrieved from http://koreabizwire.com/greater-chances-of-cyber-bullying-among-smartphone-dependent-teenagers/7284

Kormas, G., Critselis, E., Janikian, M., Kafetzis, D., & Tsitsika, A. (2011). Risk factors and psychosocial characteristics of potential problematic and problematic internet use among adolescents: A cross-sectional study. *BMC Public Health*. https://doi.org/10.1186/1471-2458-11-595

Kortelainen, T., & Katvala, M. (2012). " Everything is plentiful-Except attention" Attention data of scientific journals on social web tools. *Journal of Informetrics*. https://doi.org/10.1016/j.joi.2012.06.004

Krippendorff, K. (1980). *Content Analysis. An Introduction to Its Methodology*. London: SAGE Publications.

Krippendorff, K. (2011). Agreement and information in the reliability of coding. *Communication Methods and Measures*. https://doi.org/10.1080/19312458.2011.568376

Kücklich, J. (2005). Precarious Playbour: Modders and the Digital Games Industry. *Fibreculture Journal*, *5*. Retrieved from http://five.fibreculturejournal.org/fcj-025-precarious-playbour -modders-and-the-digital-games-industry/

Kurvinen, E. (2003). Only When Miss Universe Snatches Me: Teasing in MMS Messaging. In *Proceedings of the International Conference on Designing Pleasurable Products and Interfaces*.

Kushlev, K., Proulx, J., & Dunn, E. W. (2016). “Silence Your Phones”: Smartphone Notifications Increase Inattention and Hyperactivity Symptoms. In *Proceedings of the 2016 CHI Conference on Human Factors in Computing Systems* (pp. 1011–1020). New York, NY, USA: ACM. https://doi.org/10.1145/2858036.2858359

Kuss, D. J., Van Rooij, A. J., Shorter, G. W., Griffiths, M. D., & Van De Mheen, D. (2013). Internet addiction in adolescents: Prevalence and risk factors. *Computers in Human Behavior*. https://doi.org/10.1016/j.chb.2013.04.002

Lahlou, S. (1998). The subjective camera (SubCam): A new technique for studying representations in context. *Fourth International Conference on Social Representations. EDF R&D. Collection Des Notes de Recherche*, *HN-51*(98017), 1–37.

Lahlou, S. (1999a). Les attracteurs cognitifs et le syndrome du débordement. *EDF R&D. Collection Des Notes de Recherche.*, (HN-51/99/09), 1–34.

Lahlou, S. (1999b). Observing cognitive work in offices. In N. Streitz, J. Siegel, V. Hartkopf, & S. Konomi (Eds.), *Cooperative Buildings. Integrating information, Organizations and Architecture* (pp. 150–163). Heidelberg: Springer. https://doi.org/10.1007/10705432_14

Lahlou, S. (2000a). Attracteurs cognitifs et travail de bureau. *Intellectica*, *30*, 75–113.

Lahlou, S. (2000b). Attracteurs cognitifs et travail de bureau TT - Cognitive attractors and office work. *Intellectica*.

Lahlou, S. (2000c). Travail de bureau et débordement cognitif. In *XXXVeme Congres de la SELF* (Vol. 30, pp. 1–15). Octarès.

Lahlou, S. (2005). Cognitive Attractors and Activity-Based Design: Augmented Meeting Rooms. In *Human Computer Interaction International. 2005* (Vol. 1). Las Vegas, NA, USA.

Lahlou, S. (2006). L’activité du point de vue de l’acteur et la question de l’intersubjectivité. *Communications*. https://doi.org/10.3406/comm.2006.2384

Lahlou, S. (2007a). Human activity modeling for systems design: a trans-disciplinary and empirical approach. *Engineering Psychology and Cognitive Ergonomics*, *4562*(section 2), 512–521.

Lahlou, S. (2007b). The activity of teleconferencing | L’activité de réunion à distance. *Reseaux*, *144*(5), 59–101. https://doi.org/10.3166/Reseaux.144.59-101

Lahlou, S. (2007c). *Travail tertiaire et projection numérique : recommandations R & D sur les processus de travail et de communication* (Vol. 33).

Lahlou, S. (2008). Identity, social status, privacy and face-keeping in digital society. In *Social Science Information*. https://doi.org/10.1177/0539018408092575

Lahlou, S. (2010). Digitization and transmission of human experience. *Social Science Information*. https://doi.org/10.1177/0539018410372020

Lahlou, S. (2011). How can we capture the subject's perspective? An evidence-based approach for the social scientist. *Social Science Information*, *50*(3–4), 607–655. https://doi.org/10.1177/0539018411411033

Lahlou, S. (2017). *Installation theory: The societal construction and regulation of behaviour*. *Installation Theory: The Societal Construction and Regulation of Behaviour*. Cambridge University Press. https://doi.org/10.1017/9781316480922

Lahlou, S., Le Bellu, S., & Boesen-Mariani, S. (2015). Subjective Evidence Based Ethnography: Method and Applications. *Integrative Psychological and Behavioral Science*, *49*(2), 216–238. https://doi.org/10.1007/s12124-014-9288-9

Lahlou, S., Nosulenko, V. N., & Samoylenko, E. S. (2002). Un cadre méthodologique pour le design des environnements augmentés. *Social Science Information*, *41*(4), 471–530. https://doi.org/10.1177/0539018410372020 Social Science Information 2010 49: 2

Lahlou, S., Nosulenko, V. N., & Samoylenko, E. S. (2009). Subcam как инструмент психологического исследования. (Subcam Technology as an Instrument in Psychological Studies). *Экспериментальная Психология (Experimental Psychology)*, *2*(1), 72-80. https://doi.org/http://dx.doi.org/10.17759/exppsy

Lahlou, S., Nosulenko, V., & Samoylenko, E. (2012). *La numérisation du travail. Théories, méthodes et expérimentations*. Paris: Collection EDF R & D. Technique & Doc.

Lahlou, S., Urdapilleta, I., Pruzina, I., & Catheline, J. (2012). Changing behaviour : representation, practice and context. The case of obesity. In *European Congress on Obesity (ECO2012)*. Lyon.

Lang, A. (2000). The limited capacity model of mediated message processing. *Journal of Communication*. https://doi.org/10.1111/j.1460-2466.2000.tb02833.x

Lang, A., & Chrzan, J. (2015). Media Multitasking: Good, Bad, or Ugly? *Annals of the International Communication Association*. https://doi.org/10.1080/23808985.2015.11679173

Lanham, R. A. (2006). *The Economics of Attention. Style and Substance in the Age of Information*. *SubStance*.

Lasch, C. (1984). *The Minimal Self. Psychic Survival in Troubled Times*. New York, NY, USA: W. W. Norton.

Lasch, C. (1987). *The Culture of Narcissism: Life in an Age of Diminishing Expectations*. New York: W. W. Norton.

Latour, B. (1996). On interobjectivity. In *Mind, Culture, and Activity*. https://doi.org/10.1207/s15327884mca0304_2

Laurier, E., Brown, B., & McGregor, M. (2016). Mediated Pedestrian Mobility: Walking and the Map App. *Mobilities*. https://doi.org/10.1080/17450101.2015.1099900

Lavoie, J. A. A., & Pychyl, T. A. (2001). Cyberslacking and the procrastination superhighway: A web-based survey of online procrastination, attitudes, and emotion. *Social Science Computer Review*. https://doi.org/10.1177/089443930101900403

Le Bellu, S., Lahlou, S., & Nosulenko, V. (2010). Capture and transfer the knowledge embodied in a professional act. *Social Science Information Sur Les Sciences Sociales*.

Le Bellu, S., Lahlou, S., Nosulenko, V., & Samoylenko, E. (2016). Studying activity in manual work: A framework for analysis and training. *Travail Humain*. https://doi.org/10.3917/th.791.0007

Lee, S. J., Min, C., Yoo, C., & Song, J. (2013). Understanding customer malling behavior in an urban shopping mall using smartphones. In *UbiComp 2013 Adjunct - Adjunct Publication of the 2013 ACM Conference on Ubiquitous Computing*. https://doi.org/10.1145/2494091.2497344

LeFebvre, L. E. (2018). Swiping me off my feet: Explicating relationship initiation on Tinder. *Journal of Social and Personal Relationships*. https://doi.org/10.1177/0265407517706419

Lenette, C., Botfield, J. R., Boydell, K., Haire, B., Newman, C. E., & Zwi, A. B. (2018). Beyond Compliance Checking: A Situated Approach to Visual Research Ethics. *Journal of Bioethical Inquiry*, *15*(2), 293–303. https://doi.org/10.1007/s11673-018-9850-0

Lenhart, A. (2012). Teens, Smartphones & Texting. *Pew Research Center*.

Lepp, A., Li, J., & Barkley, J. E. (2016). College students’ cell phone use and attachment to parents and peers. *Computers in Human Behavior*. https://doi.org/10.1016/j.chb.2016.07.021

Leppämäki, E. (2004). Encountering unfamiliar foods - Construction objects in interaction. In *7th International Conference on Social Representations*. Guadalajara.

Leung, L. (2007). Stressful life events, motives for internet use, and social support among digital kids. *Cyberpsychology and Behavior*. https://doi.org/10.1089/cpb.2006.9967

Leung, L. (2020). Exploring the relationship between smartphone activities, flow experience, and boredom in free time. *Computers in Human Behavior*. https://doi.org/10.1016/j.chb.2019.09.030

Leung, L., & Wei, R. (2000). More than just talk on the move: Uses and gratifications of the cellular phone. *Journalism and Mass Communication Quaterly*. https://doi.org/10.1177/107769900007700206

Leuppert, R., & Geber, S. (2020). Commonly done but not socially accepted? Phubbing and social norms in dyadic and small group settings. *Communication Research Reports*. https://doi.org/10.1080/08824096.2020.1756767

Levinson, D. B., Smallwood, J., & Davidson, R. J. (2012). The Persistence of Thought. *Psychological Science*. https://doi.org/10.1177/0956797611431465

Lewin, K. (1926). Vorsatz, Wille und Bedürfnis. *Psychologische Forschung*. https://doi.org/10.1007/BF02424365

Lewin, K. (1999). *The Complete Social Scientist: A Kurt Lewin Reader*. (M. Gold, Ed.). Washington D.C.: American Psychological Association.

Ley, D. (2017). No, Dopamine is Not Addictive. Retrieved September 10, 2019, from https://www.psychologytoday.com/us/blog/women-who-stray/201701/no-dopamine-is-not-addictive

Li, L., & Lin, T. T. C. (2019). Smartphones at Work: A Qualitative Exploration of Psychological Antecedents and Impacts of Work-Related Smartphone Dependency. *International Journal of Qualitative Methods*. https://doi.org/10.1177/1609406918822240

Libet, B. (1985). Unconscious cerebral initiative and the role of conscious will in voluntary action. *Behavioral and Brain Sciences*, *8*(4), 529–539. https://doi.org/10.1017/S0140525X00044903

Libet, B., Gleason, C. A., Wright, E. W., & Pearl, D. K. (1983). Time of conscious intention to act in relation to onset of cerebral activity (readiness potential). *Brain*, *106*(3), 623–642. https://doi.org/10.1093/brain/106.3.623

Licoppe, C. (2004). “Connected” presence: The emergence of a new repertoire for managing social relationships in a changing communication technoscape. *Environment and Planning D: Society and Space*. https://doi.org/10.1068/d323t

Licoppe, C., & Figeac, J. (2013). Patterns of Gaze Switching in the “Naturally-Occurring” Uses of Smartphones in Urban Mobile Settings. *Paris: TELECOM ParisTech*.

Licoppe, C., & Figeac, J. (2014). Direct video observation of the uses of smartphones on the move. Reconceptualizing mobile multi-activity. In A. De Souza E Silva & M. Sheller (Eds.), *Mobility and Locative Media: Mobile Communication in Hybrid Spaces* (pp. 48–64). London: Routledge. https://doi.org/10.4324/9781315772226-14

Licoppe, C., & Figeac, J. (2018). Gaze Patterns and the Temporal Organization of Multiple Activities in Mobile Smartphone Uses. *Human-Computer Interaction*. https://doi.org/10.1080/07370024.2017.1326008

Licoppe, C., Rivière, C. A., & Morel, J. (2016). Grindr casual hook-ups as interactional achievements. *New Media and Society*. https://doi.org/10.1177/1461444815589702

Liegl, M., & Schindler, L. (2013). Media assemblages, ethnographic vis-ability and the enactment of video in sociological research. *Distinktion*. https://doi.org/10.1080/1600910X.2013.863791

Lin, L., Robertson, T., & Lee, J. (2009). Reading performances between novices and experts in different media multitasking environments. *Computers in the Schools*. https://doi.org/10.1080/07380560903095162

Lin, Y. H., Lin, Y. C., Lee, Y. H., Lin, P. H., Lin, S. H., Chang, L. R., … Kuo, T. B. J. (2015). Time distortion associated with smartphone addiction: Identifying smartphone addiction via a mobile application (App). *Journal of Psychiatric Research*. https://doi.org/10.1016/j.jpsychires.2015.04.003

Ling, R. (2004). *The Mobile Connection: The Cell Phone's Impact on Society*. *The Mobile Connection: The Cell Phone's Impact on Society*. https://doi.org/10.1016/B978-1-55860-936-5.X5000-4

Ling, R. (2005). Mobile communications vis-à-vis teen emancipation, peer group integra- tion and deviance.". In R. Harper, A. Taylor, & L. Palen (Eds.), *The Inside Text: Social perspectives on SMS in the mobile age* (pp. 175–189). London: Klewer.

Ling, R. (2018). *New Tech, New Ties*. *New Tech, New Ties*. Boston: MIT Press. https://doi.org/10.7551/mitpress/7568.001.0001

Ling, R., & Pedersen, P. (Eds.). (2005). *Mobile communications: Re-negotiation of the social sphere*. London: Springer VS.

Ling, R., & Yttri, B. (1999). Nobody sits at home and waits for the telephone to ring: Micro and hyper-coordination through the use of the mobile telephone. *Telenor Forskning Og Utvikling, FoU Rapport*.

Ling, R., & Yttri, B. (2002). Hyper-coordination via mobile phones in Norway. In J. E. Katz & M. Aakhus (Eds.), *Perpetual contact. Mobile communiaction, private talk, public performance.* (pp. 139–169). Cambridge: Cambridge University Press.

Litt, E. (2012). Knock, Knock. Who's There? The Imagined Audience. *Journal of Broadcasting and Electronic Media*, *56*(3), 330–345. https://doi.org/10.1080/08838151.2012.705195

Livingstone, S. (2004). On the relation between audiences and publics. *Reseaux*, *126*(4), 17–55. https://doi.org/10.3917/res.126.0017

Livingstone, S. (2008). Taking risky opportunities in youthful content creation: Teenagers' use of social networking sites for intimacy, privacy and self-expression. *New Media and Society*, *10*(3), 393–411. https://doi.org/10.1177/1461444808089415

Livingstone, S., Bober, M., & Helsper, E. (2005). Internet literacy among children and young people. Retrieved from http://www.lse.ac.uk/collections/children-go-online/%5Cnhttp://www.lse.ac.uk/collections/children-go-online/

Livingstone, S., & Brake, D. R. (2010). On the rapid rise of social networking sites: New findings and policy implications. *Children and Society*, *24*(1), 75–83. https://doi.org/10.1111/j.1099-0860.2009.00243.x

Livingstone, S., & Helsper, E. (2010). Balancing opportunities and risks in teenagers' use of the internet: The role of online skills and internet self-efficacy. *New Media and Society*, *12*(2), 309–329. https://doi.org/10.1177/1461444809342697

Livingstone, S., Mascheroni, G., & Murru, M. F. (2011). Social networking among European children: New findings on privacy, identity and connection. *HERMES (France)*, (59), 89–97.

Livingstone, S., Ólafsson, K., Livingstone, S., Ólafsson, K., & Staksrud, E. (2011). Social networking age and privacy EUKIDS ONLINE.

Livingstone, S., Ólafsson, K., & Staksrud, E. (2013). Risky social networking practices among "underage" users: Lessons for evidence-based policy. *Journal of Computer-Mediated Communication*, *18*(3), 303–320. https://doi.org/10.1111/jcc4.12012

Lo, S. K. (2008). The nonverbal communication functions of emoticons in computer-mediated communication. *Cyberpsychology and Behavior*. https://doi.org/10.1089/cpb.2007.0132

Locke, E., & Latham, G. (1990). *A Theory of Goal Setting and Task Performance*. Englewood Cliffs, NJ: Prentice-Hall.

Lohan, E. (1997). No parents allowed!: Telecoms in the individualist household. In A. Kant & E. Mante-Meyer (Eds.), *Blurring Boundaries: When Are Information and Communication Technologies Coming Home?* (pp. 131–144). Stockholm: Telia.

Loid, K., Täht, K., & Rozgonjuk, D. (2020). Do pop-up notifications regarding smartphone use decrease screen time, phone checking behavior, and self-reported problematic smartphone use? Evidence from a two-month experimental study. *Computers in Human Behavior*. https://doi.org/10.1016/j.chb.2019.08.007

London School of Economics and Political Science. (2019). Research ethics: guidance on lse research ethics, code of research conduct, and training.

Lopez-Tovar, H., Charalambous, A., & Dowell, J. (2015). Managing Smartphone Interruptions Through Adaptive Modes and Modulation of Notifications. In *Proceedings of the 20th International Conference on Intelligent User Interfaces* (pp. 296–299). New York, NY, USA: ACM. https://doi.org/10.1145/2678025.2701390

Lorenz, K. (1937). Über die Bildung des Instinktbegriffes. *Die Naturwissenschaften*, *25*(19), 289–300. https://doi.org/10.1007/BF01492648

Lorenz, K. (1963). *On aggression [Das sogenannte Böse. Zur Naturgeschichte der Aggression]. On aggression.*

Lorenz, K., & Tinbergen, N. (1970). Taxis and instinct in egg-rolling response of the greylag goose. *Studies in Animal and Human Behavior*, (1), 328–342.

Lou, H., Chau, P., & Li, D. (2005). Understanding Individual Adoption of Instant Messaging: An Empirical Investigation. *Journal of the Association for Information Systems*. https://doi.org/10.17705/1jais.00066

Luff, P., & Heath, C. (1998). Mobility in collaboration. *Proceedings of the ACM Conference on Computer Supported Cooperative Work*. https://doi.org/10.1145/289444.289505

Luhmann, N. (1975). Einführende Bemerkungen zu einer Theorie symbolisch generalisierter Kommunikationsmedien. In *Soziologische Aufklärung 2*. https://doi.org/10.1007/978-3-663-12374-3_9

Luhmann, N. (1987). *Soziale Systeme. Grundriß einer allgemeinen Theorie*. Frankfurt am Main: Suhrkamp.

Luhmann, N. (1994). *Die Wirtschaft Der Gesellschaft*. Frankfurt am Main: Suhrkamp.

Luo, C., Visuri, A., Klakegg, S., van Berkel, N., Sarsenbayeva, Z., Möttönen, A., … Kostakos, V. (2019). Energy-efficient prediction of smartphone unlocking. *Personal and Ubiquitous Computing*. https://doi.org/10.1007/s00779-018-01190-0

Luor, T., Wu, L. L., Lu, H. P., & Tao, Y. H. (2010). The effect of emoticons in simplex and complex task-oriented communication: An empirical study of instant messaging. *Computers in Human Behavior*. https://doi.org/10.1016/j.chb.2010.02.003

Lyngs, U. (2019). Putting Self-Control at the Centre of Digital Wellbeing. *2019 ACM CHI Conference on Human Factors in Computing Systems (Position Paper)*. https://doi.org/https://doi.org/10.1145/3290605. 3300361.

Lyngs, U., Lukoff, K., Slovak, P., Binns, R., Slack, A., Inzlicht, M., … Shadbolt, N. (2019). Self-control in cyberspace: Applying dual systems theory to a review of digital self-control tools. In *Conference on Human Factors in Computing Systems - Proceedings*. https://doi.org/10.1145/3290605.3300361

MacCormick, J. S., Dery, K., & Kolb, D. G. (2012). Engaged or just connected? Smartphones and employee engagement. *Organizational Dynamics*. https://doi.org/10.1016/j.orgdyn.2012.03.007

Mahboob, S., Iqbal, K., Farman, H., Khan, M. Y., & Wasi, S. (2018). Drive pattern analyzer using smartphones. In *Proceedings - 2017 13th International Conference on Emerging Technologies, ICET2017*. https://doi.org/10.1109/ICET.2017.8281659

Mahfouz, A., Muslukhov, I., & Beznosov, K. (2016). Android users in the wild: Their authentication and usage behavior. *Pervasive and Mobile Computing*.

https://doi.org/10.1016/j.pmcj.2016.06.017

Marengo, D., Sindermann, C., Häckel, D., Settanni, M., Elhai, J. D., & Montag, C. (2020). The association between the Big Five personality traits and smartphone use disorder: A meta-analysis. *Journal of Behavioral Addictions*. https://doi.org/10.1556/2006.2020.00069

Margetts, H. (2016). Understanding political turbulence: the data science of politics. In *WebSci '16: Proceedings of the 8th ACM Conference on Web Science*. https://doi.org/10.1145/2908131.2908136

Mark, G., Christensen, U., & Shafae, M. (2001). *A methodology using a microcamera for studying mobile IT usage and person mobility*.

Mark, G., Czerwinski, M., & Iqbal, S. T. (2018). Effects of individual differences in blocking workplace distractions. In *Conference on Human Factors in Computing Systems - Proceedings*. https://doi.org/10.1145/3173574.3173666

Mark, G., Gonzalez, V. M., & Harris, J. (2005). No task left behind? Examining the nature of fragmented work. In *CHI 2005: Technology, Safety, Community: Conference Proceedings - Conference on Human Factors in Computing Systems*.

Mark, G., Gudith, D., & Klocke, U. (2008). The cost of interrupted work: More speed and stress. In *Conference on Human Factors in Computing Systems - Proceedings*. https://doi.org/10.1145/1357054.1357072

Mark, G., Iqbal, S. T., Czerwinski, M., Johns, P., Sano, A., & Lutchyn, Y. (2016). Email Duration, Batching and Self-interruption. https://doi.org/10.1145/2858036.2858262

Markham, A., & Buchanan, E. (2012). Ethical Decision-Making and Internet Research Recommendations from the AoIR Ethics Working Committee. *Recommendations from the AoIR Ethics Working Committee (Version 2.0)*.

Marwick, A., & Boyd, D. (2014). 'It's just drama': teen perspectives on conflict and aggression in a networked era. *Journal of Youth Studies*, *17*(9), 1187–1204. https://doi.org/10.1080/13676261.2014.901493

Massena, M., Everri, M., & Mancini, T. (2019). Are smartphones transforming parent-child everyday life practics? A cross-generational qualitative study comparing parents' and early adolescents' representations. *Media Education - Studi, Ricerche, Buone Pratiche*, *10*(1), 1–23.

Mayer, S., Lischke, L., Woźniak, P., & Henze, N. (2018). Evaluating the Disruptiveness of Mobile Interactions: A Mixed-Method Approach. In *Proceedings of the 2018 CHI Conference on Human Factors in Computing Systems* (pp. 406:1--406:14). New York, NY, USA: ACM. https://doi.org/10.1145/3173574.3173980

Mayring, P. (2000). Qualitative Content Analysis. *FQS - Forum Qualitative Social Research*.

Mayring, P. (2015). Qualitative Content Analysis: Theoretical Background and

Procedures. https://doi.org/10.1007/978-94-017-9181-6_13

Mazzella, A., & Testa, I. (2016). An investigation into the effectiveness of smartphone experiments on students' conceptual knowledge about acceleration. *Physics Education*. https://doi.org/10.1088/0031-9120/51/5/055010

McCauley, B., Merola, G., & Gumbley, S. (2017). Play on demand: Why do players play the mobile games they do. *International Journal of E-Business Research*. https://doi.org/10.4018/IJEBR.2017100103

McFarlane, D. C. (1999). Coordinating the interruption of people in human-computer interaction. *Human-Computer Interaction, INTERACT'99: IFIP TC. 13 International Conference on Human-Computer Interaction, 30th August-3rd September 1999, Edinburgh, UK*.

McLennan, J. N., Holgate, A. M., Omodei, M. M., & Wearing, A. J. (2006). Decision Making Effectiveness in Wildfire Incident Management Teams. *Journal Of Contingencies And Crisis Management*, *14*(1), 27–37.

McMillan, D., Brown, B., Lampinen, A., McGregor, M., Hoggan, E., & Pizza, S. (2017). Situating Wearables. *Proceedings of the 2017 CHI Conference on Human Factors in Computing Systems - CHI '17*, 3582–3594. https://doi.org/10.1145/3025453.3025993

McMillan, D., McGregor, M., & Brown, B. (2015). From in the wild to in vivo: Video analysis of mobile device use. In *MobileHCI 2015 - Proceedings of the 17th International Conference on Human-Computer Interaction with Mobile Devices and Services*. https://doi.org/10.1145/2785830.2785883

McMillan, D., Morrison, A., Brown, O., Hall, M., & Chalmers, M. (2010). Further into the wild: Running worldwide trials of mobile systems. In *Lecture Notes in Computer Science (including subseries Lecture Notes in Artificial Intelligence and Lecture Notes in Bioinformatics)*. https://doi.org/10.1007/978-3-642-12654-3_13

McMillan, S. J., & Hwang, J. S. (2002). Measures of perceived interactivity: An exploration of the role of direction of communication, user control, and time in shaping perceptions of interactivity. *Journal of Advertising*. https://doi.org/10.1080/00913367.2002.10673674

Mehrotra, A., & Musolesi, M. (2017). Intelligent Notification Systems: A Survey of the State of the Art and Research Challenges. *CoRR*, *abs/1711.1*. Retrieved from http://arxiv.org/abs/1711.10171

Mehrotra, A., Pejovic, V., Vermeulen, J., Hendley, R., & Musolesi, M. (2016). My Phone and Me: Understanding People's Receptivity to Mobile Notifications. In *Proceedings of the 2016 CHI Conference on Human Factors in Computing Systems* (pp. 1021–1032). New York, NY, USA: ACM. https://doi.org/10.1145/2858036.2858566

Mendelson, A. L., & Papacharissi, Z. (2007). Reality vs. fiction how defined realness affects cognitive & emotional responses to photographs.

International Journal of Phytoremediation, *21*(1), 231–243. https://doi.org/10.1080/15551390701730224

Milewski, A. E. (2006). Interruption management and telephone call screening. *International Journal of Human-Computer Interaction*, *20*(1), 19–33. https://doi.org/10.1207/s15327590ijhc2001_3

Milheim, W. D., & Martin, B. L. (1991). Theoretical bases for the use of learner control: Three different perspectives. *Journal of Computer-Based Instruction*.

Mills, J. E., Hu, B., Beldona, S., & Clay, J. (2001). Cyberslacking! A liability issue for wired workplaces. *Cornell Hotel and Restaurant Administration Quarterly*. https://doi.org/10.1177/0010880401425004

Milne, E., Mitchell, C., & de Lange, N. (Eds.). (2012). *Handbook of Participatory Video*. Lanham: Rowman and Littlefield.

Minear, M., Brasher, F., McCurdy, M., Lewis, J., & Younggren, A. (2013). Working memory, fluid intelligence, and impulsiveness in heavy media multitaskers. *Psychonomic Bulletin and Review*. https://doi.org/10.3758/s13423-013-0456-6

Mocanu, D., Rossi, L., Zhang, Q., Karsai, M., & Quattrociocchi, W. (2015). Collective attention in the age of (mis)information. *Computers in Human Behavior*. https://doi.org/10.1016/j.chb.2015.01.024

Mok, T. M., Cornish, F., & Tarr, J. (2015). Too Much Information: Visual Research Ethics in the Age of Wearable Cameras. *Integrative Psychological and Behavioral Science*, *49*(2), 309–322. https://doi.org/10.1007/s12124-014-9289-8

Mondada, L. (2012). Talking and driving: Multiactivity in the car. *Semiotica*. https://doi.org/10.1515/sem-2012-0062

Monsell, S. (2003). Task switching. *Trends in Cognitive Sciences*. https://doi.org/10.1016/S1364-6613(03)00028-7

Montag, C., Błaszkiewicz, K., Sariyska, R., Lachmann, B., Andone, I., Trendafilov, B., … Markowetz, A. (2015). Smartphone usage in the 21st century: Who is active on WhatsApp? *BMC Research Notes*. https://doi.org/10.1186/s13104-015-1280-z

Morrison, A., Xiong, X., Higgs, M., Bell, M., & Chalmers, M. (2018). A large-scale study of iPhone app launch behaviour. In *Conference on Human Factors in Computing Systems - Proceedings*. https://doi.org/10.1145/3173574.3173918

Mudaly, N. (2015). The Rights of Pre-verbal Children involved in Video-recorded Research: An Examination of the Ethical Issues. *International Journal of Children's Rights*. https://doi.org/10.1163/15718182-02302008

Münch, R. (1991). *Dialektik der Kommunikationsgesellschaft*. Frankfurt am Main: Suhrkamp.

Munger, K. (2020). All the News That's Fit to Click: The Economics of Clickbait Media. *Political Communication*. https://doi.org/10.1080/10584609.2019.1687626

Mutinelli, S. (2017). *The psychology of waste: A subjective evidence-based ethnography for domestic activity. MSc Thesis*. London School of Economics and Political Science.

Nelson, J. L., & Webster, J. G. (2016). Audience Currencies in the Age of Big Data. *JMM International Journal on Media Management*. https://doi.org/10.1080/14241277.2016.1166430

Nguyen-Huu, K., Song, C. G., & Lee, S. W. (2018). Smartwatch/smartphone cooperative indoor lifelogging system. *International Journal of Engineering and Technology Innovation*.

Niemi, I. (1993). Systematic error in behavioural measurement: Comparing results from interview and time budget studies. *Social Indicators Research*. https://doi.org/10.1007/BF01078729

Nosulenko, V., Barabanshikov, V. A., Brushlinsky, A. V., & Rabardel, P. (2005). Man–technology interaction: Some of the Russian approaches. *Theoretical Issues in Ergonomics Science*. https://doi.org/10.1080/14639220500070051

Nosulenko, V., & Samoylenko, E. (2001). Evaluation de la qualité perçue des produits et services : approche interdisciplinaire. *International Journal of Design and Innovation Research*, *2*(2), 35–60.

Nosulenko, V., & Samoylenko, E. S. (2009). Psychological Methods for the Study of Augmented Environments. In S. Lahlou (Ed.), *Designing User Friendly Augmented Work Environments. From Meeting Rooms to Digital Collaborative Spaces* (pp. 213–236). London: Springer. https://doi.org/10.1007/978-1-8400-098-8

O'Conaill, B., & Frohlich, D. (1995). Timespace in the workplace: dealing with interruptions. In *Conference on Human Factors in Computing Systems - Proceedings*.

O'Hara, K., Massimi, M., Harper, R., Rubens, S., & Morris, J. (2014). Everyday dwelling with WhatsApp. In *Proceedings of the ACM Conference on Computer Supported Cooperative Work, CSCW*. https://doi.org/10.1145/2531602.2531679

Ocaña, M., Llamazares, Á., Revenga, P. A., García-Garrido, M. A., Hernández, N., Álvarez, P., … Alonso, J. M. (2021). Estimation of Customer Activity Patterns in Open Malls by Means of Combining Localization and Process Mining Techniques. In *Advances in Intelligent Systems and Computing*. https://doi.org/10.1007/978-3-030-62579-5_3

Oeldorf-Hirsch, A., & Sundar, S. S. (2016). Social and Technological Motivations for Online Photo Sharing. *Journal of Broadcasting and Electronic Media*. https://doi.org/10.1080/08838151.2016.1234478

Oh, H., Jalali, L., & Jain, R. (2015). An intelligent notification system using context from real-time personal activity monitoring. In *Proceedings - IEEE International Conference on Multimedia and Expo*. https://doi.org/10.1109/ICME.2015.7177508

Okoshi, T., Nozaki, H., Nakazawa, J., Tokuda, H., Ramos, J., & Dey, A. K. (2016). Towards attention-aware adaptive notification on smart phones. *Pervasive and Mobile Computing*. https://doi.org/10.1016/j.pmcj.2015.10.004

Okoshi, T., Tokuda, H., & Nakazawa, J. (2016). Interruptibility research: Opportunities for future flourishment. In *UbiComp 2016 Adjunct - Proceedings of the 2016 ACM International Joint Conference on Pervasive and Ubiquitous Computing*. https://doi.org/10.1145/2968219.2968543

Oksman, V., & Turtiainen, J. (2004). Mobile Communication as a Social Stage. *New Media & Society*. https://doi.org/10.1177/1461444804042518

Omodei, M. M., Wearing, A. J., & McLennan, J. (1997). Head-mounted video recording: A methodology for studying naturalistic decision making. In R. Flin, M. Strub, E. Salas, & L. Martin (Eds.), *Decision making under stress: Emerging themes and applications* (pp. 137–146). Aldershot: Ashgate.

Ophir, E., Nass, C., & Wagner, A. D. (2009). Cognitive control in media multitaskers. *Proceedings of the National Academy of Sciences of the United States of America*. https://doi.org/10.1073/pnas.0903620106

Oschinsky, F. M., Klesel, M., Ressel, N., & Niehaves, B. (2019). Where Are Your Thoughts? On the Relationship between Technology Use and Mind Wandering. In *Proceedings of the 52nd Hawaii International Conference on System Sciences*. https://doi.org/10.24251/hicss.2019.803

Oulasvirta, A., Rattenbury, T., Ma, L., & Raita, E. (2012). Habits make smartphone use more pervasive. *Personal and Ubiquitous Computing*. https://doi.org/10.1007/s00779-011-0412-2

Oulasvirta, A., Tamminen, S., Roto, V., & Kuorelahti, J. (2005). Interaction in 4-second bursts: The fragmented nature of attentional resources in mobile HCI. *CHI 2005: Technology, Safety, Community: Conference Proceedings - Conference on Human Factors in Computing Systems*, 919–928.

Ozanne, L. K. (2010). Learning to exchange time: Benefits and obstacles to time banking. *International Journal of Community Currency Research*.

Painter, J. E., Wansink, B., & Hieggelke, J. B. (2002). How visibility and convenience influence candy consumption. *Appetite*, *38*(3), 237–238. https://doi.org/10.1006/appe.2002.0485

Palladino, V. (2016, April 3). The science behind the Insane popularity of “react” videos on YouTube. *ArsTechnica*. Retrieved from https://arstechnica.com/gaming/2016/04/the-science-behind-the-insane-popularity-of-react-videos-on-youtube/

Panova, T., Carbonell, X., Chamarro, A., & Puerta-Cortés, D. X. (2020). Specific smartphone uses and how they relate to anxiety and depression in university students: a cross-cultural perspective. *Behaviour and Information Technology*. https://doi.org/10.1080/0144929X.2019.1633405

Panova, T., & Lleras, A. (2016). Avoidance or boredom: Negative mental health outcomes associated with use of Information and Communication Technologies depend on users' motivations. *Computers in Human Behavior*. https://doi.org/10.1016/j.chb.2015.12.062

Papacharissi, Z., & Rubin, A. (2010). Predictors of Internet Use. *Journal of Broadcasting & Electronic Media*, *44*(2), 155–174. https://doi.org/10.1207/s15506878jobem4402

Papademas, D. (2009). IVSA code of research ethics and guidelines. *Visual Studies*. https://doi.org/10.1080/14725860903309187

Pardes, A. (2020, July). A New Card Ties Your Credit to Your Social Media Stats. *WIRED*. Retrieved from https://www.wired.com/story/karat-influencer-credit-card-social-media-stats/

Park, S., Ko, M., Kim, J., Liu, Y., & Song, J. (2011). The politics of comments : Predicting political orientation of news stories with commenters' sentiment patterns. In *Proceedings of the ACM Conference on Computer Supported Cooperative Work, CSCW*. https://doi.org/10.1145/1958824.1958842

Parkin, S. (2018). Has dopamine got us hooked on tech? | Technology | The Guardian. Retrieved September 10, 2019, from https://www.theguardian.com/technology/2018/mar/04/has-dopamine-got-us-hooked-on-tech-facebook-apps-addiction

Parmentier, M. A., Fischer, E., & Reuber, A. R. (2013). Positioning person brands in established organizational fields. *Journal of the Academy of Marketing Science*. https://doi.org/10.1007/s11747-012-0309-2

Parry, D. A., & le Roux, D. B. (2019). Media multitasking and cognitive control: A systematic review of interventions. *Computers in Human Behavior*. https://doi.org/10.1016/j.chb.2018.11.031

Parsons, T. (1963). On the concept of influence. *Public Opinion Quarterly*. https://doi.org/10.1086/267148

Paskewitz, E. A., & Beck, S. J. (2021). "Put the phone away!": Does text message content influence perceptions of group member texting? *Computers in Human Behavior*. https://doi.org/10.1016/j.chb.2020.106591

Pavlov, I. P. (1927). *Conditioned reflexes: an investigation of the physiological activity of the cerebral cortex (tr. G.V Anrep)*. London: Oxford University Press.

Pea, R. (1999). New media communication forums for improving education research and practice. In E. Lagemann & L. Shulman (Eds.), *Issues in Education Research: Problems and Possibilities* (pp. 336–370). San Francisco: Jossey-Bass.

Pea, R. D. (2007). Video-as-Data and Digital Video Manipulation Techniques for

Transforming Learning Sciences Research, Education, and Other Cultural Practices. In *The International Handbook of Virtual Learning Environments*. https://doi.org/10.1007/978-1-4020-3803-7_55

Pejovic, V., & Musolesi, M. (2014). InterruptMe: Designing intelligent prompting mechanisms for pervasive applications. In *UbiComp 2014 - Proceedings of the 2014 ACM International Joint Conference on Pervasive and Ubiquitous Computing*. https://doi.org/10.1145/2632048.2632062

Pempek, T. A., Yermolayeva, Y. A., & Calvert, S. L. (2009). College students' social networking experiences on Facebook. *Journal of Applied Developmental Psychology*, *30*(3), 227–238. https://doi.org/10.1016/j.appdev.2008.12.010

Perlow, L. A. (1999). The time famine: Toward a sociology of work time. *Administrative Science Quarterly*. https://doi.org/10.2307/2667031

Perneger, T. V. (1998). What's wrong with Bonferroni adjustments. *British Medical Journal*, *316*, 1236–1240. https://doi.org/10.1136/bmj.316.7139.1236

Perry, M., & Rachovides, D. (2007). Entertaining situated messaging at home. *Computer Supported Cooperative Work*. https://doi.org/10.1007/s10606-007-9042-7

Petersen, D., & Böhmer, M. (2018). Understanding mobile information supply: Studying the amount of textual information smartphones provide. In *ACM International Conference Proceeding Series*. https://doi.org/10.1145/3240167.3240205

Phelps, J. M., Strype, J., Le Bellu, S., Lahlou, S., & Aandal, J. (2018). Experiential learning and simulation-based training in norwegian police education: Examining body-worn video as a tool to encourage reflection. *Policing (Oxford)*. https://doi.org/10.1093/police/paw014

Pielot, M., de Oliveira, R., Kwak, H., & Oliver, N. (2014). Didn'T You See My Message?: Predicting Attentiveness to Mobile Instant Messages. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems* (pp. 3319–3328). New York, NY, USA: ACM. https://doi.org/10.1145/2556288.2556973

Pink, S. (2011a). *Doing Visual Ethnography*. *Doing Visual Ethnography*. London: SAGE Publications. https://doi.org/10.4135/9780857025029

Pink, S. (2011b). Planning and Practising 'Visual Methods': Appropriate Uses and Ethical Issues. In *Doing Visual Ethnography*. https://doi.org/10.4135/9780857025029.d5

Pink, S., Postill, H., Hjorth, J., Lewis, T., & Tacchi, J. (2016). *Digital Ethnography. Priciple and Practice.* London: SAGE Publications.

Pinsker, J. (2015, March). Finland, Home of the $103,000 Speeding Ticket. *The Atlantic*.

Pizza, S., Brown, B., McMillan, D., & Lampinen, A. (2016). Smartwatch in Vivo. In *Proceedings of the 2016 CHI Conference on Human Factors in Computing Systems* (pp. 5456–5469). New York, NY, USA: ACM. https://doi.org/10.1145/2858036.2858522

Pontoppidan, N. H., & Christensen, J. H. (2019). User behavior with evotion hearing aids. In *Proceedings of the International Congress on Acoustics*. https://doi.org/10.18154/RWTH-CONV-239878

Pool, M. M., Koolstra, C. M., & van der Voort, T. H. A. (2003). The impact of background radio and television on high school students' homework performance. *Journal of Communication*. https://doi.org/10.1093/joc/53.1.74

Pope, C. C., De Luca, R., & Tolich, M. (2013). How an exchange of perspectives led to tentative ethical guidelines for visual ethnography. In *Ethics and Academic Freedom in Educational Research*. https://doi.org/10.4324/9781315872711

Prior, M. (2009). The immensely inflated news audience: Assessing bias in self-reported news exposure. *Public Opinion Quarterly*. https://doi.org/10.1093/poq/nfp002

Puurveen, G., Phinney, A., Cox, S., & Purvest, B. (2015). Ethical issues in the use of video observations with people with advanced dementia and their caregivers in nursing home environments. *Visual Methodologies*.

Qiu, L., De Luca, A., Muslukhov, I., & Beznosov, K. (2019). Towards understanding the link between age and smartphone authentication. In *Conference on Human Factors in Computing Systems - Proceedings*. https://doi.org/10.1145/3290605.3300393

Quan-Haase, A., Cothrel, J., & Wellman, B. (2005). Instant messaging for collaboration: A case study of a high-tech firm. *Journal of Computer-Mediated Communication*. https://doi.org/10.1111/j.1083-6101.2005.tb00276.x

Quinn, K. (2016). Why We Share: A Uses and Gratifications Approach to Privacy Regulation in Social Media Use. *Journal of Broadcasting and Electronic Media*, *60*(1), 61–86. https://doi.org/10.1080/08838151.2015.1127245

Ram, N., Yang, X., Cho, M. J., Brinberg, M., Muirhead, F., Reeves, B., & Robinson, T. N. (2020). Screenomics: A New Approach for Observing and Studying Individuals' Digital Lives. *Journal of Adolescent Research*. https://doi.org/10.1177/0743558419883362

Randall, J. G., Oswald, F. L., & Beier, M. E. (2014). Mind-wandering, cognition, and performance: a theory-driven meta-analysis of attention regulation. *Psychological Bulletin*. https://doi.org/10.1037/a0037428

Rangaswamy, N., & Arora, P. (2016). The mobile internet in the wild and every day: Digital leisure in the slums of urban India. *International Journal of Cultural Studies*. https://doi.org/10.1177/1367877915576538

Rasmussen, M. K., Troiano, G. M., Petersen, M. G., Simonsen, J. G., & Hornbæk,

K. (2016). Sketching Shape-changing Interfaces: Exploring Vocabulary, Metaphors Use, and Affordances. In *Proceedings of the 2016 CHI Conference on Human Factors in Computing Systems* (pp. 2740–2751). New York, NY, USA: ACM. https://doi.org/10.1145/2858036.2858183

Rattenbury, T., Nafus, D., & Anderson, K. (2008). Plastic: A metaphor for integrated technologies. In *UbiComp 2008 - Proceedings of the 10th International Conference on Ubiquitous Computing*. https://doi.org/10.1145/1409635.1409667

Reeves, B., Ram, N., Robinson, T. N., Cummings, J. J., Giles, C. L., Pan, J., … Yeykelis, L. (2019). Screenomics: A Framework to Capture and Analyze Personal Life Experiences and the Ways that Technology Shapes Them. *Human-Computer Interaction*. https://doi.org/10.1080/07370024.2019.1578652

Reeves, B., Roy, S., Gorman, B., & Morley, T. (2008). A marketplace for attention: Responses to a synthetic currency used tosignal information importance in e-mail. *First Monday*.

Rieken, J., & Lahlou, S. (2010). *Theories, Protocols and Techniques Used to Elicit and Record the Production of Know-How by Experts.* London.

Roberts, G. (1998). Competitive altruism: From reciprocity to the handicap principle. *Proceedings of the Royal Society B: Biological Sciences*. https://doi.org/10.1098/rspb.1998.0312

Robinson, J. (1977). *How Americans use time*. Praeger Publishers Inc.

Robson, S. (2011). Producing and using video data in the early years: Ethical questions and practical consequences in research with young children. *Children and Society*. https://doi.org/10.1111/j.1099-0860.2009.00267.x

Rochat, L., Bianchi-Demicheli, F., Aboujaoude, E., & Khazaal, Y. (2019). The psychology of “swiping”: A cluster analysis of the mobile dating app Tinder. *Journal of Behavioral Addictions*. https://doi.org/10.1556/2006.8.2019.58

Rosa, H. (2016a). *Resonanz. Eine Soziologie der Weltbeziehung*. Frankfurt am Main: Suhrkamp.

Rosa, H. (2016b). *Social Acceleration*. *Social Acceleration*. https://doi.org/10.7312/rosa14834

Rose, G. (2014). On the relation between “visual research methods” and contemporary visual culture. *Sociological Review*. https://doi.org/10.1111/1467-954X.12109

Rosen, L. D., Mark Carrier, L., & Cheever, N. A. (2013). Facebook and texting made me do it: Media-induced task-switching while studying. *Computers in Human Behavior*. https://doi.org/10.1016/j.chb.2012.12.001

Rouch, J., & Morin, E. (1961). *Chronique d’un Été*. France: Argos Films.

Roxburgh, S. (2004). “There just aren’t enough hours in the day”: The mental health consequences of time pressure. *Journal of Health and Social Behavior*. https://doi.org/10.1177/002214650404500201

Rozgonjuk, D., Kattago, M., & Täht, K. (2018). Social media use in lectures mediates the relationship between procrastination and problematic smartphone use. *Computers in Human Behavior*. https://doi.org/10.1016/j.chb.2018.08.003

Ruby, J. (1991). *Picturing Culture: Explorations of Film and Anthropology*. Chicago: University of Chicago Press.

Salmons, J. (2015). *Qualitative Online Interviews*. Thousand Oaks, CA: SAGE Publications.

Salovaara, A. (2008). Struggling with gift-giving obligations: When mobile messages are too laborious to reciprocate. In *Proceedings of the 22nd British HCI Group Annual Conference on People and Computers: Culture, Creativity, Interaction, BCS HCI 2008*. https://doi.org/10.14236/ewic/hci2008.39

Salvucci, D. D., & Taatgen, N. A. (2008). Threaded Cognition: An Integrated Theory of Concurrent Multitasking. *Psychological Review*. https://doi.org/10.1037/0033-295X.115.1.101

Sanbonmatsu, D. M., Strayer, D. L., Medeiros-Ward, N., & Watson, J. M. (2013). Who Multi-Tasks and Why? Multi-Tasking Ability, Perceived Multi-Tasking Ability, Impulsivity, and Sensation Seeking. *PLoS ONE*. https://doi.org/10.1371/journal.pone.0054402

Sbarra, D. A., Briskin, J. L., & Slatcher, R. B. (2019). Smartphones and Close Relationships: The Case for an Evolutionary Mismatch. *Perspectives on Psychological Science*. https://doi.org/10.1177/1745691619826535

Schäfer, A. (2020). Sexually transmitted infections and tourism. *Gynakologe*. https://doi.org/10.1007/s00129-020-04565-8

Scharkow, M. (2016). The Accuracy of Self-Reported Internet Use—A Validation Study Using Client Log Data. *Communication Methods and Measures*. https://doi.org/10.1080/19312458.2015.1118446

Schembri, S., & Boyle, M. V. (2013). Visual ethnography: Achieving rigorous and authentic interpretations. *Journal of Business Research*. https://doi.org/10.1016/j.jbusres.2012.02.021

Schleidt, W. M. (1974). How "Fixed" is the Fixed Action Pattern? *Zeitschrift Für Tierpsychologie*. https://doi.org/10.1111/j.1439-0310.1974.tb02131.x

Schouten, A. P. (2007). *Adolescents ' online self-disclosure and self-presentation*. University of Amsterdam.

Schreier, M. (2014). The SAGE Handbook of Qualitative Data Analysis Qualitative Content Analysis. *The SAGE Handbook of Qualitative Data Analysis*. https://doi.org/10.4135/9781446282243

Schroer, M. (2014). Visual Culture and the Fight for Visibility. *Journal for the Theory of Social Behaviour*. https://doi.org/10.1111/jtsb.12038

Schuck, S., & Kearney, M. (2006). Using Digital Video as a Research Tool : Ethical Issues for Researchers. *Journal of Education Multimedia and Hypermedia*.

Schulze, F., & Groh, G. (2014). Studying how character of conversation affects personal receptivity to mobile notifications. In *CHI EA '14 CHI '14 Extended Abstracts on Human Factors in Computing Systems* (pp. 1729–1734). https://doi.org/10.1145/2559206.2581320

Schulze, F., & Groh, G. (2016). Conversational Context Helps Improve Mobile Notification Management. In *Proceedings of the 18th International Conference on Human-Computer Interaction with Mobile Devices and Services* (pp. 518–528). New York, NY, USA: ACM. https://doi.org/10.1145/2935334.2935347

Schumacher, E. H., Seymour, T. L., Glass, J. M., Fencsik, D. E., Lauber, E. J., Kieras, D. E., & Meyer, D. E. (2001). Virtually Perfect Time Sharing in Dual-Task Performance: Uncorking the Central Cognitive Bottleneck. *Psychological Science*. https://doi.org/10.1111/1467-9280.00318

Schwarz, N. (2007). Retrospective and Concurrent Self-Reports: The Rationale for Real-Time Data Capture. *The Science of Real-Time Data Capture: Self-Reports in Health Research*.

Scott, G. G., Sinclair, J., Short, E., & Bruce, G. (2014). It's Not What You Say, It's How You Say It: Language Use on Facebook Impacts Employability But Not Attractiveness. *Cyberpsychology, Behavior, and Social Networking, 17*(8), 562–566. https://doi.org/10.1089/cyber.2013.0584

Seyfang, G., & Longhurst, N. (2013). Growing green money? Mapping community currencies for sustainable development. *Ecological Economics*. https://doi.org/10.1016/j.ecolecon.2012.11.003

Shah, D., Upasini, A., & Sasidhar, K. (2020). Findings from an experimental study of student behavioral patterns using smartphone sensors. In *2020 International Conference on COMmunication Systems and NETworkS, COMSNETS 2020*. https://doi.org/10.1109/COMSNETS48256.2020.9027496

Sharp, C. (1981). *The Economics of Time*. Oxford: Robertson.

Shin, C., & Dey, A. K. (2013). Automatically detecting problematic use of smartphones. In *UbiComp 2013 - Proceedings of the 2013 ACM International Joint Conference on Pervasive and Ubiquitous Computing*. https://doi.org/10.1145/2493432.2493443

Shin, M., Webb, A., & Kemps, E. (2019). Media multitasking, impulsivity and dual task ability. *Computers in Human Behavior*. https://doi.org/10.1016/j.chb.2018.11.018

Shin, W., Huh, J., & Faber, R. J. (2012). Tweens' Online Privacy Risks and the

Role of Parental Mediation. *Journal of Broadcasting and Electronic Media*, *56*(4), 632–649. https://doi.org/10.1080/08838151.2012.732135

Simmel, G. (2016). The metropolis and mental life. In *Social Theory Re-Wired: New Connections to Classical and Contemporary Perspectives: Second Edition*. https://doi.org/10.4324/9781315775357

Simon, H. A. (1971). Designing Organizations for an Information-Rich World. In *Computers, Communication, and the Public Interest.*

Skinner, B. F. (1938). *The Behavior of Organisms: An Experimental Analysis*. New York: Appleton-Century-Crofts.

Smith, A. N., & Fischer, E. (2020). Pay attention, please! Person brand building in organized online attention economies. *Journal of the Academy of Marketing Science*. https://doi.org/10.1007/s11747-020-00736-0

Smith, J., Lavygina, A., Ma, J., Russo, A., & Dulay, N. (2014). Learning to Recognise Disruptive Smartphone Notifications. In *Proceedings of the 16th International Conference on Human-computer Interaction with Mobile Devices & Services* (pp. 121–124). New York, NY, USA: ACM. https://doi.org/10.1145/2628363.2628404

Smith, J., Lavygina, A., Russo, A., & Dulay, N. (2014). When did your smartphone bother you last? In *UbiComp '14 Adjunct Proceedings of the 2014 ACM International Joint Conference on Pervasive and Ubiquitous Computing: Adjunct Publication* (pp. 409–414). https://doi.org/10.1145/2638728.2641701

Soikkeli, T., Karikoski, J., & Hammainen, H. (2011). Diversity and end user context in smartphone usage sessions. In *International Conference on Next Generation Mobile Applications, Services, and Technologies*. https://doi.org/10.1109/NGMAST.2011.12

Sonck, N., Nikken, P., & de Haan, J. (2013). Determinants of Internet Mediation: A comparison of the reports by Dutch parents and children. *Journal of Children and Media*, *7*(1), 96–113. https://doi.org/10.1080/17482798.2012.739806

Song, B. (2019). The West May Be Wrong About China's Social Credit System. *New Perspectives Quarterly*. https://doi.org/10.1111/npqu.12191

Srivastava, L. (2005). Mobile phones and the evolution of social behaviour. *Behaviour and Information Technology*. https://doi.org/10.1080/01449290512331321910

Stachl, C., Au, Q., Schoedel, R., Gosling, S. D., Harari, G. M., Buschek, D., … Bühner, M. (2020). Predicting personality from patterns of behavior collected with smartphones. *Proceedings of the National Academy of Sciences of the United States of America*. https://doi.org/10.1073/pnas.1920484117

Stachl, C., Hilbert, S., Au, J. Q., Buschek, D., De Luca, A., Bischl, B., … Bühner, M. (2017). Personality Traits Predict Smartphone Usage. *European Journal* *of Personality*. https://doi.org/10.1002/per.2113

Stangeland, H. (2016). *Technology-enhanced learning in operative policing: Expert illustration videos and subjective evidence-based ethnography (SEBE) as learning tools among Norwegian police novices*. London School of Economics and Political Science.

Stanković, M., Nešić, M., Čičević, S., & Shi, Z. (2021). Association of smartphone use with depression, anxiety, stress, sleep quality, and internet addiction. Empirical evidence from a smartphone application. *Personality and Individual Differences*. https://doi.org/10.1016/j.paid.2020.110342

Stanovich, K. E., & West, R. F. (2000). Individual differences in reasoning: implications for the rationality debate? *Behavioral and Brain Sciences*, *23*(5), 645–665; discussion 665-726. https://doi.org/10.1017/S0140525X00003435

Steelman, Z., Soror, A., Limayem, M., & Worrell, D. (2012). Obsessive compulsive tendencies as predictors of dangerous mobile phone use. In *18th Americas Conference on Information Systems 2012, AMCIS 2012*.

Stieglitz, S., Mirbabaie, M., Ross, B., & Neuberger, C. (2018). Social media analytics – Challenges in topic discovery, data collection, and data preparation. *International Journal of Information Management*. https://doi.org/10.1016/j.ijinfomgt.2017.12.002

Stromback, D., Huang, S., & Radu, V. (2020). Mm-fit Multimodal deep learning for automatic exercise logging across sensing devices. *Proceedings of the ACM on Interactive, Mobile, Wearable and Ubiquitous Technologies*. https://doi.org/10.1145/3432701

Stróżak, P., & Francuz, P. (2017). Event-Related Potential Correlates of Attention to Mediated Message Processing. *Media Psychology*. https://doi.org/10.1080/15213269.2016.1160787

Sumter, S. R., & Vandenbosch, L. (2019). Dating gone mobile: Demographic and personality-based correlates of using smartphone-based dating applications among emerging adults. *New Media and Society*. https://doi.org/10.1177/1461444818804773

Sumter, S. R., Vandenbosch, L., & Ligtenberg, L. (2017). Love me Tinder: Untangling emerging adults' motivations for using the dating application Tinder. *Telematics and Informatics*. https://doi.org/10.1016/j.tele.2016.04.009

Sun, T., & Zhong, B. (2020). Multitasking as multisensory behavior: Revisiting media multitasking in the perspective of media ecology theory. *Computers in Human Behavior*. https://doi.org/10.1016/j.chb.2019.09.027

Szalai, A. (1966). Trends in Comparative Time-Budget Research. *American Behavioral Scientist*, *9*(9), 3–8.

Tagg, C. (2015). *Exploring Digital Communication: Language in Action*. New York: Routledge.

Takao, M., Takahashi, S., & Kitamura, M. (2009). Addictive personality and problematic mobile phone use. *Cyberpsychology and Behavior*. https://doi.org/10.1089/cpb.2009.0022

Tams, S., Thatcher, J., Grover, V., & Pak, R. (2015). Selective attention as a protagonist in contemporary workplace stress: implications for the interruption age. *Anxiety, Stress and Coping*. https://doi.org/10.1080/10615806.2015.1011141

Tassi, P. (2018). Media: From the contact economy to the attention economy. *International Journal of Arts Management*.

Teevan, J., Karlson, A., Amini, S., Brush, A. J. B., & Krumm, J. (2011). Understanding the importance of location, time, and people in mobile local search behavior. In *Mobile HCI 2011 - 13th International Conference on Human-Computer Interaction with Mobile Devices and Services*. https://doi.org/10.1145/2037373.2037386

Thomée, S., Härenstam, A., & Hagberg, M. (2011). Mobile phone use and stress, sleep disturbances, and symptoms of depression among young adults - A prospective cohort study. *BMC Public Health*. https://doi.org/10.1186/1471-2458-11-66

Throuvala, M. A., Griffiths, M. D., Rennoldson, M., & Kuss, D. J. (2019). Motivational processes and dysfunctional mechanisms of social media use among adolescents: A qualitative focus group study. *Computers in Human Behavior*. https://doi.org/10.1016/j.chb.2018.12.012

Tinbergen, N. (1952). The Curious Behavior of the Stickleback. *Scientific American*, *187*(6), 22–26. https://doi.org/10.1038/scientificamerican1252-22

Tinbergen, N., & Iersel, J. J. A. Van. (1947). “Displacement Reactions” in the Three-Spined Stickleback. *Behaviour*, *1*(1), 56–63.

Tindell, D. R., & Bohlander, R. W. (2012). The Use and Abuse of Cell Phones and Text Messaging in the Classroom: A Survey of College Students. *College Teaching*. https://doi.org/10.1080/87567555.2011.604802

Tolmie, P., Crabtree, A., Rodden, T., & Benford, S. (2008). “Are you watching this film or what?”: Interruption and the juggling of cohorts. In *Proceedings of the ACM Conference on Computer Supported Cooperative Work, CSCW*. https://doi.org/10.1145/1460563.1460605

Tonetto, L., Lagerspetz, E., Yi Ding, A., Ott, J., Tarkoma, S., & Nurmi, P. (2021). The mobility laws of location-based games. *EPJ Data Science*. https://doi.org/10.1140/epjds/s13688-021-00266-x

Tossell, C. C., Kortum, P., Shepard, C. W., Rahmati, A., & Zhong, L. (2012). Getting real: A naturalistic methodology for using smartphones to collect mediated communications. *Advances in Human-Computer Interaction*. https://doi.org/10.1155/2012/815972

Truong, K. N., Shihipar, T., & Wigdor, D. (2014). Slide to X: Unlocking the potential of smartphone unlocking. In *Conference on Human Factors in*

Computing Systems - Proceedings. https://doi.org/10.1145/2556288.2557195

Tulving, E. (2002). Episodic Memory: From Mind to Brain. *Annual Review of Psychology,* (53), 1–25.

Turkle, S. (2015). *Reclaiming conversation : the power of talk in a digital age*. New York : Penguin Press.

Uncapher, M. R., K. Thieu, M., & Wagner, A. D. (2016). Media multitasking and memory: Differences in working memory and long-term memory. *Psychonomic Bulletin and Review*. https://doi.org/10.3758/s13423-015-0907-3

Uncapher, M. R., Lin, L., Rosen, L. D., Kirkorian, H. L., Baron, N. S., Bailey, K., … Wagner, A. D. (2017). Media multitasking and cognitive, psychological, neural, and learning differences. *Pediatrics*. https://doi.org/10.1542/peds.2016-1758D

Vaish, R., Wyngarden, K., Chen, J., Cheung, B., & Bernstein, M. S. (2014). Twitch crowdsourcing: Crowd contributions in short bursts of time. In *Conference on Human Factors in Computing Systems - Proceedings*. https://doi.org/10.1145/2556288.2556996

Válek, L., & Jašíková, V. (2013). Time Bank and Sustainability: The Permaculture Approach. *Procedia - Social and Behavioral Sciences*. https://doi.org/10.1016/j.sbspro.2013.08.788

Valkenburg, P. M., Schouten, A. P., & Peter, J. (2005). Adolescents' identity experiments on the internet. *New Media and Society*, *7*(3), 383–402. https://doi.org/10.1177/1461444805052282

Van Berkel, N., Luo, C., Anagnostopoulos, T., Ferreira, D., Goncalves, J., Hosio, S., & Kostakos, V. (2016). A systematic assessment of smartphone usage gaps. In *Conference on Human Factors in Computing Systems - Proceedings*. https://doi.org/10.1145/2858036.2858348

Van Damme, K., Courtois, C., Verbrugge, K., & De Marez, L. (2015). What's APPening to news? A mixed-method audience-centred study on mobile news consumption. *Mobile Media and Communication*. https://doi.org/10.1177/2050157914557691

van Krieken, R. (2019). Georg Franck's 'The Economy of Attention': Mental capitalism and the struggle for attention. *Journal of Sociology*. https://doi.org/10.1177/1440783318812111

Van Laethem, M., van Vianen, A. E. M., & Derks, D. (2018). Daily fluctuations in smartphone use, psychological detachment, and work engagement: The role of workplace telepressure. *Frontiers in Psychology*. https://doi.org/10.3389/fpsyg.2018.01808

Veblen, T. (2007). *The theory of the leisure class. Edited with an Introduction and Notes by Martha Bantha*. Oxford: Oxford University Press.

Verduyn, P., Schulte-Strathaus, J. C. C., Kross, E., & Hülsheger, U. R. (2021).

When do smartphones displace face-to-face interactions and what to do about it? *Computers in Human Behavior*. https://doi.org/10.1016/j.chb.2020.106550

Visuri, A., Sarsenbayeva, Z., Van Berkel, N., Goncalves, J., Rawassizadeh, R., Kostakos, V., & Ferreira, D. (2017). Quantifying sources and types of smartwatch usage sessions. *Conference on Human Factors in Computing Systems - Proceedings*, *2017-May*, 3569–3581. https://doi.org/10.1145/3025453.3025817

Vitak, J. (2012). The Impact of Context Collapse and Privacy on Social Network Site Disclosures. *Journal of Broadcasting and Electronic Media*, *56*(4), 451–470. https://doi.org/10.1080/08838151.2012.732140

Vitak, J., Crouse, J., & Larose, R. (2011). Personal Internet use at work: Understanding cyberslacking. In *Computers in Human Behavior*. https://doi.org/10.1016/j.chb.2011.03.002

Von Zezschwitz, E., De Luca, A., Janssen, P., & Hussmann, H. (2015). Easy to draw, but hard to trace? On the observability of grid-based (Un)lock patterns. In *Conference on Human Factors in Computing Systems - Proceedings*. https://doi.org/10.1145/2702123.2702202

Von Zezschwitz, E., Dunphy, P., & De Luca, A. (2013). Patterns in the wild: A field study of the usability of pattern and PIN-based authentication on mobile devices. In *MobileHCI 2013 - Proceedings of the 15th International Conference on Human-Computer Interaction with Mobile Devices and Services*. https://doi.org/10.1145/2493190.2493231

von Zezschwitz, E., Koslow, A., De Luca, A., & Hussmann, H. (2013). Making graphic-based authentication secure against smudge attacks. https://doi.org/10.1145/2449396.2449432

Vrabcová, T. (2015). *I would never eat that back home. Analysing changes in food habits among Canadian and Chinese students in London: subjective evidence-based ethnography. MSc Thesis*. London School of Economics and Political Science.

Wagner, D. T., Rice, A., & Beresford, A. R. (2014). Device analyzer: Understanding smartphone usage. In *Lecture Notes of the Institute for Computer Sciences, Social-Informatics and Telecommunications Engineering, LNICST*. https://doi.org/10.1007/978-3-319-11569-6_16

Wajcman, J., Bittman, M., & Brown, J. E. (2008). Families without borders: Mobile phones, connectedness and work-home divisions. *Sociology*. https://doi.org/10.1177/0038038508091620

Wallis, C. (2010). *The impacts of media multitasking on children's learning and development: Report from a research seminar*. *Report from a research seminar. In: The Joan Ganz Cooney Center at Sesame Workshop,*. https://doi.org/10.1089/cyber.2010.0350

Walsh, S. P., White, K. M., & Young, R. M. (2008). Over-connected? A qualitative exploration of the relationship between Australian youth and their mobile phones. *Journal of Adolescence*. https://doi.org/10.1016/j.adolescence.2007.04.004

Wang, G., & Suh, A. (2018). Disorder or driver?: The effects of Nomophobia on work-related outcomes in organizations. In *Conference on Human Factors in Computing Systems - Proceedings*. https://doi.org/10.1145/3173574.3173624

Wang, Z., Irwin, M., Cooper, C., & Srivastava, J. (2015). Multidimensions of media multitasking and adaptive media selection. *Human Communication Research*. https://doi.org/10.1111/hcre.12042

Weber, D., Voit, A., Exler, A., Schröder, S., Böhmer, M., & Okoshi, T. (2017). Intelligent Notification and Attention Management on Mobile Devices. In *Proceedings of the 16th International Conference on Mobile and Ubiquitous Multimedia* (pp. 561–565). New York, NY, USA: ACM. https://doi.org/10.1145/3152832.3152840

Wegmann, E., Müller, S. M., Turel, O., & Brand, M. (2020). Interactions of impulsivity, general executive functions, and specific inhibitory control explain symptoms of social-networks-use disorder: An experimental study. *Scientific Reports*. https://doi.org/10.1038/s41598-020-60819-4

Wei, P. S., & Lu, H. P. (2014). Why do people play mobile social games? An examination of network externalities and of uses and gratifications. *Internet Research*. https://doi.org/10.1108/IntR-04-2013-0082

Weinschenk, S. (2012). Why We're All Addicted to Texts, Twitter and Google. Retrieved September 10, 2019, from https://www.psychologytoday.com/us/blog/brain-wise/201209/why-were-all-addicted-texts-twitter-and-google

Weng, L., Flammini, A., Vespignani, A., & Menczer, F. (2012). Competition among memes in a world with limited attention. *Scientific Reports*. https://doi.org/10.1038/srep00335

Westermann, T., Möller, S., & Wechsung, I. (2015). Assessing the Relationship Between Technical Affinity, Stress and Notifications on Smartphones. In *Proceedings of the 17th International Conference on Human-Computer Interaction with Mobile Devices and Services Adjunct* (pp. 652–659). New York, NY, USA: ACM. https://doi.org/10.1145/2786567.2793684

Westermann, T., Wechsung, I., & Möller, S. (2016). Smartphone Notifications in Context: A Case Study on Receptivity by the Example of an Advertising Service. In *Proceedings of the 2016 CHI Conference Extended Abstracts on Human Factors in Computing Systems* (pp. 2355–2361). New York, NY, USA: ACM. https://doi.org/10.1145/2851581.2892383

Whillans, A. V., Dunn, E. W., Smeets, P., Bekkers, R., & Norton, M. I. (2017). Buying time promotes happiness. *Proceedings of the National Academy of Sciences of the United States of America*. https://doi.org/10.1073/pnas.1706541114

Whiting, A., & Williams, D. (2013). Why people use social media: a uses and gratifications approach. *Qualitative Market Research: An International Journal*. https://doi.org/10.1108/QMR-06-2013-0041

Whittaker, L., & Gillespie, A. (2013). Social Networking Sites: Mediating the Self and its Communities. *Journal of Community and Applied Social Psychology*, *23*(6), 492–504. https://doi.org/10.1002/casp.2148

Wickens, C. D. (2002). Multiple resources and performance prediction. *Theoretical Issues in Ergonomics Science*. https://doi.org/10.1080/14639220210123806

Wiles, R., Coffey, A., Robinson, J., & Heath, S. (2012). Anonymisation and visual images: Issues of respect, “voice” and protection. *International Journal of Social Research Methodology*. https://doi.org/10.1080/13645579.2011.564423

Wiles, R., Coffey, A., & Robison, J. (2010). Anonymisation and visual images : issues of respect , ‘ voice ’ and protection NCRM Hub , University of Southampton WISERD , University of Cardiff August 2010 ESRC National Centre for Research Methods NCRM Working Paper Series Anonymisation and visual ima, (August), 1–25.

Wiles, R., Prosser, J., Bagnoli, P., Clark, A., Davies, K., Holland, S., & Renold, E. (2008). *Visual Ethics: Ethical issues in visual research.* (No. 11).

Wills, W. J., Dickinson, A. M., Meah, A., & Short, F. (2016). Reflections on the Use of Visual Methods in a Qualitative Study of Domestic Kitchen Practices. *Sociology*. https://doi.org/10.1177/0038038515587651

Wilson, M. L., & Mackay, W. (2011). RepliCHI - CHI should be replicating and validating results more: Discuss. *Conference on Human Factors in Computing Systems - Proceedings*, 463–466. https://doi.org/10.1145/1979742.1979491

Winckler, M. (2014). The temptation of documentation: Potential and challenges of videographic documentation and interpretation. a case-study from a civic education research project in germany. *Journal of Social Science Education*. https://doi.org/10.2390/jsse-v14-i1-1288

Wood, K., Fleck, R., & Williams, L. (2004). Playing with sensecam. *Proc. Playing with Sensors (W3) at UbiComp 2004*.

Woodcock, J., & Johnson, M. R. (2019a). Live Streamers on Twitch.tv as Social Media Influencers: Chances and Challenges for Strategic Communication. *International Journal of Strategic Communication*. https://doi.org/10.1080/1553118X.2019.1630412

Woodcock, J., & Johnson, M. R. (2019b). The Affective Labor and Performance of Live Streaming on Twitch.tv. *Television and New Media*. https://doi.org/10.1177/1527476419851077

Wright, J. (2011). S1E2 Black Mirror - “Fifteen Million Merits.”

Wright, J. (2016). S3E1 Black Mirror - “Nosedive.”

Wu, F., & Huberman, B. A. (2007). Novelty and collective attention. *Proceedings of the National Academy of Sciences of the United States of America*. https://doi.org/10.1073/pnas.0704916104

Yan, T., Chu, D., Ganesan, D., Kansal, A., & Liu, J. (2012). Fast app launching for mobile devices using predictive user context. *MobiSys’12 - Proceedings of the 10th International Conference on Mobile Systems, Applications, and Services*, 113–126. https://doi.org/10.1145/2307636.2307648

Yeykelis, L., Cummings, J. J., & Reeves, B. (2014). Multitasking on a Single Device: Arousal and the Frequency, Anticipation, and Prediction of Switching Between Media Content on a Computer. *Journal of Communication*. https://doi.org/10.1111/jcom.12070

Yeykelis, L., Cummings, J. J., & Reeves, B. (2018). The Fragmentation of Work, Entertainment, E-Mail, and News on a Personal Computer: Motivational Predictors of Switching Between Media Content. *Media Psychology*. https://doi.org/10.1080/15213269.2017.1406805

Yuan, F., Gao, X., & Lindqvist, J. (2017). How Busy Are You?: Predicting the Interruptibility Intensity of Mobile Users. In *Proceedings of the 2017 CHI Conference on Human Factors in Computing Systems* (pp. 5346–5360). New York, NY, USA: ACM. https://doi.org/10.1145/3025453.3025946

Zaman, B., Nouwen, M., Vanattenhoven, J., de Ferrerre, E., & Looy, J. Van. (2016). A Qualitative Inquiry into the Contextualized Parental Mediation Practices of Young Children’s Digital Media Use at Home. *Journal of Broadcasting and Electronic Media*, *60*(1), 1–22. https://doi.org/10.1080/08838151.2015.1127240

Zhang, M. X., & Wu, A. M. S. (2020). Effects of smartphone addiction on sleep quality among Chinese university students: The mediating role of self-regulation and bedtime procrastination. *Addictive Behaviors*. https://doi.org/10.1016/j.addbeh.2020.106552

Zhang, X., Pina, L. R., & Fogarty, J. (2016). Examining unlock journaling with diaries and reminders for in situ self-report in health and wellness. In *Conference on Human Factors in Computing Systems - Proceedings*. https://doi.org/10.1145/2858036.2858360

Zhao, F., Ghorpade, A., Pereira, F. C., Zegras, C., & Ben-Akiva, M. (2015). Quantifying mobility: Pervasive technologies for transport modeling. In *UbiComp and ISWC 2015 - Proceedings of the 2015 ACM International Joint Conference on Pervasive and Ubiquitous Computing and the Proceedings of the 2015 ACM International Symposium on Wearable Computers*. https://doi.org/10.1145/2800835.2800957

Zhou, T., & Lu, Y. (2011). Examining mobile instant messaging user loyalty from the perspectives of network externalities and flow experience. *Computers in Human Behavior*. https://doi.org/10.1016/j.chb.2010.11.013

APPENDIX

A. PAPER 1: THE ECONOMICS OF ATTENTION REVISITED

In this section I present the draft version of the first Paper that evolved from this research project, which makes a theoretical contribution to the field of attention economics by connecting the existing discussions on attention as a currency to Luhmann's and Parsons' work on generalised media of communication, which outlines a path where attention can be truly exchanged and traded. This Paper is a condensed version of the discussion of the theoretical literature presented in chapter 2. I am the sole author of this Paper.

Introduction

The notion of the 'information society' has existed for quite a while now, and a great deal has been written about how information and know-how have become commodities (Beller, 2006; Goldhaber, 1997a). At the same time, it is impossible to ignore that information is all but short in supply. In fact, "[w]e're drowning in it. There is too much information around to make sense of it all. Everywhere we look, we find information overload" (Lanham, 2006). And it is not just the information itself that seeks to capture our attention, but also the increasingly interactive artefacts surrounding us (Janlert & Stolterman, 2017). What is it that is scarce then? As Herbert Simon's often-cited answer goes: It is, what information consumes, that is, attention (Simon, 1971). With the rise of the internet in the mid to late nineties, research on a potential 'attention economy' started to develop, centring around several publications by Michael Goldhaber (Ghosh, 1998; Goldhaber, 1997a, 2006). The main concern of this debate was how such an attention economy would look like; and in many instances whether or not it really was an independent economy or just the next step in the corporations' fight for the money of the consumer. The discourse swayed towards the latter position and has thus produced a fairly detailed account of the economic models underlying such an 'advertising' attention economy (Falkinger, 2007, 2008). In recent years, attention economics have experienced another major surge in scientific scrutiny, mostly due to the exponential growth of influencer marketing on social media. This literature focuses on understanding how spending attention on social media translates into buying preferences, and how receiving attention translates into individual capital, specifically through reputation and personal branding (Fournier & Eckhardt, 2019; Parmentier, Fischer, & Reuber, 2013; A. N. Smith & Fischer, 2020).

Despite this relatively sizeable amount of existing work, to this day the attention economy remains confined to the economic modelling of a 'regular' competition for money by proxy of attracting consumer attention. This line of research points to neuroscience and psychology to understand the physiological basics of the issue (Beller, 2006; Crogan & Kinsley, 2012). On the other hand, the route of conceptionalising the attention economy as an independent entity remains underdeveloped to this day, which is mostly due to two factors: First, up until recently there was little opportunity for people to engage in attention economics in the fullest sense, a) due to a lack of technology infrastructure and b) due to a lack of social readiness; that is to say, both consumers and producers of content on social media needed to recognise and ‘catch up’ to the technical possibilities together. Hence, while an attention economy appeared intuitive in theory, it lacked empirical footing and had to remain merely more than an academic pipe dream, if one with strong anticipatory power. Second, the main question for such a full attention economy, how attention could look like as a currency and especially how it could be accumulated, stored, and traded, which had already been posed in response to Goldhaber’s original conjectures, still has not been answered satisfactorily from a theoretical standpoint (Ghosh, 1997, 1998).

This paper will focus on the route that understands the attention economy as an independent entity, and will try and shed light on how such a full attention economy could look like by addressing the two factors mentioned before. To do so, we are going to discuss how attention could function as a universal currency using a framework of symbolic capital and systems theory (Luhmann, 1987; Parsons, 1963). Crucially, we are going to look at how this currency can be brought to economic fruition and exchanged rather than just accumulated. We are then going to discuss how a full attention economy could look like and provide some observations of recent developments on social media and changes in user behaviour to see how far down the road these processes already are. Finally, we will point towards some of the implications this might have for individual users and society as a whole, and provide an overview of issues surrounding the attention economy that require monitoring and further investigation.

Summary of Attention

In his *Principles of Psychology*, William James famously and courtly concluded that “everyone knows what attention is”, and ever since, it has often been treated as a self-explanatory, experiential or mental state which does not require further discussion (James, 2006). Perhaps aware however, how unsatisfactory it would be for his readership to be left with an ‘it is what it is’, James adds: “It is the taking possession of the mind, in clear and vivid form, of one out of what seem several simultaneously possible objects or trains of thought” (James, 2006). A cursory look at definitions of attention from dictionaries and the extant literature shows that they have in common three general elements that seem to make up the core concept (e.g. “Attention,” 2020b; “Attention,” 2020a):

1. Attention is a mental state or a mental faculty
2. Attention requires readiness and receptivity of the mind
3. Attention is an act of selection of something, or of something taking possession of the mind

Following James, while everyone may know what attention is on an experiential level, when looking more closely at these definitions, different types of attention varying in nature and intensity appear to be subsumed under the umbrella term ‘attention’. From everyday experience, we know that paying attention to someone or something can be an active, meaningful activity, like solving a Rubik’s cube, as well as a passive, meaningless activity like staring at a news screen while waiting at the airport without really noticing what is being displayed. Awareness appears to be antecedent to attention; conversely, in order to speak of attention, it seems that a certain threshold of awareness has to be surpassed:

> *“Attention occurs between a relatively unconscious narrowing phase, in which we screen out most of the sensory inputs around us (we are aware of many things, but not paying attention to them), and a decision phase, in which we decide to act on the attention-getting information. Without both phases, there is no attention. A causal relationship exists between awareness, attention, and action. For example, attention is a link in the decision-making chain prior to the decision to buy, move, or otherwise act. If you do not get to the point at which you are considering some kind of action, you really have not given an item your attention.”* (Davenport & Beck, 2001)

Another approach distinguishes between contact, attention, and emotion:

> *“Contact with content is therefore the catalyst for a chain reaction; it is necessary, yet not sufficient, for drawing attention, and if this attention is sustained and transforms into interest, it can arouse emotion, depending on the kind of content received.”* (Tassi, 2018)

The idea of different ‘stages’ of attention is rather straightforward and even though it is mostly unconscious, everyone has anecdotal experience of it. If you try to look at everything that is within your visual field on your desk, you will inevitably lose focus of what is around it – unless you have a very tidy desk. The amount of sensory impressions that we can be aware of at the same time is biologically limited (Stróżak & Francuz, 2017).

This reading works well to describe situations like solving a Rubik’s cube, or staring at an airport TV, but it does not really take into consideration the wilfulness (or forcedness in the airport situation) of these activities, nor their outcomes. To move attention beyond a purely passive capacity, these theories then tie attention to action or emotion. Nevertheless, the line between full attention and its antecedents would still remain fuzzy in many situations, which points towards the bigger issue at stake here: The problem with tying attention to action or emotion is that it tries to define attention *as experienced by the individual*. This may be intuitive, but at the same time sets up attention so that it can only be understood in relation to the person that is acting, and her subjective thoughts and actions. However, the ‘raw material’ that becomes either awareness or attention is constantly depleting from our stock with every moment that passes. Hence, whether you stare out of the window of a train apathetically, aware of your surroundings, or attentive to your surroundings, you inevitably expend the ‘biological resource’ that holds the possibility to become awareness, attention, or action. This biological resource is at the very centre of the economics of attention.

From the Economics of Time to the Economics of Attention

Economic approaches to thinking about the use of time have implicitly used this understanding of the biological resource attention for several decades already: “Since the scarce resource of time must be spent, a basic problem of human existence is to spend it well, to use it to bring in the greatest return of happiness that can be achieved” (Sharp, 1981). At the same time, the utility that can be gained from spending a continuous amount of time on one thing may be decreasing, or even discontinuous when it turns into a displacement activity. The analogy between time (or attention) and money as a resource, further, ends when it comes to the ability to *not* use it, to store it, or to accumulate it: “While we are alive we are compelled to spend our store of hours. Other goods and services that may yield displeasure need not be acquired, or can be given away or remain unused. But time must be spent even if it produces boredom or unhappiness or pain" (Sharp, 1981). Thus, as time is available to everybody in a fixed and finite amount it can be a source of pressure, creating *time stress*. Time stress, like poverty, is a problem that arises from a lack of resources, but while the constraint on goods relaxes in a growing economy, time stress increases: With an increased availability of information, individuals will increasingly feel that their time does not suffice to consume everything they desire (Hamermesh & Jungmin, 2007). In support of this, several studies find that the experience of high time pressure is associated with depression (Roxburgh, 2004), lowered life-satisfaction (Hamermesh & Jungmin, 2007; Whillans et al., 2017), and interpersonal conflicts both at work and at home (Höge, 2009). More generally, the research on time-use raises the question where the time-crunch and the struggle for attention originate.

While the focus of the literature often lies on understanding attention expenditure, it makes sense to start with the circumstances under which people receive and proactively attempt to attract attention first. In his treatise on metropolitan life, Georg Simmel argued that the uprooting of the individual from traditional social settings had two adverse effects that eventually set the stage for the attention economy: On one hand, people were liberated from the constraints of traditional societies, which gave them more freedom for self-expression. On the other hand, strong social ties are also a source of purpose and identity, the lack thereof possibly resulting in a loss of self-hood (Simmel, 2016). As a result, Simmel observed, individuals living in large cities developing the "strangest eccentricities, [...] specifically metropolitan extravagancies of self-distantiation, of caprice, of fastidiousness, the meaning of which is no longer to be found in the content of such activity itself but rather in its being a form of being different - of making oneself noticeable" (Simmel, 2016). Being emancipated from the constraints of traditional societies, the individual enters into a competition to be noticed and to forge a recognisable identity for herself: "There's always something to see in cities. People dress for others, show off what they possess, make the most astonishing efforts to induce others to watch" [14, translation]. The wish to be famous and successful has therefore evolved into an end in itself (Lasch, 1984, 1987). And while the esteem an individual was held in by other others was traditionally rooted in her accomplishments, as well as her moral integrity, celebrities in modern society derive their reputation from the coherent, and often visually appealing, public identity they maintain, or just any other means by which they have managed to draw attention to themselves (their ‘front’, see (Goffman, 1959)). It can, thus, be argued that individuals in modern societies do not strive directly for power, fame, or wealth, but rather seek the public attention that usually comes with the possession of these things, which makes the economics of attention really also an economics of reputation (Ghosh, 1998; A. N. Smith & Fischer, 2020). In this sense, attention economics is something that humans are more or less hardwired to do, judging from the lifestyle of our early ancestors and the behaviour of our closest animal relatives (e.g. (Latour, 1996)).

Since this early foreshadowing of the competition for attention, technological progress has made the world a ‘global village’, essentially decoupling locality and temporality (Giddens, 1990). In such a society, “in which everything is moved by communication, nobody can defy the pressure to attract public attention. Otherwise, one is forgotten and lost” [41, translation]. Hence, two new complications in the struggle for attention arise: The competition for attention, first, expands exponentially with the growing number of people and devices that try to capture our attention. The individual is, thus, forced to be highly selective about what she directs her attention to, which information she consumes, and which she does not (Franck, 1998). And since social media are not just a tool to store and distribute information, but also a channel for communication between individuals, they have become a prime contributor to the constant stream of information individuals are subjected to. They are thus both a means to attract attention, as well as a reason why attention is becoming increasingly scarce.

The second complication is that it is much harder to filter out what is currently considered important with the increased amounts of diverse information available. The individual is then forced to use more of her attention to ‘be in the know’, and the freedom of choice offered by modern societies becomes constrained again by the need to attract attention (Münch, 1991). The important insight here is that external appreciation can only be acquired “wrapped in the attention” of others (Franck, 1998; translation). If we need the attention of others to feel good about ourselves, while attention overall becomes both increasingly scarce and difficult to attract, a "fight for visibility" ensues (Schroer, 2014). Modern media, have thus created "centripetal attention structures that bottle celebrity, and celebrities, for sale" (Lanham, 2006): Since every individual needs to spend attention to understand what is required to attract attention (this applies in any field, politics, academics, fashion, art, restauration, sports), those 'in the know' are moved into the spotlight, become opinion-leaders, and eventually gain agenda-setting power. Hence, although information is overabundant and days are limited to 24 hours for everyone, an imbalance in the distribution of attention arises like in any other economy (Aigrain, 2006). The amount of attention that is 'being paid to' an individual depicts her entrepreneurial success in this new economy, and with the increasing relevance that social media play in society, the amount of attention being paid to an individual will have to be understood less metaphorically and more literally. This sets the stage for the accumulation of 'capital' in the attention economy.

Attention as a Currency

We will now turn to how attention behaves as a currency, how it could be traded, and where and how the analogy between attention and other currencies falls short. Much like modern monetary currencies attention is not valuable in itself, only as a means to provide access to valuable things, in this case information. Unlike modern currencies, however, attention is inherently limited, it cannot be saved for later, and it is foregone if it is not spent 'wisely' – at least to date.[8] In this sense, attention as experienced by the individual should not be treated as a stock, but as a *flow* currency. Our stock of attention constantly empties and refills itself at the same time, with the maximum amount of attention we can hold at any given time determined by a biological limit that remains largely invariant for the individual (different bodily states like hunger or fatigue, as well as stimulants can of course temporarily influence this biological limit). While time use studies have attempted to document what individuals spend their attention on, the sheer size of the attention economy and the microtransactions that make it up have been made visible to full extent only through social media. Surely, the number of copies a newspaper sold,

[8]It is beyond the scope of this paper to delve into the physiological aspects of this issue. For the current research agenda, a socio-psychological understanding of the nature and the limitations of attention is adequate. As a first point for the reader interested in examining the discussed phenomena from a neuro-biological or physiological viewpoint Lang's *limited capacity model of motivated message processing* may be interesting as a framework of analysis (Lang, 2000), and Strózak & Francuz' EEG studies on attention allocation as a way of measurement (Stróżak & Francuz, 2017).

or the viewers who tuned into a TV programme hint at the underlying processes, but it is only with likes, views, and followers that the immediacy of the flow of attention from consumer to producer and the circularity of the system become evident. When watching a video on YouTube, every single viewer immediately contributes to the accumulated view count, which subsequently influences how many other viewers the video is suggested to. On Instagram, likes count social approval as a hard currency for social comparison and the number of followers quantify a user’s personal audience, i.e., the people who regularly pay attention to them (e.g. Hayes et al., 2016). By recording, storing, and making visible the attention users expend and receive instead of letting it dissipate at the end of the transaction, social media have found a way around the fleeting nature of attention. Whilst still unable to store or save up attention internally, in the original form of the flow currency, social media allow attention to accumulate and calcify externally. Of course, calcified attention is different from the flow attention we use in our lives; you cannot ‘use’ the attention that people paid to a photo you have taken to take yet another photo, but it can determine how many people will pay attention to the next photo you take, and how much someone might be willing to pay you to feature their product in it. This translation of flow attention into a digitally stored stock currency is the central mechanism of a true attention economy.

To understand the modalities of how exchanges in the attention economy take place, attention should be treated as a *symbolic currency* (Luhmann, 1975; Parsons, 1963). In its calcified form displayed as subscribers, followers, likes, etc., attention acts as a signifier of reputation and status that puts into evidence previous success in the attention economy, a) with the promise of attracting more attention in the future, and b) with the opportunity to ‘exchange’ it for other valuable resources, such as money. Parsons had theorised that money is a specialised language that enables its users to symbolically communicate meaning to one another. Money, he argued:

> *“[...] is a symbolic "embodiment" of economic value, of what economists in a technical sense call "utility." Just as the word "dog" can neither bark nor bite, yet "signifies" the animal that can, so a dollar has no intrinsic utility, yet signifies commodities that do, in the special sense that it can in certain circumstances be substituted for them, and*

> *can evoke control of relations with them in the special kind of process of social interaction we call economic exchange. This means that holders of objects of utility will, on occasion, be willing to relinquish control over them for money, and, conversely, holders of money will be able to acquire, by use of the money (its "expenditure"), control over objects of utility."* (Parsons, 1963)

Parsons called this class of symbolic signifiers *generalised media of communication*; Luhmann then employed the notion for his conceptualisation of systems theory (Luhmann, 1975, 1987, 1994). This approach divides society into subsystems such as the economy, the legal system, or the political sphere, which are understood to mostly revolve around themselves, using a specific symbolic currency as their transactional medium to reduce the complexity of internal relationships (Luhmann, 1975). This would be influence for the political system, expertise for the legal system, or money for the economic system (Luhmann, 1994). For exchanges between systems, one symbolic currency can normally be translated into another, either directly or indirectly; e.g. expertise into influence, or influence into money. As we have seen before, calcified attention like Instagram followers or views on YouTube videos symbolically communicate a system specific meaning and are a signifier of success or 'power' on the social networks or, more generally, in the public sphere. Attention can moreover be translated into other subsystem currencies like influence or money relatively easily, albeit not as easily as money. In that regard, attention behaves more like power or influence as the exchange resembles a credit or a loan on the attention that one has rather than giving away a specific quantity of it for something else (Ghosh, 1998). An exchange of calcified attention into political power or influence for example is relatively easy: a typical case would be a famous actor or singer raising awareness for a pro-environmental campaign or engaging in dialogue with a politician on Twitter. An illustrative example of an exchange of attention into money is product placement: Most content creators on the internet have accumulated their following through the content they produce. If they then start capitalising too much on this following and mostly use the attention of their followers to advertise products to them (and receive large reimbursements) rather than continuing to produce content, they will lose their following rather quickly. If they find the right balance, however, their following will likely accept the occasional advertisement and an exchange of audience attention for money is possible without a loss of calcified attention (i.e. followers).

Crucially, the number of views on YouTube or followers on Instagram directly influence how easily attention can be exchanged into other symbolic currencies and at which ‘exchange rate’. The larger the following of an individual on social media, the more likely for example politicians are to engage with them if they comment on current matters, and the more a company would pay for a sponsorship. Because large amounts of calcified attention hold the promise of attracting attention in the future, individuals rich in calcified attention can also exchange the flow attention *of their audiences* into other generalised media of communication. Thus, people can take out a ‘credit’ on calcified attention, on one hand, by virtue of the signalling value of being able to attract attention again in the future (just like reputation or political power), and on the other hand, by acting as a channelling point for other people’s attention, explicitly guiding their audiences in certain directions. This duality in the way in which the attention individuals receive can be spent makes the ways in which attention works as a currency highly complex and is the key to understanding transactions in the attention economy. The remaining question to clarify for attention as a currency is for which system attention is the symbolic currency. Tentatively, the modern, mediated public can be seen as an independent subsystem for public life in the sense in which the ancient Greeks understood the *agora*. Alternatively, attention might be a secondary currency for the economic system and eventually replace money. Lastly, given the influence attention has on all subsystems of society already, it might evolve into meta-currency that is indigenous to each part of society. It is too early to give a definitive answer in which of these routes, if any of them, the attention economy is heading. In many respects, however, a broader shift towards attention as the prime medium of exchange appears to be under way already. What we are witnessing could be a fledgling revolution in the societal mode of exchange and production. As Goldhaber suggested:

> *“Attention transactions, which already are far more numerous than monetary transactions will come to dominate even further. So even if you have lots of money, you will find it less and less convenient or worthwhile to bother to use it. As a result, our deeply ingrained desire*

> *for monetary recompense will begin to fade as well"* (Goldhaber, 1997a).

Recent developments

The main reason why the concept of attention as a currency has remained underdeveloped so far is that only relatively recent developments on social media have made the attention economy fully visible. And while a full attention economy is of course still far from being reality, it is much more developed now compared to when the debate originated in the late 1990s. Social media was merely the starting point through which the credo of attention maximisation has gained a grip on people's minds, and the very same logic is slowly permeating into every aspect of our lives. In journalism, investigative pieces are struggling to compete with sensationalist content and 'clickbait' headlines (Chakraborty, Paranjape, Kakarla, & Ganguly, 2016; Munger, 2020). In politics, as false promises and populism often trump feasibility and content, political messages are amplified, distributed, and sometimes altered through the social networks (Park, Ko, Kim, Liu, & Song, 2011). The attention of the public thus becomes "'micro-donations' of time and effort to political causes: liking, sharing, following, downloading, signing petitions and so on, which extend the ladder of participation at the lower end and draw more people into politics, particularly in younger age groups" (Margetts, 2016). Even in academia, publication counts, and scores like the h-index greatly determine job trajectories for individual researchers, and journals compete over impact factors and social media attention (Entradas & Bauer, 2019; Karmakar, Banshal, & Singh, 2020; Kortelainen & Katvala, 2012). In this contest for scholarly authority, academic citations are the "attention fee" that is paid to authors (Franck, 1999). Lastly, making the exchange of attention into money even more immediate, a company now offers a credit card to influencers that determines the creditworthiness of its users through the size of their following on social media and the interactions their content receives (Pardes, 2020). While only being aimed at influencers who have already amassed relatively large amounts of calcified attention for now, this clearly points into the direction where attention may become more "convenient to use" than money (Goldhaber, 1997a).

In general, social media of course remain at the spearhead of these developments, acting as both a testing ground and a space in which typically younger generations are socialised. It is, thus, likely that more practices of pioneer attention economists on social media will inform, or be directly adopted by society at large in one way or another in the long run. We shall discuss here exemplarily one of the fastest growing trends on social media, live streaming, which has wide-reaching implications for the attention economy. The market for live streaming on platforms like Twitch, YouTube, or DouYu has grown exponentially in recent years, with the amount of hours watched doubling across the industry from 2019 to 2020, and Twitch users alone watching 1.65 billion hours of content in April 2020 (Easton, 2020). Streamers interact with their audience in real-time, most commonly talking to or playing computer games for and with their audiences. Here, interactions between content creators and their audience become even more immediate compared to asynchronous social media interactions (Hamilton, Garretson, & Kerne, 2014; Hilvert-Bruce, Neill, Sjöblom, & Hamari, 2018). One common format of live streams entails streamers ‘reacting’ to media content, sharing their opinions on it with their audience (Palladino, 2016). Reactors are thus able to tap into the attention that the author of the original content has (when reacting to a famous song or personality for example). Furthermore, this allows users to publicly discuss with their audiences, take requests, and even engage with other content creators, using mutual reactions as a stage for public discussion, and to exchange streams of audience attention. Early studies in the still nascent field of live-streaming research hint at the performative elements of the streamers’ interactions with their audiences, (Woodcock & Johnson, 2019b) and the ‘affective labour’ that they are performing (Hardt & Negri, 2004). In this context, terms like “playbour” (Kücklich, 2005) have been used to emphasise that live streaming often blurs the lines of work and play, while the terms “aspirational work” (Duffy, 2017) or “hope labour” (Johinke, 2020) highlight that the majority of streamers neither receive monetary compensation for these activities, nor manage to build up substantial amounts of calcified attention (Woodcock & Johnson, 2019b). In this vein, it has further been argued that, unlike other platform markets, livestreaming platforms *highlight* rather than hide the labour of workers (Johnson & Woodcock, 2019). This is one of the key reasons why streaming platforms lend themselves well to pioneering the translation of performative work, and the attention it receives, into other currencies.

Already as of now, there is a variety of ways in which these platforms facilitate the conversion of attention into money. One common way is users paying a monthly subscription fee to gain access to special emotes and badges, or additional content. A more immediate way of converting attention into money are ‘donations’ that viewers send their chosen streamers. These donations are usually displayed on the live stream image and rewarded with little jingles or animations, and often an explicit expression of gratitude by the streamer. In some cases, donators can also write a message that appears live on stream, asking a question, or suggesting a song to listen to or a video to watch. Taking this one step further, many streamers also feature the names of their ‘top-donators’ on the stream image. In these ways, viewers can receive some attention themselves, and actually convert money into vicarious attention from the streamers’ audience.

> *“There is a circular, self-reinforcing and self-reproducing dynamic: attention generates more attention. Paying attention to an attention-rich public figure, a celebrity, is in turn a means of attracting attention (to one-self). This is an essential component of how Twitter and Facebook function. One can observe second-order attention wealth-creation: the attention of those rich in received attention is ‘worth’ correspondingly more.”* (van Krieken, 2019)

Following this format, different streamers employ various activities like live calls, chats, or competitions for sending in the best song, meme, etc. to engage their audiences, promising access to the attention of the community to viewers, and increasing their own attention capital at the same time. Lastly, some streamers set “donation targets” upon which being reached they will tell a certain story or play a different game, and there even are on-screen games based on donations that users can play against each other by donating money. It is also common practice for content creators to share wish-lists (e.g. on Amazon) with their audiences, and sometimes viewers even pay for streamers’ meal deliveries (see (Johnson & Woodcock, 2019) for a detailed discussion for ways in which streamers can convert their attention capital into money). In this way, live-streaming platforms broker the exchange of attention into money and vice versa; streamers can directly convert attention into money, and users can convert money into attention, receiving an acknowledgement or answer to their question from their chosen streamer and becoming visible to the entire audience of the stream for a moment. But the platforms themselves are also becoming a massive testing-ground for new ways of converting audience attention into money and other material goods, both for streamers and platform operators. Twitch is trialling the gamification of influencing activities with 'bounty boards' that give missions like watching a promotional video live on stream, or playing a specific game for a while, to streamers. This allows even the 'smallest' of content creators in terms of audience size, who would not normally be noticed by advertisers, to convert their audience's attention into other currencies, and advertisers to reach into the farthest corner of the platform (Woodcock & Johnson, 2019a). As streaming platforms are overseeing the exchange of the affective labour of content creators and the attention they receive, and translating it into money or goods already, the step to cutting out the intermediary exchange of attention into money altogether is only small, and for the payment side this step has already been made with *Facebook Gaming Stars* or *Twitch Bits*; the latter of which can not only be purchased with money, but also earned by watching advertisements, i.e. 'paying attention'. Especially when content creators can exchange these attention currencies for goods, or get food or other goods from their audiences directly without engaging in a monetary transaction themselves, these individuals might become the first ones who find the use of money less convenient than the use of attention, as Goldhaber had suggested (albeit the monetary exchange still being performed at this point of course; just by one of the viewers). But with competition for attention continuing to increase on social media and in society in general, holding the attention of an audience and eliciting interaction to be able to continue to convert attention into money and other symbolic currencies will be the next challenge for attention economists. Audiences as "producers of attention" in standard economic terms will be the next 'scarce' element in this new economy of attention (Goldhaber, 1997b). This development is very clearly visible in the music industry, where the model of limiting access to music and selling physical units has been replaced almost entirely by streaming models that maximise access and remunerate artists on the basis of the attention their music receives (with all the imbalances in distribution of income this brings) (Aly-Tovar, Bacache-Beauvallet, Bourreau, & Moreau, 2020; Bruenger, 2019).

Current developments on social media provide clear indications that the attention economy is steadily extending its reach and its impact. Calcified attention as an indicator of quality or success has gained importance far beyond the realm of social networks and many of our daily choices are now guided by it, be it directly through our choices, or indirectly through what is available to choose from. Inversely, it is becoming increasingly difficult to participate in society without leaving digital traces that contribute to the attention capital of others, be it by reading an article, listening to a song, or reserving a table at a restaurant. It is furthermore becoming increasingly easy to exchange attention into money and other symbolic currencies, and in certain areas even necessary, with social media and particularly live streaming remaining and the spearhead of these developments. Money now "tracks attention", meaning that those who manage to attract attention find it easy to make money as well, and those who do not will find themselves struggling to obtain money (Goldhaber, 2006). Moreover, the notion that attention may be the more convenient medium of exchange does not seem as incredibly distant as it did twenty years ago when the economics of attention entered the spotlight of research for the first time.

THE ATTENTION ECONOMY IN THE REAL WORLD

While some of the recent developments around live streaming and social media generally hint at the direction society is moving into, the most pressing question is of course how a true attention economy would function in the real world, and what implications it would have for society as a whole, and the lives of individuals. Turning to film and literature in such a situation can provide useful insights, and several interesting ideas on how such societies revolving around attention could look like have been explored already: In Cory Doctorow's *Down and Out in the Magic Kingdom*, for example, the 'whuffie' is a digital social currency that is used in lieu of money and measures how much social esteem an individual holds (Doctorow, 2003). Similarly, the TV series *Black Mirror* has explored both individual psychological, as well as societal and economic effects of digital currencies relating to reputation and status (Wright, 2011, 2016). The media tend to draw a rather dystopian picture of attention economies as highly unequal, repressive societies that subject individuals to constant social surveillance reminiscent of Bentham's panopticon (Bentham, 1791). In these societies, wealthy individuals form a ruling class that is 'beautiful' and lives lavish lives, but is either ignorant or morally corrupt. The masses of people, on the other hand, live in precarity and feed the system, always being on the brink of ruin and without any chance of social mobility. These narratives borrow heavily from the classical Marxian criticism of capitalism, but are also reminiscent of Horkheimer and Adorno's writings on the culture industry (Horkheimer & Adorno, 1988). But these narratives are of course intentionally dramatized to sell a narrative. It is not within the scope or the aim of this paper to explore how fair the distribution of resources in our current economy is, and what the chances for social mobility are. But we can note that while (monetary) wealth is distributed rather unequally in the present system, violent repression and dictatorial plotting by ruling classes, pushing societies in a state of quasi-civil-war are significantly less prevalent than in these dramatizations. It is therefore questionable whether a society using attention as its main currency would necessarily lead to more inequalities than a monetary system, and whether these inequalities would be more likely to cause social unrest or even revolution. What can be said, however, is that just because every individual has access to the same amount of flow attention to dispose of, the distribution of wealth in the attention economy is not necessarily going to be more equal. Unlike a universal basic income in the monetary system, the ability to *pay* attention in an attention economy does not immediately translate into the ability to consume (in principle) any type of good. Before flow attention can be used as a medium of exchange, it needs to be converted into calcified attention, which is currently largely scaffolded by the previously mentioned platforms that broker attention transactions and create 'centripetal attention structures' (Lanham, 2006). And while this system holds the opportunity for more and more rapid social mobility both upwards and downwards ('going viral' vs. 'getting cancelled'), it is still predisposed to result in large inequalities.

But apart from the 'eyeball market', there are of course other ways in which flow attention can be translated into calcified attention, with time banks being the most illustrative. Time banks, originally developed by Edgar Cahn (Cahn, 1999, 2001; Cahn & Rowe, 1996), are agency-based credit systems that enable local communities to support each other and 'call in favours' in exchange for credit obtained by performing social services oneself. Studies on time bank users show that motivations to participate in such schemes go beyond just an extension of purchasing power, but also revolve around creating a better society and improving the quality of life in the area (Collom, 2007), and arguments that a time bank model lends itself better to a sustainable mode of production and exchange have been put forward (Ozanne, 2010; Seyfang & Longhurst, 2013; Válek & Jašíková, 2013). What is interesting here is that time banks translate social service and labour in general into a social currency that possesses and showcases an inherent value, that is, time spent on prosocial activity. The time bank model could thus be a way in which each individual can translate their flow attention into calcified attention as time spent on something that is socially reputable (or at the very least 'productive', which is effectively closely approximating paid labour), and current practices on live streaming platforms suggest that these structures work exceptionally well for attention economics. But this of course also raises the question whether socially undesirable behaviours should lead to a loss of wealth in an attention economy, akin to the social credit system the Chinese government is currently trialling (Kobie, 2019). While such scenarios are usually the point when the narratives turn dystopian in media representations, and Western governments were quick to condemn China for this, they may have been a bit too quick (Song, 2019). The question is whether this would better enable punishing anti-social behaviour. Can a wealthy individual in such a system just act without repercussions because their demeanours are not relevant in comparison to the social accolades they have amassed? And how is this different to a monetary system, where, for example, speeding tickets have very little financial impact on those who can afford cars that lend themselves to speeding (note that many countries in Scandinavia have thus begun to calculate fines based on income (Pinsker, 2015)?

Another highly interesting question is what the infrastructure to run such a system would have to look like. The favoured model in the media seems to favour the Orwellian notion of 'Big Brother' and a total surveillance infrastructure, which is going to be costly and difficult to install and enforce. Nevertheless, China is currently trialling such an infrastructure-based model, and the discourse around smart cities suggests that the sensors already in existence in many cities nowadays effectively render them akin to a panopticon (e.g. Haumann, 2020). Without wanting to engage in the discussion whether an infrastructure solution necessarily needs to lead to dystopian outcomes (as for example forecast in *Fifteen Million Merits* (Wright, 2011)), these structures are going to be challenging to put into place, but the process is well under-way already. Installed infrastructure, however is not the only way to record and exchange such a currency, and a model of user input (individuals rating each other with personal devices, as suggested in *Nosedive* (Wright, 2016)) is more in line with the current way attention is being accumulated and traded. If audience currencies mixing attention with reputation become more prevalent, and the consequences of possessing larger or smaller numbers of it become more relevant, social enforcement as can be observed in uber-ratings or restaurant reviews nowadays will reach an unprecedented, qualitatively different level. Game-theoretical modes of human interactions such as reciprocal punishment and competitive altruism (Fehr & Gächter, 2000, 2002; Roberts, 1998) provide an interesting outlook on the direction social interactions might be headed, and the often-mentioned caveat that these models do not translate well into actual calculations individuals make may appear less relevant when an attention currency makes the ‘payoffs’ of interactions more tangible.

This, lastly, leads to another important issue to consider, which is that the immediacy with which wealth and poverty are tied to an individual and her personal characteristics will have a much stronger influence on the psychological well-being of the individual in such a system. Poverty, in an attention economy, does not just mean a lack of resources, but also a lack of appreciation and social approval, while wealth, does not just like in our current monetary system often come with social repute, or gives access to it, but quite literally *is* positive reputation. Taking into account discussions of the effects of social comparison on social media on psychological well-being that are already visible at the moment (Bessenhof, 2006; Throuvala et al., 2019; Woodcock & Johnson, 2019b), the general effects of wealth and particularly poverty on mental health are likely to be exacerbated in an attention economy.

Outlook

In this paper we have discussed the theoretical foundations of the attention economy and recent developments that have increased its prevalence in our society. With an overwhelming supply of information in contemporary society, attention is now a scarce resource that needs to be spent selectively. Social media are one means that allow such selective and individualised expenditure of attention, but at the same time are main contributors to the stream of information that makes it impossible for users to pay attention to everything that is addressed at them. Attention thus becomes increasingly valuable, not just for individuals who need to expend it, but also for media, politicians and marketers who have to attract it to move their messages or products. Conversely, anything that attracts large amounts of attention is now almost automatically valuable, desirable, or relevant; what does not, likely is not. Hence, social media have developed numerous indicators of calcified attention like view counts or likes that document and exhibit such 'success'.

It is difficult to anticipate future developments and we are not saying that money will disappear immediately (or completely necessarily). The overall value of one currency is in great parts defined by how easily it can be translated into other currencies. While money currently still is the most interchangeable, this has not always been the case. In the feudal and barter economies that preceded the current system, money played a second-order role before it rose to prominence. But:

> *"When the market-based, proto-industrial economy first began to replace the feudal system of Western Europe, in which the prime form of wealth was aristocratic lineage and inheritance of land, both the noble titles and the lands that went with them soon ended up disproportionately in the hands of those who were good at obtaining what was then the new kind of wealth, namely money."* (Goldhaber, 1997a)

Just as the role-relationships between land, lineage, and money reversed, money might fall victim to the same fate with attention. It is yet to be seen, however, what shape the basic structures and mechanisms required for society to progress to an attention economy from a theoretical standpoint will take in real world contexts. Moreover, closely monitoring these processes to make sure we are aware of and understand where the societal mode of exchange is heading, and what consequences this may entail is crucial. Specifically, we see seven important questions that need to be investigated in a next step:

1. Where will the attention currency be stored, and in which form? Are we going to see a time bank model that is taken on by (streaming) platforms that connect content creators and audiences and broker the exchange of attention into a digital currency? And how are individuals going to store their wealth? Will there be digital wallets similar to those of cryptocurrencies, or will the attention currency be connected to a profile that is connected to a user through biometric identification markers, for example?
2. How exactly will the attention currency be traded? Is it going to be a digital currency (stars, bits) that can be exchanged for anything and essentially behaves like current monies, or will it be a token of performed acts, like credits in the time bank, that can be exchanged for a specified set of (social) goods and will need to be translated into other currencies before it can be used in other areas of society?
3. Moreover, will there be a unitary attention currency that is universal to platforms, or will we see many different currencies that hold different 'attention value' and can be exchanged like British Pound into US Dollars?
4. How will the act of acquiring the attention currency look like? Will all 'productive' activities eventually attract some attention from others, or have to attract attention from others? Or will the attention capital be generated and 'bottled at source' by individuals who are engaged in highly visible, performative labour and then distribute it to others?
5. How do people 'lose' attention capital and what are the psychological implications of this?
6. How far are the lines between work and leisure (playbour) going to blur in a society that is mainly driven by attention flows and calcified attention? With less and less humans involved in the production of the means of

subsistence, the amount of individuals performing affective labour is going to increase even further. With boundaries between receiving and paying attention, as well as work and play blurring, the notion of earning and paying stand to get entangled as well, and ultimately the concept of economic exchange, as we currently understand it, might change dramatically.

7. Currently the common denominator of exchange still is money. If attention is ‘taking over’, is it going to be a gradual process, or a momentous shift after a global event such as a financial crisis? How is this shift going to look like, and how is wealth in the old system going to translate into wealth in the new? Might this shift even cause a crisis of the current economic system when it occurs?

To address these questions, the social-psychological understanding of attention underlying this paper needs to be grounded in in neuro-biological observations. Moreover, further investigations into the macro-processes at work in society, and the possible infrastructure systems underlying the accumulation and exchange of attention are necessary. Lastly, the interactions between content creators, especially live streamers, and their audiences should be examined with ethnographic techniques to explore and better understand the nature of these relationships, and to document the decisions around attention allocation both parties make.

B. PAPER 2: BOOK CHAPTER ON VIDEO ETHICS

In this section I present the published version of the book chapter that evolved from a collaborative project on research ethics for video-ethnographic methods with Dr. Marina Everri, Dr. Paulius Yamin and Prof. Saadi Lahlou. The goal of this project was to refine the technique, make sure it complies with the highest ethical standards and the European Union's General Data Protection Regulation (GDPR) which came into effect in May 2018 and, more importantly, to produce useable and transferable guidelines for other applications and users. I have presented the results of this project at the conference *Ethnography with a twist* at the University of Jyväskylä, Finland in February 2019. The resulting Paper has been published under the following reference:

> Everri, M., Heitmayer, M., Yamin-Slotkus, P. & Lahlou, S. (2020). Ethical challenges of using video for qualitative research and ethnography: State of the art and prospective solutions. In: Koistinen, Lähdesmäki, Čeginskas: *Ethnography with a Twist. Methodological and Ethical Challenges and Solutions in Contemporary Research*. Milton Park, United Kingdom: Routledge. ISBN: 978-0-367-37688-8.

This book chapter was jointly co-authored between Dr. Marina Everri, who contributed 40% of the work, Dr Paulius Yamin-Slotkus, Prof. Saadi Lahlou, and me, who each contributed 20% of the work.

Ethical challenges of using video for qualitative research and ethnography

State of the art and guidelines

Marina Everri, Maxi Heitmayer, Paulius Yamin, Saadi Lahlou

Qualitative video research as well as digital ethnography techniques based on video recordings are steadily increasing. The affordability of high-quality technical equipment, e.g. wearable micro-cameras, and the superior quality of video data compared to other forms of recording have given a 'visual turn' to social research methods that is here to stay. The present contribution provides a comprehensive and consistent point of reference for unified guidelines on the ethical conduct of video-ethnography and qualitative research designs based on video data. The chapter includes four main sections. The first provides a systematic review of current research ethics guidelines to collect visual data with different populations (e.g., adults and children), institutions, and informal settings. The second highlights the main challenges, namely critical issues and gaps concerned with a) researcher-researched rapport, b) informed consent, and c) participants' rights (anonymity, confidentiality, data ownership and release). The third tackles solutions, including setting up the research in a way that fosters ethical behaviours by design. We illustrate this with exemplary cases. The fourth provides practical advice for an 'ethical twist' on ethnographic visual research methods by looking at the future of ethical regulations for video research in ethnography.

Introduction

Visual methods have been essential in ethnography from the start: the iconic ethnographer (or anthropologist) is pictured equipped with cameras and a notebook full of drawings. "Visual" refers to diverse methods of investigations based on the collection, analysis, dissemination of still (photography, drawings, paintings, etc.) or moving images (film, live performance) often associated with audio (e.g. video). But compared to the 16mm B&W camera used in the seminal "Cinéma Vérité" of ethnographer Jean Rouch and sociologist Edgar Morin (Rouch & Morin, 1961), which renewed the concept of "documentary", the increased affordability of high-quality equipment and the superior quality of video data compared to other forms of recording brought a “visual turn” (Rose, 2014) in many social sciences. Additionally, the rich, visually appealing and seductive nature of video-based data can convey a strong sense of direct experience with the phenomena studied (R. Pea, 1999). Therefore, research relying on visual methods as well as ethnography techniques based on video recordings have steadily increased over the last decade (Gubrium & Harper, 2016; Pink, Postill, Hjorth, Lewis, & Tacchi, 2016). This raises new ethical challenges. Images pose specific ethical issues for research participants because they afford physical recognition of persons, spaces and places, and give the impression of an “objective depiction of reality” (de Laat, 2004). Videos can provide confidential information on participants’ habits and behaviours. The audio embedded in images puts participants’ privacy at risk.

The issue is the following: techniques which aim at depicting or understanding generic aspects of behaviour for scientific purposes (where specific identity does not matter) nevertheless document behaviours on specific identifiable individuals (therefore making these specific individuals publicly accountable for their behaviour). This problem of course applies to many types of data in social science (or medicine), but the visual nature of the data makes anonymization especially challenging. As we discuss below, current guidelines, inspired by medicine, focus on anonymization – which may work for physiology but not for social behaviour – rather than on the actual problem which is the potential impact of public disclosure of personal behaviour.

Interestingly, the majority of ethical guidelines do not make specific distinctions between photographs and videos – most regulations apply to both. Therefore, we maintain here the usage of the term “visual” as we discuss the literature on the topic; we will then introduce specifications when referring to ethical issues pertaining to video.

This contribution proposes a comprehensive and consistent point of reference for unified guidelines on the ethical conduct of video-ethnography and qualitative research designs based on video data. The chapter includes four main sections. The first provides a systematic review of current research ethics guide- lines to collect visual data with different populations (e.g., adults and children), institutions, and informal settings. The second highlights the main challenges and gaps concerned with a) researcher-researched rapport, b) informed consent, and c) participants' rights (anonymity, confidentiality, data ownership, and release). The third tackles prospective solutions including setting up the research in a way that fosters ethical behaviours by design. It is illustrated with exemplary cases. The fourth provides practical advice for an "ethical twist" towards participants on ethnographic visual research methods.

Ethnography and visual research ethics guidelines: state of the art.

We carried out a systematic analysis of the literature to get a broad overview of ethical issues in relation to visual methods. Three databases (Scopus, Web of Science, Ebsco) were searched independently with the following combination of keywords: video + ethnography + ethic*; visual ethnography + ethic*; video research + ethic*. This provided 54 references, including journal articles, handbooks, and book chapters; four in which ethics was peripheral were deleted. Current regulations and guidelines on visual research were found across different disciplines and institutional boards both in academic and non-academic institutions.

While most ethical issues regarding textual material can be solved using abbreviations, initials, pseudonyms, etc., scientific and institutional boards are still struggling with visual techniques. Very few publications (Kelly et al., 2013; Wiles et al., 2008) provided a comprehensive account of ethical issues in visual research, for example concerning privacy, researcher-participant rapport, and informed consent. The majority tackled methodological (18 references) and health issues (13 references), the latter comprising research carried out in psychotherapy, clinical psychology, medicine and nursing. Resources on health issues focused on sensitive environments, such as emergency interventions or patients with dementia. Four of them (Derry et al., 2010; Haeckling, 2013; Schuck & Kearney, 2006; Winckler, 2014) discussed visual methods and ethical issues in education; six addressed children (Aarsand, 2016; Aarsand & Forsberg, 2010; Flewitt, 2005; Heath, Hindmarsh, & Luff, 2017; Mudaly, 2015; Robson, 2011). In the latter case, they question the role of parents and guardians for informed consent, but do not mention informed assent for children. Lastly, a few papers connected visual ethics to the specific realms of anthropology (four: de Laat, 2004; Eglinton, 2013; Pink, 2011;

Pope, De Luca, & Tolich, 2013) and sociology (four: Clark, Prosser, & Wiles, 2010; Milne, Mitchell, & de Lange, 2012; Papademas, 2009; Salmons, 2015). The guidelines produced by scientific boards dwell on issues similar to scientific publications. The Association of Internet Researchers (2012), the American Anthropological Association (2001), the Association of Social Anthropologists of the UK (2011), the British Sociological Society (2017), or the International Visual Sociology Association (Papademas, 2009) all provided recommendations on consent and results accessibility, harm and vulnerability, data management, and anonymity and confidentiality with emphasis on aspects consistent with the purposes of their specific scientific community.

Universities and other research institutions, such as the British Economic and Social Research Council (ESRC), often have dedicated research ethics committees. For example, the London School of Economics has a general Research Ethics Policy and Procedures document, a Code of Research Conduct and an Ethics Code (accompanied by an ethics guidance document). Researchers must complete a Research Ethics Review Form, which is the only document explicitly mentioning visual research, linked to potential confidentiality and anonymity issues (London School of Economics and Political Science, 2019).

These guidelines conform with the recent EU General Data Protection Regulation (GDPR), put into place to guarantee the lawful, fair and transparent collection of personalised data. GDPR does not apply to anonymised data, but it is important to note that while pseudonymisation can be sufficient to anonymise certain types of data, the situation with visual data is more complicated. For example, a video showing a participant commuting to work, even with faces blurred, still shows their home and the work address, which can be identifiers.

In summary, the literature on research ethics seems to converge on general ethics guidelines concerned with participant data protection. Some scientific boards provide regulations on visual research, however without making specific reference to the collection, analysis, treatment and protection of video data as well as to the peculiarities of ethnographic research.

From visual to video-research: critical aspects and literature gaps when using video

We found ample criticism both for research institutions and ethics boards in almost every article we surveyed. The rigidity of formal ethics processes in academic institutions, by narrowly focusing on what regulation will allow (Wiles, Coffey, & Robison, 2010) neglects crucial aspects embedded in qualitative and ethnographic inquiry. These are: the characteristics of researcher-researched rapport; procedures for achieving truly informed consent; the acknowledgement of participants' rights, namely researchers' measures taken to guarantee participants' anonymity, confidentiality, and data ownership and release. Across these aspects, the social and cultural particularities of research contexts play a key role and must be assessed and negotiated beforehand by researchers. These differences might determine, for example, the appropriateness of using video and photography techniques (Kelly et al., 2013), the general understanding that participants have of privacy, consent and data ownership, and what constitutes sensitive activities or images (Cox et al., 2014). For example, while filming breakfast is usually innocuous, documenting sexual practices may not be. Ethical guidelines rarely focus on the actual risk assessment of the disclosure, making it difficult if not impossible to record a football match played by children, while allowing recording of an identifiable adult describing or performing any behaviour as long as an "informed" consent is signed. Overall, we found consensus among social scientists that the "biomedical model", which has served as the basis for ethical guidelines for the social sciences, is deficient when applied to visual research, and ethnographic research more broadly (Atkinson, 2009).

Researcher-researched rapport

There is a power imbalance between researchers and participants, related to status, knowledge, and nature of the relationship in which both parties are engaged (Carroll, 2009). During the process of ethnographic data collection, however, the boundaries become "fuzzy" (Gubrium et al., 2014). Many researchers point out that it becomes difficult to anticipate ethical issues with such a flexible researcher-researched relationship, making reflexive practice an ongoing concern throughout the research process (e.g. Blazek & Hraňová, 2012; Cox et al., 2014). Reflexivity must not mean merely going beyond "deploying the method" (Carroll & Mesman,

2018) and reflecting on one's practice as a researcher, but also being continuously aware of, and questioning the prescribed roles of researcher and researched, and their relationship. In consequence, taking the collected video as depicting a "hard reality" cannot be sufficient for truly reflexive practice; participants' voices must also be included during the interpretation of the data, creating a third voice, "which combines the view of the researcher and the researched" (Ruby, 1991).

Informed consent

Pre-formatted checklists distributed by institutional ethics boards, that usually are to be filled out prior to data collection, neither enable researchers to react adequately to issues arising during research, nor do they enable ethics boards to ensure adherence to ethical standards (e.g. Cox et al., 2014; Gubrium et al., 2014). Rapidly progressing technologies in video-ethnographic research further complicate this issue: "many visual dilemmas emerge in specific contexts and cannot be resolved by appeal to higher principles and codes" (Clark et al., 2010).

Achieving truly informed consent with checklists and by handing out paper forms prior to data collection, which is the standard procedure for most academic institutions (Gubrium et al., 2014; Lenette et al., 2018), is not possible. In practice, evaluating whether the outcome potentially discloses things detrimental to participants is often difficult to assess before the visual material is presented in the results; at that stage sensible editing can make the material innocuous to individual participants; conversely awkward presentation can make innocuous material harmful.

In practice it is almost impossible to obtain informed consent from everyone that is captured in the video. Consider filming in shopping centres, airports or in the streets. Even providing information about the research project to those entering the video recorded place or space (a common practice in video-research) is often impracticable in natural contexts (Aarsand, 2016). Moreover, in most ethnographic investigations, the researcher's level of control can be limited or voluntarily transferred to participants. For instance, the SEBE (Subjective Evidence Based Ethnography) research protocol is based on first-person video recordings;

participants carry out the recordings and researchers are not with them in the field, whilst available remotely (Lahlou et al., 2015). Therefore, it is not possible to know in advance the detailed contents of recordings. Furthermore, as participants can review and download their films before handing them to the researcher in SEBE (precisely to make sure they are happy with the content disclosed), they could potentially share this content to third parties. That is true for most investigations where participants collect data themselves, such as story-telling using cameras (Gubrium & Harper, 2016), video-tours (Demuth & Fatigante, 2012) and self-recording with wearable devices (e.g. Kelly et al., 2013).

Participants' rights: anonymity, confidentiality, data ownership and release

Anonymity and confidentiality are long-established principles in social research practice (Wiles et al., 2010). However, visual material makes anonymisation problematic if not impossible (Clark et al., 2010). Furthermore, some participants might agree or want to have their personal information disclosed. Asking participants to participate in an ethnographic investigation using visual methods is "equivalent to requesting them to share with the world their insight and perspective" (Schembri & Boyle, 2013).

The release of video materials is a sensitive issue: they might expose participants to stigma, discrimination, and other types of harm (Gubrium et al., 2014; Wiles et al., 2008). Particularly important are the considerations around "where, why and by whom" (Gubrium et al., 2014) are visual materials released. No data is confidential per se: we share sensitive data about our health with our doctor, about sexual preferences with our partner, financial details with our banker and so forth (Lahlou, 2008). The context of where and to whom the material is published matters. As new technologies allow to easily capture, review, interpret, and share "too much information" (Mok, Cornish, & Tarr, 2015), the issues of who controls and stores the data, who is the author or owner, who decides what to share and how have become central in visual research (Cox et al., 2014; Heath et al., 2017; Schuck & Kearney, 2006). Often participants agree to share their videos with the research team but refuse publication of identifiable material beyond that trusted community. New technologies and devices (such as smartphones and digital video) mean that participants can have more control over research materials, but it also means that they may easily view, copy and share them (Mok et al., 2015). Additionally, as hinted above, it is difficult for participants to foresee the future implications of the existence of their data and, hence, to give informed consent beforehand (Aarsand, 2016; Wiles, Coffey, Robinson, & Heath, 2012). Failing to appropriately negotiate and acknowledge authorship and ownership of visual data might endanger the integrity of research and the confidence of participants in it. (which impacts their insights, contributions, and future willingness to take part – see Cox et al., 2014)

Additionally, in video research there is the assumption that images are objective and can accurately represent "the reality" (de Laat, 2004), more than text (Schuck & Kearney, 2006). This "myth of film-as-reality" (de Laat, 2004) in research has been questioned: images are cultural constructs, and the same videotape can create in viewers different interpretations of the situation (Liegl & Schindler, 2013; Rieken & Lahlou, 2010).

Prospective solutions for video ethnography methods

The literature reviewed, beyond caveats and interdictions, provides practical advice for ethical visual research. Among these few it is agreed that "research ethics are contested, dynamic and contextual" (Wiles et al., 2008). Therefore, besides considering ethical regulations, it is crucial to understand the concrete situations in which ethics regulations are applied. The adoption of reflexive and collaborative approaches can serve this function (see Cox et al., 2014; Gubrium et al., 2014; Liegl & Schindler, 2013; Rose, 2014; Schembri & Boyle, 2013).

Researcher-researched rapport: situatedness, reflexivity, and collaboration

"Because ethics are so embedded in the specific research contexts in which ethnographers work, like decisions about which visual research methods to employ in a project, ethical decisions cannot be concluded until the researcher is actually in the field" (Pink, 2011b). As a result, a continuous reflexive approach paying attention to what is ethical in the participants, not just in the researchers' culture, is necessary.

Reminding researchers to think about general ethical standards regarding, for instance, privacy, anonymity, and voluntary informed consent is, thus, only the first step to truly ethical research. In a second step, contextual judgement and ongoing consent processes as outlined by Cicourel (1964) should be accommodated for in standard research ethics procedures (e.g. Carroll and Mesman 2018; Mok et al. 2015). Researchers should plan for, and actively manage and mitigate both the physical and psychological risks that visual research creates for participants (Pope et al., 2013; Schembri & Boyle, 2013). Mok and colleagues recommend that an ongoing, participatory exchange with the public around the ethicality or acceptability of novel research methods be put into place (Mok et al., 2015).

Collaborative approaches include both acquiring a deep knowledge of local contexts and their intrinsic power relations (Liegl & Schindler, 2013; Schembri & Boyle, 2013), as well as engaging in critical dialogues with participants about potential risks and harm and how to manage them (Cox et al., 2014; Schembri & Boyle, 2013). This is particularly relevant when working with vulnerable populations such as children (Mudaly, 2015) or exploring illegal activities (Gubrium et al., 2014).

In our view, the efficacy of video ethnography as a research method depends on establishing a relationship of trust between the participant and the researcher (Lahlou, 2006, 2011). It is a necessary condition for participants to disclose their thoughts to the researcher, engage in cooperative observation, and contribute to the interpretation of data (Lahlou et al., 2015). Studies using SEBE , involving different participant cohorts in various settings (e.g. children and families, consumers, office workers, doctors and nurses, drivers, cooks, policemen, nuclear plant operators), consider participants as co-researchers (not "subjects") as they do not only collect the data, but also contribute to data interpretation by commenting on their own video recordings in a face to face interview with the researcher. This Replay-interview (RIW) confronts emic (informants') and etic (researchers') perspectives to find a description that is acceptable to both based on the joint review of the video evidence (Lahlou, 2011). This form of democratic collaboration allows participants (of any age, gender, status) to feel empowered, and researchers to test their hypotheses and interpretations in vivo. While not all protocols include a phase of confronting the participants with the material and its interpretation, we suggest that discussing the (pre) final version of the visual material to be published, and its interpretation, with at least some of the participants is a major ethical safeguard. These con- versations, if done in a pilot, will also inform the researcher on the actual ethical issues in that context, and impact the protocol.

Informed consent as a negotiation process

In most cases researchers face the "impossibility of setting a-priori conditions about what participation will involve and what images might be filmed or photographed" (Wills, Dickinson, Meah, & Short, 2016). There is agreement among ethnographers to consider consent as a process that requires negotiations with participants at different stages of the research. This can be done by negotiating consent prior and following the video recordings, or by opting for an ongoing consent negotiation to monitor whether the research is continuing to develop within the participants' expectations (Flewitt, 2005). This comes with specific consent forms to be handed to participants at different times (video data collection, analysis, presentation, dissemination) (Haeckling, 2013; Wiles et al., 2008).

With children for whom consent from parents is mandatory, different informed consent models have been proposed. One is a two-stage consent: one for data collection (how data are collected, who collects, constraints on ultimate use) and one for the use (who will have access to which data, how, plans for data publication and destruction). The other is a graduated model providing a menu of uses to accept; for instance, viewing by the research team only, restricted sharing among research teams, presentation at professional meetings, full Web distribution (Derry et al., 2010). Informed consent forms can be restrictive or permissive: both bring advantages and disadvantages. Very permissive forms allow for unrestricted use of the videos but can reduce participants' willingness to participate. Conversely, restrictive forms limiting publication and promoting privacy might favour participants' involvement in the study (Derry et al., 2010; Schuck & Kearney, 2006). A compromise which favours sharing appears to be the best solution (Derry et al., 2010).

For children or participants with mental conditions (e.g. dementia), provisional consent can be negotiated with carers and participants (Puurveen, Phinney, Cox, & Purvest, 2015), and revisited constantly during the research process (Robson, 2011). With adolescents (14–16 years), we used both informed assent forms for adolescents' individual recordings and a collective negotiation of informed consent with all family members (parents, adolescents, and siblings or other co-habiting persons) before the recordings and after the discussion of findings which happened in a home visit with the whole family (Everri, 2017, 2018).

Researchers should carefully consider the circumstances and adopt a flexible stance to meet participants' needs and settings' conditions (Wiles et al., 2012). For instance, in emergency medical interventions consent for video recording should be sought afterwards given the circumstances: time pressure and patients' and relatives' mental/emotional conditions might alter their capacities (Gelbart, Barfield, & Watkins, 2009). In psychotherapy sessions, sensitive content can emerge during the video recording; therefore, an iterative negotiation of consent is preferable (Hutchby, O'Reilly, & Parker, 2012).

In addition to obtaining previous consent that specifies the aims of the research, methodological procedures, and data management and dissemination, participants can be encouraged to review, edit, and delete portions of the recordings before the researchers have access to it, as in SEBE (Lahlou et al., 2015). This, together with the collaborative interpretation between participant and researcher, the possibility to withdraw and destroy the data at any time, and the final disclosures about research results, creates in practice several instances of well- informed consent.

Beyond target participants, researchers often need to obtain verbal or written consent by third parties or "the cast" (Lahlou, 2017): family members, co-habitants, friends, colleagues, and so forth who willingly or not appear in the recorded scene. In this context, verbal permission recorded in the video or audio material itself is often an effective solution. In our research projects we asked participants to video record the moment in which permission is sought and given by third parties (Everri, 2017; Lahlou, 2017). While it is preferable to do that before the study commences for reasons discussed in the previous paragraphs, sometimes verbal consent can only be done on the spot – but that does not require recording the name of the cast, who can give anonymous (but recorded) consent. This solves a tricky issue: written informed consents need to be linked to the person on the film for blurring, etc., which unfortunately requires visual identification!

While privacy and anonymity of third parties must be protected and no identifying image should be published without their consent (Kelly et al., 2013; Lahlou et al., 2015), this condition must be balanced with reason and risk: in most cases that does not apply to passers-by in public space, where one expects to be seen in public. For instance, the ethical rules of TV industry about filming (e.g. BBC, 2019) state that consent is not normally obtained from individuals who are incidentally caught on camera as part of the general scene. However, the right of individuals to ask to stop filming because of a concern of privacy is acknowledged unless it is editorially justified to continue.

In summary, informed consent in video research can be considered as a collaborative decision-making process (Banks, 2011) negotiated among the present parties actively involved in the filming or acting as third parties (when asking consent is reasonably possible). It is an unfolding process and should thus be sought or confirmed at different stages of the research.

Acknowledging participants' rights

There seems to be some consensus in the literature about the need to clearly define and agree with participants the rules and procedures for the ownership and release of materials before data collection (Cox et al., 2014; Gubrium et al., 2014; Heath et al., 2017; Mok et al., 2015; Schuck & Kearney, 2006). This includes defining who has rights and access to the data, who can refuse access, for how long and for what purposes the data will be stored, what implications the release of the data might have, how and when it will be anonymised, how copies will be made, and which data will be available to other audiences and how (see Heath et al., 2017). Mok, Cornish, and Tarr (2015) discuss the need to limit the scale and scope of data capture in order to minimize risks and to limit the right of participants to possess and share materials. Schuck and Kearney (2006) recommend constructing multi-media documents and materials to report the research rather than publishing un-critical and un-edited materials. Special care must be taken with digital data that is easy to disseminate. In this vein, there has been an increasing use of data management plans.

As an example, management plans for SEBE video recordings (including automated self-recording) include information about a) the nature, type, approximate duration of data that can be collected, with examples; b) it should be specified that participants can forget they are wearing the device and record unwanted or unflattering images with examples provided (e.g., bathroom visits, online banking). Therefore, they should be clearly reminded to switch off the device or delete these scenes and how; c) participants should remove the device or temporarily pause image capture whenever they wish; d) participants should clearly understand that no individual will be identifiable in any research dis- semination without their consent, therefore participants will have the opportunity to view (and delete if necessary) their images in privacy. e) Additionally, participants need to know that data concerning illegal activities may not be protected by confidentiality and may be passed to law enforcement depending on the national law and nature of the activity. f) Lastly, participants will not get copies of their images, only a team of specially trained researchers will have access to the image data (Kelly et al., 2013; Lahlou, 2011). Nevertheless, in some cases a copy of the data is given to participants as a souvenir, provided they are made aware of the limitations to publication (Everri, 2017).

Our research as well as other studies based on wearable devices for video recording everyday life situations (Kelly et al., 2013; Lahlou, 2011) transfer part of the control over collection (filming) and management (review and deletion) of data to participants; nevertheless, the researchers must guarantee that ethical guidelines for research are followed still (Aarsand, 2016).

Data management plans should provide a set of detailed measures as well as being open to revisions and inclusions of issues that emerge later: such discussions should be accommodated for in the protocol (for example during RIWs in the SEBE protocol). Pilot studies can also serve to test and refine data management plans as well as other aspects that should be included in informed consents (Everri, 2017).

The issue of data ownership can be particularly controversial here. Initially, participants are the owner of the data, who decide to share – by handing the recordings to researchers – their habits, practices, routines, places and spaces. The SEBE protocol empowers participants to exercise their rights of data ownership by allowing them to review and delete their own data, to decide what to share with researchers, and to review researchers' interpretations and comments on the collected material in the Replay-interview. Taken together, these practices acknowledge participants as the real expert. But once the data have been transferred to the researcher, the ethical responsibility is on the researcher.

The "ethical twist" for the future of visual ethnography

This chapter examined the ethical challenges faced by ethnographers when dealing with visual data. Interestingly, one of the most often reported challenges is negotiating with academic research ethics committees. Those tend to be risk averse, especially when they are not familiar with a technique. Anecdotes include ethics committee members rejecting video protocols in fear of children using the equipment to record porno- graphic action, of birthday parties potentially turning into bullying sessions that would be recorded, and so forth. Reality is fortunately less wild than the imagination of some ethics committee members. Experienced ethics committees know that those researchers who made a good risk analysis of their protocol are usually also careful during the research. If necessary, committees should be reminded their role is not just to criticize but also to advise, and discussions should take place. For example, our team's ethical reflections were positively nourished by discussions with the ethics board at the London School of Economics, grounded in a systematic review of potential incidents and risks in 198 films (117.1 hours of video recording) made with the SEBE protocol. The discussion, despite challenging in the initial phases, proved to be an occasion to allow the LSE research ethics committee to review and update research ethics regulations including aspects related to video research brought to their attention.

Therefore, besides discussions with research ethics committees which is the cornerstone of any research ethics process, we believe the "ethical twist" for visual research is to consider those involved as participants in the research rather than subjects of observation, or informers. That "participatory twist" improves the quality of data collected through the trust obtained by transparency and participation. It also helps to solve the complex (and often emergent) issues arising from the disclosure of specific behaviours to other publics, with the informed help of the involved "natives", in the most culturally adapted way.

A risk analysis should be conducted; rather than trying to completely avoid risks, which is futile, it is useful to think of how to prevent them, and then what will be done in the rare case something does happen. Risk can often be dealt with by raised awareness, simple precautions, and quick adapted intervention when issues emerge. In automotive driving, active safety (having good brakes, etc.) is considered paramount, still one doesn't brake continuously. We advise the same on research: stay aware all along and be prepared to address emergent issues.

At a more operational level, while we are aware that fellow researchers would like a tick box list to show their ethics committee, we are convinced that each case is specific, and that tick box lists and templates do not foster the participative, reflexive exercise that we believe is necessary. For this reason, we have opted for the provision of a generic (but comprehensive) guide for each researcher to build their own ethical guidelines, procedures and cases for their ethics committee (see Table 5.1).

The "solutions" summarized in Table 5.1 have emerged from researchers' experiences, negotiations, mistakes and coping strategies. Bear in mind to adapt guidelines to the local context. Our experience taught us participants are the ones who know their field best and can both point to potential issues and assess the validity of solutions. Having a transparent discussion with participants on the actual motives of the research, on how it will be used, and addressing candidly the potential problems are the best way forward, for ethical as well as heuristic reasons.

Table 5.1 Problems and proposed solutions for video research ethics

Problems/ critical issues	*Description*	*Proposed solutions*
Researcher-researched rapport	Video research methods blur researcher-researched boundaries > Power imbalances > Ethical issues on rapport	Before commencing the study: - Apply contextual judgement - Practice reflexivity: consider multiple stakeholders' perspectives - Consider participants as "research collaborators" - Pilot study including some data analysis discussion with participants
Informed consent	Collection of video recordings is rarely pre-defined > Emergence of new data from recordings in the field > Ethical issues on dominant "a priori bio-medical" informed consent protocols	- Negotiate/renew consent at different stages of the research - Involve children and parents in consent negotiations (when children are research participants) - Use video-recorded verbal consent from third-parties (cast)
Participants' rights	Videos challenge participants' privacy > Provide vivid details > Easy to share > Ethical issues on anonymity, confidentiality, ownership, and release of data	Use data management plans: - Details participants' rights and duties - Be open to negotiate to reach a balance between participants' protection and usability of the material for scientific scopes - Make explicit arrangements in the consent forms

C. PAPER 3: SMARTPHONES AT THE WORKPLACE

In this section I present the published version of the second Paper that evolved from this research project, which focuses on the use of smartphones at the workplace. Parts of the literature reviewed in chapter 4 and the qualitative analysis presented in chapter 8 of this thesis have been used in this Paper in adapted form.

This Paper was published on the 29th of May 2020 in the Conference Proceedings of the Asian Conference on Psychological & the Behavioural Sciences (ACP) 2020 under the following reference:

> Heitmayer, Maxi (2020). Smartphones at the Workplace: An in situ Mixed-Method Study on Smartphone Use During Intellectual Work. *The Asian Conference on Psychology & the Behavioral Sciences 2020 Official Conference Proceedings,* 31-50.

I have been awarded an IAFOR Scholarship for this Paper and the related conference presentation I have delivered. The Paper is available under an open access license at: https://papers.iafor.org/submission55826/

I am the sole author of this Paper. I am thankful to Prof. Saadi Lahlou for his helpful comments on the final draft.

Smartphones at the workplace: An in situ mixed-method study of smartphone use during intellectual work

Maxi Heitmayer, Department of Psychological and Behavioural Science, London School of Economics and Political Science, London, United Kingdom

ABSTRACT

Smartphones and other ICTs have become permanent companions in our daily lives, and increased use of these devices has impacted and often changed our daily routines. Users are in constant negotiation and coordination between the online and offline worlds they inhabit, and decisions about how to use their time and attention are becoming increasingly challenging. This has serious implications for tasks that require undivided attention or longer periods of focus, with work perhaps being the most relevant. Particularly intellectual work is susceptible to be affected by these developments, as it makes heavy use of such technologies. This paper presents findings from a mixed-methods study using first-person wearable video cameras. The data set comprises 200 hours of audio-visual and self-confrontation interview footage with 1130 unique smartphone interactions, of which 462 took place while participants were working (N=37 users). Building upon a transdisciplinary body of literature on time-use and human-computer-interaction, we provide new empirical evidence on the perceived disruptiveness of ICTs at the workplace, and the decisions users make on where to direct their attention in real, naturally occurring contexts. We observe that (a) time management relates to a set of self-regulation strategies involving the smartphone that structure work tasks, breaks, and leisure activities, (b) interaction patterns and intervals between instances of smartphone use remain statistically invariant across activities despite users' expressed preferences to use their devices less during work tasks, (c) it is not notifications, but the thought of a potential notification that leads to interruptions, with 89% of smartphone interactions being user-initiated.

KEYWORDS

Video Ethnography, subjective experience, smartphones, workplace, interruptions

Introduction

Constant and ubiquitous access to the Internet afforded by smartphones has changed how people navigate their daily lives, and communicate with others. The immediacy with which smartphones relay messages and information has dramatic effects on the volume of external influences that users need to manage while engaged in virtually any task, be it work or leisure. At the same time, smartphones and other portable devices allow users to work flexibly both on the temporal and spatial dimension. They can thus be an enabling factor for, or a barrier to productivity, with research producing mixed results. Crucially, previous research has generally used either external observations or self-report measures independently, and it has de-contextualised the studied activities. We use Subjective Evidence Based Ethnography (SEBE), to document the individual experience of using the smartphone during work and make sense of these often complex situations (Lahlou et al., 2015). This creates a mixed method, *in situ* account of the lived experiences of users, the challenges they face, and the practical solutions they have developed based on first-person video recordings, in-depth interviews and quantitative analyses from a dataset of over 200 hours of video with 1130 unique smartphone interactions, 541 of which took place during work. We give an ethnographic account grounded in objective observations and subjective user interpretations to show pathways for further steps to improve our understanding of habitual smartphone use. Specifically, we address the questions:

- How do smartphones affect the flow of activities?
- How do users experience smartphones interactions during work?

Previous Research

Smartphone use at work is ultimately a question of time and attention allocation. For employees, it is a decision on work and leisure utility, balancing private and professional demands, and for employers it is a question of productivity and profit. Traditional studies have investigated decision-making related to time from an economic angle (Aguiar et al., 2012; Andorka, 1987; Hill, 1985; Perlow, 1999; Robinson, 1977; Szalai, 1966). For many occupations, and especially for intellectual and creative jobs, reaching a state of “flow”, i.e., full absorption in an activity is crucial (Csikszentmihalyi, 2008, 2012). To reach this state, undivided attention over a longer period of time is necessary. Here, smartphones enter the stage. The smartphone has become a steady companion to 3.5 billion people around the globe (Holst, 2019) and almost every employee in the developed world has access to one (Van Laethem, van Vianen, & Derks, 2018, p. 3). Always within arm's reach, it caters to most of our needs instantaneously. But smartphones afford a constant *over*-supply of information, thus becoming drivers of time stress and complicating reaching flow.

Several studies show an association of *Media-Multitasking*, the use of multiple devices in parallel or in short consecutive turns (Wallis, 2010), with difficulties in focusing on an ongoing task (Baumgartner & Sumter, 2017; Cain & Mitroff, 2011; Ophir et al., 2009; Rosen et al., 2013; M. Shin et al., 2019; Uncapher et al., 2017) and reductions in working and long-term memory (Sanbonmatsu, Strayer, Medeiros-Ward, & Watson, 2013; Uncapher, K. Thieu, & Wagner, 2016; cf. Minear, Brasher, McCurdy, Lewis, & Younggren, 2013). Early work found that "time spent uninterrupted on individual activities was spent in very short blocks of time, sandwiched between interactive activities. Seventy-five percent of the blocks of time spent uninterrupted on individual activities were one hour or less in length, and, of those blocks of time, 60 percent were a half an hour or less in length" (Perlow, 1999, p. 64). This study was published before the widespread use of smartphones, and things have changed dramatically since then.

Studies find that users switch to their phones from work activities every four to six minutes (Rosen et al., 2013; Yan et al., 2012), while the numbers for general use are slightly higher (Van Berkel et al., 2016; Visuri et al., 2017). Experimental work found that half of adolescents and one third of adults stay on their main task for less than two minutes before switching to another media activity (Baumgartner & Sumter, 2017). More generally, due to the reduction in continuous time spent on tasks and an increase in interruptions, the nature of work itself has changed (Yeykelis, Cummings & Reeves, 2014, 2017). Paradoxically, strong media-multitaskers appear to be worse at switching between tasks effectively (Ophir et al., 2009). Finally, dividing one's attention between tasks was related to reduced overall task performance (L. L. Bowman et al., 2010).

Interventions to address media-multitasking have considered three pathways so far, awareness, restriction, and mindfulness, with evidence being inconclusive, particularly for restrictive approaches (Parry & le Roux, 2019). Since most studies also did not control for long-term effects, it is necessary to examine media-multitasking in context before meaningful interventions can be made. This is further underlined by the finding that smartphones are "habit-forming" devices (Oulasvirta et al., 2012) and robust data from large scale studies showing a convergence of fast-paced app launching and switching behaviours among users (Böhmer et al., 2011; D. Ferreira, Goncalves, Kostakos, Barkhuus, & Dey, 2014; Morrison et al., 2018). Given that children and adolescents are particularly susceptible to media-multitasking, future "media generations" (Sun & Zhong, 2020) might need additional support.

These general findings are reproduced in workplace environments. Qualitative studies find that users associate smartphones with increased mobility and flexibility at work, an enhanced capacity to engage with colleagues and clients, as well as reduced uncertainty and fewer mistakes (Li & Lin, 2019; MacCormick et al., 2012). On the downside, this reliance on smartphones can turn into dependence, leading to anxiety, uncontrolled use, and ultimately decreases in productivity (Li & Lin, 2019). Quantitative evidence supports these perceptions, linking smartphone addiction to lowered work-related and non-work-related productivity and finding a negative relationship between total hours spent on the smartphone and total hours worked (Adamczyk & Bailey, 2004; Czerwinski et al., 2000; Duke & Montag, 2017). Another issue is cyberslacking, the personal use of devices at work (Lavoie & Pychyl, 2001; Mills et al., 2001). Cyberslacking becomes particularly problematic when it is triggered by dysphoric states or repetitive, boring tasks (Vitak et al., 2011). Messaging applications are one of the key tension lines between smartphones enhancing work and cyberslacking, with researchers suggesting to separate private and work conversations within individual apps (Y. Jeong et al., 2020).

Smartphone use at work also increases the duration of smartphone use after work and reduces the emotional well-being of users (Cambier et al., 2019; Derks et al., 2014; Duke & Montag, 2017; Van Laethem et al., 2018). As people use their work phones at home or their private phones for work, job pressures can intrude into their private lives (Derks et al., 2014). This, together with the feeling of having to respond to work communication as soon as possible creates *telepressure* (Barber & Santuzzi, 2015). Responses to being constantly connected vary tremendously between, and fluctuate even within individuals (Cambier et al., 2019), making it difficult to recommend straightforward policies. Importantly, telepressure intrudes back into the workplace, increasing smartphone use at work and reducing perceived engagement (Van Laethem et al., 2018). Similarly, *nomophobia*, a feeling of discomfort related to not being reachable and potentially missing out on information when users do not have access to their devices has mixed effects on productivity (King et al., 2013). Workers high in nomophobia perceive themselves as more engaged and productive when they use the phone to enhance their work performance. On the other hand, these users also experience reduced levels of productivity, emotional stress, and exhaustion when they cannot check their device (G. Wang & Suh, 2018). Simply restricting the use of smartphones will, therefore, result in unintended consequences.

Frequent interruptions also cause *disruption* as users need time to return to their previous task and make more errors completing them after having been interrupted (Borst et al., 2015). An early study found that people only return to their previous work task in 40% of cases after an interruption (O'Conaill & Frohlich, 1995). More recently, it was shown that tasks interrupted externally were more likely to be resumed, and resumed faster than the ones users self-interrupted (Mark et al., 2005), with observational research suggesting that users interrupt themselves about as often as they get interrupted (V. M. González & Mark, 2004). External interruptions furthermore significantly increase subsequent self-interruptions in following hours, suggesting that certain environments condition people to self-interrupt (Dabbish et al., 2011). Workers who are constantly interrupted seem to adapt their working style to their experience and one study found that interrupted work was performed faster than uninterrupted work (Mark et al., 2008). However, interrupted workers also experience more stress, time pressure, and effort, as well as a higher workload and frustration (Mark et al., 2008, p. 110). Importantly, workers with high levels of self-control experienced significant costs when blocking software was installed on their devices as interruptions serve as structuring elements and breaks for them (Mark et al., 2018).

The Present Study

Current literature either relies on qualitative and survey data, which is susceptible to *self-report bias* (Andrews, Ellis, Shaw, & Piwek, 2015; Boase & Ling, 2013; Ellis, Davidson, Shaw, & Geyer, 2019), or logging techniques that can are limited to data from the device. This contrasts with the importance context plays for human behaviour. Some researchers have begun to collect visual data to provide empirical evidence of how users interact with their devices in context (B. Brown et al., 2013, 2014, 2015; Licoppe & Figeac, 2013; D. McMillan et al., 2017; Pizza et al., 2016). We propose to take this further with Subjective Evidence-Based Ethnography. The SEBE protocol consists of three phases: First, participants are given unobtrusive, miniature cameras worn at eye-level (*Subcams*) to gather first-person audio-visual material (*Subfilms*). In the *Replay-interview*, participant and researcher watch the Subfilms together and discuss salient moments. Finally, the researcher conducts the analysis and consults participants for feedback on her interpretation to triangulate the results (Lahlou, 2011; Lahlou et al., 2015). As users often misremember their actual behaviour, the use of SEBE provides clarification and enables the researcher to obtain rich data on situated multi-media processes, and interpretations, even if the participant did not notice her behaviour in the moment. The SEBE protocol also upholds the highest ethical standards and participant privacy by design (Everri et al., 2020; Lahlou, 2017).

The experience of time stress is an ailment typical of the young, urban, working population (Hamermesh & Jungmin, 2007). We created a typical case sample for this group with international, but predominantly European participants aged 21-29, mostly living in London, UK (N= 37, 43% female). Participants were asked to wear their Subcams throughout the day doing what they would do normally. Overall, this has generated a data corpus of over 200 hours of video materials. This extraordinarily large and rich data corpus enabled an analysis of situated user behaviour on an unprecedented level.

Results

4.1 Qualitative Analysis

Interviews were transcribed literally and analysed using directed Qualitative Content Analysis to describe emerging themes in a systematic way (Mayring, 2000, 2015; Schreier, 2014). Participants were enthusiastic about the research experience and generally concluded that the material they gathered constituted an accurate and representative depiction of their behaviour, with many of them reporting that they forgot about the camera after wearing it for a short time. The interviews covered a broad range of smartphone activities users engaged in. In this paper, we focus on two key themes that emerged from the analysis: *Managing the use of time* and *Notifications.*

All participants described *managing their use of time* through the phone, both for work and for leisure. Participants use asynchronous conversations through chat to do multiple things at the same time as “full attention is not needed” (P18) and to stall for time while figuring out responses. They also frequently used short phone breaks to plan their schedules, from the bus ride to an appointment, to a night out with friends.

Smartphones were further used to *pass time*, for example while waiting for friends or commuting to “make it feel like time is going faster” (P24). Low levels of engagement in work tasks and other activities that were perceived as non-rewarding like cooking, cleaning, or commuting, led participants to take their phones “looking for something to do with it” (P8). Importantly, almost all participants ‘fidget’ with their phones occasionally. Fidgeting is user-initiated and includes opening and closing apps without an evident purpose and even typing. Most participants could not give a reason for their behaviour beyond stating that it felt natural to regularly check the phone.

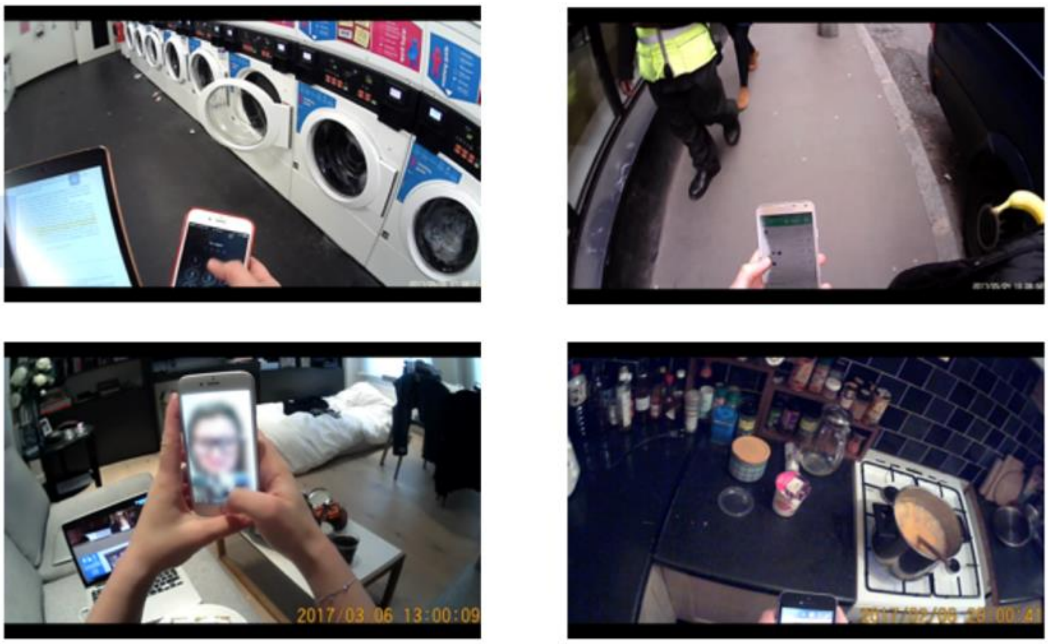


Figure 1: Various instances of smartphone use (clockwise): Tablet and Smartphone while doing laundry, looking up public transport on the go, watching videos and sending selfies during dinner, sharing pictures of food while cooking.

Most participants check all apps and notifications in preparation of putting their phone aside to *settle into work*: “I try to get rid of the messages before I work, so I can focus. Otherwise, it is in the back of my mind” (P7). Similarly, participants described that ‘getting into the flow’ with work depended on their surroundings (“It’s like the atmosphere has changed now. You know, sometimes there’s this ‘ebb and flow’ while working. I also think I was more focused because people before me were working as well”, P4), and the presence of the smartphone (“If I really want to get into the flow, the smartphone needs to be gone”, P5). Though most participants described feeling pressed for time during work, they usually allowed themselves to check their phones as a short break:

> *But my thought process is like I don’t have enough time to take an actual full-time break, I don’t have enough time to go outside or read a book. So, I’ll only allow myself 2 minutes and really it’s the only thing that I can do in that time. It’ll be like I’ve been typing for a while and I can feel my attention dropping and I know if I just stop for like two minutes I can carry on. (P24)*

At the same time, participants acknowledged that their break time could be spent differently, and breaks often become longer than planned:

> *Sometimes that time for easing your mind would be better spent just stretching instead of going on facebook. Because it gets you in a loop. Like, 'I'm gonna be here for five seconds. Oh, but this video is fun. Okay, I'm gonna see just one more video. Okay wait, this video is funny and down here, another video that I wanna see. And I'm gonna see those two videos and then I'll go back to work...' And then five seconds turn into five or ten minutes. (P3)*

Participants also used their phones to *structure the flow activity*. Phones, thus, helped to 'fill in' unproductive spaces between activities:

> *I'm waiting for the machine to do a calculation and I want to use this break time efficiently, so I'm checking maps to figure out how to get to the event tonight. (P28)*

Similarly, participants use the phone to organise their private lives during work to help with nomophobia:

> *I'm gonna send a message to one of the groups and see if someone wants to do something. It's awesome. Because you know, in ten minutes you can make up a plan and enjoy the night. Which would be harder if you don't have your device. (P17)*

But distractions were also welcomed under certain circumstances. Many participants mentioned being more lenient with themselves and 'wanting to be distracted' after completing a task, or when the workday comes to an end ("Mentally, it's like: Oh, it's five! You've worked so much, you can be on the phone", P7). This depended on the type of work participants were doing, and could even carry on into the next day:

> *It depends on how interesting and close to my goals the things I'm doing are. If I finished or delivered something and the day after I'd go to work, I'd be really distracted and would probably use my phone more. Here I was doing an analysis and it was really difficult to distract me. (P19).*

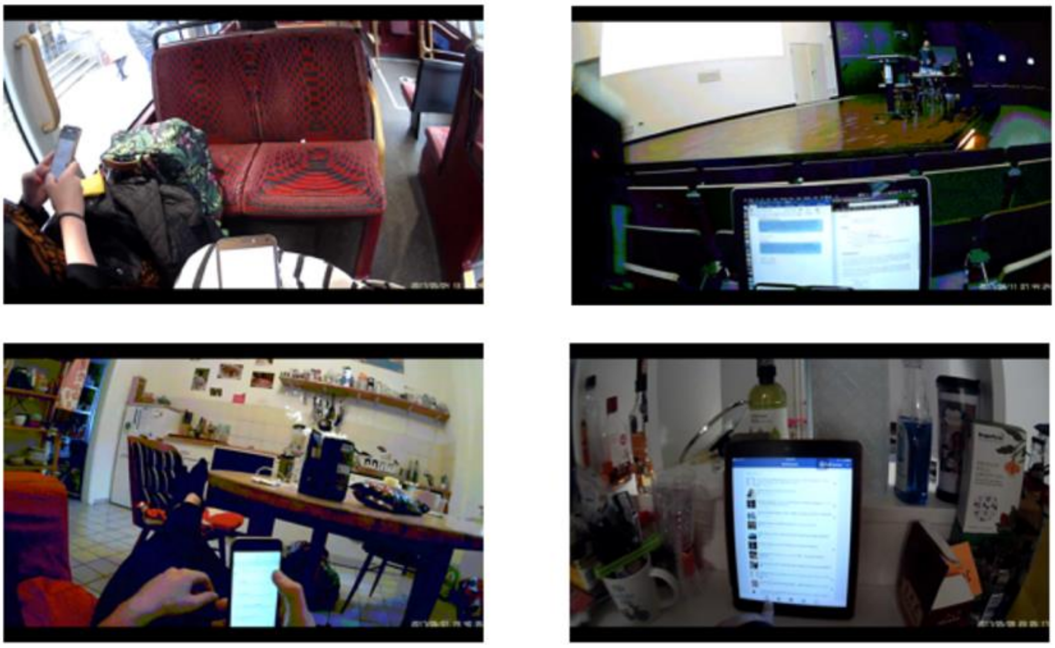


Figure 2: Various habits and routines of ICT use (clockwise): Smartphones during commute, Smartphone hidden behind Laptop during lecture, 'Coming home' with groceries still on the table, Tablet while preparing tea.

Participants also enjoyed being able to briefly distract themselves whenever they want, and suggested that they evaluate these distractions based on the utility they gain:

> *But here I reach out for the phone and social media for a purpose, so it's okay, it's not just a waste of time (P4).*
>
> *I feel like I'm scrolling for a long time, and I haven't found anything interesting. Which means that I have been wasting my time and start feeling guilty. At least I should be getting something interesting, otherwise it's obvious that I am not using my time wisely. (P3)*

The second key theme figuring in the interviews was *notifications*. All participants described varying *preferences for receiving* notifications for different settings. Strategies for achieving the right level of 'distance' include muting the phone, putting it out of reach, or turning off notifications for specific apps, but also harsher measures such as switching off the phone, leaving it at home, wearing earplugs, and even handing over passwords to social media accounts to friends.

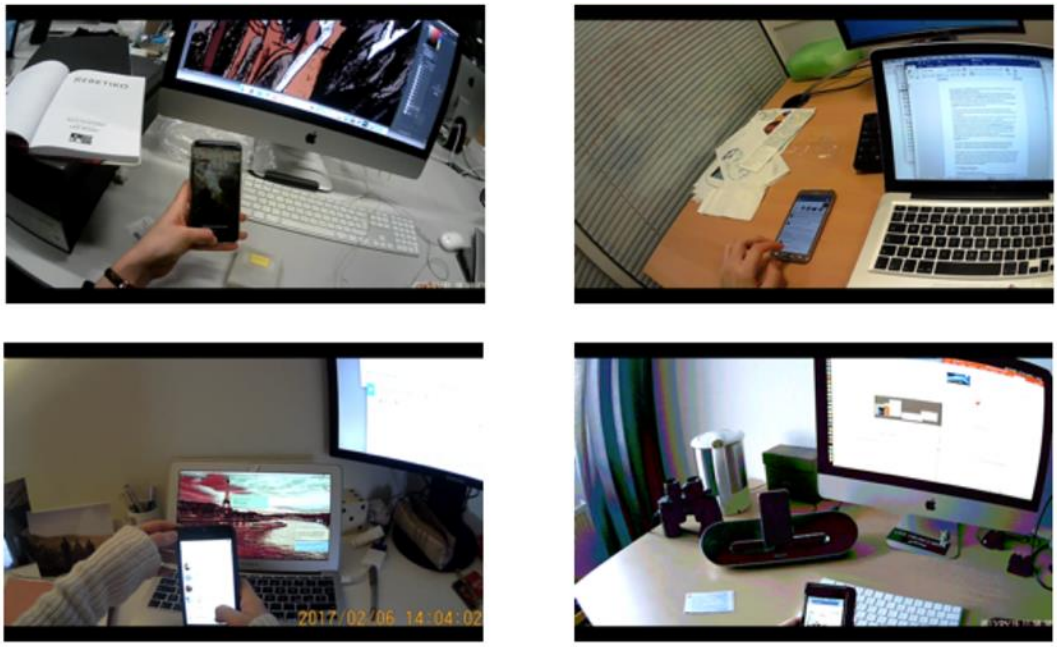


Figure 3: Various instances of smartphones disrupting intellectual work.

> *Actually, that's something important from my housemate. All chats are silenced except for this one. If it's something that I haven't pre-programmed as important then the phone isn't even going to vibrate. (P19)*

Participants also perceived different levels of *urgency to respond,* depending on the nature of the message. Overall, participants agreed that most notifications are unimportant. One frequently mentioned exception to this were notifications connected to coordinating offline activities. Another exception were E-Mails, which were generally regarded as high priority, demanding quick responses and turning other notifications into distractions and nuisance. Particularly client-facing messages demanded immediate responses:

> *I tend to put off my standard deadlines because it's always less urgent than dealing with an annoying client who's breathing down your neck like 'I need it now'. (P11)*

Constantly *being available* was cited as negative for well-being by most participants due to being 'mentally tiring' and spouses, family and friends 'getting mad when you don't answer'. Particularly group chats were characterised as sources of 'information overload' and distress. Notably, for several participants this pressure extended into sleeping hours:

> *No, I never turn it off. Only at night sometimes. But sometimes I get paranoid and think what if something happens back home? I want to be reachable, but I feel I should turn it off more because you don't get that sense of freedom. It's a nice feeling to be unreachable. (P28)*

Finally, notifications were also perceived as *disruptions*. Receiving a notification led participants to almost immediately attend to their phones (see fig. 3). Several participants also reported having a folder for 'disruptive' apps on their phone. Interestingly, some users were aware that their notifications might distract colleagues within earshot:

> *I have my phone on my notebook cuz sometimes it's going to buzz, and I don't want people to hear it, but I also don't want to turn it off completely in case there's something important. It kinda muffles the sound, cuz on the table it goes like "naa, naa" and I get a bit embarrassed. (P11)*

The disruptiveness of smartphones at the workplace became especially evident when other disruptions were present too. When a ringing phone, an incoming Email or talking colleagues interrupted participants, they usually picked up their phones. This was most salient in open-plan offices where ambient noise levels tend to be high ("Ok, too much talking around me. I can't do any work. So, facebook." P12). Adjusting notification settings, thus, was often not sufficient to regulate engagement with a device to the desired level. In fact, most participants were annoyed with how regularly they check their phone for messages. In that context, the phone has been poignantly described as a 'vice' that is pleasurable to indulge in, but needs to be avoided to attain daily goals (P19).

4.2 Quantitative Analysis

After the qualitative analysis we quantitatively coded smartphone use in the Subfilms. For every instance in which participants used their smartphones, we recorded duration, location, type of interaction, and other variables characterising the interaction. Overall, this resulted in a dataset of N=1130 smartphone interactions. We did not observe significant differences in use across age, sex, and education levels. Smartphone interactions lasted 64.4s on average. Note that this

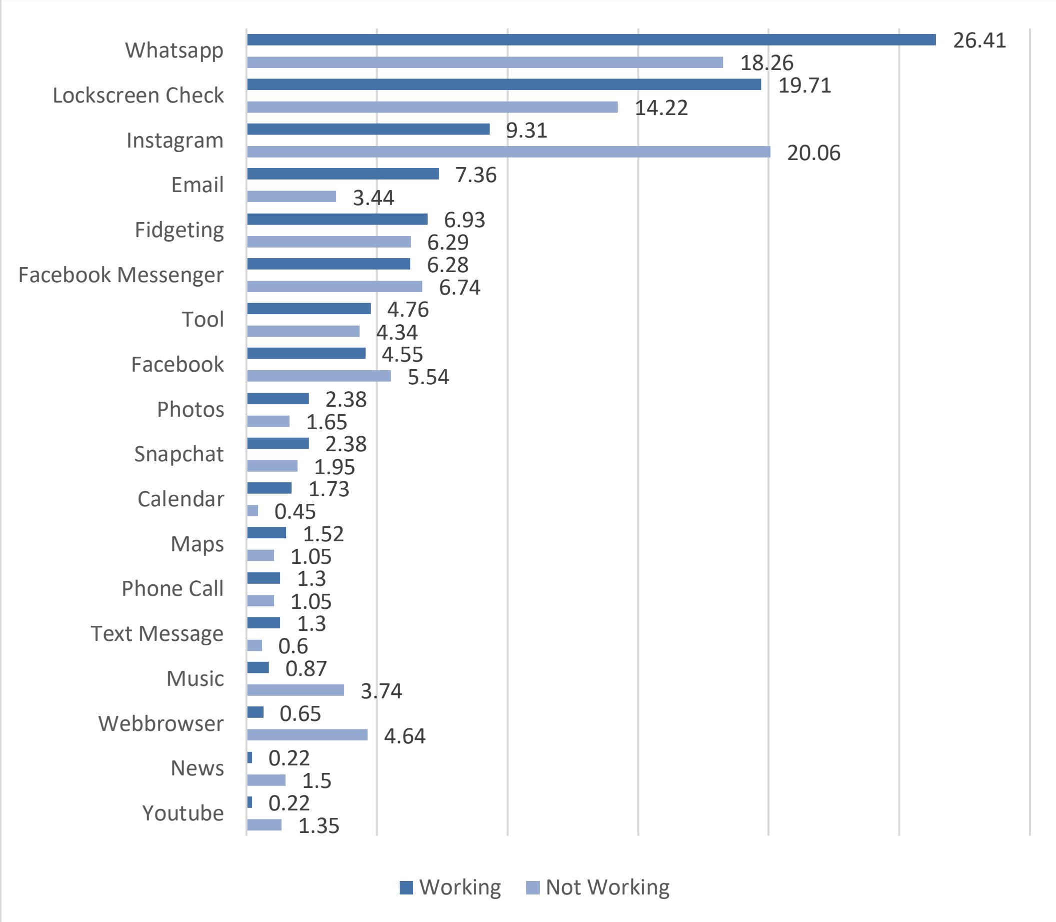


Figure 4. Observed smartphone activity categories by frequency while participants were working vs. not working (Activities with a frequency <1% in both contexts have been excluded).

value is affected by a few longer outlier cases; 25% of interactions lasted 8s, and 50% 23s or less. A similar picture emerged for the time between smartphone interactions, which averaged at 290.5s, with 25% of intervals between use being 40s, and 50% being 137s or less. Based on the averages, our findings indicate that participants interact with their phones for 10 minutes every hour in a 'one minute every five minutes pattern' (note that data collection was limited to waking hours).

The most frequent smartphone activity we observed in our sample was using WhatsApp, a popular messaging app in most of Europe, which represented one quarter of all interactions in working, and one fifth in non-working contexts. The lock screen check, i.e., briefly activating the screen without fully unlocking the phone, Instagram, and Email followed after. Calls, text messages, and maps only made up about 1% each of the sample (see fig. 4). Especially for work contexts, it would be insightful to examine the distribution of tasks across devices (landline, smartphone, computer, etc.) to understand which devices participants use for which activity, and why.

Smartphone usage lasts longer when users were interacting with their phones before, compared to when they come from a different activity (104s vs. 46s, $p < .000$). This confirms the notion that users can get caught in a loop when they engage with their devices more in-depth. Furthermore, while the type of activity participants were engaged in did not significantly influence time between pickups, its influence on the duration of use was highly significant ($p < .000$). Interactions with facebook, Instagram, and the browser, apps conducive to prolonged scrolling, lasted significantly longer than others ($p < .000$, respectively; see fig. 5).

Moreover, interactions initiated by users lasted longer on average than those initiated by devices (67s vs. 43s), suggesting that participants respond to prompts when their phones are calling their attention, but actively engage with them when they pick them up out of their own initiative. While this is aligned with the qualitative analysis, the difference is marginally insignificant in our sample ($p < .095$), making further investigation necessary.

Participants worked at their workplace in roughly half of cases, at home in a third, and at other locations in the rest (see fig. 5). We find that interactions were significantly shorter when participants were working (37s vs 83s; $p < .000$), but we, again, did not find a significant effect for time elapsed between interactions ($p = .201$). We further did not find significant differences when participants worked from home, suggesting that the activity participants are engaged in matters more than the context they are in. We also found that people were alone roughly half of the time, both when they were at work and when they were working, suggesting an even spread of social contexts participants worked in.

Importantly, 89% of smartphone interactions in our sample were initiated by users. There were no significant differences for being at the workplace or in other locations, which is not surprising as most participants keep their phones muted most of the time. However, when participants were working, significantly less interactions were initiated by the phone compared to when they were not working (7% vs 17%, $p < .000$). Given that the intervals between smartphone interactions do not vary between working and non-working contexts, users actually self-

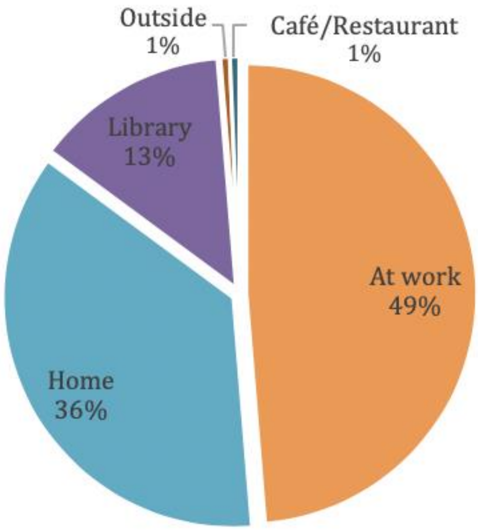


Figure 5. Distribution of observed smartphone interactions while working between different locations.

interrupt more to attend to their phones while working, which is in line with previous research. In situations where notifications were not muted, there was no significant difference in response time across working and non-working activities (p = .078).

Discussion

The analysis revealed the smartphone as the key logistical tool that connects the professional and private lives of participants and helps managing experienced workload by segregating larger tasks into smaller portions. We further observed a strong tension between the desire to engage with smartphones to obtain information and communicate with others, and the desire to focus and avoid frequent distractions. To deal with this tension, participants have developed nuanced habits that help them achieve the desired 'distance' to their devices. Yet, the data shows that contexts are blurry and motivations to engage with or avoid the phone overlap.

The quantitative analysis revealed that phone interactions were shorter, and proportional use of 'time-consuming' apps like Instagram or facebook was lower when participants were working. This suggests a more task-oriented approach to smartphone use while working, compared to a focus on discovery and distraction in non-working contexts. However, the intervals between smartphone interactions remain statistically invariant across every context we observed and tested. Hence, though participants use their phones in a more focused manner while working, they cannot resist the urge to check their phones every five minutes. This urge to interact with the phone in such frequent intervals stands as the central finding of this paper and appears to be both cause and effect of the patterns of smartphone interactions we observed.

Notifications are the key to understanding these patterns, both when they occur, and when they do not. First, they attract the attention of users. Participants have, thus, described various preferences on which, and what type of notifications they allow in different contexts. While, generally speaking, the more demanding the task, the less participants wanted to receive notifications, when tasks became too intense or difficult, participants actually welcomed notifications as means for escapism. Settling into work was usually preceded by dealing with notifications and then switching them off. Switching them back on helped participants transition back into their private lives and often occurred before participants completely stopped working.

We observed that phones were set to silent in most situations and, consequently, that 89% of interactions were initiated by users. With notifications muted, participants checked their phones proactively much more, which is in line with the predictions of telepressure and nomophobia. This draws into question the sentiment of many users that notifications are disrupting them. Rather, the *thought of a potential notification* seems to drive smartphone interactions. Hence, it is not push-based information delivery that causes disruption and needs to be addressed, but user-initiated pull-based information searching. Supporting evidence for this can be found in other studies as well (Banovic et al., 2014; Church et al., 2015).

We further found that natural breakpoints occurring between and within activities are key for understanding when and why participants pick up their phones. Moments like turning a page, switching software, but also drinking or stretching in one's seat routinely led participants to interact with their phones. After a natural break, three types of interactions occurred (lock screen checks, regular interactions, and fidgeting) with the first two being the most common. Participants generally exhibited surprise when they saw themselves fidgeting aimlessly, and were unable to reconstruct what they were doing (typically, fidgeting interactions entailed rapidly opening and closing apps, sometimes before they had fully launched, and swiping around on the touchscreen). A tentative interpretation points to participants' descriptions of phone use as being natural, automatic, and the device being "an extension of the body" (P23). Given that the patterns and triggers of fidgeting appear deeply embodied, cues from natural breakpoints may lead participants to perform these unconscious interactions while their minds remain preoccupied with another activity. Investigating this phenomenon further is important to develop strategies and interventions to help users reduce the frequency in which they interact with their phones. Although it had already been suggested that phone-checking may be more automatic than users believe (Duke & Montag, 2017), the extent to which habitualised smartphone interactions occurred in this study has greatly exceeded what we expected.

Based on our findings, we do not think that limiting the use of devices or certain apps at the workplace will benefit productivity and well-being. Apart from the problem that private and professional are hard to separate sometimes, our findings lead us to believe that people will be more productive if they can quickly check their devices if needed. It is not the nature of the interaction that causes slacking, but the reason why the phone is in the user's hand: When responding to a prompt, both private and professional matters can be dealt with without running a large risk of slacking. Picking up their phone proactively, users are likely to spend more time than intended in work and private contexts alike.

Conclusion

This paper investigated smartphone use with a situated first-person technique, providing empirical evidence on the subjective experience of using a smartphone in working and non-working contexts. Not too long ago, it was argued that "in practice, time must be allocated in large discontinuous ‚lumps', often between ‚packages' of activities" (Perlow, 1999, 114). Since then, the widespread use of smartphones and other devices has drastically changed how users spend their time:

Smartphones now are the key tool participants use to structure the flow of their daily lives and a much larger share of smartphone interactions than expected was habitualised and even occurred without participants taking conscious note.

89% of interactions in our sample were initiated by users, not devices. Strikingly, our participants interacted with their phones roughly every five minutes irrelevant of any external influence. We have thus observed ‘lived’ telepressure and nomophobia on an unprecedented scale. Hence, we believe that limiting the use of smartphones or apps at work will not only not yield the desired results, but also create substantial negative externalities. Rather, it appears that users need to re-learn how to engage with their devices purposefully. Given that participants in our study have developed successful coping strategies that are fine-tuned to their specific use, an exciting avenue for the design of policies and interventions is to build upon these strategies and co-create natural, embodied, and applied interventions with users in the contexts of their workplace.

D. PAPER 4: WHY ARE SMARTPHONES DISRUPTIVE?

In this section I present the published version of the third Paper that evolved from this research project, which focuses on the use of disruptions caused by smartphones. Parts of the literature reviewed in chapter 4 and the qualitative analysis presented in chapter 8 of this thesis have been used in this Paper in adapted form.

This Paper was published online on the 21st of November 2020 in the journal Computers in Human Behavior (IF=5.003), and will be published physically in March 2021 under the following reference:

> Heitmayer, Maxi; Lahlou, Saadi (2021). Why Are Smartphones Disruptive? An Empirical Study of Smartphone Use in Real-Life Contexts. *Computers in Human Behavior,* 116, https://doi.org/10.1016/j.chb.2020.106637.

I am the main and corresponding author of this Paper. My co-author, Saadi Lahlou has contributed to this Paper in the following way:

- Saadi Lahlou helped with the conceptualisation of the qualitative and quantitative analysis of the data.

- Saadi Lahlou provided feedback and edits for the first version of the Paper submitted to the journal and he provided feedback and edits during the revision process.

Why Are Smartphones Disruptive? An Empirical Study of Smartphone Use in Real-Life Contexts

Maxi Heitmayer, Saadi Lahlou, Department of Psychological and Behavioural Science, London School of Economics and Political Science, London, United

ABSTRACT

Notifications are one of the core functionalities of smartphones. Previous research suggests they can be a major disruption to the professional and private lives of users. This paper presents evidence from a mixed-methods study using first-person wearable video cameras, comprising 200 hours of audio-visual first-person, and self-confrontation interview footage with 1130 unique smartphone interactions (N=37 users), to situate and analyse the disruptiveness of notifications in real-world contexts. We show how smartphone interactions are driven by a complex set of routines and habits users develop over time. We furthermore observe that while the duration of interactions varies, the intervals between interactions remain largely invariant across different activity and location contexts, and for being alone or in the company of others. Importantly, we find that 89% of smartphone interactions are initiated by users, not by notifications. Overall this suggests that the disruptiveness of smartphones is rooted within learned user behaviours, not devices.

KEYWORDS

Video analysis; Notifications; Smartphones; Addiction, SEBE

1. Introduction

The smartphone has become a universal tool that permeates society to the degree that its overuse is starting to raise concerns. While on-screen activity is well studied, how screen use inserts itself into off-screen activity is less known. Notifications in particular have received ample attention, as they are often cited as a downside of owning a smartphone and source of distraction by users. The 'buzzing smartphone' or a 'backlog of notifications' have thus become a synonym for time pressure and stress recognized across different societies (Chiu, 2014; Hamermesh & Jungmin, 2007). Quite naturally, notifications have also sparked the interest of researchers working on human computer interaction trying to understand the psychological outcomes for users.

Yet, current research overlooks most off-screen context of smartphone use as it relies only on the phones' sensors, if at all, and it is therefore bound to arrive at inadequate conclusions – and solutions. The relevant questions are: What was the user doing before reaching for the smartphone? What is she doing in parallel, etc.? These questions are impossible to answer with data gathered solely through the phone. To overcome this problem, we conduct an *in vivo* study using Subjective Evidence-Based Ethnography (SEBE) to gather first-person video of actual user behaviour in naturally occurring contexts, have in-depth interviews based on these videos with participants, and subsequently quantitatively check the interpretations arising from the data, resulting in a dataset of over 200 hours of video with 1130 unique smartphone interactions.

We discuss the limitations of current logging and field experiment methodologies for the study of smartphone use and describe the method we used to address some of them; we also illustrate this process with an analysis of how people reach for the screen. We address the questions:

- how users perceive smartphone notifications and how they manage them,
- how and in which circumstances smartphones are disrupting the everyday lives of users.

2. Background

About 20 years after pioneering studies in the field of notifications (Adamczyk & Bailey, 2004; Horvitz, Koch, & Apacible, 2004; McFarlane, 1999; Milewski, 2006) had recognized a beginning transformation in the communicative patterns of society, Fitz and colleagues proclaimed its culmination:

> *Notifications – visual cues, auditory signals, and haptic alerts – are the most ubiquitous feature of the most ubiquitous device on the planet. In less than a decade, receiving a notification has become one of the most commonly occurring human experiences* (Fitz et al., 2019).

While most researchers and users agree that notifications are useful, many studies have shown that the pressure to be 'constantly available' (Frissen, 2000) or the fear of missing out (fomo) (Fitz et al., 2019) can affect well-being and interpersonal relationships (e.g. Höge, 2009; Sbarra, Briskin, & Slatcher, 2019). Notifications have thus been imbued with negative connotations at the colloquial and the pop-cultural level.

At the scientific level, the discussion of notifications has been trifold: It focuses, first, on understanding the perceptions users have of why and how they use smartphones and social media (Baek et al., 2014; Hargittai & Hsieh, 2010; Hargittai & Walejko, 2008; Humphreys, 2012), how this use influences their social life (Baym & Boyd, 2012; Boyd, 2007; Bradner et al., 1999; Ishii, 2006; Schroer, 2014; Turkle, 2015), how they feel about the messages and the number of messages they receive (Lenhart, 2012; Reeves et al., 2008; Walsh et al., 2008), and how notifications affect their daily routines (Arnold, 2003; Bertel, 2013; Frissen, 2000; Hamermesh & Jungmin, 2007; Roxburgh, 2004; Yeykelis et al., 2014, 2018). The consensus found amongst users is that smartphones have a significant impact on their daily lives, demanding large amounts of attention and regularly distracting them from their current tasks (Iqbal & Horvitz, 2010; Kushlev et al., 2016). Importantly, while most users explicitly acknowledge the overall benefits of owning a smartphone, the valence towards it is often quite negative, especially when it comes to its influence on social interactions (Turkle, 2015) and to creating social pressures (Pielot et al., 2014). Overall, the results of these studies have moved research on notifications as a driver of screen abuse and potential addiction up on the agenda

The second focus of the literature is to investigate variations in the perceived and actual 'disruptiveness' of notifications in the field, conditional on various hardware, software, and some environmental factors. Research has found that place is an important mediator of the disruptiveness of notifications (Do et al., 2011; Exler et al., 2016; Oulasvirta et al., 2005; Yuan et al., 2017). Quite logically, it seems that users are happy to be interrupted when they are waiting or idle (e.g. at bus stations or whilst queuing for food), while disruptions in places such as the cinema or the library are not acceptable (Exler et al., 2016). Moreover, when users are in "nomadic contexts", i.e. on the move or in places with a short duration of stay, they are more likely to use their phones for micro-coordination of their schedules or with other people (Do et al., 2011). Studies have further found a positive correlation between the perceived level of disruption and the amount of attention demanded by the activity users are engaged in. Notifications are thus regarded as most disruptive while users are working on, or finishing up tasks, and least disruptive when they are idle (Mehrotra et al., 2016). Research has furthermore found a negative correlation between the perceived importance of a notification and the perceived level of disruption (Beja et al., 2015). This is also reflected in the finding that system messages or messages from subordinates are perceived as most disruptive, whereas messages from friends and family are considered least disruptive, particularly when users are enacting a private rather than a work-related role (C. Anderson et al., 2019; Mehrotra et al., 2016). Moreover, the day and time when notifications are delivered (Morrison et al., 2018; Visuri et al., 2017; Westermann et al., 2016) and the mood users are in (Yuan et al., 2017) seem to play a relevant role for interruptibility as well, with users being more interruptible when they are in an unpleasant mood and response time to notifications being the lowest on Fridays.

Overall, while several 'intuitive' findings emerge from the literature, it is evident that the perceived disruptiveness of notifications, as well as the interruptibility of users is complex and context dependent. Further, neurological research shows that with increasing complexity, media messages quickly occupy a large portion of users' attentional resources (Cudo, Francuz, Augustynowicz, & Stróżak, 2018). Attentional inhibition seems to be the only trait allowing users to prevent disruptive stimuli from entering their working memory, ultimately enabling them to exercise control over the disruptiveness of notifications (Tams, Thatcher, Grover, & Pak, 2015).

The technological solution to smartphone disruptions is for users to turn off or edit their notifications. Yet, while users ask for fine-grained notification settings, there is evidence that they do not actually use them when they are given the opportunity (Westermann, Möller, & Wechsung, 2015), which suggests that self-regulating notification systems might be the way to address this issue. Consequently, the third and largest strand of the literature on notifications focuses on designing and testing different intelligent notification systems that ameliorate the disruptiveness and overall negative effects on attention, productivity, and well-being of users (see Mehrotra & Musolesi, 2017 for an overview). One straightforward solution is to automatically bundle notifications to reduce the volume of disruptions, for which three batches a day seem to be the right balance between staying on top of incoming messages, not eliciting fomo, and not getting interrupted too much (Exler et al., 2017). Similarly, determining appropriate break points in between activities so that notifications don't actually interrupt the user can reduce frustration about incoming messages (Iqbal & Bailey, 2007, 2008; Okoshi, Nozaki, et al., 2016; Okoshi, Tokuda, et al., 2016; Pejovic & Musolesi, 2014; Weber et al., 2017). Another approach is to adapt notifications that users receive to the situation. While a classic study has investigated this idea by adding additional information about the call to the generic 'ring' of the phone (Milewski, 2006), recent applications have employed user preferences and machine learning to automatically detect and silence unwanted calls based on the devices' sensors and usage data (De Russis & Monge Roffarello, 2017; Fisher & Simmons, 2011; Oh et al., 2015; Schulze & Groh, 2014, 2016; J. Smith, Lavygina, Ma, et al., 2014; J. Smith, Lavygina, Russo, et al., 2014).

A third approach tries to develop systems that offer more and different types of notifications or give users entirely new ways of responding to notifications to help them cope with disruptions better. While vibrations and sounds are the easiest to perceive for users (Exler et al., 2017), the binary default choice that most devices afford (e.g. vibration or audible) seems to be appropriate for only 45% of situations; by adding visual or LED flashes, acceptance of notifications increased by 60%

(Lopez-Tovar et al., 2015). It has further been shown that using external devices leveraging the peripheral vision of users results in more accurate and overall less disruptive delivery (L. Jones et al., 2017; K. Kobayashi & Yamada, 2013; Rasmussen et al., 2016). Lastly, giving users more options to respond to notifications than simply ‘opening’ them (Banovic et al., 2014) and different gestures or other haptic interactions (Mayer et al., 2018) can increase engagement with ongoing tasks and make device interactions more efficient.

Interestingly, the bulk of the literature focuses on the moment when the user takes the phone, and on that very action. Focusing on the action seems natural and is reinforced by techniques that gather data from the phone itself, resulting in device-centric research. This strikingly contrasts with the evident fact that context plays a major role in the experience and nature of “interruption”. And thus, while off-screen context is difficult to record, researchers have begun to collect audio-visual data (B. Brown et al., 2013, 2014, 2015; Licoppe & Figeac, 2013; D. McMillan et al., 2017; Pizza et al., 2016) on smartphone usage to provide empirical evidence of what actually happens when users interact with their devices.

Many studies focusing on notifications endorse the assumption that push-based information delivery through notifications has actually superseded the traditional, user-initiated pull-based delivery. Indeed, users complain about notifications. Unfortunately, qualitative methods based purely on user-reports produce inaccurate data for tasks as minute and routinised as smartphone interactions. As we will show below, participant reports have sent researchers on the wrong track; it appears that most smartphone interactions are user-initiated (Banovic et al., 2014; Church et al., 2015). While users feel and think that notifications are disrupting them, and rightfully they are, in the overwhelming majority of cases it is actually the users actively checking their phones, even though they are switched to ‘silent mode’. Consequently, the studies cited above testing various levels and contexts of disruptiveness produce statistically significant results based on counterfactual usage situations by forcing users to have notifications switched on. And research on intelligent notification systems, while creating innovative solutions to make notifications less disruptive, therefore misses the crucial point that the main cause for frequent device interactions, and thus the root of the experienced disruption, does not lie within the devices, but within the users.

3. The present study

In this paper, we propose using SEBE, a video-based, in vivo technique that combines qualitative and quantitative methods and treats participants as contributors, to study the problem of smartphone disruptions (Lahlou, 2011; Lahlou et al., 2015). SEBE is especially valuable for explorative studies aiming to investigate actual user behaviour while it occurs, as it provides rich, contextual user data, and incorporates ‘checks and balances’ that avoid misremembering by participants and misinterpretation by researchers.

The SEBE protocol consists of three phases: First, participants are given unobtrusive, miniature cameras worn at eye-level (Subcams, see fig. 1) to gather first-person audio-visual material (Subfilms). This enables participants to go about their lives naturally, without being disrupted or distracted, while gathering complete data on their daily experiences (first person perspective, wide angle, stereo sound recordings). In the second step, the Replay-interview, participant and researcher watch the Subfilms together and discuss salient moments. Here, participants can explain and reflect on what is happening in the tape, and they can object to interpretations by the researcher and suggest alternatives based on solid data as they relive their experiences. Crucially, these interviews usually unearth things that go unnoticed by participants in the course of the action, because the tapes can be rewound, slowed down, and stopped. Most importantly, reviewing one’s own first-person perspective recording elicits accurate remembrance of actions, intentions, and emotions – similar to re-enactment or an access to episodic memory (Lahlou, 2011; Tulving, 2002). This grounds introspective investigation in all elements of the context of action which are made visible on the video. Finally, the researcher is left with many hours of situated first-person videos and a set of interviews that can be analysed with quantitative and qualitative techniques.

For the study of smartphone use, SEBE is particularly relevant as it allows, unlike stand-alone interviews or any form of logging method, to document the merging and the interaction of the physical and the digital environments users find themselves in, and both their online and offline behaviours in real-time. Based on the first person recordings, the Replay-interview leverages multimodal episodic memory and offers insights into the cognitive and emotional experience of the user

Figure 1. A researcher wearing the Subcam. The camera weighs only 7 grams and can be mounted on a pair of research glasses or the participant's own (here); it has about 3 hours of autonomy with the internal, and several days with an external battery.

behind the behaviour itself (Glăveanu & Lahlou, 2012; Lahlou, 2011, 2017; Lahlou et al., 2015).

4. Data Collection

The SEBE protocol includes stringent ethical guidelines ensuring participants' full control over the data throughout the research process (Everri et al., 2020); the protocol received ethical approval from the London School of Economics and Political Science (08.11.2017). Participants have been asked to wear their Subcams throughout the day, engaging in everyday activities as they would normally, to capture smartphone use in different settings. Participants have been asked to wear their Subcam on at least three consecutive days, collecting at least 5 hours of video material. Data collection took place in the UK, France, and Germany with the majority of participants residing in the Greater London area. This generated an international but predominantly European sample of N=37 participants. The age of participants ranged from 21 to 29 years with 43% being female. Participants have furthermore been instructed to only wear the camera in situations in which they felt comfortable and could forget about wearing it. Allowing participants to self-select when to wear the Subcam results in more natural behaviours, while also protecting their privacy. As part of the protocol, participants are regularly reminded they can delete data if they feel they have recorded something undesired. No participant used this opportunity. This has generated a data corpus spanning a breadth of activities and locations like commuting, working in the office, attending lectures at university, spending time with friends and family, and relaxing at home. Throughout the sample we find a rather even spread of Subfilms recorded at home, work, and outside. Overall, the data corpus comprises over 200 hours of video material.

5. Findings

We first present a qualitative analysis based on the Replay-interviews where participants comment on their actions, intentions, and emotions as they review their own recordings. This phase informed the systematic coding of interactions with the smartphone, which is then analysed in the quantitative analysis that follows.

5.1 Qualitative analysis

The Replay-interviews have been video-recorded, transcribed literally and analysed using directed Qualitative Content Analysis (QCA) to describe emerging themes and ideas in a systematic and coherent way (Mayring, 2000, 2015; Schreier, 2014). All participants judged that the Subfilm material they had gathered constituted an accurate and representative depiction of their behaviour, with many of them reporting that after wearing the camera for a short time, they were not conscious of it anymore (“Did you see that? I wouldn’t have thrown around the plastic bottle like this if I was thinking about the cam”; P5). However, while the camera weights 7 grams and is easily forgotten, some participants who do not wear glasses reported that they were conscious about the device at times (“The embodied way of the glasses is hard to miss”; P4). This did not, according to them, change their behaviour.

Participants turned out to be enthusiastic about the SEBE-technique. When prompted in the Replay-interviews, they reported that they enjoyed being able to re-live their experiences, and that they observed behaviours they had not been aware of before. Several participants subsequently recruited other participants for the study. The interviews covered a broad range of smartphone activities in which users engaged on tape. The qualitative analysis of this rich and diverse material yielded six major themes with two to four subthemes, respectively. Within the limited scope of this paper, we focus on the three most pertinent to the experience of disruption, that is, why participants *pick up their phones*, their *preferences for and responses to receiving notifications*, and the *usage habits and strategies* they have developed.

5.1.1 Picking up the phone

First, when asked about why they picked up their phones, participants usually reported it feeling natural or automatic, and even unconscious "like when you cough and put your hand over your mouth" (P24). Moreover, participants often exhibited genuine surprise at the intensity of their use:

> *I wouldn't consider myself someone who isn't attached to their phone much. But seeing this has made me realise that I don't even remember picking it up- I think I use it a lot more than I let myself believe. It's really interesting for me to see how much I use it and how much I rely on it.* (P27)

In another striking example one participant spent about an hour cooking dinner and then turned to her phone as soon as she had plated the food. After fifteen minutes of the food getting cold and not having eaten, she exclaimed in the Replay-interview: "I just don't get it, even though I'm so hungry I'm still on my phone" (P1). Participants also reported how frustration or boredom with the ongoing activity led their minds to 'drift off', and to eventually pick up the phone or switch to their social media. This commonly applies to unenjoyable work tasks but also to other activities that were perceived as non-rewarding, like cooking, cleaning, or commuting.

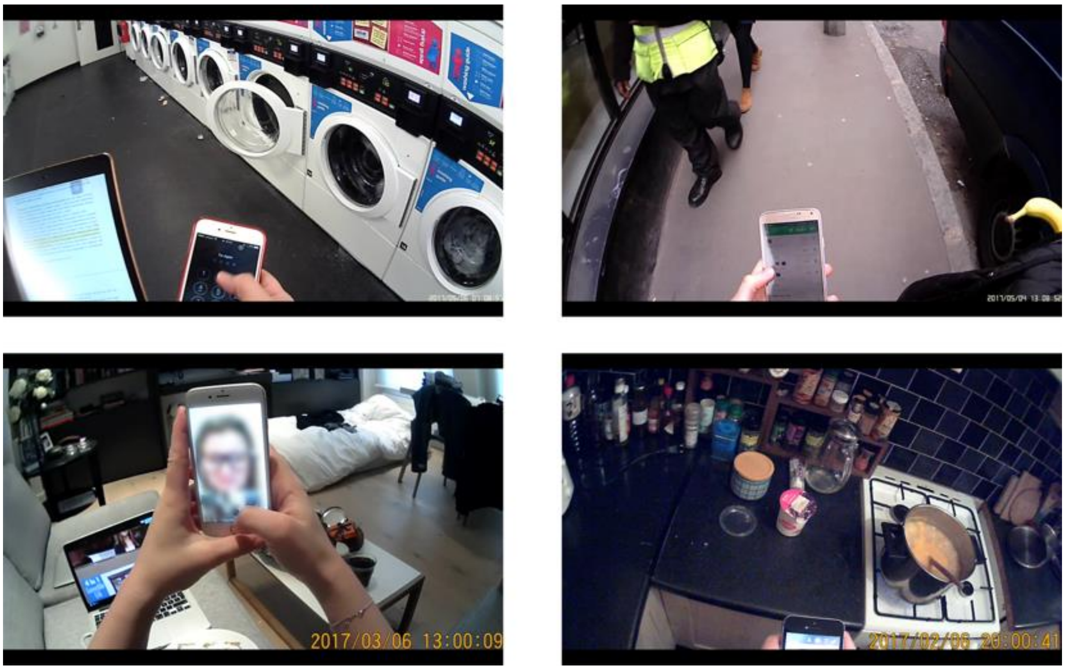


Figure 2. Various instances of smartphone use (clockwise) extracted from Subcam recordings: Tablet and Smartphone while doing laundry, looking up public transport on the go, watching videos and sending selfies during dinner, looking up recipe while cooking.

Second, engagement with one social media platform usually triggered a chain of subsequent engagements with other platforms, characterised as getting caught in a loop, which lead many participants to spend more time on the phone than they wanted as social media suggests new options to them: “And I tell myself those lies. You know, like ‘I’m gonna finish this video and then I’m going back to work’. But then I keep scrolling like ‘No, just one more video’ (P3). On one hand, this can be attributed to a ‘lingering’ loop pattern that entails participants cycling through apps, and different functions (e.g. Instagram feed and Instagram stories) after finishing an activity on the phone, even though there are evidently no new notifications.

> *It happens often when I’ve just been on my phone. I wasn’t just using it to procrastinate, I was actually using it to do something that was useful. But then, it’s just something that there’s like feedback loop, you know, and you have to...* (P12)

On the other hand, most participants had routine orders in which they accessed their social media apps. In combination with automatic pick-ups, this induces participants to go about their routines while they figure out why they picked up their phones in the first place:

> *Here I actually check the time and then go about my routine. So, WhatsApp, Email, the important things, and then faffing. Probably wanted to check the weather or something like this and I usually go on Instagram or facebook. I pick it up for something, then I forget what I wanted to do and check all the things, my routine, and then I remember, ah yeah, I wanted to check the weather.* (P19)

A third, striking finding is that almost all participants pick up the phone, unlock, play around with them and put them back without doing anything in particular (‘fidgeting’). This often also includes opening and closing apps without an evident purpose and even typing. Fidgeting is user-initiated and happens without any prompt from the smartphone. Most participants could not give a reason for their behaviour beyond stating that it felt natural to regularly check the phone. A few participants also reported that fidgeting with apps on the touchscreen felt relaxing or therapeutic.

Overall, picking up the phone seems to be widely automatic and habitualised, with participants often ending up with their phone in hand without intending to do so, or longer than they had originally intended. In this context, all but two of our participants mentioned that they felt they spent too much time on their phones.

5.1.2 Notifications

When talking about notifications, participants often mentioned the social pressure of constantly being available as having a negative impact on their well-being. Apart from it being “mentally tiring” (P19), participants specifically highlighted others getting mad at them for not responding promptly:

> *Realistically how long is it going to take you? I’m never in a situation where I just can’t answer my phone you know? There’s this expectation that you’re going to be on your phone. People literally say to me: ‘Why didn’t you text me back because I know you had your phone on you?’. And I just say: ‘Yeah, you’re right, I probably could have to be honest. I just chose not to for once, you know.’* (P21)

As a qualification to this, though, most participants did describe different levels of perceived urgency to respond, depending on the nature of the message and who sent it. Notifications connected to managing schedules and offline activities emerged as the highest priority.

> *Things that require immediate responses are, I don't know. It's 12:45, I have a lunch date for 1pm and I get a notification: 'I need ten more minutes'. Then I'd write: 'Yeah sure, no problem.'* (P25)

Similarly, Emails and other work-related notifications were, generally regarded as high priority, not only demanding a quick response, but also turning other notifications into distractions and nuisance. In contrast, even though participants generally agreed that group chats were a source of distress and most messages in them rather unimportant, longer absence from a conversation was cited as a reason to respond: "So, it's because there have been a few messages and I have been silent for a while" (P4). Linking this to the previously discussed pressure of being available, while there seem to be notifications that are more urgent in nature than others, social pressure appears to drive perceived urgency of notifications as well.

Most importantly, all participants characterised notifications as disruptions. In the Subfilm material, receiving a notification nearly always led the participants to immediately interrupt their current activities and attend to their phones. In our discussions, participants took an almost fatalistic view on interactions with their smartphones:

> *Usually I just have my phone on the table and I won't look at it. Hopefully nobody messages me but if they do then I will.* (P26)

> *I try and put it a bit away but obviously if a message pops up then I want to answer right away. Not that I always do but I want to.* (P36)

> *I just feel like anytime someone messages me it just sets off a stream of 'oh I can do this, this and that' you know? It's not ideal, which is why I'll let my phone die or put it in a different room because I feel like once you pick your phone up you've got one notification then you have ten of them.* (P21)

In sum, participants appear to be caught in a double bind where having the phone in a place or setting that makes notifications noticeable to the sense renders it impossible not to engage with them immediately, and when notifications are not noticeable social pressure and a backlog of things to deal with accumulate. As one participant poignantly put:

> *A lot of the apps that I have on there, I've switched off the notifications. Which means that I'm not hassled as much. But I find myself checking more regularly to see whether something's come up.* (P29)

5.1.3 Usage habits & strategies

To manage the intellectual tension between the different demands and desires around engaging or disengaging with the phone, participants have developed a nuanced mixture of intentional strategies and unintentional habits that have developed over time.

All participants cited avoidance strategies that helped them to not attend to their phone. These can be broadly categorised as either 'software' and 'hardware' approaches. Software strategies focused on adjusting the phone's settings to specific situations. Usually, this entailed having multiple sets of notification settings for specific contexts. Most participants differentiated between work-settings, in which the phone should not make lights or noises, and leisure settings, in which it could. The exact settings varied greatly between participants with all three common forms of notifications (tactile, visual, audible) being described as either the least or the most disruptive by some. A more drastic approach entailed handing over the password to social media accounts to a friend to control the access.

Hardware strategies were aimed to alter the physical connection participants had with their phones. These include moderate approaches such as turning the phone upside down or putting it out of immediate reach, but also harsher measures such as switching off the phone, hiding it under a pillow, wearing earplugs to not hear the phone, and even leaving it at home when going to work or university. Most of these strategies, again, exhibited a fatalistic view on smartphone interactions and ultimately sought to address a perceived lack of self-control on the side of the participants. As one of them described:

> *I use my phone a lot yeah, but I try to plan in advance to avoid hurdles. If I just go ahead with my day it's difficult to control myself but if I plan in advance then; you silence the chats or a particular one.* (P19)

Moreover, social aspects were described as drivers of avoidance strategies, both for work and leisure contexts. At work, participants said that they wanted to appear focused and hard-working, and that it "would be embarrassing when the phone went off in a meeting, etc." (P6). Especially with regard to newspapers and other non-social media apps, some participants mentioned that they want to receive the information contained in the notifications, but that they did not need it immediately. For leisure contexts, most participants described people who used their smartphones during social occasions as annoying and conversations in which people were on their phones as 'slightly lacking', since people got absorbed in their smartphones: "I would say that when I see something that actually matters online and I need to concentrate, some of my responses are... just fillers" (P27). Hence, several participants also saw this as an opportunity for impression management or to set a positive example: "It's like, the way I want to be seen by others and I want to control that, I don't want to be seen in a different way. I want to be this guy who pays attention" (P18).

On the other hand, participants also reported engagement strategies that enabled them to interact with their phones when they wanted and, at times, while carrying out other tasks. Reflecting the dilemma of having to check the phone and wanting to focus on other things, most participants exploited natural breakpoints between activities and actively created short mental breaks in order to 'engage to not engage'. Participants thus used the phone when they knew their computers were loading for some time, while they were waiting for water for a tea to boil or when they were walking from one place to another. Participants also used their phones to fill gaps in between activities: "There's no notifications on my phone. I'm just going on it because I'm awkwardly standing in line" (P27).

Figure 3. Various routines of smartphone use (clockwise): Smartphones during commute, answering messages during 'mental break', lock screen check after turning the page, 'Coming home' with groceries still on the table.

Several participants furthermore described that they check all apps and notifications and reply to all unanswered messages in preparation of putting the phone aside for another task: "I try to get rid of the messages before I work, so I can focus. Otherwise, it is in the back of my mind" (P7). At the same time, particularly when their current task was either very stressful or dull, participants allowed themselves to check the phone to give their minds a little break, and as an excuse to take time off working. Finally, several participants stated that they sometimes leave the phone face up on the table when they want to be distracted, to 'take their mind off things', or 'slowly fade out work in the evening':

> *It's something to look forward to when I open Instagram or facebook. When I have my phone in my hand I know that I have access to that now. I feel like I'm obliged to look through some kind of social media. I don't know how it is for other people, but it is something that I've ingrained in myself.* (P24)

We also found specific routines that pertained to going to bed or waking up. In this context, smartphones and social media were described as a tool that helped participants to wake up ("a light that wakes up your eyes"; P17) and to fall asleep. At the same time, participants also switched off the phone or even left it in another room for the night to prevent themselves from going on it ("Otherwise, I'm always reaching over when I can't sleep or whatever"; P37).

A particularly interesting finding was that one participant would go to the bathroom if he had to respond to a message while in company:

> *It's going to sound weird but what I do is, I go to the bathroom. Because that's socially acceptable. Sometimes I also use it but often I just go there and reply to messages for 5 minutes. I'm not rude in front of people as I'm using the toilet, but I'm not.* (P18)

Once more, this highlights the dilemma of social expectations around smartphone use. On one hand, the physically present people expect him to not use his phone, on the other, those who are not expect him to check his notifications.

At the end of the interviews we asked participants whether they had noticed anything in their behaviour they weren't aware of before if this had not arisen naturally from the conversation already. Generally, the answers to this question were mixed, with some participants stating they thought they use the phone less than what appeared on recording (usually paired with negative valence), and some saying they saw what they expected (usually with neutral valence). The majority of participants, however, were surprised at the frequency with which they checked the phone, and the automaticity with which this occurred:

> *It's just this automatic thing. I don't remember getting my phone out. When I see that moment, I don't remember doing that [...] I feel as if to feel normal I have to have my phone next to me and I'm surprised that I keep checking it.* (P28)

As a methodological side note, this lack of awareness by the users of their own automatic behaviour illustrates and emphasizes our caveats in the introduction about excessive reliance on user reports to understand the use of smartphones. While we expected some differences between behaviour and awareness, we (and our participants) were struck by their amplitude. The quantitative section that follows will illustrate this further.

5.2 Quantitative Analysis

After analysing the interviews, the Subfilms were coded quantitatively. Every time participants used their smartphones on tape, we recorded duration, time elapsed since last phone interaction, location, type of interaction, the context they were in (e.g. working at the office, commuting), whether there was a notification (and if so, what type) and the nature of the activity. When users switched between apps or functionalities within one continuous session of using the phone, we coded this as multiple interactions.[9] Overall, this resulted in a dataset of N=1,130 smartphone interactions. We did not find any significant differences in use for sex, age, or education.

Smartphone interactions lasted 64.4s on average. Note that this value is affected by several substantially longer phone sessions caught on tape; 25% of interactions lasted 8s, and 50% 23s or less. The same picture emerged for the time elapsed between smartphone interactions, which averaged at 290.5s, with 25% of intervals between use being 40s, and 50% being 137s or less. Using these averages, our findings purport that participants engage with their phones for 10 minutes every hour in a ‘one minute every five minutes’ pattern. The most frequent smartphone activity we observed in our sample was using WhatsApp, a popular messaging app in most of Europe, followed by the lock screen check, i.e., briefly activating the phone screen without unlocking all of the phone’s functionalities, and Instagram. Phone calls, text messages, and maps only made up about 1% each of the total sample (see fig. 4).

We then ran several ANOVAs to investigate some of the issues that emerged from the interviews. We find that smartphone interactions last longer when users were interacting with their phones before, compared to when they come from a non-smartphone activity (104s vs. 46s; ($\beta = 58.71$, $SD = 9.36$, $p < .000$). This confirms the idea that users can get caught in a loop when they engage with their smartphones for longer sessions that include multiple apps. Furthermore, while the type of activity participants were engaged in did not significantly influence time between

[9] Unfortunately, the Subfilms for three participants were corrupted in the transfer process after the interview, resulting in an N = 34 for the quantitative analyses.

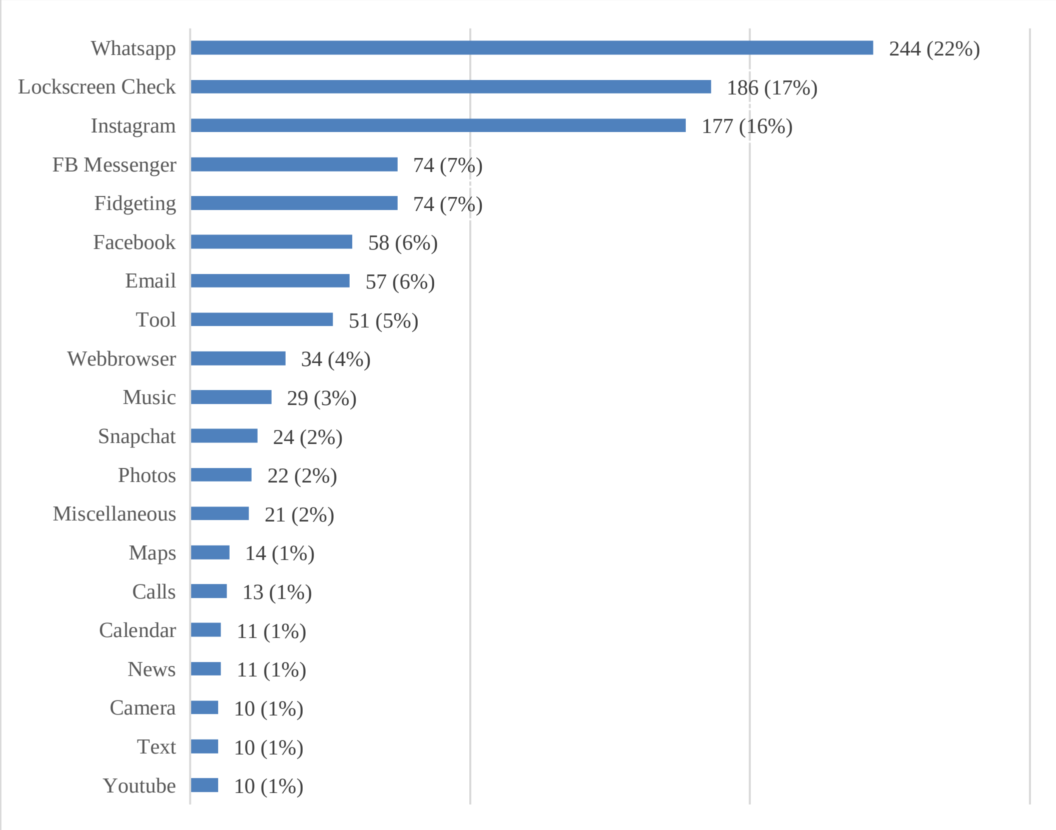


Figure 4. Observed smartphone activity categories by frequency (Activities with a frequency <1% have been excluded).

pickups, its influence on the duration of the smartphone interaction was highly significant. For example, interactions with facebook (β= 113.74, *SD* = 19.73, *p* < 0.000), Instagram (β = 63.11, *SD* = 12.01, *p* < .000) as well as the phone's web browser (β = 199.15, *SD* = 25.17, *p* < .000) lasted significantly longer than others activities. These apps are prime examples for the endless scrolling and getting caught in the loop described by participants. Note that while the ANOVA is relatively robust, due to the nature of user behaviour the data is skewed and the Bartlett's/ Brown-Forsythe tests were significant, which warrants further investigation of this finding with a larger dataset.

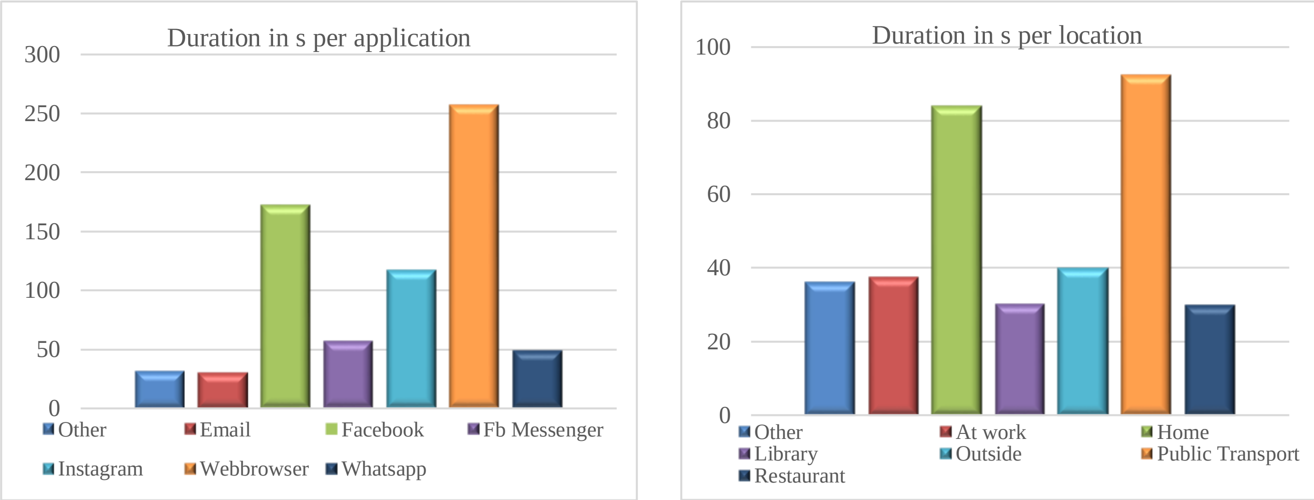


Figure 5. Mean duration of smartphone interaction in s per application and location.

Our results also indicate that phone interactions last longer when users are alone as compared to being in company (β = 22.46, *SD* = 8.84, *p* = .011). Interestingly, the effect on time elapsed since last pick up is only marginally significant (β = -58.68, *SD* = 29.94, *p* = .05). This suggests that the overall notion that being on the phone is considered rude or undesirable when one is in company leads participants to spend less time on the phone, yet they still seem to feel the need to regularly check it. Moreover, we find that the location users are in significantly influences the duration of smartphone interactions ($F(10, 1118) = 3.2$, $p < .000$, see fig. 5), but not the time elapsed between interactions ($F(10, 616) = 1.46$, $p = .151$). Unsurprisingly, testing specifically for home and work, we find that phone interactions last longer when users are at home (β = 42.53, *SD* = 8.77, $p < .000$) and shorter when they are at work (β = -36.02, *SD* = 10.29, *p* = .005), but even in these specific comparisons, we did not find a significant effect for time elapsed between interactions (*p* = .189 and .065 respectively).We further controlled for instances in which participants worked from home; they spent less time on their phones, as compared to other activity contexts at home (β = -59.05, *SD* = 16.94, *p* = .001), which suggests that the activity seems to matter more than the activity context. Overall, this again suggests that, while participants seem to engage in longer phone sessions in the comfort of their home and shorter sessions while at work, the intervals in which they check the phone are not affected by their location.

Most importantly, however, we observed that participants had their phones on silent mode or located out of noticeable distance in the vast majority of cases as 89% of interactions were user-initiated. Of the 11% of the interactions that were initiated by a notification, 59% were visual only, as compared to sound, vibration or a combination of these. In contrast, every sixth smartphone interaction in our sample was a lock screen check. These lasted 5.2s on average and entailed either returning to the previous activity or fidgeting with the phone briefly when no new notifications were available, or reading or skimming through notifications in case there were any. Again, only 15.6% of these brief checks were initiated through notifications, with 63% of them being visual only. This evidence corroborates participants' statements about regularly checking the phone out of habit, rather than being triggered by external stimuli.

We then controlled for differences between participants and the effect of differentiating between single interactions and sessions. Looking at individual participants we observe relatively homogenous usage patterns in our sample that lead us to believe the general findings adequately depict individual experiences (see fig. 6). For duration of interaction, roughly half of participants ranged between 20 and 30s, the other half between 40 and 85s with five outlier cases over 120s on the high end. While it is difficult to directly compare individual cases because of the unique composition of situations participants have recorded, one initial pointer for the source of these differences may be that the participants with significantly higher average durations recorded much more interactions that took place in public transport or at home (between 83% and 100% compared to 54% on average in the sample) than the rest of the sample, which we have found to be locations that are conducive to longer use. For time since last interaction a similar picture emerges with half of the individual means ranging between 165s and 250s, and the other half between 250s and 400s with four outliers at the high end again. Just as in our previous analyses, we did not observe any systematic variation from other participants in activities participants engaged in or locations they were in that can explain these outliers. It appears, again, that intervals between smartphone interactions depend on habits and internal motivations, not external influences.

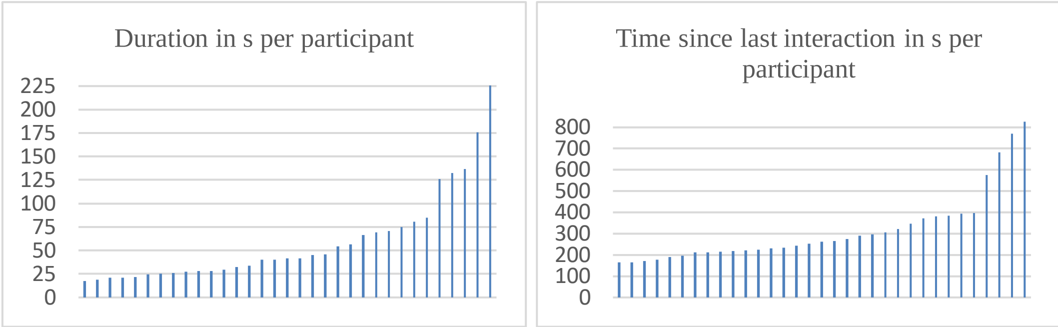


Figure 6. Mean duration of smartphone interaction and mean time since last smartphone interaction in s per participant.

Lastly, we controlled for the effect of treating full smartphone sessions that consisted of multiple interactions (e.g. different apps), as one unit of analysis, finding that the results remain the same. Out of 774 sessions, the majority consists of just 1 interaction (78%), with about 12% of sessions comprising of 2 interactions, 6% of 3, and only 4% of 4 or more interactions. The frequency distribution for the number of activities per session remains the same regardless whether the interaction was initiated by a notification or the users, again emphasizing the importance of routinised behavioural patterns and an acquired ‘drive for the screen’ for smartphone interactions.

The mean duration of sessions is unsurprisingly longer than that of individual interactions (94s vs 64s). Interestingly however, the mean duration for sessions and for single interactions is almost exactly the same when notifications arrive, and significantly shorter than either of the overall means (43s). Finally, just like individual interactions, about 11% of the full sessions were initiated by notifications, the rest by users (see fig. 7).

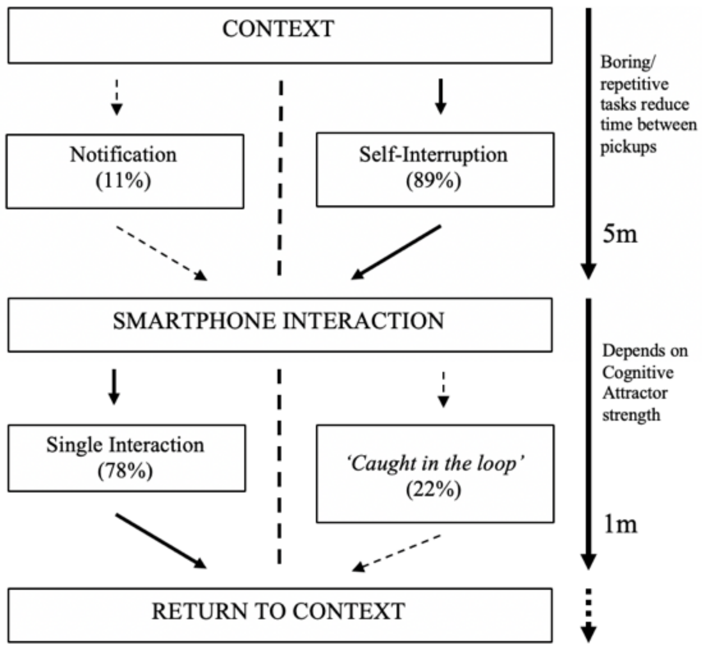


Figure 7.Process diagram for smartphone interactions.

6. Discussion

Smartphones afford a large variety of activities to their users in numerous contexts. Through the use of SEBE, we have been able to gain some unique insights into our participants' daily lives with their smartphones, and their subjective user experiences. We have furthermore been able to triangulate our findings, verifying researcher interpretations against participant comments, and participant comments against empirical observations.

Notifications, while being seen as important for managing urgent work and 'life admin' tasks, mostly emerge as disruptions and sources of social pressure, both when they are noticed by the senses and when participants actively check their phones for updates. It appeared almost impossible for participants to not immediately interrupt their current activities and attend to their phones when they noticed a new notification with their senses. They therefore often switched off notifications or limited access to the phone. In these situations, however, participants reported the social pressure of being available and the worry of missing something important as becoming increasingly more pressing as time elapsed, ultimately leading them to check their phones ("I think we're constantly conscious of thinking that someone might have sent a message"; P29). Most participants consequently appear to have adopted the fatalistic view that their phone disrupting the flow of other activities one way or another just cannot be avoided.

Our quantitative findings show that participants prefer to restrict the access to their phones or mute them: We find that only about 11% of smartphone interactions in our sample were triggered by participants actually perceiving a notification with their senses. Thus, in the large majority of cases it is users pulling information from the phone rather than smartphones pushing it onto them, which is in line with previous findings (Banovic et al., 2014; Visuri et al., 2017). Hence, our quantitative analysis suggests that participants have acquired a habit of reaching for the screen about every five minutes.

The qualitative data gives three accounts for this: One, participants use their smartphones to structure their schedule and interweave other activities with short smartphone breaks. Two, participants are subject to social and professional pressure to check for potential new information. Three, using the phone as a ‘one-stop shop’, both for staying on top of things and for escapism seems to direct automatic and unconscious fidgeting behaviours towards the phone rather than other devices or objects. These behavioural patterns have become deeply internalised, automatic, and mutually reinforcing; it will require substantial behavioural change for participants if they wish to engage with their smartphones less, and particularly less frequently.

Taken together, these findings show that research trying to manipulate hardware factors to make *notifications* less disruptive is not aiming at the right target. Specifically, it overlooks that while users report that they consider notifications disruptive – and the ones they do receive are disruptive indeed – they have found their own coping mechanisms which usually entail silencing the phone and regularly checking for notifications, which makes up the majority of smartphone interactions. Yet, even with their devices silenced, users felt that their phones were disrupting them; it is, thus, evident that the problem is not caused by external disruptions by the device such as sounds or vibrations, but by habitual, internal *self-disruptions*. Interestingly, as we saw, users are dissatisfied with realizing how frequently and unintentionally these self-disruptions occur and often attribute this behaviour to the mere presence of the phone:

> *I didn't think I checked the phone then but I do have it out. I think it's an automatic… like when you have a cough and you put your hand to your mouth - it's something like that. When I see that moment, I don't remember getting my phone out. [...] I feel as if to feel normal I have to have my phone next to me and I'm surprised that I keep checking and I'm just surprised by the amount of time I'm spending on my phone. This has been helpful to me because a lot of times I don't realise how much I'm checking my phone and it makes me question it. (P24)*

Another understanding of the disruptiveness of smartphones participants highlighted is getting caught in the loop. Many users seem to find it difficult to only use their phones briefly, and to only do what they originally intended to do with it. Moreover, certain apps that feature a 'feed' that allows for continuous scrolling through information (or similar features) were described as especially attention-grabbing, often leading users to spend much more time on their phone than they originally intended.

In line with the qualitative findings, the quantitative analysis revealed that duration of smartphone use was shorter when participants received notifications compared to when they self-disrupt. Thus, smartphone use appears to be more purpose-driven when users receive notifications, and more distraction-seeking when it is self-initiated. User interactions also lasted longer when participants had their phones in hand already, suggesting that going beyond a single, brief smartphone interaction tends to trigger longer phone sessions. In line with this, we find that use of apps that allow scrolling through a newsfeed or watching stories (particularly Instagram and facebook, but also the web browser) was indeed longer on average than other phone activities. This suggests that users are correct in assuming they are running the risk of getting caught in the loop when they engage with their device: they get trapped in a "cognitive attractor" (Lahlou, 2007a) that provides (small) amounts of satisfaction at a low cost with a high salience of the stimulus .

More generally, we find that interactions lasted 64.4s with 290.5s intervals between them on average, giving a 'rhythm of smartphone interaction' of roughly one minute every five minutes (see fig. 7). These numbers reproduce the findings of Yan and colleagues (Yan et al., 2012), but are much lower than what two other studies have found (Van Berkel et al., 2016; Visuri et al., 2017). As suggested in the literature, we also find that location and context influence how much users interact with their phones. Crucially, however, while participants usually reported being more on their phone when they were in leisure and less when they were in work settings, the quantitative analysis reveals that it is only the duration of smartphone interactions that is shorter when participants are working, while the intervals between interactions remain unchanged. The same picture emerges for being in company, which again only results in a reduction in duration of interactions, not a change in frequency. This suggests that participants were sincere when they expressed that they find it rude to be on the phone when other people are around, and that they do try to be on their phone less when they want to be productive, but it is also clear that participants underestimate just how routinised, habitualised and 'automatic' frequent smartphone interactions have become in the flow of their daily activities.

Overall, there seems to be evidence for the case of smartphone interactions being user-driven now, which is yet to be integrated into the wider research agenda of the field. The disruptiveness of smartphones is not of a physical or sensory nature, but rather lies within the demands they place on users' minds, and the interactive potential they offer. While notifications are disruptive indeed when they occur, the vast majority of smartphone interactions stem from automatic and habitual self-disruptions, which means that we need to approach the problem differently. Of course, making those notifications users do receive with their senses less disruptive is certainly a step into making their user experiences and their daily lives better. But in the overwhelming majority of instances when smartphones interrupt or disrupt users, it's not actually the devices, but the users themselves.

For research to better inform design practice in the future, we therefore propose that the disruptiveness of smartphones should not be conceptualised as a question of design, but one of embodied competences, i.e., user routines and practices. Research should focus on better understanding the habits and routines users have developed with their smartphones to help users better align their behaviour with their intentions. For this, we argue, it is essential to use first-person, in vivo techniques like SEBE to avoid jumping to 'intuitive' conclusions too quickly. Specifically, we see four avenues for further investigation:

A first potential avenue should further explore the motivations and goals of users when they pick up their phones. While there is some quantitative evidence on individual differences in smartphone use, video-ethnographic methods are a highly promising route to understand the different engagement and avoidance strategies that emerge naturally as our analysis has revealed. Especially examining the personal, but also the contextual factors that are antecedent to wanting to be disrupted and wanting to be disrupted will be relevant to understand different user profiles and their specific needs and problems. In this process, figuring out best practices together with users will be highly informative to generate effective and lasting interventions that can help users align their behaviours with their intentions. SEBE should furthermore be combined with experimental approaches to explore and empirically validate the smartphone interaction model proposed in figure 7.

A second avenue should seek to explore the nature of and the reasons for the extreme levels of fidgeting we find. Further research needs to tease out the internal, automatic motivators of this behaviour and the ecological factors that trigger fidgeting. It also needs to confirm whether the phone is actually the most common target object of fidgeting, as in our observations, and why this is the case. From a methodological perspective, there also needs to be an investigation on how to best study this phenomenon using automated and logging methods, as fidgeting looks like normal usage on current logs, but in vivo methods alone will not be able to provide sufficiently large and reliable numbers. And finally, as cognitive attractor strength is a combination of high salience, reward value, and (low) cost of completion, research on design for less phone fidgeting could explore enabling users to increase the ergonomic cost of interaction with the phone when they want to not self-disrupt.

A third avenue to be developed would be to connect the findings about high-frequency, user-initiated smartphone interactions with the recently emerging literature on the role of dopamine for smartphone use. Several researchers and industry professionals suggest that smartphones and social media leverage the dopamine response, which gets users addicted to a feedback loop (Haynes, 2018; Parkin, 2018; Weinschenk, 2012), but there is no solid confirmation of this relationship yet (Ley, 2017).

Finally, seeing that participants struggle with some of the habits they have developed, a fourth avenue for further research should look into how these habits form over time and how they can be better aligned with the preferences users report. We propose that internet literacy should be understood in a more nuanced way: While most educational and research programs to date focus on understanding and training audiences on what could be called content literacy, i.e. how to not get one's credit card data stolen, or worse, groomed, research should also focus on attention literacy, which will enable users to make more informed and conscious choices on when and how to use these undoubtedly powerful tools, and when not to.

7. Limitations

We have employed a mixed-methods approach to triangulate our findings, but this study is ultimately based on data from 37 participants. While quantitative approaches using device and application logs would not have been able to obtain some of the findings of our study, they produce more reliable data on usage patterns, which is needed to consolidate the evidence we have found. This, in combination with the mixture of conforming and contrasting results from previous studies substantiates the case for replication of smartphone use studies that has been argued in the mobile HCI community in recent years (Banovic, 2016; Church et al., 2015; Wilson & Mackay, 2011). It is important to bear in mind that, while the differences in results may be due to the different study populations, there also might be a gradual shift in usage that may occur over the years, which is then reflected in differences between the 'snapshots' that individual studies take.

From a methodological point of view, while SEBE allows a much more detailed look into the subjective experiences of users, we have not assessed which specific notifications participants had activated or disactivated, and the influence of changing the devices' notification settings on perceived disruptiveness in this paper. While this would be highly interesting, it is very difficult to reliably record in naturally occurring contexts as most people change these settings situationally (e.g. while waiting for a call); a more streamlined approach using SEBE in a slightly more controlled environment may be more suited to investigate these questions. Nevertheless, the key point remains that participants feel the phones *disrupt* them, when they actually *self-disrupt* in the majority of cases, whether different types of notifications are turned on or off.

8. Conclusion

In this paper, we have investigated the disruptiveness of smartphones with a situated first-person technique. We have found that participants report ambivalent, but very intimate relationships with their phones. While researchers and participants are in agreement that smartphones are the most powerful everyday tool we have, it has also become clear that they are a source of distraction and social pressure. We have further shown that smartphone use is largely habitualised with frequencies of user interactions being invariant across different locations and contexts. Moreover, it has emerged that 89% of smartphone interactions in our sample are initiated by users, rather than by devices. Overall, our findings purport that the perceived disruptiveness of smartphones is not mainly driven by external notifications, as commonly argued in the literature and by users, but by an urge of the user to interact with their phone that seems to occur in an almost automatic manner, just as a smoker would light a cigarette; and also by the process of being "caught in the loop" of chaining various activities in an unplanned fashion. In other words, it seems that the affordance of the phone for interaction is so strong that a lot of such interactions emerge spontaneously without the need for a pulling notification by the phone, nor a clear and strong intention of the user.

The notion of "disruption" carries the implicit idea that the cause of disruption is external to the person. What appears from our data is that disruption can have internal causes (like coughing disrupts talking), that smartphone use embodies a habitual drive to check the device which becomes an internal cause of disruption, that users are not fully aware of the frequency of this drive until they watch their own recordings, and that they are not happy with what they realise. We therefore suggest that we cannot rely on designing device-centred, high-tech solutions to every problem technology causes, but need to turn towards understanding and shaping embodied competences and habitualised behaviours of users. In the case of smartphones, it appears that users may need to re-learn how to engage with their devices healthily. An exciting avenue for design is to support users in acquiring better attention literacy and reflecting on their use of time, which would be beneficial for a more discerning use of screens, and possibly for their life in general.

E. PAPER 5: THE LOCKSCREEN CHECK IN SITU

In this section I present the draft version of the fourth Paper that evolved from this research project, which focuses on the locked use of smartphones. Parts of the literature reviewed in chapter 4 of this thesis have been used in this Paper in adapted form.

This Paper has been accepted for publication at the ACM International Conference on Mobile Human-Computer Interaction (MobileHCI) taking place in September 2021 under the following reference:

> Heitmayer, Maxi (2021). "It's Like Being Gone For A Second." Using Subjective Evidence-Based Ethnography to Understand Locked Smartphone Use Among Young Adults *The ACM International Conference on Mobile Human-Computer Interaction - Proceedings*

I am the sole author of this Paper.

"It's Like Being Gone For A Second"

Using Subjective Evidence-Based Ethnography to Understand the Antecedents of Locked Smartphone Use Among Young Adults.

MAXI HEITMAYER

Department of Psychological and Behavioural Science, London School of Economics and Political Science, London, United

Smartphone use usually refers to what happens after users unlock their devices. But a large number of smartphone interactions actually take place on the lock screen of the phone. This paper presents evidence from a mixed-methods study using a situated video-ethnography technique (SEBE) and a dataset of over 200h of first-person and interview recordings with 221 unique lock screen checks (n=41). We find eight categories contextual antecedents to locked smartphone use that influence the nature and the content of the subsequent smartphone interaction. Overall, locked smartphone use emerges as a means to structure the flow of daily activities and to balance between not getting too distracted and not experiencing fomo (the fear of missing out). It also appears as highly habitualised, which can cause over-use and disruption. Based on this analysis, we provide recommendations on how intervention and design approaches can leverage differences in context and purpose of locked smartphone use to improve user experience.

Additional Keywords and Phrases: Notifications, Smartphone, Lock screen, Video analysis

1. Introduction

For many people around the globe, the smartphone has become one of the objects, if not *the* object, they interact with the most every day. Previous studies find that users interact with their phones between 10 and 200 times on average every day (Falaki et al., 2010). Crucially, when users interact with their phones, two types of interactions can be observed; locked use and unlocked use (Hintze, Findling, Muaaz, et al., 2014; Hintze, Findling, Scholz, & Mayrhofer, 2014). Unlocked use is what is seen as the normal case where users lift the access restrictions to their device and use its full capabilities. Locked use, on the other hand, only gives users access to the 'lock screen' usually displaying time and date, notifications, and other widgets.

While unlocked use, naturally, has been studied from many angles and with a variety of methods, the investigation of locked use has been mainly focused on understanding user preferences for, and improving different authentication methods. Several studies show, however, that users check their phones only briefly in 18-35% of cases (Oulasvirta et al., 2012), and that users interact with their phones in a locked state more than half of the time (Hintze, Findling, Muaaz, et al., 2014). Moreover, short interactions often appear to be automatic and unconscious (Duke & Montag, 2017; Heitmayer, 2020; Heitmayer & Lahlou, 2021; Oulasvirta et al., 2012), leading users to interact with their phones more than they intend to, and even notice. It is, therefore, important to understand locked smartphone use in more detail. The relevant questions are: In which contexts and settings do users engage in locked use? How do they perceive and manage their use of the lock screen?

To address these questions and provide a better general understanding of locked smartphone use, we have conducted an *in vivo* study using Subjective Evidence-Based Ethnography (SEBE) (Lahlou, 2011), resulting in a dataset of over 200 hours of video with 894 unique smartphone use sessions, of which 221 constituted locked smartphone interactions. In this paper, we present evidence from first-person, audio-visual footage of user behaviour in naturally occurring contexts, in-depth interviews with participants based on the first-person footage, and a subsequent qualitative and quantitative analysis of the material to confirm and contrast findings from the literature and arising from the data. We find that locked smartphone use serves an important function for users to manage how they engage with their device and how they consume information. Overall, lock screen checks often occur in moments where users are focused on another activity, but wish to remain aware of the potentially relevant information that arrives on their phone. Locked use also serves as a displacement activity, and sometimes appears to occur automatically, raising questions around habitual usage patterns and problematic smartphone use. Based on our findings, we provide a categorisation of different contexts from which locked smartphone use arises and point to implications for the design of lock screens, as well as potential ways for interventions and data collection to leverage how users engage with the lock screens of their devices.

2. Related Work

Unlocking one's phone is a routine activity users perform many times a day to be able to fully interact with their phones. While the specific activity required to unlock a phone varies due to hardware and software differences and user preferences, the most common forms of entering a PIN, drawing a pattern, or using a biometric input all share one thing when it comes to users performing them: Unlocking happens automatically without much thought going into the process; it is a means to an end when accessing the phone, and a necessary inconvenience to protect the data stored within the phone, as well as prevent accidental inputs. The scale and magnitude of unlocking the phone is, thus, understandably easily overlooked. An estimation based on data from 2014 suggests that at least 13 billion unlock gestures are performed every day, taking up 6.2 million man-hours of sliding fingers over a distance roughly equal to the distance between the earth and the moon (Truong, Shihipar, & Wigdor, 2014). Without having to point out that current figures are likely to be significantly higher, it is clear that this *interaction before the interaction* is all but trivial in terms of time and effort spent, and therefore worth examining more closely.

Previous work around the unlocking of smartphones has focused on measuring frequencies and context of smartphone unlocking, describing different ways to unlock the device and differences between users, and some design work has investigated how the lock screen and the act of unlocking the device could be leveraged for increased productivity and well-being.

2.1 Measuring Smartphone Unlocking

Most studies on phone unlocking provide general 'metrics' of unlocking that allow to understand and categorise users and behaviours better. An early study found that users interact with their phones between 10 and 200 times a day on average (Falaki et al., 2010). Another study observed that the number of interactions ranged between 3 and 46 across participants with an average of 20. Usage time ranged between 9 minutes and 4.5 hours for an average total of 73 minutes of phone interactions spent per day (Soikkeli, Karikoski, & Hammainen, 2011). Reporting 46 phone interactions on average per day as well, a third study showed that participants who were using some form of authentication-based protection interacted with their phones significantly more often than those who did not have any access protection (51 vs. 41 instances per day on average, respectively) (Mahfouz et al., 2016). A fourth study, finally, found a large variance in the average daily number of unlocks between participants, ranging between roughly 20 and 105 unlocks (Truong et al., 2014). On average, they found that users unlock their phones 4.3 times every waking hour, with unlocks being roughly 26 minutes apart (Truong et al., 2014). They further found that 55% of unlocks occur while participants were 'on the move' between locations, i.e., when they were in places where they do not spend larger amounts of time regularly (Truong et al., 2014).

Studies have also distinguished between locked smartphone use and actual phone unlocks. In one sample, participants activated their phones 83.3 times and unlocked them 47.8 times per day on average, translating into 5.2 interactions per waking hour of which 3 were unlocked (Harbach, von Zezschwitz, et al., 2016). Another paper reports that users interacted with their phones 57 times a day spending a total of 117 minutes on their devices while, importantly, only unlocking their devices in 43% of instances (Hintze, Findling, Muaaz, et al., 2014). This suggests that participants use their phones in a locked state in many instances, underlining the importance of understanding these interactions in more detail. Initial basic numbers for locked screen use indicate that half of participants performed 9 or more lock screen checks per day on average, with the top 10% of the sample performing 52 lock screen checks per day on average (Wagner, Rice, & Beresford, 2014), and that interactions with the lock screen lasted around 13.5 seconds (Banovic et al., 2014).

The general uniformity of these patterns is also put into evidence by experimental software that can predict the next unlocking of the smartphone with reasonable accuracy (Luo et al., 2019).

2.2 Differences in Smartphone Unlocking

Research has also attempted to understand the differences in locked smartphone use between and within users, and what in the process users like and dislike. Research in this area developed from studies that investigated different unlocking methods primarily to address issues like *shoulder-surfing* or *smudge attacks* to improve the privacy and security of users (Von Zezschwitz et al., 2015, 2013; von Zezschwitz et al., 2013). Firstly, there seem to be significant age and gender differences in unlocking, with younger users more likely to use fingerprint authentication than older users (Qiu, De Luca, Muslukhov, & Beznosov, 2019). Older users also interacted with their devices less frequently, which may explain why the use of a 'slower' authentication process is not perceived as an issue. Moreover, older users were more likely to be still as compared to moving when unlocking their phones. Finally, participants' gender correlated with total daily usage, session length, and choice of authentication method (Qiu et al., 2019).

Research also shows that while the 'time cost' of unlocking only represented between 2-3% of the duration of longer interactions, it could take up to 80% of the time of shorter interactions, and that participants using pattern unlock spent 1.7s on average to unlock their devices, while password and PIN users took 4.1s on average (Mahfouz et al., 2016). Producing a similar result in terms of time use (Harbach, De Luca, & Egelman, 2016; Harbach, von Zezschwitz, et al., 2016), other studies find that PIN users were much less likely to make mistakes while attempting to unlock their devices (3.1% failed attempts for PIN vs. 12.1% for patterns) (Harbach, De Luca, & Egelman, 2016). Moreover, even when users proceed to unlock their devices, they spend a certain amount of "preparation time" between activating the device's screen and beginning the authentication process to unlock the device. The mean preparation time before participants unlocked their devices was 22.7s with the majority of instances being less than 4s. In case participants did not unlock their device following a screen activation, the mean interaction time was 71.5s, with the majority of interactions lasting less than 39s (Harbach, De Luca, & Egelman, 2016).

Another study therefore suggested classifying smartphone sessions into three different types, i.e. *glance, review*, and *engage*. During glance sessions, users only wake the device to look at the lock or home screen of the phone with no other interaction. During review sessions, users interacted with their phones for 60s or less; everything beyond that was characterised as engage sessions (Banovic et al., 2014). In their sample, roughly half of interactions were glance sessions, with review and engage sessions each making up about a quarter. Interestingly, median duration of locked screen time during interactions was shorter for review and engage sessions (2s) than for glance sessions (5s), suggesting that users had already decided to go beyond a glance session when they picked up the phone, or that the made that decision almost instantaneously. Moreover, a notification was almost twice as likely to be followed by a glance session than a review or engage session in their sample (Banovic et al., 2014).

These findings are in line with the notion of smartphones as "habit forming devices", as users develop automatic and dynamic checking habits with their smartphones (Oulasvirta et al., 2012). Further studies confirmed that users tend to spend less time on their phones when they respond to a prompt by a notification as compared to when they proactively pick them up (Heitmayer, 2020; Heitmayer & Lahlou, 2021). However, a detailed study on the gaps between smartphone sessions revealed that a common sense interpretation assuming a 'unity' of the nature of brief lock screen checks or glance sessions is not adequate in many cases (Van Berkel et al., 2016). Short activations can vary massively depending on whether they are individual interactions or are sandwiched between brief "usage gaps". Therefore, looking at the variety in locked smartphone use and the surrounding context is going to be crucial.

Following from this, the inverse question why people lock their phones, and more generally, why some users add authentication barriers to their phones and others do not has received some attention. Research indicates that about 35% of users do not add security barriers to their phones (Bruggen et al., 2013). Reasons users give for not access-protecting the phone range from not caring about it or not having considered it, as well as thinking that there is nothing that needs to be protected, to worrying about the phone not being usable in an accident or in case it got lost, which would complicate returning it to the owner. More practical considerations also included ease of access and sharing the device with other users (Egelman et al., 2014; Harbach, De Luca, & Egelman, 2016; Harbach, De Luca, Malkin, et al., 2016; Harbach, von Zezschwitz, et al., 2016).

2.3 Designing for Smartphone Unlocking

Thirdly, turning towards the application of the findings reported in the previous sections, several studies investigate how the overall usability of the phone can be improved by making use of the otherwise 'wasted' time and effort of smartphone unlocking, mostly for data collection, self-tracking, and behavioural interventions. One straightforward suggestion is to harness the unlocking action of participants for data collection, especially for brief experience-sampling methods (ESM), but also to complete large-scale human intelligence tasks or to collect personal health metrics. Different software packages include *Slide to X* (Truong et al., 2014), *Twitch Crowdsourcing* (Vaish, Wyngarden, Chen, Cheung, & Bernstein, 2014), and *I-Corps Lock Screen Query* (Abowd, 2013).

These approaches aim to leverage the time and effort participants spend on swiping motions or fingerprint authentication when unlocking their phones by presenting them with a task or prompt, ranging from simple "right or wrong" questions to more introspective self-report measures that can be completed in a similar way to drawing an unlocking pattern or entering a PIN code. Moreover, the unlocking gesture can also be used for participants to indicate their willingness to participate in a slightly longer task, directly opening the application used for data collection with the unlock gesture (Fortin, Huang, & Cooperstock, 2019; Truong et al., 2014; X. Zhang, Pina, & Fogarty, 2016). Overall, these software packages were received very positively by users and resulted in a significantly higher frequency of responses and increased timely completion, while lowering perceived intrusiveness of the questions (Fortin et al., 2019; X. Zhang et al., 2016). This technology is not only useful to improve the quality of such data, but also holds the opportunity to generate small income streams for users and even large amounts of money for charity (Truong et al., 2014).

Finally, in line with the prevalence of lock screen checks, several studies also suggested using the lock screen as a "glanceable display" to relay health-related information or positively influence user habits. Early work used a simple, visual representation of "weekly goal attainment status, physical activity behavior, and a subtle but persistent reminder of commitment to physical activity" that was placed as the wallpaper of the phone (Consolvo, Klasnja, et al., 2008; Consolvo, McDonald, et al., 2008). Other work has since used the phone's lock screen or background image to encourage healthy sleep habits (Bauer et al., 2012), provide insights into personal health (Frost, Doryab, Faurholt-Jepsen, Kessing, & Bardram, 2013), or help with the acquisition of a second language (Dearman & Truong, 2012). In a more recent application, a Slide to X approach was used to record servings of vegetables users had eaten in combination with a glanceable representation on the lock screen (Jisu Jung, Nour, Allman-Farinelli, & Kay, 2017). The glanceable display approach was generally received positively by participants and described as a reminder to keep the "eyes on the prize" (Consolvo, Klasnja, et al., 2008).

3. Methods

Several studies report difficulties with noise in the data due to technical issues such as a distortion of usage time caused by different display timeout settings, or differences in user habits, such as switching off the phone after use versus letting the device timeout automatically (Falaki et al., 2010; Hintze, Findling, Muaaz, et al., 2014). In this paper, we therefore propose using SEBE, a video-based, *in vivo* technique that combines qualitative and quantitative methods to study locked smartphone use in more detail (Lahlou, 2011; Lahlou et al., 2015). SEBE is especially valuable for explorative studies aiming to investigate user behaviour while it occurs, as it provides rich, contextual user data, and incorporates 'checks and balances' that avoid misremembering by participants and misinterpretation by researchers. The SEBE protocol consists of three phases:

Figure 1: **A researcher modelling the Subcam. The camera weighs only 7 grams and can be mounted on a pair of research glasses or the wearer's own (here). It has about 3 hours of autonomy with the internal, and several days with an external battery.**

First, participants are given unobtrusive, miniature cameras worn at eye-level (*Subcams*, see Figure 1) to gather first-person video material (*Subfilms*). This enables participants to go about their lives naturally, without being disrupted or distracted, while gathering complete data on their daily experiences (first-person perspective, wide angle, stereo sound recordings). In the second step, the Replay-interview, participant and researcher watch the Subfilms together and discuss salient moments in the tapes. Here, participants can explain and reflect on what is happening in the tape, and they can object to interpretations by the researcher and suggest alternatives as they relive their experiences. Crucially, these interviews usually unearth things that go unnoticed by participants in the course of the action as the videos can be rewound, slowed down, and stopped. Most importantly, reviewing one's own first-person perspective recording elicits accurate remembrance of actions, intentions, and emotions – similar to re-enactment or an access to episodic memory (Tulving, 2002). Finally, the researcher is left with many hours of situated first-person videos and a set of interviews, which can be analysed with different quantitative and qualitative techniques.

Similar to ethno-mining approaches (e.g. (Aipperspach et al., 2006; K. Anderson et al., 2009)), SEBE is particularly relevant for the study of device use as it allows, unlike stand-alone interviews or any type of server- or smartphone-log method, to document the interaction of the physical and the digital environments users find themselves in, as well as both their online and offline behaviours. In the field, wearable video has been shown to provide initial insightful accounts of the use of smartphones (B. Brown et al., 2013, 2015; Licoppe & Figeac, 2013) and smartwatches (D. McMillan et al., 2017; Pizza et al., 2016). Moreover, supporting interviews with logging and trace data has proven to be effective in supporting recall (P. Ferreira et al., 2015) and in contextualizing usage behaviours in "wider webs of activities" (K. Anderson et al., 2009; Rattenbury et al., 2008). The Replay-interview presents a useful addition to these approaches as the rich, first-person audio-visual material participants record leverage multimodal episodic memory in the interviews and enable participants to give detailed accounts of their activity, the context surrounding it, and their cognitive and emotional experience (see Glăveanu & Lahlou, 2012; Lahlou, 2011 for a detailed discussion).

4. Data Collection

The SEBE protocol includes stringent ethical guidelines ensuring participants' full control over the data all the way they were followed (the protocol received ethical approval from the Ethics Board at the LSE). We approach informed consent as an ongoing process as pre-formatted checklists filled out prior to data collection neither enable researchers to react adequately to issues arising while the research is being conducted, nor do they enable to update and change their consent during the research process (Cox et al., 2014; Gubrium et al., 2014). Participants were encouraged to review the material and blur or delete anything they wished, or abandon parts or all of the recordings altogether, and they were also offered technical assistance to do so if needed. Participants were also explicitly, and repeatedly, reminded about this option prior to data collection, after data collection, prior to the Replay-interview and after the Replay-interview, and consent to continue their participation was sough at each of these steps, so that the participants could rightly feel completely safe and in full control of their data. No participant made use of this option in our sample. Video recordings were then anonymised using pseudonyms and transferred to an encrypted hard disk drive to ensure confidentiality (see (Everri et al., 2020) for a detailed discussion).

Data collection took place in the UK in 2018 and 2019 with the majority of participants being residents of the Greater London area, generating an international, but mainly European sample of n=41 participants.[10] Participants were recruited through mailing lists at the LSE and through snowball-sampling. Two thirds of participants were university students, and one third (14) were working. The age of participants ranged from 21 to 29 years with 46% being female. The majority of our participants used Apple iOS devices (78%), six used Android on Samsung devices (15%), with one participant each using a Sony, Motorola, or Huawei device running Android.

Participants have been asked to wear their subcam on at least three consecutive days, collecting at least 5 h of video material. Participants have furthermore been instructed to only wear the camera in situations in which they felt comfortable and could forget about wearing it. Allowing participants to self-select when to wear the Subcam results in more natural behaviours, while also protecting their privacy, and it gives each individual the opportunity to document the parts of their lives they deem the most relevant. This has generated a data corpus spanning a breadth of activities and locations like commuting, working in the office, attending lectures at university, going to the supermarket or the museum, or spending time with friends and family (see Figure 2). Throughout we observe a rather even spread of Subfilms recorded at home, at work, and outside.

Replay-interviews lasted between 50 and 90 minutes and were conducted no more than two weeks after participants collected the subfilm material. In the interviews, we looked at every instance in which participants interacted with their phones in the subfilms and discussed reasons and motivations for the specific interaction, as well as smartphone use in general.

[10] UK (12), Italy (5), Germany (5), France (3), India (3), Latvia (3), America (2), Russia (2), Colombia (1), Czech Republic (1), Iran (1), Netherlands (1), Singapore (1), Spain (1), Sweden (1).

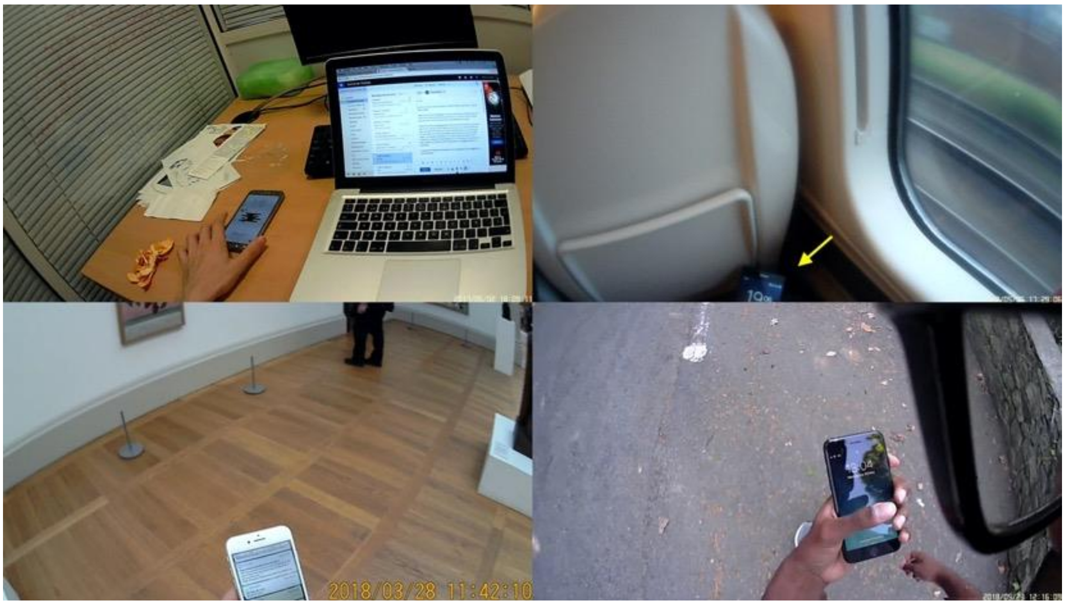


Figure 2. **Various contexts of locked use (clockwise: At work, on a train, while walking outside, at a museum).**

The interview recordings have been transcribed literally and prepared for analysis using *directed Qualitative Content Analysis (QCA)*. These transcripts make up a large corpus of complex, qualitative data, which needs to be structured and reduced to become manageable and comprehensible. QCA is perfectly suited to analyse such data, since it does not aim to fully describe the material. Rather, the goal of QCA is to carve out salient topics and unearth emerging ideas from the data corpus in a circular process, and to describe them in a coherent and systematic way (Mayring, 2000, 2015; Schreier, 2014), to generate valid and replicable results that are "divorceable from the authority of the researcher" (Krippendorff, 1980, p. 18). The interviews from the initial phase of data collection (n=37) discussed smartphone use as it was naturally emerging from the Subfilm material and, thus, covered a broad range of topics around smartphone use reported in more detail elsewhere (Heitmayer & Lahlou, 2021). After having gained a general picture of empirical observations and participant interpretations of contextual smartphone use, we carried out a second round of Subcam data collection and Replay-interviews in November and December 2020 (n=4) to discuss moments in which it was unclear from the Subfilms why participants picked up the phone in more detail with them (proactive use; see below). Overall, the data corpus comprises over 200 hours of video material.

5. General Qualitative Analysis

We first present our qualitative findings based on the Replay-interviews where participants commented on their actions, intentions, and emotions as they review their own recordings. This phase informed the systematic quantitative coding of locked smartphone use in the Subfilm material, which is presented in section 6. The qualitative content analysis of this rich material yielded four major themes around locked smartphone use that our participants talked about: *Managing awareness*, *Displacement Activities*, *External Causes for Locked Use*, and *Automatic & Unconscious Engagement*. The detailed coding frame is provided at the end of the paper.

5.1 Managing Awareness

The first and most frequently discussed explanation for locked smartphone use participants gave was that it provides awareness of relevant information at the discretion of the user. This mainly refers to the ability to 'stay on top of incoming notifications', but also included other widgets commonly included on the lock screen, like time, weather, or calendar and traffic alerts.

Participants use lock screen checks to monitor their phones when they are waiting for a specific notification such as a reply to a message or a delivery confirmation for a parcel without having to go through the process of unlocking and fully engaging with the device. In addition, locked use also is a means to check for messages that are not explicitly expected. In this way, participants make sure that they stay informed and do not experience *fomo*, the fear of missing out on interesting or urgent information their phone provides them with (Fitz et al., 2019). One participant, thus, poignantly mentioned:

> *I think we're constantly conscious that someone might have sent a message.* (P29)

Participants also used the lock screen to manage how they access their phone and what type of information they receive, and to avoid the phone intruding on their other activities. Many of our participants selectively tailored which apps or even which specific chats would be displayed as notifications on their lock screen, to make locked use even more efficient for their purpose. We generally observed two strategies: Some participants “pre-programmed what’s important” (P19), minimising the overall amount of notifications that show up on the lock screen and making sure that those that do are important. Others also included notifications with information that they did not regard as urgent or important, but which they felt they would otherwise not get ("football news for example, which I would completely miss out on otherwise.”; P5). In both cases, reading the information on the lock screen often provided sufficient awareness for participants to not take immediate action. Some participants also selectively deleted notifications from the lock screen either because the information was not needed, because reading it on the lock screen fulfilled its purpose (e.g. traffic alerts, short news headlines), because the information was not regarded as ‘urgent’ or ‘priority’ and returning to it at a later point in time was sufficient, and also to intentionally keep those notifications that remain on the lock screen as a reminder.

Regardless of the specific strategy, the lock screen provides our participants with *awareness of* information directed towards them, allowing them to deal with it more flexibly and to reduce potential disruptions to their other activities by the device. On a side note, turning off lock screen notifications for certain apps also sometimes meant that users had to unlock their phones and actively open specific apps to check for new notifications, which is more costly in terms of time.

Lastly, on a more abstract level, participants also reported using lock screen checks for impression management. On one hand, participants discussed the tension between wanting to not be interrupted by notifications and wanting to reply to important messages quickly to appear as hard-working and “on top of work” (P10) to clients, managers, and colleagues. On the other hand, participants also sometimes only read notifications on the lock screen because the other party would not receive read receipts, and they reported that they decidedly do not respond to a notification at times for example to appear busy, to wait for other people to comment first in a group conversation, or to ‘make the interlocutor wait’, usually with partners or on dating apps.

5.2 Displacement Activities

Another theme emerging from the discussions with our participants was the use of lock screen checks as a displacement activity (see (Barash, 1974) for an overview). Most participants reported that they would check their phones more towards the end of their workdays when they were getting tired, and when they were getting bored with a specific activity:

> *I'm trying to concentrate on the statistics, but every 5 minutes I'm looking at what is happening on the phone - "Can someone take me out of my misery..."* (P18)

These checks offer a quick and easy way for participants to find an excuse to take a break from working. The phone also seems to be the object that participants direct their attention to when they are having difficulties to focus. Note that in these cases, participants are not merely looking to find a reason for an unlocked interaction and lock screen checks only represent a failed attempt at displacement. Participants also re-read existing notifications, manage the information on the lock screen and play with the phone's screen (see section 5.4) rather than unlocking the device precisely because they know they need to continue with their other activities. Fully unlocking the device appears to be perceived as more intense escapism by participants than 'only' engaging with the lock screen for a moment.

Some participants, moreover, also reported briefly checking their devices in moments they felt anxious or uncomfortable. This applied to social settings when participants did not feel included in the group or did not know how to contribute to the conversation, and especially in work or university meetings when they felt scrutinized or unable to answer questions. The phone was, thus, characterized as a pacifier, and lock screen checks were described as a way of "being gone for a second" (P16).

5.3 External Causes for Locked Use

Several participants also hinted at situational and environmental cues that lead them to briefly check their devices. When participants took breaks from an ongoing task to stand up, stretch, open a window, etc., they often briefly checked their phones. Moreover, one participant also commented that a brief interruption to scratch herself, and the resulting process of moving her body and arm led her to perform a lock screen check on the phone that was lying next to the laptop she was working on.

Similarly, environmental disruptions that divert the attention of participants from their main task for a moment, such as a noisy washing machine, colleagues having a conversation, or a change to the lighting situation in the room (e.g. caused by motion sensors or clouds passing in front of the sun), often resulted in participants briefly checking the phone before returning to their previous activity ("Too much chit-chat around me, so I quickly check my messages. Nothing there. Back to work."; P4). Brief interruptions to the flow of the ongoing main activity, either arising from the natural progression from one activity to another, or from external factors, thus appear to be moments where participants briefly check their smartphones because they are not clearly focusing on a specific task or have already lost focus of their previous activity due to external reasons.

5.4 Automatic & Unconscious Engagement

Fourth and finally, however, participants were unable in many instances in the Replay-interviews to give a clear explanation for why they interacted with their phone in a specific moment and reported that checking the phone often happens unconsciously. Lock screen checks were thus described as an automatic behaviour without a clear goal or reason, and something that "just feels normal" (P27), and the phone was even described as being "like a part of me" (P24).

One participant also interestingly mentioned that playing with the widgets and the unlocking pattern on his phone (Android pattern unlock) was calming and "almost therapeutic" (P3). It thus appeared that participants were usually able to remember what they did with their devices and why, but in several cases they did not know why the picked up the device in the first place. We therefore carried out another round of data collection aiming to gain some more insights on these unclear moments.

Focusing specifically on unclear moments ('proactive glances'; see section 7.1 below) captured in the Subfilm in our second round of data collection, participants were able to provide clarifications in some instances in the interviews, typically for moments where they had either spontaneously remembered that they had something to do with the phone (e.g. reply to a message, look something up), or where they were not actually focusing on the activity they appeared to be engaged in the Subfilm and were already thinking about the phone (e.g. while watching TV). However, even during this focused investigation we were unable to reconstruct the reasons for many instances of locked phone use, and our participants indicated that they did not know why they interact with their devices in these moments:

> *And sometimes I would l just check the phone as an automatic gesture. Because I realize it's not like other times here, not like a conscious thing. "Oh, I want to check this notification or I just want to go to Instagram or whatever". I don't know, it is just like a passive thing that I do.* (P39)

Overall, this suggests that briefly checking the lock screen of the phone has become habitual and is not a conscious decision at times, as indicated by participants, and locked use seems also to be a way in which participants check the phone during breaks between activities.

6. General Quantitative Analysis

Following the qualitative analysis, we followed an ethological approach for the quantitative analysis of the Subfilm data, first of all to show trends, patterns and differences in smartphone use among participants. For every instance during which participants used their smartphones on tape, we recorded duration, time elapsed since last phone interaction, location, type of interaction, where the phone was in the physical space, the context they were in (e.g. working at the office, commuting), whether there was a notification (and if so, what type), and the nature of the activity. Overall, this resulted in a dataset of n=894 unique smartphone use sessions, of which 221 (24.7%) constituted locked phone use.[11]

All participants engaged in locked smartphone use and we observed between 2 and 17 lock screen checks per user with an average of 6.5 lock screen checks (standard deviation 4.5) and roughly five hours of Subfilm material per person. Lock screen checks ranged between 1s and 22s and lasted 4.2s on average (median 3s, standard

[11] Unfortunately, the Subfilms for three participants were corrupted in the transfer process after the interview, leaving us with data from 38 participants only for the quantitative analyses.

deviation 4.1s). Given the nature of our data and our sample size, we investigated the relationships between the key variables around smartphone use we observed using non-parametric tests (Fisher's exact test and the Kruskal-Wallis H-test where appropriate). Following the discussion by Perneger (Perneger, 1998), we do not believe that the number of statistical tests performed in a paper influence the ability to make meaningful inferences from individual tests. We therefore have not applied a correction of p-values to the statistical tests performed and relied on a value of $p < 0.05$ to determine the statistical significance of our findings.

First, we tested for a relationship between the time since users had last interacted with their phones and locked use. The results are highly significant, with the mean time since the last interaction with the phone being longer before lock screen checks (180s vs 163s, $H(1) = 4.277$, $p = .039$). Second, we find a significant interaction between notifications and lock screen checks in our sample. While 23% (181/789) of interactions are lock screen checks when the interaction was initiated by users, 31.9% (40/105) of interactions are lock screen checks when a notification led to the interaction ($p = .001$). Third, looking at the potential influences of time of day, we did not observe significant differences in frequency of locked use throughout the day in our sample (06:00-12:00, 12:00-18:00, 18:00-24:00; $H(2) = 2.850$, $p = .241$), ruling out direct effects of fatigue or daily cycles of participants on lock screen checks. Fourth, on the other hand, we do find an influence of work on locked phone use. When participants were working, slightly more smartphone interactions were lock screen checks compared to when they were not working (28.1% (110/392) vs. 22.1% (111/502), p = .025). Fifth, we also looked at the differences in locked and unlocked use for different locations participants were in. We observed significantly less locked use when participants were in public transport (5.9% (2/34) vs. 25.4% (219/860), $p = .004$), and significantly more locked use when they were outside (35.5% (22/62) vs. 23.9% (199/832), $p = .033$), but no differences when they were at home (23.5% (113/480) vs. 26.1% (108/414), $p = .211$), or at work (27.3% (58/213) vs. 23.9% (163/681), $p = .188$). Finally, in contrast to previous studies, we did not find a significant effect of participants being alone or in company on locked phone use (24.4% (104/426) vs. 25% (117/468), $p = .450$).

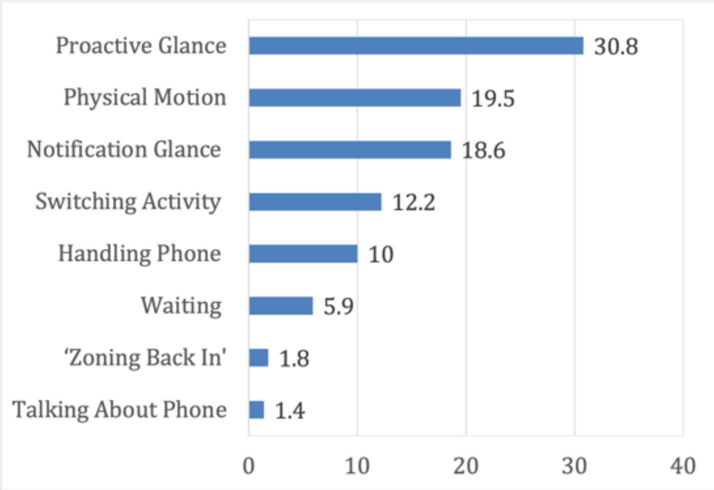


Figure 3. **Eight categories of different contextual antecedents to lock screen checks in the sample in percent (n=221).**

7. Mixed-methods analysis of Causes & Antecedents of Locked Use

After analysing the Replay-interviews and coding the general descriptive variables of locked smartphone use in our Subfilm sample, we took a closer look at the moments immediately prior to the instances of locked use our participants recorded in the Subfilm. Based on participant comments in the Replay-interviews, our qualitative analysis, and the contextual factors captured in the Subfilms, we classified the individual instances of locked use in our sample into 8 different categories of 'contextual antecedents' (see Figure 3). These categories reflect how different instances of locked smartphone use arise from the flow of activity of participants. After an initial round of coding the videos, a framework of coding instructions was produced (see Appendix A2), and the videos were double-coded independently two more times by two researchers. In the first round of double-coding, we found an inter-coder reliability of 81% (Krippendorff's α = 0.74) (Krippendorff, 2011). We then updated the coding instructions and merged two categories because of overlap, which resulted in a 94% agreement for the second round of coding (Krippendorff's α = 0.91). The remaining mismatches were reviewed jointly by coders and resolved. The following sections focus on the different contextual antecedents of locked smartphone use and provide an in-depth description of what actually happens when participants briefly check their phones in situated contexts.

7.1 Proactive Glance

The most common type of locked screen use in our sample is the 'emblematic' notion of the lock screen check, where participants proactively interrupt the flow of their current activity to check their phones. These checks are not, by and large, performed as a response to an external prompt, or following from a prior 'build-up phase'. However, we did observe that major changes in location while participants were on the move led several participants to perform proactive lock screen checks, most notably getting off public transport or entering the workplace. In the Replay-interviews, participants were usually not able to explain why they checked their phones in moments categorised as proactive glances, and sometimes exhibited surprise, but usually referred to the activity having become automatic and unconscious:

> *I think it's one of the times that I kind of mindlessly, not exactly mindlessly, but I don't know. I have this automatic thing that I check my phone every once in a while. I think it's because, yeah, I'm supposed to be working and I want to make sure that I got no notifications.* (P37)

> *So I looked at my phone and didn't do anything. I have no idea what I did. I just went and had a look.* (P14)

And while we did not find a significant difference in the likelihood of proactive glances being followed by locked or unlocked use (24% (68/283) vs. 25% (153/611), p = .406), the overall prevalence of proactive lock screen checks (7.6% of all smartphone interactions in our sample) reflects participant sentiments around unconscious and automatic use.

7.2 Physical Motion

Another common trigger of locked screen use was when participants had interrupted themselves and were already moving in close proximity to the phone, especially when they were moving their hands, or when their physical motion caused the phone to enter their field of vision. Illustrative examples were picking up or putting down objects like a mug or a tv remote in close physical proximity to the phone, or sitting down with the phone within arm's reach (see Figure 4). In cases where participants checked their phones after being in motion already, they usually did not have an immediate main task they were pursuing, or have taken the decision to take a short break already, which allows the phone to intrude into the flow of activity:

> *I go on it just out of boredom. I'm not even looking at the screen properly, it's just out of nothing better to do. (P21)*

> *I was sort of scratching myself and then just picked the thing up. (P39)*

Lock screen checks following physical motion again support the automatic character of regular brief checks of the phone our participants talked about in the interviews. They further sit well with participant comments on external interruptions; and it appears that the phone intrudes into the activities of users, but also that they become aware of the device and the opportunity to briefly check their phones once they have already interrupted what they were doing. Further inquiry as to whether this leads them to check their phones briefly only, or whether they engage with their devices fully is necessary, however, as the statistical difference is close to, but not fully significant (30.5% (43/141) vs. 23.6% (178/753), $p = .054$).

7.3 Notification Glance

The third most common type of locked phone use, glances in response to audio-visual cues sent by the phone, are the only type we observed that is not initiated by the user. In our sample, receiving a notification immediately led participants to interrupt their current activities, with the mean time between arrival of notifications in the Subfilms and participants picking up their devices being 2.1s (standard deviation 2s).

> *I try and put it a bit away but obviously if a message pops up then I want to answer right away. Not that I always do but I want to.* (P26)

> *I checked it again here, for the same stupid reason. Because a notification could be anything. Could be WhatsApp, Telegram, Facebook...* (P28)

We also observed that participants visibly jolted their heads to move the device into their visual field as soon as a notification arrived. However, in roughly 40% of

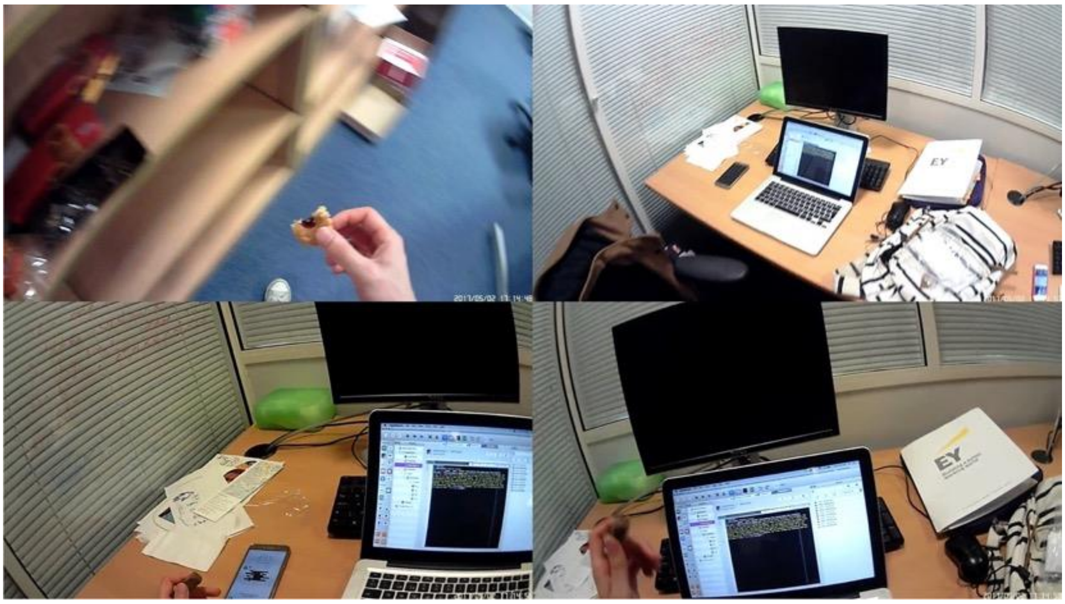


Figure 4. **A participant fetching a biscuit and checking their phone after sitting back down (clockwise from top left).**

interactions that followed a notification, participants just read the notifications, swiped the lock screen up or down, or removed the notification from the lock screen without engaging with the prompt in more detail (see Figure 5, top row). This replicates previous findings on notifications and locked use (Banovic et al., 2014), and reflects participant sentiments that most notifications do not require an immediate response. Notification glances also support the notion that locked use is a means for users to balance the capacity to be alerted to new information with the option to not fully engage with it in the exact moment. The finding that locked use follows almost twice as much as unlocked use when the interaction is triggered by a notification, compared to when participants interacted with their phones for other reasons further underlines this (39% (41/105) vs. 22.9% (180/789), $p < .001$). We also find that notification glances are more likely to occur while participants were working, compared to when they were not (30% (33/110) vs. 8.1% (9/111), $p < .000$), which is in line with participant sentiments around using the smartphone as a displacement activity during work. Notifications that arrived while participants were working were, however, perceived as “embarrassing” and “annoying to colleagues”, and we accordingly find that participants were more likely to set notification delivery to visual only compared to sound, vibration, or a combination of the three in these moments (85.7% (54/63) vs. 68.6% (338/493), $p < .000$).

Figure 5. **Three instances of lock screen checks (top to bottom): Notification glance followed by deleting unwanted notifications from lock screen, Physical motion check after moving hand to turn page while reading, phone moving into the visual field of the participant (yellow circle) while talking to a friend followed by sitting down. Note the time stamps as well.**

7.4 Switching Activity

Participants also performed lock screen checks when switching between different activities. In 'digital contexts', brief locked screen use followed events such as sending out an Email, or switching to a different software:

> *It's just a moment where I don't think. But it's also curiosity, what are my friends doing? But not even that... Yeah it is almost automatic: "Ok. Break, drink, [pretends to pick up phone]. Nothing interesting happening, [pretends to put phone back down], focus."* (P17)

We also observed locked use after a wide range of switches in real world activities such as cooking, tidying up, or looking at paintings in a gallery. Turning the page while reading stands out as an exemplary case of a short break within an activity that routinely leads users to engage with their phones. Similarly to when participants were moving already, brief lock screen checks in between activities often appeared habitual and automatic, and enabled users to make sure with a quick glance that they are not missing out on important information:

> *I just collect the notifications on the [lock] screen, and I can select myself when I see them and when not, so to speak. I collect them and then I delete those I don't want to see anymore. (P5)*

However, switching activities significantly more often led to fully-fledged, unlocked interactions in our sample (26.8% (194/723) vs. 15.6% (27/171), p = .001), which confirms participant comments around using the opportunity to fully engage with their phones when there is a break or another opportune moment:

> *Sometimes it's like: "Oh, I've gotten this thing done. Now I can take a small break. Oh, I'll look at my phone as a sort of small break!" And then I'll maybe check WhatsApp cuz I have a few groups and my boyfriend texts me of course.* (P17)

This is also supported by the finding that duration of smartphone use is significantly longer for interactions that occurred when users were switching activities (38.4 vs. 32.1s; $H(1) = 7.394$, $p = .007$).

7.5 Handling Phone

Another situational trigger of locked phone use was when participants were handling their phones as physical objects without the intention to use its affordances. Typical cases comprise rearranging objects on the desk and, thus, moving the phone, picking up the phone to place it in a bag or pocket, or connecting the phone to a charging device (see Figure 6). Naturally, locked use followed proportionally more often after participants were handling the phone than unlocked use compared to other lock screen checks (51.2% (22/43) vs. 23.4% (199/851), $p <$ .001). We also observed that lock screen checks following handling the phone often occurred even though participants had used the device only moments before, when they could have a reasonable degree of certainty that no new information would be present. This, again, supports the narrative of automatic and habitual engagement with the phone:

> *Well, I guess I had it in my hand already, so I peeked and then put it out of the way. (P33)*

***Figure 6.* Lock screen check after moving the phone out of the way to access writing pad.**

7.6 Waiting

The sixth type of locked screen use we observed followed brief periods of idleness, typically while participants were waiting for their computers to download or launch something, but also in everyday activities such queueing for a coffee. This reflects the sentiment expressed by participants that they want to optimize the use of their time in situations where they have nothing else to do:

> *No, I don't think there was a vibration. I'm just swiping away some notifications so I don't see them anymore. I think I'm just waiting for the computer*. *(P6)*

Moreover, one participant poignantly described that they checked their phone because they did not want to *look like* they have nothing else to do: "I'm just going on it because I'm awkwardly standing in line", (P27). Smartphone use while participants were waiting therefore also supports the notion of lock screen checks as a displacement activity. And while the slightly higher proportion of locked use compared to unlocked use in situations of waiting we observed suggests that users often did not find anything to do with their phones, the difference was not statistically significant (34.2% (13/38) vs. 24.3% (208/856), p = .118).

7.7 'Zoning back in' and Talking About Phone

The last two types of locked phone use only make up a small percentage of our sample, partly also because they are difficult to observe. Nevertheless, we found it important to report on these as well. On a few occasions, participants had 'zoned out' for a moment, e.g. staring onto a wall or out of a window being completely idle, or fully falling asleep (which we have only been able to capture on tape once). Once they returned from that idleness, usually marked by shaking their head and heavy breathing, participants immediately checked their phones, both as a clock but also to see whether messages had arrived. Yet, in none of these cases, even where notifications had arrived, did they unlock their phones immediately. Instead, they took a moment to fully get back to their senses before interacting with their phones in an unlocked state. These findings resonate with participant comments on the intimate relationship with the phone and sleep: For example, it was mentioned that "the phone is the first thing I check after I wake up" (P18) and "the light of the phone helps waking up the eyes" (P10). Again, these findings also hint at the compulsive nature of the *fomo* that leads participants to interact with their devices. Lastly, when phones or apps were mentioned in a conversation by participants or interlocutors, both as a general topic ("Have you heard that the WhatsApp servers were down all over Europe for 30 minutes yesterday?") or targeting the user's device in specific ("Should I send them a text and ask if they want to grab a drink tonight?"), participants tended to perform a lock screen check.

8. Discussion

8.1 General Discussion

Our analysis revealed that lock screen checks are much more than just a quick glance for users. We find that about a quarter of smartphone interactions represent using the phone for a very brief amount of time (3-4s on average) in a locked state. With a range between 2 and 17 lock screen checks per user and an average of 1.6 instances of locked use per hour, our results reproduce earlier findings, albeit at the lower end of the spectrum (Harbach, von Zezschwitz, et al., 2016; Hintze, Findling, Muaaz, et al., 2014; Wagner et al., 2014). From the perspective of the participants, lock screen checks enabled them to time-efficiently manage their awareness of new information that arrives on their phone, helping them to cope with the demands of their daily lives but also to effectively deal with *fomo*. These sentiments are in line with our quantitative findings, showing that intervals between smartphone interactions were longer before locked use, and that locked use was more likely to occur when participants were working. Thus, especially when participants were engaged in longer periods of focused activity, they utilise lock screen checks to balance the desire to be focused with the worry of missing important information.

This is also reflected in the finding that lock screen checks were more likely to occur when users themselves initiate the interaction with the device compared to notifications. The majority of participants reported that they would silence their phone in one way or another when they had to be particularly focused, to not get distracted by it. While muting the device enables participants to reduce the amount of times they are being interrupted by their phones, this also creates the need to proactively check the device to stay aware of incoming notifications, for which the lock screen check seems to be the most convenient [see 29,30].

Interestingly though, we observed that locked use following a notification was twice as likely to occur when participants were working in our sample, reproducing earlier findings (Banovic et al., 2014). This suggests that they are willing to make a trade-off and allow short interruptions to their work activities to occur in exchange for being alerted to new information promptly and being able to choose whether to engage with it or not. It is important also that working usually entailed sitting at a desk for most of our participants, with the phone positioned in their peripheral vision, notifying participants of new notifications not through sounds or vibrations, but only by activating the screen. Thus, when participants were working, the phone clearly served as a glanceable display, which has important implications for design (see section 8.3).

The location participants are in also influenced locked use in our sample. While we did not observe a significant influence of participants being at home or at work on locked use, participants engaged in locked use significantly more often when they were outside, and significantly less often when they were on public transport. As commuting often leads to longer periods of idleness, participants either fully engaged with their phones or spent their time doing other activities (e.g. reading, listening to music) in our sample. This reproduces earlier findings on short bursts of smartphone use while being ‘on the go’, and longer interactions while being stationary (D. Ferreira et al., 2014; Licoppe & Figeac, 2013), but adds an important nuance for public transport, as commuting can be seen as a part of being on the go but appears to constitute idleness for users.

We further observed that our participants often used their phones during natural breakpoints in the flow of their activity, when they were switching from one task to another. In these instances, we found that participants significantly more often engaged with their devices in a full, unlocked way. This suggests that these moments provide an opportune moment to fully engage with the information that has arrived since their last unlocked interaction with the device, but has not required and immediate response or interaction. And it is exactly this information which participants had, in turn, ascertained and managed with lock screen checks previously. Again, the ability to use the lock screen as a glanceable display to come to quick decisions whether immediate action in response to a specific piece of information that has recently arrived on the smartphone seems to be one of the core functionalities of how participants in our sample engage with their devices. Locked smartphone use, thus, allows participants to alternate between full unlocked interactions that require more focused attention and are more time-consuming overall, and brief glances that allow them to return to their other activities quickly and to increase the duration of the intervals between instances in which they have to direct their full attention to the device.

On the other hand, we also observed that brief smartphone interactions sometimes are not so clearly purposeful or focused on efficiency. Participants described regular checks as automatic and unconscious, while holding, touching, and swiping on the device’s screen were characterised as natural and therapeutic. Here, the categories of locked use we identified tell an illustrative story of the phone as a *habit forming* device (Oulasvirta et al., 2012). Roughly half of all lock screen checks in our sample (51%), apart from notification glances, which are a response to the device’s functions, and proactive glances, occur as a response to contexts or environmental cues which participants have consciously and unconsciously earmarked for themselves as moments in which they can engage with the device. Locked use after setting down a glass or switching between work tasks on a computer are illustrative examples of this. Importantly, we find strong evidence that these habits are not merely, and perhaps not even mainly, driven by and rooted within the framework of the software of the device (e.g. swiping down to refresh the Email inbox), but in the hardware and the surrounding context in which users and devices are embedded. Given that the contextual cues associated with the different antecedents of locked use we have identified are ubiquitous in the daily lives of participants, it is not surprising that the majority of participants do not perceive what exactly causes the urge or 'brings to mind' the thought to pick up the phone. This is the reason why smartphone use is experienced as natural, automatic and almost unconscious by participants. However, with almost a third of the lock screen checks in our sample being proactive glances, and participants usually unable to give a concrete reason why they interacted with the device in these instances, it will be crucial to examine these moments in more detail, together with users, to develop a way towards how these interactions, and what causes them, can be studied.

An interesting starting point for further inquiry emerging from our data seems to be the salience of the device for participants. Whenever they had lost focus of their main activity, or their main activity ended, it appeared to be the phone that immediately attracted their attention in our sample. Moreover, a phone being talked about was sufficient in many cases for participants to engage with their devices, if only briefly.

Another potential explanatory factor can be found in our participants' descriptions of using the phone as a displacement activity. Following from the ethological observation of the behaviour of animals who, caught between two competing urges, find relief in a third, unrelated activity (Tinbergen, 1952; Tinbergen & Iersel, 1947), locked smartphone interactions in our sample that occurred when participants were idle or waiting for something out of their immediate control seems to reproduce these patterns. Also, proactive lock screen checks could arise from a tension between conflicting desires, and some participants provided indications that they check the phone as a means to escape an uncomfortable situation, for example when they were unable to answer question but felt that they should be, or when they wanted to get a specific task done but disliked or struggled with the work required to do so. However, in our second round of data collection focusing specifically on proactive smartphone use, participants did not usually report that they interacted with their smartphones as a form of displacement in these moments. Hence, further

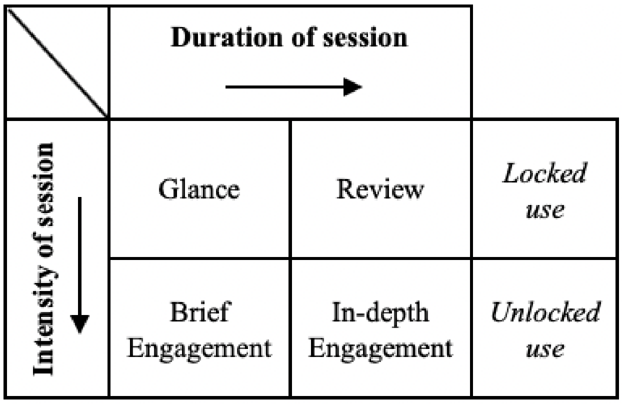


Figure 7. **Classification of types of smartphone interactions.**

investigation as to whether this is indeed the case or not, whether participants struggle with remembering or even consciously taking note of moments of cognitive tension that drive them towards displacement, and how the difficulty with recording this could be remedied will be required.

8.2 Classifying Smartphone Interactions

Overall, we also found ample evidence for the usefulness of classifying smartphone interactions into different types such as *glance*, *review*, and *engage*, based on their nature and 'intensity' as suggested in (Banovic et al., 2014). However, in our study, locked use (=glance sessions) made up only a quarter of all interactions rather than half. More importantly, however, based on the fine-grained differences in locked use we observed, our data suggests that both a lot of 'reviewing' as well as 'engagement' actually takes place during glance sessions, that is, locked use, which renders the naming of the categories counterintuitive. We suggest the label *glance* session should only apply to the shortest of instances of locked use in which users look for notifications or the time, do not interact with the touch screen, and move on with their activities immediately after the phone screen lights up. *Review* sessions would then apply to locked usage during which users spend more time on their phone, actually read notifications, or manage the information on the lock screen. Unlocked use should differentiate between brief interactions (the original *review* session category) and more in-depth interactions (the original *engagement* session category). The label 'engagement' could then be supplemented with qualifiers such as 'brief' and 'in-depth', or replaced by a label focusing on the number of apps used or different activities performed, as we observed 'engagement' and proactive use in other categories as well. Overall, this classification would yield a typology of two types of locked use during which users manage awareness (*glance* and *review* sessions), and two types of unlocked use during which users engage with information (*brief unlock* and *in-depth use* sessions), differentiated in their respective duration and intensity of interaction, which would, based on our data, more adequately represent the rough categories of smartphone interactions (see Figure 7). In a next step, when discussing habits around smartphone use more broadly, it will be highly informative to look at the antecedents of unlocked use as well and draw a more detailed comparison between locked and unlocked usage habits and cues (e.g. for switching between activities, which seems to trigger unlocked use, or proactive glances, for which the evidence is less clear). It will then, furthermore, be possible to look at the different types of smartphone use and see whether certain types of antecedents are more or less likely to lead to certain types of interactions.

8.3 Implications for Design and Interventions

Based on this analysis, we will now point to several pathways for design and interventions. Our data shows that being sedentary or spending longer periods of time at one place when users are not working is much more likely to lead to unlocked phone use when the device is picked up; when users are moving around or working, more brief instances of locked use follow, which also makes sense intuitively. From a design standpoint, ESM or Slide to X applications could tap into device data on whether people are moving or sedentary (which could also be supplemented with GPS patterns, but not everyone works in the same office every day). If repeated locked use occurs, users are probably working and want as little distraction as possible. When they are moving, they might be looking for specific information, but there is a chance that they would be willing to briefly interact with the phones when they are just walking around. Here, again, using data from the phone's sensors and position data to present information based on location, preferences, and predicted state the user is in may increase willingness to engage and overall take up, and reduce perceived disruptiveness.

Locked use also appears to be more likely to follow after the arrival of a notification. In line with participant interpretations, many notifications only require a quick glance rather than a full, unlocked interaction, and they use notification glances to manage their awareness of incoming information. However, although this allows participants to not miss out on and respond timely to important information, putting the phone into a setting that allows notifications to be delivered noticeably also causes more instances of external disruption where the information provided is not relevant, either situationally or generally. This is problematic because studies on interruptions show that users only return to their original activity after an interruption in 40% of cases (O'Conaill & Frohlich, 1995), that they take more time and make more errors completing it after being interrupted (Borst et al., 2015), and that they are more likely to self-interrupt after having been interrupted externally (Dabbish et al., 2011). Moreover, external interruptions have been shown to increase feelings of stress, time pressure and frustration, as well as perceived effort and workload (Mark et al., 2008).

Based on our observations, locked smartphone use following notifications shows a clear direction for notification design to revise the affordances of the device to reduce negative user experiences. And while ways to reduce the amount of interruptions by the device have of course been explored already to reduce interruptions (e.g. [19]), it is important to bear in mind that the phone not delivering messages will increase fomo and lead to subsequent self-interruptions. Therefore, systems that enable users to distinguish between different types of notification delivery for different applications and to easily prioritise them over each other in specific moments appear especially promising and could leverage findings on decreasing the overall disruptiveness of notifications, for example around batching (Fitz et al., 2019; Mark et al., 2016), predicting appropriate breakpoints (Exler et al., 2017; Okoshi, Nozaki, et al., 2016; Pejovic & Musolesi, 2014; Weber et al., 2017), and offering different and new types of notification delivery (L. Jones et al., 2017; K. Kobayashi & Yamada, 2013; Lopez-Tovar et al., 2015; Rasmussen et al., 2016). Users could, thus, distinguish between information that they want 'forced' upon them, be gently alerted to, and information that only needs to be included in the 'digest' the next time they check their lock screen to manage their notifications.

Moreover, more complex ways to interact with notifications on the lock screen check have already been shown to make device interactions more efficient (Banovic et al., 2014; Mayer et al., 2018), and while responding directly from the lock screen, for example, has been incorporated into most systems, features that allow for more complex sorting, clustering, or setting delayed reminders, for example, could be a fruitful way to incorporate the desire of participants to use the lock screen to manage their awareness of incoming information into software design. It is important to note, however, that a study has found that users may not actually make use of these more fine-grained settings when they are being given the opportunity (Westermann et al., 2016), which means more effort than simply providing these features may be required.

For *switching* or interrupting activities such as intellectual work tasks, but also everyday activities such as cooking, however, we observed a significantly higher chance for unlocked use to follow. It seems that users take the time to reset and relax their brains in between tasks and take short breaks. In these moments, participants engage with the information that the notifications they have often been managing on their lock screen prior to this full interaction represent, and the more complex sorting and response options described before can unfold their full effect for an efficient and enjoyable users experience. At the same time, they also describe being conscious that these breaks can spiral out of control and take much longer than planned. It appears that when users take their phones and are willing to unlock and properly engage with them, they are also in a receptive state of mind. This presents an excellent design lever for ESM and Slide to X approaches. Application designs could thus seek to harness participant desires for these breaks and try to provide tasks or content that combine the purpose of the application with the user's willingness to take a break, functioning as little 'brain teasers', while also highlighting that the type of break they are offering is more likely to be rewarding than uncertain scrolling through information on social media. More importantly, such approaches could emphasize the temporally limited nature of these breaks to not cause negative consequences for users by getting them 'caught in the loop' and causing cyberslacking (Heitmayer, 2020). A straightforward application of this could be an unlocking choice that allows users to swipe to choose a time for when they receive a reminder that their 'break time' is over (e.g. 1, 3, or 5 minutes), or to choose between different HITs (reading an article, filling in a survey, etc.) or different components of the ESM instrument (quick multiple choice or in depth-diary) to complete during the break depending on their length.

On the other hand, the automatic and unconscious instances of locked phone use, following after *handling the phone*, *physical motion*, and *proactive glances* are key examples for the automatic behaviours that are perceived as disruptive by participants and often do not generate informational gain or any other added value for users. From a design point of view, suppressing questionnaires or HITs on the lock screen when the phone is being connected to headphones or a charger, for example, could be used to try and increase acceptance and lower perceived disruptiveness for participants.

However, given that about half of the brief smartphone use we observed occurs automatically, triggered by habits or contextual factors, and keeping in mind issues around *fomo*, it is clear that changing the design of the device can only partly address these problems, which is why the user should be moved into the centre of the stage for interventions that aim to reduce problematic smartphone use and the perceived disruptiveness of devices. From an intervention point of view, these are the interactions that lead to negative feelings towards the phone for having it in one's hand constantly without knowing the reason why. They should, thus, be tackled to improve participant representations of the phone, and healthy device use overall. A starting point could be the previously tested *glanceable display* approach, e.g. changing the background of the lock screen to include a reminder to use the phone less or regularly display metrics based on usage statistics (see for example "Screen Time" on iOS).

The numbers of instances of *waiting* we observed in our data were relatively low, so we can only make some tentative suggestions. Studies on interruption management have shown that users perceive notifications from the phone when they are idle or waiting as the least disruptive, and actually welcome them as a distraction (Do et al., 2011; Exler et al., 2016). Our observations are in line with this 'common sense' interpretation, but it also appeared that participants often do not find what they are looking for when the perform a lock screen check in these instances. This may be because there was no relevant information available to be displayed to them, or because the options displayed were inappropriate for the situation they are in (watching a video with sound may not be desirable when queuing at the supermarket checkout, replying to an Email may take too long). If existing approaches like (Luo et al., 2019) can be further developed to efficiently predict that users are waiting for something external when unlocking the phone, these would be excellent instances to apply brief ESM or Slide to X treatments, not only increasing acceptance because they would not constitute disruptions in these cases, but also by leveraging the user's desire to reduce the time spent 'idling' and putting it to efficient use instead.

9. Limitations

We have employed a mixed-methods approach to triangulate our findings, but this study is ultimately based on data from 41 participants. Our sample only includes young adults, and two thirds of participants in the sample are university students. This study therefore presents a relatively narrow snapshot of the smartphone use of a group of users who to tend to be tech-savvier on average compared to older generations, but also distinctly differ in their usage patterns from younger users. It is therefore unclear how well the findings in this paper apply to different age cohorts, especially to the generally under-researched older parts of population compared to millennials and members of gen Z when it comes to smartphone use. Another issue is that the SEBE technique is heavy and labour-intensive for participants. Particularly the Replay-interviews require a lot of time and focus from participants, and it was sometimes not possible to fully explore everything that was recorded in the Subfilms, which is for example why we had to do a second round of data collection.

Another limitation of the technique is that the cameras are not always recording data, like logging applications would. We specifically noticed that smartphone use immediately prior to going to sleep and after waking up was talked about by our participants in the interviews, but they did not record these moments in the Subfilms, which is, although not surprising given the nature of the technique, problematic since smartphone use habits seem to be intimately interwoven with sleep (e.g. (Böhmer et al., 2011; Hadlington, White, & Curtis, 2019)). A detailed investigation of in situ smartphone use connected to sleep, although difficult, would provide a tremendous contribution to our understanding of smartphone use.

While quantitative approaches using device and application logs would not have been able to obtain some of the findings of our study, they produce more reliable data on the prevalence of usage patterns in society, which is needed to consolidate the evidence we have found. This, in combination with the mixture of conforming and contrasting results from previous studies substantiates the case for replication of smartphone use studies that has been argued in the mobile HCI community in recent years (Banovic, 2016; Church et al., 2015; Wilson & Mackay, 2011). We therefore believe that the use of in situ techniques should always be the first step in a line of research that attempts to understand situated user and device interactions and deeper underlying motivations in detail, and quantitative approaches should be used to triangulate these findings. It is also important to bear in mind that, while the differences in results may be due to the different study populations, there also might be a gradual shift in usage that may occur over the years, which is then reflected in differences between the 'snapshots' that individual studies take.

10. Conclusion

In this paper, we have investigated locked smartphone use with a situated first-person video ethnography technique (SEBE). We have observed eight different categories of contextual antecedents to lock screen checks which depend on the device, the user, and the situation they are in. From the qualitative analysis of the interviews with our participants, locked smartphone use has emerged as the 'middle ground' between not being distracted by the device too much and being alerted to relevant information, as well as not experiencing *fomo*. It was also used as a means to manage the way participants engaged with their devices and sometimes served as a displacement activity in moments where participants experienced discomfort. A large share of locked use, however, also appeared to be driven by automatic habits following from situational cues rather than by conscious choices participants made.

Our quantitative analysis confirmed these interpretations and revealed that lock screen checks are especially useful for managing the way participants engaged with information on their phones while they were working, but also that locked use is highly habitualised and automatic, which relates back to over-use and perceived disruptiveness of the smartphone. Importantly, because locked smartphone interactions were often triggered by environmental cues which mostly go unnoticed by users, they contributed to the perceived disruptiveness of the device and are the reason why smartphone interactions were described as unconscious and automatic in our conversations with participants.

Based on this analysis grounded in naturally occurring behaviour, we suggested that notification systems could be tailored more specifically to the different ways in which users interact with the lock screen to reduce the disruptiveness of the device and increase their efficiency at managing awareness of information that hey afford users. Specifically Slide to X and glanceable display approaches appeared appropriate to leverage differences in antecedents and purpose of locked screen use to improve user experience.

The next steps in this line of research will be to put the recommendations arising from our analysis to an empirical test, and to extend our findings on locked smartphone use to full, unlocked use and compare the two in more detail. Particularly a further development of the typology of smartphone interactions (see Figure 7), based on an in-depth characterisation of unlocked use, as well as a systematic investigation of the relationship between these different types of smartphone interactions and the different types of contextual antecedents to smartphone interactions will be informative. Lastly, our observations underline the importance of moving towards understanding habitualised behaviours and shaping embodied competences when it comes to smartphone use.

QCA Lock Screen Checks

Category	Subcategory	Description	Example
Managing Awareness	Staying up to date	Participants describe how they use the lock screen checks to stay aware of incoming notifications	Yeah, phone, checking that nobody wrote me and nothing interesting happened and back to work (P17) Here I check the phone to see the time. And I wanted to see if I had any messages from my supervisor telling me that I was late. Because I was late. (P28)
	Managing access/avoiding intrusion	Participants describe how they manage their use to the phone, and the notifications settings they choose	I just collect the notifications on the [lock] screen, and I can select myself when I see them and when not, so to speak. I collect them and then I delete those I don't want to see anymore. (P5) I try and put it a bit away on the desk but obviously if a message pops up then I want to answer right away. Not that I always do, but I want to. (P26)
	Impression management	Participants describe how the use lock screen checks to be seen in a specific way by others	You know, so it doesn't come up as read? Because sometimes it's something quite important. And I actually want to think about a response. And if it's important and I read it and ignored it then they're gonna be like: "Oy, reply, what's wrong?" (P37)
Displacement Activities	Boredom/ Need a break	Participants describe how they use lock screen checks when they are bored with or tired of an activity	I probably need a break. Yes. So usually when I do that, it's like I'm bored or tired or something like that. And checking the screen is a quick, easy thing that I can do, uhm, and get engaged for like a few seconds (P40)
	Escape from uncomfortable situation	Participants describe how lockscreen checks enable them to briefly avoid uncomfortable moments	If I'm in a situation where I feel a bit observed or scrutinize, or like at work, we're having a meeting about something and I'm not really sure what to answer to some questions, I might just like. My eyes might dart down, and I might look at my phone because it is a bit of a pacifier. (P41)
External Causes for Locked Use	Situational cues	Participants describe specific moments that lead them to check the lockscreen of their phone	I was sort of scratching myself and then just picked the thing up. (P39) Yeah I just took a break and since I'm standing there already I'll just check my phone. (P7)
	Environmental cues	Participants describe specific external cues that lead them to check the lockscreen of their phone	I think I was also getting really distracted by the washing machine. I was, you hear it right? It's spinning and it's very loud, and maybe it's like, again, sort of a reaction to check the phone. (P39)
Automatic & Unconscious engagement	"No clue"	Participants state that they do not know why they engaged with the device and sometimes provide possible explanations	So, I looked at my phone and didn't do anything. I have no idea what I did. I just went had a look I guess. (P14)
	Normal/Calming	Participants describe how interacting with the device feels normal and calming	I really don't realise it. It just feels normal. (P27) Yeah, it's like nice how it moves [picks up phone during interview and shows how he plays with the unlock pattern]. There, as you can see, I'm not doing anything. I'm just moving around the things. (P3)

F. PAPER 6: ETHOLOGY OF SMARTPHONE USE

In this section I present the published version of the sixth Paper that evolved from this research project, which presents a human ethology of smartphone use and outlines contextual cues as well as individual motivations to engage with the smartphone, in an attempt to tease out what drives smartphone use from the data. The working title of the Paper is:

> *Habit, Appetite or Addiction? Smartphones and Affordance for Distraction. An Examination of the Antecedents of Smartphone Use and Mindless Engagement with the Device*

I am the corresponding author of this Paper. This Paper has been jointly co-authored with Saadi Lahlou. I have contributed 70% of the work and my co-author has contributed 30% of the work. Saadi Lahlou has contributed to this Paper in the following way:

- Saadi Lahlou helped with the conceptualisation of the qualitative and quantitative analysis of the data.

- Saadi Lahlou helped in writing the draft of the Paper and provided continuous feedback and edits

1. Introduction

For many people around the globe, the smartphone has become one of the objects, if not *the* object, they interact with the most every day. Previous studies find that users interact with their phones between 10 and 200 times on average every day (Falaki et al., 2010). In recent years, the field has focused on problematic and addictive usage patterns, showing that users find it difficult to resist interacting with their phones in very regular and short intervals (Oulasvirta et al., 2012). But the frequent use of smartphones is not limited to "problematic" or "addictive" use. Most "normal" owners of smartphones have frequent, and apparently to some degree automatic, interactions with their smartphone, sometimes beyond the will of users themselves: Recent studies show that interactions with the phone occur more than users intend to or are happy with, but also more than they themselves take conscious note of (Duke & Montag, 2017; Heitmayer, 2020; Heitmayer & Lahlou, 2021). Furthermore, in many cases users do not fully unlock their devices during interactions and use them for a few seconds only, which questions the very rationale of the behaviour.

This raises several questions. Why do users actually reach for their smartphone? In what context do they do so? To do what? What reason do they give for the interactions that seem automatic? To address these questions and provide a better general understanding of smartphone use we have conducted an *in vivo* study using Subjective Evidence-Based Ethnography (SEBE, Lahlou, 2011), resulting in a dataset of over 200 hours of naturalistic video with 774 unique smartphone use sessions. Occurrences where users reach for their smartphone for no obvious reason were investigated in further depth through self-confrontation with the first-person perspective tapes users had recorded of their behaviour.

In this paper, we present evidence from first-person, audio-visual footage of user behaviour in naturally occurring contexts, in-depth interviews with participants based on the first-person footage, and a subsequent qualitative and quantitative analysis of the material to determine what drives smartphone use in naturally occurring contexts.

2. Related Work and theoretical backgrounds

Research on smartphone use has started to recognise that certain groups of users display seemingly ‘addictive’ behavioural patterns in various contexts. These behaviours are often subsumed under the term *problematic internet use* and research generally discusses the negative effects of smartphone ‘overuse’ and compulsive usage patterns (Ezoe et al., 2009; Horwood & Anglim, 2019; Marengo et al., 2020; Steelman et al., 2012). Especially habitual, routine patterns of smartphone interactions have been shown to lead to overuse (Davazdahemami et al., 2016; Oulasvirta et al., 2012; Walsh et al., 2008).

The literature has investigated problematic smartphone use in relation to a variety individual characteristics such as personality traits (Horwood & Anglim, 2018; Hussain et al., 2017; Marengo et al., 2020; Takao et al., 2009), emotional attachment-styles and anxiety (Baek et al., 2014; Contractor et al., 2017; Stanković et al., 2021), as well as psychological dependency on the device (Chen et al., 2017; Kaviani et al., 2020; King et al., 2013; G. Wang & Suh, 2018). Moreover, a lack of self-control has been associated with problematic smartphone use (Davey et al., 2020; Lyngs, 2019; Lyngs et al., 2019), even though recent studies argue that attentional impulsivity rather appears to be the main driver (Cudo, Torój, Demczuk, et al., 2020; Cudo, Torój, Misiuro, et al., 2020; Wegmann et al., 2020).

Problematic phone use has further been linked to lowered cognitive functioning and procrastination (Ezoe et al., 2009; Lepp et al., 2016; Rozgonjuk et al., 2018), problems with getting sufficient amounts of sleep (Edward Bernroider et al., 2014; Stanković et al., 2021; M. X. Zhang & Wu, 2020), and even the risk of physical injury, particularly connected to driving (Bendak et al., 2019; Crisler et al., 2008; Steelman et al., 2012), but also mobile gaming (Ayers et al., 2016; Faccio & McConnell, 2020). Lastly, frequency of daily use and its development over time have been shown to be associated to smartphone addiction (Y. H. Lin et al., 2015).

Because some users complain about their own behaviour, because some report that reaching for the smartphone is compulsive, because some report an urge to use the smartphone. and a “fear of missing out” (*fomo*; e.g. Fitz, Kushlev, Jagannathan, Lewis, & Paliwal, 2019), the idea that smartphones, like the internet, can produce addiction seems natural. Nevertheless, it also turns out that, for technical reasons, the actual behaviour of users is not well known, and that user reports are not reliable. Reported usage time was significantly lower than measured usage time, suggesting that users might underestimate their own use. Further attempts have, thus, been made to predict problematic smartphone use directly through the device (Y. H. Lin et al., 2015; C. Shin & Dey, 2013). For a systematic review on problematic internet use, see Busch & McCarthy (2021). But measures based on the smartphone use itself a) do not record the situation in which the smartphone was reached for, nor the motives of the user and her experience; and b) do not properly document “locked smartphone” interaction, where the user reaches for the phone but does not interact with its software (e.g. just looking at the clock, fiddling with the terminal, or looking for notifications on the lock screen). This led to the implicit belief that smartphones are disruptive because they prompt the user to interact; and this started a prolific stream of research on notifications and the unobtrusive management of user attention. But that belief is unsubstantiated. A recent study found that only 11% of all interactions with smartphones were initiated by a notification (Heitmayer & Lahlou, 2021). The vast majority (89%) is user initiated. The same study found that the phone is accessed on average once every 5 minutes, with a small standard error (95% confidence interval: 4:20; 6:15). The regularity of the behaviour suggests that some internal mechanism is at play that drives users to access their phones, which chimes with some user reports that the problem lies in themselves rather than in the device:

> *It’s kinda therapeutic to just like [gestures swiping fingers over a phone] move the things on the phone and play around with it. (P3)*
>
> *Yeah, here I was just looking for something to do on my phone. (P8)*
>
> *Well, I know I took it out there. I'm just fidgeting. Again, it's this thing, my partner got up to go get the cheese and the pepper that we needed to eat the pasta. And so I guess at that moment there is somebody doing something for me. I feel useless. So I take out my phone to let the moment pass. And I mean, you can see on the screen, right? I'm not really looking at anything on the phone or, say, I wasn’t checking my notifications because it was a very tough week of work and I was ruminating over some emails or whatever and checking if I had gotten an answer. I can tell you for sure, because I do this quite often, that I'm*

not really looking at anything in particular, I'm just letting the moments go by. (P42)

But then why do users actually reach for their phone? In what context do they do so? To do what? What reason do they give for the interactions that seem automatic? These are the research questions we address in this paper. To do so, we chose a detailed naturalistic approach that captures the behaviour in great detail and then enables introspection based on self-confrontation with the recordings, SEBE (see below). This technique is labour-intensive but powerful as it provides both detailed and complete empirical evidence on actual behaviour, and interpretation by the actors themselves.

3. Some hypotheses: smartphone as cigarette, smartphone as candy, smartphone as scratching one's head, cognitive attractors

We are exploring here the causes of the smartphone *Engagement Behaviour* (EB), that is, the action of initiating an interaction with the device, touching it and looking at it. This definition is wider than smartphone *use*, because there are instances where the person touches and looks at the device, but leaves the screen locked, or simply fidgets with the phone. The main issue here, which is at the root of all research on overuse or problematic smartphone use, is that in many cases the EB is not intentional; it is 'mindless'. We are therefore studying movements that are not the result of a decision-making process, where alternative possibilities are considered and weighed, but rather spontaneous, possibly involuntary, and sometimes even unconscious movements.

Such movements are in a bit of a grey zone in psychology, as it is difficult to get an account of conscious mental processes that led to the movement from participants, precisely because likely there weren't any. Current research in neuroscience has made considerable progress on the study of volition and of the precise moment when the decision to act, or the consciousness of motor command, takes place. To put it simply, there seems to be a gradual building up of a "readiness potential" in the moments preceding voluntary actions (Haggard, 2008, 2019). When a threshold is met, the movement is triggered. Interestingly, *consciousness* of the decision ('urge') to move occurs *after* the readiness potential started building up (Libet, 1985; Libet et al., 1983).

Yet even these fine-grained models do not tell us why the readiness potential grows; that is what the *motive* for action is. When a stimulus is present, we attribute to it the cause of the action, with the hypothesis that the stimulus evokes some neural activity which in turns builds the response; this is well in line with almost a century of experimental research on conditioning (Pavlov, 1927; Skinner, 1938). At least, that is, when the stimulus is clearly identified as such. Determining what is actually the stimulus for an observed action is not trivial unless one can run a controlled experiment. Put simply, we assume that some difference in the context is the stimulus only because we see a response that seems correlated with that difference (stimulus-contrast: Andrew, 1963). To be sure, we should also check all the moments where the 'stimulus' happens and see if the 'response' appears, too. Alas, this is very difficult in practice, especially when the stimulus is not a visible event in the context, but rather an internal change within the person (such as getting bored). Let us examine some of the classic forms of actions that are in this grey zone of mindless behaviour.

3.1 Habits

Habits are "any regularly repeated behaviour that requires little or no thought and is learned rather than innate. A habit - which can be part of any activity, ranging from eating and sleeping to thinking and reacting - is developed through reinforcement and repetition." (Encyclopaedia Britannica, 2021). The notion of habit involves a generic cause in its formation (repetition, reinforcement) but does not say much about the conditions for execution. We will assume here that habits are triggered in specific contexts, which reproduce the conditions of habit formation. As smartphone EB happens between 10 and 200 times every day, and in our sample every five minutes (Heitmayer & Lahlou, 2021), we can assume it is frequent enough to become a habit. Nevertheless that "habit" can have been reinforced by several types of activities or stimuli: answering to a ringtone, checking for a notification, and many other things. Several "habits" may therefore in theory be underlying the EB. Due to this vagueness, the concept of habit may not be very useful here in terms of explanation, but we should be able to verify that the presence of the phone as a salient stimulus increases EB.

3.2 Fixed action Patterns

Reaching for the phone has many characteristics of what used to be called in ethology a “fixed action pattern” (FAP). These actions are hardwired motor scripts that, when triggered by the appropriate stimulus, are executed to completion in an automated way, even if the stimulus disappears on the way (‘endogenous running out’). These actions, unlike reflexes, can be complex sequences of movements and reaching out for the phone, thus, could be one. FAPs were classically described initially by Tinbergen and Lorenz for actions connected with nesting and mating in birds and fish (Lorenz & Tinbergen, 1970; Tinbergen, 1952). The term FAP has been abandoned as behaviours are, as we now know, plastic rather than fixed; but the automatic release of stereotyped behavioural patterns remains a fact. More generally, release of an automatic behaviour is usually a combination of internal drive and external stimulus: the presence of the stimulus releases the execution of the stereotyped sequence (Schleidt, 1974). This is relevant for smartphone use as the reach for the phone appears as an automatic sequence of actions.

3.3 The hydraulic theory

Interestingly in cases where the animal has not had the opportunity to execute the behaviour for a long time, the FAP can be executed *without stimulus*, which is called a “vacuum activity”. This is believed to be caused by a gradual build-up of the motivation for that activity, in what Lorenz proposed as the “hydraulic model” (Lorenz, 1963). In this model, the “pressure to act” accumulates with time like in a hydraulic reservoir. The right stimulus opens the valve and the pressure to act is released as the action is executed. As a result, the consummation of the behaviour empties the pressure to act from the reservoir, which then starts filling up again until the next release. But if the pressure becomes too high in the reservoir, it may force the valve open and release the behaviour. For example, sparrows that have been deprived of hunting have been observed executing hunting behaviour “in vacuum”, chasing, and pretending to eat, non-existent flies in their cage (Lorenz, 1937). The hydraulic theory seems to apply well to some basic drives where consummation extinguishes the drive (e.g. feeding, reproduction, suckling), and where the motivation to act grows with duration of deprivation. In addition, the withdrawal from drugs produces a similar effect of a growing desire to take a dose. The hydraulic theory suggests the subject has embodied a constant "need" to execute the behavioural sequence, and that need grows with time so deprivation will increase the desire to execute it. This may be relevant here as some users appear to feel an increasingly pressing urge to reach for the phone after some time, at least with lengthy deprivation (e.g. a workday).

3.4 Appetite

But not all needs grow with time, and not all actions are stereotypic. FAPs and movements in vacuum can be seen as extreme cases of appetite, that is, the tendency to search for the stimulus of consummatory behaviour. This notion may be relevant here as reaching for the phone is a way to access what could be considered as consummatory behaviour: It allows getting social contact by accessing social networks or communicative apps, distraction from unwanted tasks or entertainment (e.g. by browsing videos or playing games), and reassurance of basic needs (reading the news, checking a stock portfolio, checking the weather forecast and the train service for the commute back home):

> *An appetite, so far as externally observable, is a state of agitation which continues so long as a certain stimulus, the appeted stimulus, is absent. When the appeted stimulus is at length received it releases a consummatory reaction, after which the appetitive behavior ceases and is succeeded by a state of relative rest, a state of satisfaction. The appetitive behavior serves to bring about the appeted situation by trial and error. The appetitive state includes a certain readiness to act. When most fully predetermined this has the form of a chain reflex. (...) The entire behavior of the human being is, like that of the bird, a vast system of cycles and epicycles, the longest cycle extending through life, the shortest being measured in seconds, each cycle involving the rise and the termination of an appetite. This view helps us to understand the laws*

> *of attention; for example, the law that attention cannot be held continuously upon a faint, simple stimulus. For as soon as such a stimulus is brought to maximum clearness, which constitutes the consummatory situation, the appetite for it is quickly discharged and its cycle comes to an end".* (Craig, 1917, p. 685)

In satisfying appetite we can control the execution of the behaviour and its modalities, but the availability of the stimulus and ease of access in the context are very important.

3.5 Addiction

Addiction is a step further in need than appetite. The subject feels an irrepressible need to perform the behaviour that releases the tension. While this definition could apply to any vital need (intake of air, food etc.) the term addiction is reserved to acquired behaviour that the subject could do without if she were not addicted, and especially drugs. As an example, the American Psychiatric Association defines substance abuse disorder as:

> *Substance use disorder (SUD) is complex a condition in which there is uncontrolled use of a substance despite harmful consequence. People with SUD have an intense focus on using a certain substance(s) such as alcohol, tobacco, or illicit drugs, to the point where the person's ability to function in day to day life becomes impaired. People keep using the substance even when they know it is causing or will cause problems. The most severe SUDs are sometimes called addictions. (Colon-Rivera & Balasanova, 2020)*

3.6 Displacement

"Displacement activity" or "Displacement reaction" (Tinbergen & Iersel, 1947) are movements irrelevant to the situation that can be observed when the subject is torn between incompatible or opposite courses of action. For example, an animal alternating between the urge to attack and to escape, neither of which can be carried out, finally is driven by this tension to find an outlet in an irrelevant action

(Tinbergen, 1952). Displacement activities in humans such as, finger tapping, fidgeting, lower-body position changes, self-grooming, head-scratching, etc., can be easily observed in people who face stress or frustration, and can be interpreted as a spill over of energy that releases some of the tension experienced by the subject. Barash (1974) provides an insightful illustration of humans torn between the desire to stay and to flee. As he notes humorously: "Curiously, individuals of this species [Homo sapiens] are known voluntarily to submit themselves to situations of great conflict. One of the most notable (and amenable to study) of these situations commonly occurs in waiting rooms of dental offices". And the observed patients in a dental office waiting room exhibited significantly more displacement activities than non-patients (e.g. those accompanying patients). Displacement activities may therefore be relevant here as phone fidgeting seems to occur in situations where the direction which behaviour should take is unclear (boredom) or contradictory (such as when the subject is busy with a task they wish to escape).

3.7 Cognitive attractors

One of the most puzzling phenomena in behavioural studies is that subjects often seem to do things they would prefer not to, although they actually have complete freedom to not do them. This is frequently the case in office settings, where workers get trapped doing Emails or wasting time in minor tasks, especially small routines, instead of doing what they consider important. Lahlou (2000, 2005) describes how subjects are led into a specific activity path by a combination of patterns in the context ("data") and corresponding representations in their mind ("lata") which, in conjunction, produce an automatic interpretation (in the musical sense of playing a sequence) of the context:

> *Cognitive attractor theory predicts that if a critical mass of data and connected lata are present, the drive for the corresponding activity spontaneously emerges (…) automatically, beyond the subject's will: "it just happens", just like a Gestalt imposes a pattern to perception when a sufficient portion of the pattern is present (…) The strength of attractors is a combination of three factors: pregnance (attraction of attention), value (attraction of desire) and cost to be completed*

> *(attraction of effort). (…) presence of the relevant data in the environment will change the probability of occurrence of a given activity. By affording a specific activity track, they will favour it over another possible activity. By evoking the associated lata, they may induce motivation for an activity in subjects among participants initially without motivation. (…) As long as the activity is fluid, with continuous coupling with the environment and adequate system response, chances are that the subject will continue on the same track. But if some obstacle or failure occurs, there may be a recomputation of "what to do" and some locally stronger attractor may take over. For example, in the course of some activity, Robert needs to send an e-mail to someone. He opens his mailbox to do so and sees a just-arrived message from his big boss. Chances are he will open the message, and get side-tracked.* (Lahlou, 2005)

This may be relevant here as the phone appears to be the most prominent cognitive attractor that participants find around themselves. In moments where a break in the flow of activity occurs, participants are particularly vulnerable to direct their attention to the smartphone and reach out for the device. This is in line with the notion of *valence* or *Aufforderungscharakter* as defined by Kurt Lewin:

> *It is common knowledge that the objects and events of our environment are not neutral towards us in our role of acting beings. Not only does their very nature facilitate or obstruct our actions to varying degrees, but we also encounter many objects and events which face us with a will of their own: they challenge us to certain activities. (…) A stairway stimulates the two-year-old child to climb it and jump down; doors, to open and to close them; small crumbs, to pick them; the chocolate and a piece of cake want to be eaten. (...) The intensity with which objects and events challenge us varies greatly. The shadings of such challenge range from "irresistible temptations", to which child as well as adult yields unthinkingly and against which self-control is little help if at all, to those which have the character of "command", to the weaker "urgings" and "attractions", which can be easily resisted and become*

> *noticeable only when the person tries to find something to do. The term "valence" comprises all these shadings". (Lewin, 1926, 1999: 95)*

The notion of valence has been abandoned because it changes with the state of the subject and is therefore not a very operational concept. Lewin himself noted that:

> *For instance, someone intends to drop a letter into a mailbox. The first mailbox he passes serves as a signal and reminds him of the action. He drops the letter. The mailboxes he passes thereafter leave him altogether cold. In general, the occurrence of the occasion (referent-presentation) as a rule has no effect once the intentional action has been "consummated". (Lewin, 1926, 1999: 84).*

Gibson suggested the notion of affordances (the actions the object allows the subject)[12], which do not change once the need of the subject is resolved (Gibson, 1982). In practice, the Aufforderungscharakter of the phone remains largely the same for users. The crux with smartphone, as our participants note, seems to lie in the fact that "it has everything" (P4) and, thus, provides the polyvalent affordance of "something to do" (P26). Let us note furthermore that the smartphone contains per se most of the components necessary for many types of small activities, without requiring anything beyond the user herself. This makes it a ready-to-use "installation" (Lahlou, 2017) for short activities. That characteristic, as we shall see later, is crucial.

3.8 The influence of sight and reach

The models above stress the importance of how available and easy to reach the triggering stimulus or object instrumental to the consummatory behaviour is in the environment. A highly interesting experiment on mindless consumption of hedonic food provides further qualification on this: Painter and colleagues investigated how the visibility and the convenience of access influenced consumption and perceived consumption of a hedonic food (Painter et al., 2002). Participants were given a

[12] "Roughly, the affordances of things are what they furnish, for good or ill, that is what they afford the observer. . . they are ecological, in the sense that they are properties of the environment relative to an animal (...) Affordances do not cause behaviour but constrain or control it. Needs control the perception of affordances (selective attention) and also initiate acts. An observer is not 'bombarded' by stimuli. He extracts invariants from a flux of stimulation." (Gibson, 1982)

closed container holding chocolates that was either placed on top of their desk, where it was convenient and visible, in a drawer, where it was convenient, but not visible, or on a shelf two meters away, so it was visible but participants had to leave the desk to obtain the candy. The mean consumption of candies was: 8.6 per day for visible and convenient, 5.7 for not visible, but convenient, and 3.0 for visible but inconvenient; and participants slightly overestimated their consumption of the visible candies, and underestimated their consumption of the non-visible ones (Painter et al., 2002). It appears we eat more hedonic food when it is "in sight and in reach". This finding is in line with the observation that participants feel they are better able to manage their phone use when it is out of reach and our sight (Everri, 2017; Heitmayer, 2020; Heitmayer & Lahlou, 2021), but also reflects the surprise at how often they use their smartphone many participants expressed when they watched their own video footage.

3.9 Summary

As we have seen, in the classic digital media literature, reaching for the phone tends to be classified as *problematic use*. This is mostly based on a negative evaluation by users themselves, but does not provide a clear explanation of how and why this behaviour occurs, except for 'habit' or 'addiction', which are descriptive rather than explanatory. The ethological literature provides descriptions and explanations of a wealth of seemingly similar behaviours, ranging from the automatic and irrepressible execution of hard-wired, stereotyped action scripts (FAP), over the loose coupling of an appetite in the subject, to the presence of an 'attractive' and easily reachable object triggering opportunistic satisfaction by consummatory behaviour.

The 'cause' of a behaviour can be attributed to an external stimulus, or an internal drive, or a combination of those. More generally, the behaviour will be more likely to emerge if there is a sufficient degree of internal motivation and an opportunity to execute it. The greater the motivation, the more salient the affordance and the easier the opportunity to execute the behaviour, the more likely it will occur. Consciousness of these various components is not necessary for the behaviour to occur, as the interpretation can become automatic with reinforcement and create a shortcut from situation to action, where conscious decision-making is bypassed or occurs after the fact. Recent literature, following the remarkable review by (Stanovich & West, 2000), has popularized the difference between “system 1” processes (a variety of more or less automatic, associative, fast processes) vs “system 2” (slower, analytic, controlled) processes of reasoning involving higher cognitive functions. The EBs we study here are at best system 1 ; in fact there does not seem to be any reasoning here.

It is also suggested that some moments of the activity course, especially when a contradiction, obstacle, or the end of a step occur, are more prone to triggering mindless behaviour (see the discussion on valence and attractors above). Can we empirically determine if, between these various models, one or several are more relevant for smartphone reach? Assuming we are able to capture all the occurrences of such behaviour, we can hypothesize :

H1 (Smartphone use as satisfying appetite):

- If smartphone use is driven by appetite for something, or for phone use itself, we should observe many occurrences where subjects actively search for their phone when it is out of reach. We also expect to see an increased likelihood in smartphone use when users are idle (as the appetite would then have no other drive to compete with), and as a displacement action when they are distressed or frustrated (where smartphone use presents itself as a good, third option versus the conflicting pair).

H2 (Smartphone use as addiction)

- If smartphone use has become an addiction, we should observe a relative stable frequency of interactions over time for spontaneous (i.e. user-initiated) smartphone use, likely following a Poisson law. We also expect an increased likelihood of interactions the longer a user has not interacted with the smartphone (hydraulic theory; the urge for EB increases with time), an “intense focus” on the smartphone and in some cases an irrepressible urge for EB.

H3 (Smartphone use as pure habit triggered by availability):

- If smartphone use is influenced by ease of access, we should observe more frequent and longer interactions when the phone is visible and within reach. We should also observe participants choosing to interact with their phone over other activities in moments when their flow of activity is interrupted (cognitive attractors).

H1, H2 and H3 are not mutually exclusive; we will explore which one is the most likely, or whether some take precedence over the others.

4. The present study

Many existing studies report difficulties with noise in the data due to technical issues such as a distortion of usage time caused by different display timeout settings, or differences in user habits, such as switching off the phone after use versus letting the device timeout automatically (Falaki et al., 2010; Hintze, Findling, Muaaz, et al., 2014). Moreover, relying exclusively on the smartphone to collect data on user behaviour limits what can be observed to the device and its sensors, ignoring crucially important context. User-reports alone, on the other hand, are prone to participants not or mis-remembering their actions, and studies show that smartphone logging and user-report data are only moderately correlated (Boase & Ling, 2013; Junco, 2013; T. Kobayashi & Boase, 2012; Scharkow, 2016). To address some of these issues, in this paper we use SEBE, a video-based, *in vivo* technique that combines qualitative and quantitative methods to study locked smartphone use in more detail (Lahlou, 2011; Lahlou et al., 2015). SEBE is especially valuable for explorative studies aiming to investigate user behaviour while it occurs, as it provides rich, contextual user data, and incorporates ‘checks and balances’ that avoid misremembering by participants and misinterpretation by researchers. The SEBE protocol consists of three phases: First, participants are given unobtrusive, miniature cameras worn at eye-level (*Subcam*, see fig. 1) to gather first-person video material (*subfilms*). This enables participants to go about their lives naturally, without being disrupted or distracted, while gathering complete data on their daily experiences (first-person perspective, wide angle, stereo sound recordings).

In the second step, the Replay-Interview, participant and researcher watch the subfilms together and discuss salient moments in the tapes. Here, participants can explain and reflect on what is happening in the tape, and they can object to interpretations by the researcher and suggest alternatives as they relive their experiences. Crucially, these interviews usually unearth things that go unnoticed by participants in the course of the action as the videos can be rewound, slowed down, and stopped. Most importantly, reviewing one's own first-person perspective recordings elicits accurate remembrance of actions, intentions, and emotions – similar to re-enactment or an access to episodic memory (Glăveanu & Lahlou, 2012; Lahlou, 2011; Tulving, 2002). Finally, the researcher is left with many hours of situated first-person videos and a set of interviews, which can be analysed with different quantitative and qualitative techniques.

SEBE is particularly relevant for the study of smartphone use as it allows, unlike stand-alone interviews or any type of server- or smartphone-log method, to document the interaction of the physical and the digital environments users find themselves in, as well as both their use of the device and their lives around it. In the field, wearable video has proved its value to study the use of smartphones (B. Brown et al., 2013, 2015; Everri, 2017; Figeac & Chaulet, 2018; Gouveia et al., 2018; Licoppe & Figeac, 2013, 2018) and smartwatches (D. McMillan et al., 2017; Pizza et al., 2016) to provide insightful initial accounts of situated smart-device use. The Replay-Interview presents a useful addition to this as it leverages multimodal episodic memory and offers an insight into the cognitive and emotional experience of the user behind the behaviour itself.

Figure 1. A researcher wearing the Subcam. The camera weighs only 7 grams and can be mounted on a pair of research glasses or the user's own (here); it has about 3 hours of autonomy with the internal, and several days with an external battery.

5. Data Collection

The SEBE protocol includes stringent ethical guidelines ensuring participants' full control over the data all the way they were followed (Everri et al., 2020); the protocol received ethical approval at the London School of Economics and Political Science. Participants have been asked to wear their Subcam throughout the day while engaging in everyday activities as they would normally, to observe how they use their smartphones in different settings. Data collection took place in the UK, France, and Germany, with the majority of participants being residents of the Greater London area, generating an international, but mainly European sample of n=41 participants. The age of participants ranged from 21 to 29 years with 46% being female.

Participants have furthermore been instructed to only wear the camera in situations in which they felt comfortable and could forget about wearing it. Allowing participants to self-select when to wear the Subcam results in more natural behaviours, while also protecting their privacy, and it gives each individual the opportunity to document the parts of their lives they deem the most relevant. As part of the protocol, participants are regularly reminded they can delete data if they feel they have recorded something uncomfortable. No participant used this opportunity. This has generated a data corpus spanning a breadth of activities and locations like commuting, working in the office, attending lectures at university, going to the supermarket or the museum, or spending time with friends and family. Throughout we observe a rather even spread of subfilms recorded at home, at work, and outside.

The replay-interviews have been transcribed literally and prepared for analysis using *directed Qualitative Content Analysis (QCA)*. These transcripts make up a large corpus of complex, qualitative data, which needs to be structured and reduced to become manageable and comprehensible. QCA is perfectly suited to analyse such data, since it does not aim to fully describe the material. Rather, the goal of QCA is to carve out salient topics and unearth emerging ideas from the data corpus in a circular process, and to describe them in a coherent and systematic way (Mayring, 2000, 2015; Schreier, 2014), to generate valid and replicable results that are "divorceable from the authority of the researcher" (Krippendorff, 1980, p. 18). The interviews from the initial phase of data collection (n=37) covered a broad range of topics around smartphone use reported in more detail elsewhere (Heitmayer & Lahlou, 2021). To show trends, patterns and differences amongst participants, then, we followed an ethological design for the quantitative analysis of the subfilm data. For every instance during which participants used their smartphones on tape, we recorded duration, time elapsed since last phone interaction, location, type of interaction, where the phone was in the physical space, the context they were in (e.g. working at the office, commuting), whether there was a notification (and if so, what type), and the nature of the activity. Overall, this resulted in a dataset of n=774 unique smartphone use sessions.[13] After having gained this general picture of contextual smartphone use, we carried out a second round of Subcam data collection and Replay-Interviews (n=4) to discuss moments in which it was unclear from the Subfilms why participants picked up the phone in more detail with the participants (proactive use; see below). Overall, the data corpus comprises over 200 hours of video material. This large and rich data corpus enables an analysis of real-life smartphone user behaviour on an unprecedented level.

[13] Unfortunately, the subfilms for three participants were corrupted in the transfer process after the interview, resulting in an N=34 for the quantitative analyses.

6. Context of smartphone use

We now focus on the contexts and causes of smartphone interactions in our sample. Based on participant comments in the replay interviews and an analysis of the subfilm data, we have categorised the 774 unique instances in which participants picked up their phone in our sample into 10 different categories (*archetypes*) of antecedents (i.e. context at the onset of the reach gesture) of smartphone use, which we will discuss in the following (see fig. 2).

6.1 Proactive Pickups

For roughly a third of the interactions in our sample (31.6%), we did not observe any contextual cue that led participants to pick up their phone. In these situations, participants interrupted the flow of their current activity out of their own motivation and proactively picked up the phone. We also did not observe an extended "build-up phase" prior to the interaction. This archetype represents interactions that are fully driven by the whim of participants and must also encompass instances where thinking about the phone intrudes into participants minds, as well as habitualised checking behaviours. It is of course not possible to look inside the head of participants, but for some instances of proactive pickups, participants were able to give us a clear reason, as expected, while SEBE provides us with detailed, contextual data:

> *I remember that day I was really tired. And I was just thinking about things that I had to do. And then, [watching] the film is part of work, but I was kind of losing time, it just took two hours basically not working. Well, working, but not like other work. And so yeah, I think I was thinking about things I had to do and emails to reply to and um, I don't know why I picked up the phone during this particular scene, but I wasn't engaged with the thing.* (P38)

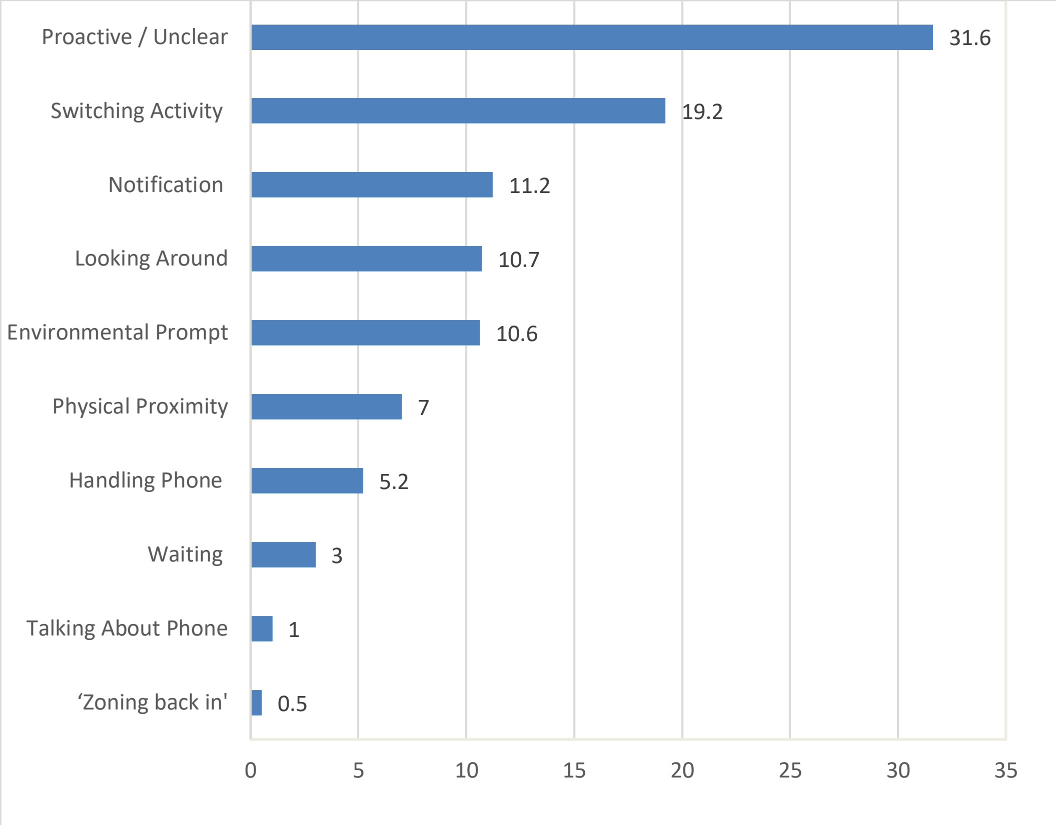


Figure 2. Ten different types of contextual antecedents to smartphone use (n=774).

Nevertheless in the majority of cases that we classified as *proactive pickups;* participants did not know themselves why they interacted with their phone:

> *So I looked at my phone and didn't do anything. I have no idea what I did. I just went and had a look.* (P41)

6.2 Switching Activity

Participants also often used their smartphones when they switched from one activity to another, such as after sending out an Email, when switching to a different software, finishing cutting vegetables or tidying up the room, but also when there were natural breakpoints within activities such as finishing writing a paragraph in an Email, or turning the page of a book while reading.

> *It's just a moment where I don't think. But it's also curiosity, what are my friends doing? But not even that... Yeah it is almost automatic: 'Ok. Break, drink, [pretends to pick up phone]. Nothing interesting happening, [pretends to put phone back down], focus.' (P17)*

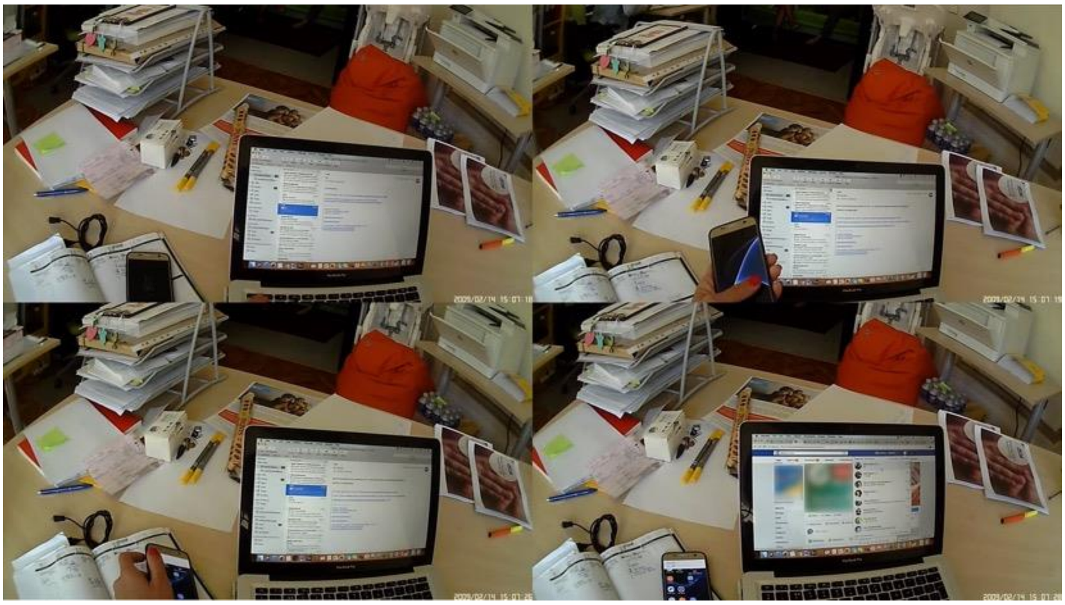


Figure 3. A participant finishing working on an Email on their laptop and using their phone before switching to facebook on the laptop (clockwise from top left).

Curiously, we observed that participants inhaled and exhaled deeply when they have finished their first activity, before they pick up the phone, and after finishing using the phone, before starting the following activity almost every time they used their devices during a switch. These breathing patterns seem to be markers of a release of cognitive load or a cesura in the flow of activity and warrant further investigation. The same type of 'sigh' has been observed in another SEBE study when participants passed the threshold of their home when coming back after a day at work, and was interpreted as a sign of relaxation (Cordelois, 2010).

6.3 Notifications

Notifications were the third most common precursor to smartphone interactions in our sample (11%). Receiving a notification immediately led participants to interrupt their current activities, often moving the device into their visual fields with an illustrative jolt of the head (see fig. 4). These interactions exemplify the perceived disruptiveness of the smartphone when it does indeed relay notifications to the users. However, given that notifications precede only 11% of all interactions in our sample, this finding also purports that the vast majority of interactions are initiated by participants and arise out of the context (Banovic et al., 2014; Church et al., 2015; Heitmayer & Lahlou, 2021). Notifications arrive in the form of sounds, vibrations, and visual only (i.e. the screen lighting up), the latter of which made up two thirds of all notifications observed in the sample.

6.4 Looking Around

Another common trigger of smartphone use was the device simply moving into the visual field of participants when they were looking or walking around, or sitting down with the phone within arm's reach (see fig. 5). In cases where participants are looking around as a precursor to smartphone use, they either do not have an immediate main task they are currently pursuing, or they are moving their heads while being engaged in another task (i.e. repositioning oneself on a chair, getting a cooking ingredient from a shelf) which then moves the phone into vision and allows it to intrude into the flow of activity.

6.5 Environmental Prompt

Sometimes the situation or the environment itself that participants found themselves in called for a use of the phone. Typically, the phone functioned as a tool in these interactions, for example when participants used their phones as a stopwatch to time an event, to find the title of a song that was playing in the radio with Shazam, or to take a photo. Similarly, paying with the phone or showing a digital ticket or boarding pass are instances of environmental prompts.

6.6 Physical Proximity

Another common trigger of smartphone interactions was participants moving closely by the phone, or interacting with objects in close physical proximity to the device. Illustrative examples were picking up or putting down a mug or a tv remote in close physical proximity to the phone, which led participants to interact with their devices. Similarly, stretching or scratching oneself often triggered smartphone interactions as participants were moving their hands already and had caused an interruption in their current activity.

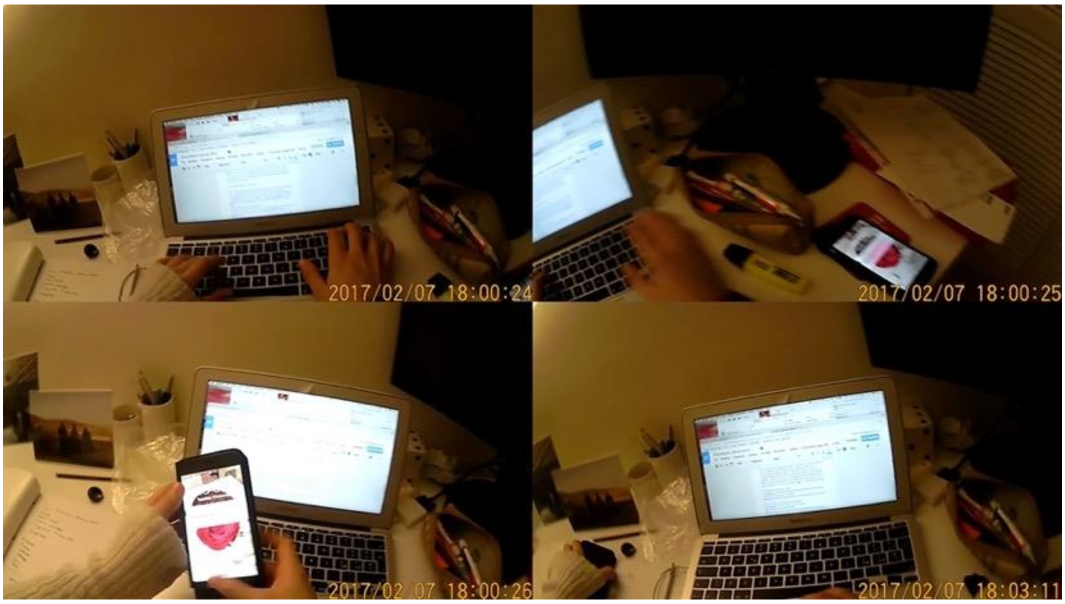


Figure 4. A notification disrupting work on a laptop (clockwise from top left). The participant immediately turns their head towards the phone and picks it up when the device's screen lights up (see time stamps of frame 1-3). The participant then returns to their original task 2min and 46s after the interruption.

6.7 Handling Phone

Another situational trigger that led participants to interact with their devices was when they were handling their phones as physical objects without the intention of using it. Typical cases comprise rearranging objects on the desk and, thus, moving the phone, picking up the phone to place it in a bag or pocket, or connecting the phone to a charging device (see fig. 6). Naturally, smartphone use that follows after handling the phone is highly conducive to fidgeting as there is not a clear, immediate purpose for interacting with the device properly, as compared to moving it around as an object in surrounding space.

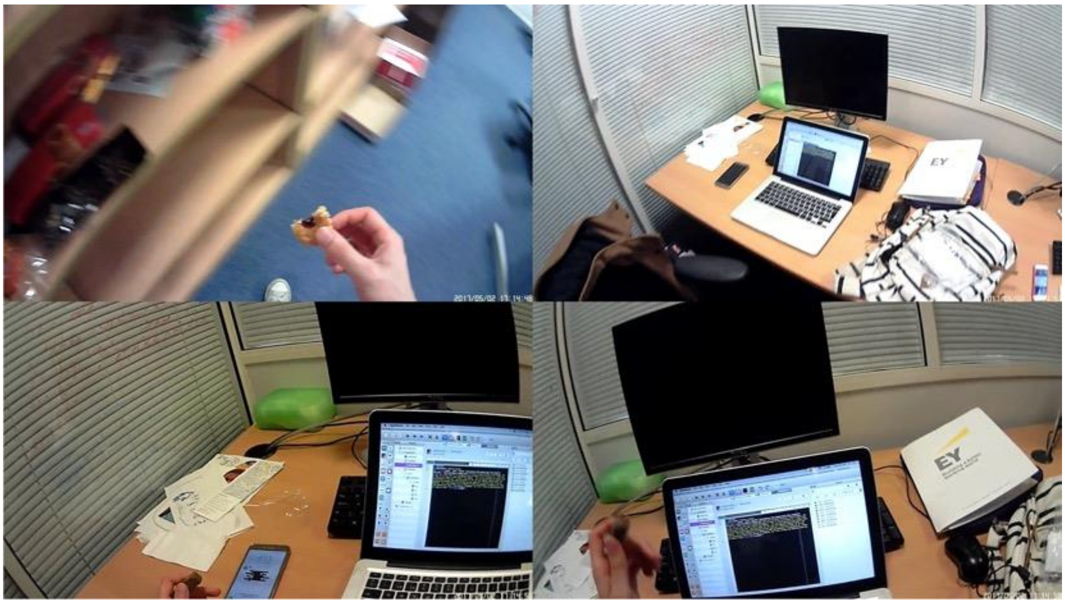


Figure 5. A participant fetching a biscuit and checking their phone after sitting back down (clockwise from top left).

6.8 Physical Proximity

Another common trigger of smartphone interactions was participants moving closely by the phone, or interacting with objects in close physical proximity to the device. Illustrative examples were picking up or putting down objects like a mug or a tv remote in close physical proximity to the phone, which led participants to interact with their devices. Similarly, stretching or scratching oneself often triggered smartphone interactions as participants were moving their hands already and had caused an interruption in their current activity.

6.9 Handling Phone

Another situational trigger that led participants to interact with their devices was when they were handling their phones as physical objects without the intention of using it. Typical cases comprise rearranging objects on the desk and, thus, moving the phone, picking up the phone to place it in a bag or pocket, or connecting the phone to a charging device (see fig. 6). Naturally, smartphone use that follows after handling the phone is highly conducive to fidgeting as there is not a clear, immediate purpose for interacting with the device properly, as compared to moving it around as an object in surrounding space.

Figure 6. Checking the phone prior to connecting it to the charger.

6.10 Waiting

Brief periods of idleness, typically while participants were waiting for their computers to load or launch something, but also everyday activities such as queueing for a coffee or waiting for a bus, were antecedents to smartphone use in our sample. Interactions following from waiting further reflect the sentiments expressed by participants around optimising the use of their time in situations where they have nothing else to do. Moreover, one participant described that they checked their phone because they did not want to *look like* they have nothing else to do: "I'm just going on it because I'm awkwardly standing in line" (P27).

6.11 'Zoning back in' and Talking About Phone

The last two types of antecedents only make up a small percentage of our sample, partly also because they are difficult to observe. Nevertheless, we found it important to report on these as well. On a few occasions, participants had 'zoned out' for a moment, e.g. stared onto a wall or out of a window being completely idle, or fully fell asleep (which we have only been able to capture on tape once). Once they returned from that idleness, usually marked by shaking their head and heavy breathing, participants immediately checked their phones, both as a clock but also to see whether messages had arrived. Yet, in none of these cases, even where notifications had arrived, did they fully interact with their phones immediately.

Instead, they took a moment to fully get back to their senses before interacting with their phones in an unlocked state. These findings resonate with participant comments on the intimate relationship with the phone and sleep: For example, it was mentioned that “the phone is the first thing I check after I wake up” (P18) and “the light of the phone helps waking up the eyes” (P10). Again, these findings also hint at the compulsive nature of *fomo* that leads participants to interact with their devices. Lastly, when phones or apps were mentioned in a conversation, both as a general topic (“Have you heard that the WhatsApp servers were down all over Europe for 30 minutes yesterday?”) or the user’s own device in specific (“Should I send them a text and ask if they want to grab a drink tonight?”), participants picked up and checked their phones.

7 Data Analysis

We now turn to the quantitative analysis of the first-person Subcam videos gathered by our participants. Given the nature of our data and our sample size, we investigated the relationships between the key variables around smartphone use we observed using non-parametric tests (Fisher’s exact test and the Kruskal-Wallis H test where appropriate).

Firstly, 89% of smartphones interactions we observed in our sample were initiated by users. Of the 11% that were initiated by a notification, 59% were visual only, as compared to sound, vibration, or a combination of these. The phone was visible to participants prior to their interaction with it 89% of occurrences, and accessible within arm’s reach 94% of occurrences; only in 2% of the cases did participants have their phones neither visible nor within immediate reach. The majority of the smartphone use sessions we observed in our sample (78%) consisted of participants using one app or doing one task only. About 12% of sessions comprised of 2, 6% of 3, and 4% of 4 or more apps or interactions. These numbers remain the same regardless whether the interaction was initiated by the device (i.e. through a notification), or by participants, highlighting that habitual interactions and participants’ internalised ‘drive for the screen’ appear more important than circumstantial factors. Smartphone use sessions lasted 64s on average, with 25% of sessions lasting 6s or less and 50% 24s or less.

Looking in more detail at mean duration for amount of interactions in the session, we find that going beyond a single interaction leads to a highly significant increase in the duration of the session, almost tripling the mean from 39s for sessions with 1 interaction to 153s for sessions with 2 ($H(1) = 77.981$, $p < .001$). Sessions comprising of three interactions also lasted slightly longer on average than sessions with 2 interactions (209s, $H(1) = 9.278$, $p = .002$). Lastly, while the mean duration of sessions consisting of 4 or more different interactions or app lasted much longer than shorter sessions (649s), this can be attributed to outlier cases and a low number of observations of sessions beyond 3 interactions (139); we did not find a significant difference in duration between sessions consisting of 3 versus 4 or more sessions ($H(1) = 2.198$, $p = .138$, see fig. 7).

The time between different smartphone use session averaged at 291s, with 25% of intervals between use being 40s, and 50% being 137s or less. Using these averages, our findings purport that participants engage with their phones for 10 minutes every hour in a 'one minute every five minutes' pattern (Heitmayer & Lahlou, 2021).

7.1 Effect of context on characteristics of smartphone use

Firstly, testing the influence of contextual antecedents and being at home, we only observed a significant interaction between waiting and being at home ($p = 0.001$). Unsurprisingly, participants were using their phones more while they were waiting for something when they were not at home (4.8%, 20/409) compared to when they were (0.8%, 3/366). In addition to that, using the phone because participants were moving in proximity to the phone occurred significantly more often when they were at home (8.7% (32/366) vs. 5.4% (22/409), $p = .045$).

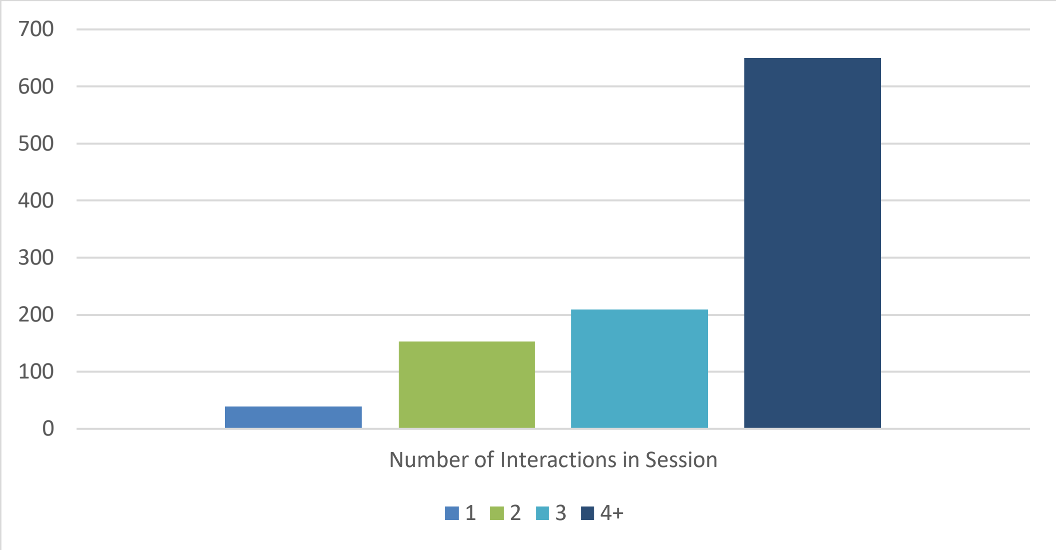


Figure 7. Mean duration of smartphone use sessions in s by number of different interactions in session.

Testing further the influence of context on smartphone interactions during work (at home or at the workplace) we find that proactive interactions occur significantly less when participants were working (10.4% (63/347) vs. 42.5% (182/428), $p <$ .001). On the other hand, contextual factors that bring the phone into the awareness of the users appear to be more likely to lead to smartphone interactions while participants were working: switching between tasks (27.4% (95/347) vs. 12.6% (54/428), $p < .001$) and notifications (19% (66/347) vs. 4.9% (21/428), $p < .001$) were more likely to be antecedent to smartphone use while participants were working.

When participants were alone, notifications were more likely to lead to an interaction (14.2% (55/387) vs. 8.2% (32/388), $p = .006$). Similarly, proximity use also occurred more when participants were alone (9.6% (37/387) vs. 4.4% (17/388), $p = .003$).

When the phone was not in the visual field of users, participants picked their phones up proactively significantly more compared to when it was visible (64.6% (62/96) vs. 26.9% (180/669), $p < .001$). This was especially the case in waiting situations when the phone was not visible; then users reached for the phone more often (10.4% (10/96) vs. 1.9% (13/669), $p < .001$), On the other hand, notifications (12.7% (85/669) vs. 2.1% (2/96), $p < .001$) and situational cues like moving in proximity to the device (7.9% (53/669) vs. 1% (1/96), $p = .005$), looking around (97.5% (78/669) vs. 2.1% (2/96), $p = .001$), and switching between activities (20.9%

(140/669) vs. 6.25% (6/96), $p < .001$) led to significantly more interactions when the device was visible.

Not a single interaction was initiated by notifications in our sample when the phone was not easily accessible to participants (0% (0/51) vs. 12.2% (87/714), $p = .002$). Similar to visibility, switching between activities is also more likely to lead to interactions when the phone is within the reach of users (20% (143/714) vs. 5.9% (3/51), $p = .006$). When the phone is not within the immediate reach of participants, handling the device 19.6% (10/51) vs. 4.2% (30/714), $p < .001$) and environmental prompts (25.5% (13/51) vs. 9.5% (68/714), $p = .001$) led to more interactions.

Testing for the effect of the different antecedents of smartphone use we observe on duration of sessions, we find that proactive use appears to increase mean duration of smartphone use sessions by 79s ($H(1) = 4.589$, $p = .032$). Similarly, waiting increased the duration of interactions by 26s ($H(1) = 8.084$, $p = .005$). When participants were merely handling the phone, on the other hand, the duration of interactions was 78s shorter (H $(1) = 14.53$, $p < .001$). Note that although notifications appeared to have a negative effect, reducing the duration of interaction of sessions by 58s, which is in line with previous findings, this finding is highly insignificant ($H(1) = 1.055$, $p = .3043$). Participants handling the device as a physical object, moving it to the side to make place for a mug on a desk for example, or to connect it to a charger unsurprisingly leads to locked use, and often shorter interactions, and (9.7% (18/186) vs. 3.7% (22/589), $p = .002$).

7.2 Causes for specific smartphone activities.

We observed a variety of different smartphone activities in our sample with WhatsApp (21.6% of all interactions), lock screen checks (16.5%) and Instagram (15.5%) being the most frequent (for a more detailed discussion of smartphone activities see Heitmayer & Lahlou, 2021). We will now present some of the results regarding the most prominent activities in our sample and the different antecedents that led to smartphone interactions.

WhatsApp (the most commonly used instant messaging app in Europe at the time of this study) follows more often after notifications (22.4% (41/183) vs. 7.8% (46/592), $p < .001$), and when participants were waiting (6% (11/183) vs. 2%

(12/592), p = .009. Conversely, when environmental cues solicit smartphone interactions (1.6% (3/183) vs. 13.3% (79/592), p < .001), or when participants were handling the phone (.5% (1/183) vs. 6.6% (39/592), p < .001), WhatsApp was less likely to be used.

Just like WhatsApp, use of the facebook messenger is also significantly more often preceded by notifications (21.6% (11/51) vs. 10.5% (76/724), p = .02; 13.7% of all notifications) and follows less often after environmental prompts (2% (1/51) vs. 11.1% (81/724), p = .02).

Instagram, on the other hand, follows less often both after notifications (1.6% (1/64) vs. 12.1% (86/711), p = .003) and environmental prompts (3.1% (2/64) vs. 11.3% (80/711), p = .024), but more when participants are switching tasks (29.7% (19/64) vs. 18.3% (130/711), p = .024) and going for the phone proactively (42.2% (27/64) vs. 4% (28/711), p = .041).

Similarly, the use of Email on the smartphone is more likely to occur when participants are switching between different activities (34.4% (11/32) vs. 18.6% (138/743), p = .029). Participants use their phones as tools, i.e., camera, stopwatch, navigation, etc. significantly less when there is a notification (0% (0/34) vs. 11.7% (87/741), p = .016), they are switching tasks (0% (0/34) vs. 20.1% (149/741), p < .001) or they are picking up the phone proactively (14.7% (5/34) vs. 32.4% (240/741), p = .019). On the other and, tool use follows more after environmental prompts than after all other contextual antecedents combined (64.7% (22/34) vs. 8,1% (60/741), p < .001, see fig. 8). On a similar note, participants use the phone's browser significantly more often proactively than other categories (60% (12/20) vs. 30.9% (233/755), p < .001).

Figure 8. Various instances of tool use following after environmental prompts (clockwise from top left): Tuning a guitar, paying for a coffee, taking a phone of a dog fetching a ball, Timing a work task.

Fidgeting follows less after notifications (1.8% (1/57) vs. 7.8% (56/718), p = .008) or environmental prompts (1.8% (1/57) vs. 11.3% (81/718), p = .011). Conversely, when participants switch between activities, fidgeting is more likely to occur (31.6% (18/57) vs. 18.2% (131/718), p = .014). The majority of fidgeting behaviours we observed followed after proactive use (35.1%) and after switching activity (31.6%). Figure 9 provides a summary of the interactions between antecedents and contexts participants are in directly prior to the interaction with the smartphone, and the ways in which they use them.

Antecedent of EB	More associated with	Less associated with
Proactive	Web browser, (Instagram), Long Duration	Tool App, Phone Visible, Working,
Switching Activity	Email, Instagram, Fidgeting, Phone Visible, Phone Accessible, Working,	Tool App
Notification	WhatsApp, facebook Messenger, Visible, Accessible, Working, Being Alone,	Instagram, Tool App, Fidgeting
Looking around	Phone Visible	Being Alone
Environmental Prompt		WhatsApp, facebook Messenger, Instagram, Phone Accessible
Proximity	Phone Visible, Being Alone	
Handling Phone	Fidgeting	WhatsApp, Accessible
Waiting	WhatsApp	Phone Visible, Being Alone

Figure 9. Effects of antecedents to device interactions on different activities and characteristics of smartphone use.

7.3 Drivers of Smartphone Use

To tease out whether smartphone use seems to be driven by habits, addiction, or availability, we now look at the patterns of duration of smartphone interactions, time between interactions and number of interactions per usage session. We provide a visual analysis of the data first, and then control with Kruskal-Wallis ANOVAs and Poisson regressions as suggested in Schleidt (1974, p. 193).

The relationship between time since the last smartphone interaction and the duration of the session appears a bit unclear. The visual analysis suggests that duration of use might be shorter, the more time elapsed since the last interaction (fig 10a), but this pattern is not statistically significant ($H(310) = 292.834$, $p = .75$). Further controlling for the pattern following a Poisson law, we do not find a statistically significant association ($\chi 2(1) = 1.61$, $p = .204$). The visual analysis of the relationship between the duration of sessions and the number of interactions in the previous session (fig 10b) seems to suggest that the more interactions in the previous session, the lower the duration of the current one, but this pattern is, again, not statistically significant ($H(8) = 5.955$, $p = .652$). Further controlling for the pattern following a Poisson law, we do not find a statistically significant association ($\chi 2(1) = 1.61$, $p = .204$). The relationship between the duration of sessions and the time until the next session is a bit less clear again (fig. 10c). The visual analysis suggests that longer usage is followed by more interactions sooner than shorter interactions, but this pattern is, again, not statistically significant ($H(312) = 316.13$, $p = .424$). Further controlling for the pattern following a Poisson law, we do not find a statistically significant association ($\chi 2(1) = 1.61$, $p = .204$).

We have also investigated these three associations specifically for proactive smartphone use. We do not find an effect of the time since the last smartphone interaction ($H(118) = 111.832$, $p = .643$), or the number of activities in the previous session ($H(8) = 5.955$, $p = .652$) on the duration of smartphone use, as well as the duration of the previous sessions on the time until the next interaction ($H(55) = 51.422$, $p = .612$) for proactive use in our sample. Finally, we also do not observe a significant effect of proactive use on the time since the last smartphone interaction in general ($H(1) = 1.324$, $p = .25$).

Turning towards visibility and accessibility, we observe that accessibility seems to influence the duration of use (21s vs. 28s; $H(1) = 4.266$, $p = .039$), but not the time between interactions ($H(1) = 2.692$, $p = .101$), while visibility does not seem to influence the duration of use (H(1) = 1.531, p = .216), but the time since last interaction (273s vs 201s; $H(1) = 4.955$, $p = .026$). We did not observe more proactive use when the phone was accessible (31.4% (224/714) vs. 35.3% (18/51), $p = .33$). However, proactive use occurred more when the smartphone was not visible (26.9% (180/669) vs. 22.4% (64.5), $p < .001$). This last result is rather mechanical, as there will be less situational cues when the phone is not in sight.

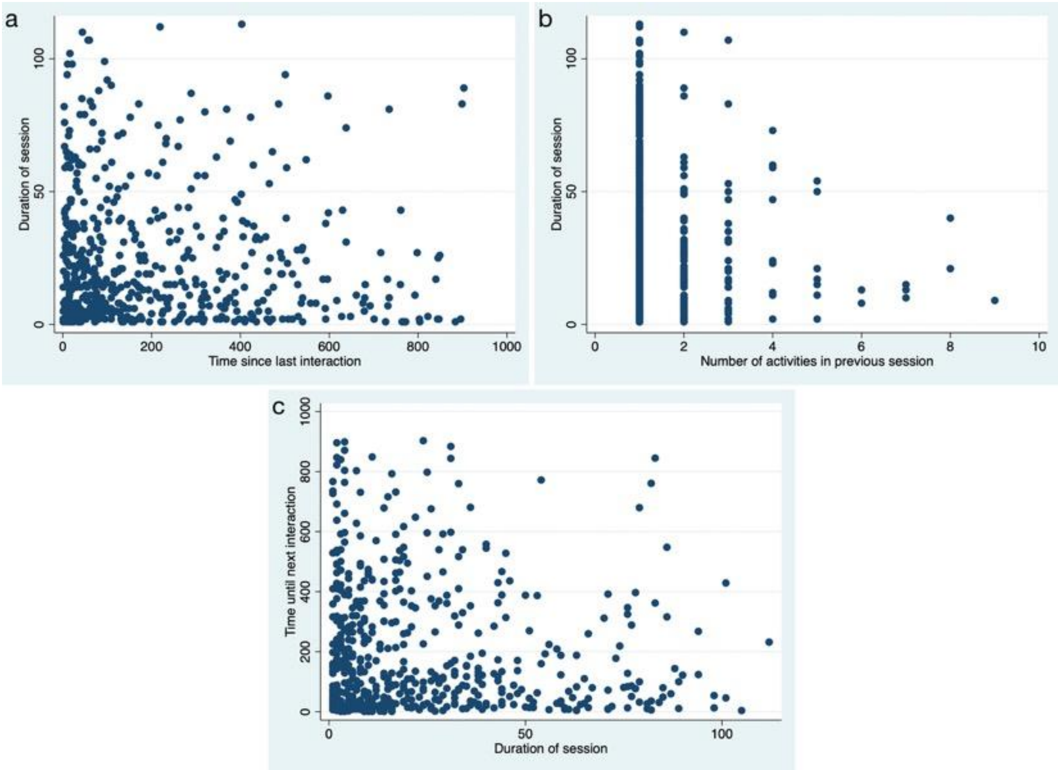


Figure 10. The relationship between (a) time since last smartphone interaction and duration of session, (b) number of activities in previous session and duration of session, (c) duration of session and time until next smartphone interaction.

8 Discussion

Our data shows a variety of different contextual cues that either force the phone into the attention of participants, or situations that leave them looking for something to direct their attention to - for which the phone usually ends up winning it.

8.1 Effect of context on characteristics of smartphone use

Participants used their phones more when they were waiting for something outside their home. This is mostly because interactions outside of the house can cause delays more often (queueing, waiting for public transport, etc.), and may to a certain degree also be due to the fact that periods of waiting in the house can be compensated more easily with other activities because the environment is rich and less socially controlled (e.g. going to take a snack from the fridge is not possible when queuing for the bus).

We also find that participants use their phones significantly less proactively when they are working, but contextual and situational cues are more likely to lead to interactions. This sits well with the previous discussion of cognitive attractors; as participants have a primary goal already, they will find themselves "looking for something to do" less often. As discussed previously, contemporary work, especially with computers is characterised by fragmented diaries and repeated task-switching and discussed above (Bogunovich & Salvucci, 2011; Yeykelis et al., 2018). It is therefore not surprising that task switching, which appears to leave participants vulnerable to pick up their phones, occurs more often when participants are working. The finding that notifications led to more interactions while participants were working compared to when they were not, on the other hand, does not appear intuitive at first sight given that participants overall report they do not want the phone to send notifications during work to not be interrupted, but also to avoid annoying colleagues or being embarrassed in front of them. We found two potential explanations for this in the data: 1) In work settings where participants cannot monitor their phones proactively regularly because they are absorbed in other tasks, the experience of *fomo* and the worry of not being able to stay on top of incoming notifications may be stronger. We thus observed that in the majority of cases, participants had their phones lying face up on their desks while working with sounds and vibrations muted, but the screen lighting up when a notification arrived. This way, incoming notifications were received immediately without risking embarrassment or bothering others. Moreover, given that the phone often stays in the same setting when participants are not working, and they do not normally have their phone in vision, they are less likely to take note of incoming notifications in these cases 2) In some instances, participants also use their phone for activities related to work and therefore monitor incoming notifications.

When participants were alone, interactions with the device are initiated by the device significantly more often, which may be attributed to the fact that they allow their phones to send notifications when they do not disturb other people, but also because being in company of other people usually means that participants have other main objectives. Similarly, proximity to the device and looking around also triggered interactions more frequently, when participants were alone, which suggests that they keep the phone out of immediate reach and move it around less when they are in company, which is in line with strategies to avoid engaging with the phone too much when they are with other people that are cited by participants. Moreover, users appear to be monitoring their environment more when other people are around, and once they are disconnected from their main task, the strength of the phone as a cognitive attractor captures their attention. In a similar vein, higher distraction and noise levels may lead participants to look around more.

Regarding accessibility, it appears that when the phone is not visible, contextual and environmental cues trigger EB with the phone less, and participants may divert their attention elsewhere. On the inverse, when the phone is not visible, participants are more likely to pick up their devices proactively. When participants have their phone out of immediate reach, they seem to focus more on the activity they are engaged in, as situational cues like breaks in the flow of activity, again, lead to significantly less interactions compared to when the phone is within reach. Notifications did not lead to interactions at all when participants had their phone out of reach, which is intuitive given that most participants keep their phone in a setting where it does not make sounds, but is still very 'noticeable' in close proximity. When the smartphone is out of reach, participants picked it up more to deal with an issue arising from the context (looking up something, tool apps) or to move the device to another place (typically charging it).

Looking at the duration of smartphone use, more different interactions with the device in one session significantly increase the duration of use, especially when participants go beyond a single interaction, which is in line with previous findings around cognitive attractors and getting caught in the loop (Heitmayer, 2020; Heitmayer & Lahlou, 2021). We also observe that duration of smartphone use is longer when participants interact with their devices proactively and when they are waiting for something, but shorter when they are only handling the device as a physical object. The time between different interactions, however, remains the same regardless of the different triggers that cause the interaction. While it is intuitive that participants would interact with the device for shorter periods of time when they are moving it to the side to make place on their desk for a mug for example, or to connect it to a charger, and longer when they are waiting, as this use is quite literally intended to occupy time in these situations, the finding regarding proactive use is quite alarming overall. Given that it captures the interactions in our sample for which it was not possible to determine an environmental or situational cue that could have led participants to pick up the phone, it appears that proactive use depicts deeply internalised checking behaviours. We have further controlled for the number of different apps or interactions within a session and did not find a significant difference between proactive smartphone use and the other categories. In other words, when participants pick up the phone out of internal, and possibly habitual, motivation, smartphone use lasts 1 minute and 20 seconds longer on average compared to when an environmental cue solicits the interaction.

8.2 Causes for specific smartphone activities:

We also found that different contextual triggers of smartphone use influenced the activities participants engage in with their phones. WhatsApp was used more frequently after notifications and when participants were waiting, but less after environmental cues or when participants were handling the device. This makes sense intuitively as it is the main communication app for participants (49.2% of all notifications received in our sample were received through this app alone). Similarly, when people are bored or idle, WhatsApp usually offers a variety of options from messages to reply to, to sending out new messages to friends and family. Environmental prompts usually call for tool uses of the phone like the camera or maps (see below). Moreover, because WhatsApp usually leads to longer interactions as they require reading and responding to messages, participants are less likely to open up the app when they are just picking up the phone to move it into another place. The same holds true for facebook messenger. Again, messaging tools send more notifications than other apps and their use is rarely called upon by environmental cues.

Use of Instagram, on the other hand, is less frequently triggered by environmental prompts or notifications, but more when participants pick the phone up proactively or during breaks in the flow of activity, which is consistent with participant descriptions of their use of the app as aimless and distraction-seeking. Instagram seems to plug itself in when users are reorienting their attention and looking for distraction from an ongoing activity. Especially the finding regarding proactive use is concerning again, as Instagram has been described as major source of ‘getting caught in the loop' and spending too much time with the device (Heitmayer & Lahlou, 2021), and proactive use is further associated with longer smartphone interactions in our sample. *Overall, it appears that smartphone use is less goal-oriented, more distraction-seeking and longer when clear contextual prompts are absent and participants engage with their phones proactively.*

The use of Email on the smartphone is also more likely to occur during breaks in the flow of activity, as participants do indeed seem to make use of their phones during brief breaks to check their inboxes and make sure they stay on top of incoming messages. The finding that participants use the phone's web browser proactively more often warrants further investigation, also because the overall prevalence of its use is relatively low, but may allude to the fact that use of the phone's browser is highly diverse and can serve both entertainment/distraction and tool purposes.

Tool use is most likely to follow after environmental prompts, but participants engage in it less proactively, when they are switching tasks, or after notifications, which, again, is intuitive. Tool apps do not normally send notifications (0 in our sample) or promise distraction during breaks, but are used as a response to a specific demand that arises from the situation like looking up the next bus, setting a timer while cooking, taking a picture or using a tuning app to check the pitch of an instrument (see fig. 8).

Fidgeting, finally, is less likely to occur after notifications or environmental prompts, but more when participants are switching tasks. Given that notifications and environmental prompts come with clear objectives, it is not surprising that users fidget less after these triggers. Conversely, when participants switch between activities there is no clear objective scaffolding the situation which opens the gate to unconsciously interact with the device in the 'mental orientation phase' in the gap before a new task is begun.

8.3 Drivers of Smartphone Use

While many of the responses to contextual antecedents we observe appear deeply habitualised and automatic, for about 30% of all interactions we did *not* observe any distinguishable environmental or situational cues. We therefore took this proactive use as a starting point for our analysis of the internal drivers of smartphone use. Even in discussions with our participants, we were unable to reconstruct the reasons for the interaction for a large portion of proactive use and the motivation to interact with the phone seems to come from within the users themselves. These behaviours need to be studied in more detail, as they represent what participants refer to when they speak about automatic and *unconscious* interactions. From the descriptions of our participants, it appears that they can usually remember or reconstruct the interaction itself quite well, but not the reason why they pick up the device:

> *And sometimes I would check the phone just as an automatic gesture. Because I realize a lot of times this is not a conscious thing like: "Oh, I want to check this notification or I just want to go to Instagram or whatever". I don't know, it's just a passive thing that I do.* (P38)

> *I think it's an easy, or automatic… like when you have a cough and you put your hand to your mouth- it's something like that*. (P24)

Hence, smartphone use appears to occur automatically overall, and users do not seem to pick up their phones 'intentionally' in the full sense of the term in the majority of situations. This supports the notion that picking up the smartphone use may be a FAP, over which participants have little agency once triggered. But that does not account for what is the trigger.

Proactive smartphone use being longer than other types of use would suggest that appetite may be relevant for smartphone interactions. Appetite as a driver of smartphone use also sits well with the notion that patterns of engagement with the device may follow a Poisson law, which is further reflected in the varying engagement and voidance strategies for different contexts our participants report (e.g. working vs. being at home), which are discussed in more detail elsewhere (Heitmayer, 2020; Heitmayer & Lahlou, 2021).

We did not observe any relationship between different antecedents of smartphone use and the intervals between interactions, which makes a case for a hydraulic explanation: Environmental cues and other causes, as well as feelings of fomo may not be as salient for participants until a certain threshold (i.e. time away from the phone) is reached again. Similarly, if an opportune moment to interact with the phone does not arise from context, participants end up picking up their devices proactively. Yet, we do not observe an increased likelihood of proactive (or any other type of) smartphone use when users have not interacted with their smartphones for longer periods of time or when the previous interaction was short, which contradicts hydraulic explanations.

The finding that participants tend to pick up their phone when they are waiting or idle, builds the case for smartphone use as a displacement activity. Participants further report that they sometimes use their phones to ease their mind:

> *I don't know why I did that. II literally just looked to the right, unlocked my phone, locked it again. And I cannot tell you what time it was because I didn't look, it's just a bit evasive, I think. Because it's a mechanism. It's something that I do when I'm bored or something that I do if I need to, like, change my mind, you know. If I'm a bit stressed or so, I'll watch a video or something like that. I guess my hypothesis is that, yes, if I'm in a situation where I feel a bit observed or scrutinized or like at work, when we're having a meeting about something and I'm not really sure what to answer to some questions, my eyes might dart down, and I might look at my phone because it is a bit of a pacifier. (P42)*

The phone, thus, appears to have the affordance to "distract", that is, to offer a different, new, track of activity when the task at hand is finished, and when there is a conflict between activities (e.g. the subject being torn between two possible activities, or not wanting to continue the current task because it is boring, stressful, or exhausting). The affordance of course is the more salient if the phone is in sight, present in peripheral attention, or in the focus of attention.

Similar to the study on the consumption of hedonic foods (Painter et al., 2002), we also find support for explanations focusing on the availability of the phone. The time between smartphone interactions was 72s shorter in our sample when the phone was in the visual field of participants, and the duration of smartphone interactions was 7s longer on average when the phone was within arm's reach of participants. Looking at the different antecedents to smartphone use, visibility appears to play a large enabling role for environmental cues like switching activities, looking around, or proximity use, but also use following notifications, and proactive use, are more prevalent. When the phone is not immediately accessible to participants, they do not appear to notice notifications and, thus, pick up their device at all. This supports the sentiments of participants that placing the device somewhere else helps them to engage with it less:

> *Sometimes I get it farther away from me as much as I can to not get distracted as much.* (P28)

> *If it's next to my bed at night I'm literally going to be on it all the time. Even if I wake up, you know how you sometimes wake up in the middle of the night? For example when I'm in a hotel and the socket is next to the bed, I'm always reaching over when I can't sleep or whatever. So overnight, I always keep my charger outside of my room.* (P37)

> *On Saturday afternoons, I practice for my bar exam and I only got to the library for that. Then I actually leave the mobile phone at home to fully focus. (P5)*

Participants seem to have an intuitive understanding that reducing the accessibility of the device can help them regulate their phone use. But just facing the device downwards on the table to not notice the screen lighting up, or moving it a bit farther away on the desk does not create sufficient 'distance' between the device and the user. Moreover, environmental cues, like for visibility, are less likely to lead to smartphone interactions when the phone is not easily accessible. In these situations, moving the phone into a different location (often charging it), or when it is needed as a tool is more likely to make people get up and fetch the device.

It is important to note though that the participants keep their devices visible and accessible in the overwhelming majority of cases (the phone was neither visible nor accessible before only 2% of the smartphone interactions we observed). Hence, further investigation into the effect of visibility and accessibility of the device in a controlled setting, and formally controlling and testing the perceptions of users, will be necessary to confirm these effects and to see where participants direct their attention to when they these contextual cues occur while the phone is not visible and/or accessible. Nevertheless, visibility and particularly accessibility appear to be a highly promising route for further investigations into effective ways to reduce smartphone use.

Even though we observe a stable frequency of interactions, we cannot confirm the predictions of reservoir theory and therefore have to reject H2 (smartphone as addiction), especially since we did not find any evidence of an ‘urge’ to use the phone, or an ‘intense focus’ on phone EB, nor expressions of intense satisfaction or relief after EB. And while the findings for visibility and accessibility are in line with predictions, we can only partially confirm the expected patterns. Therefore, even though nothing in our data immediately contradicts H1 and H3, active searching and accessibility alone can only provide an insufficient explanation for variations in motivation and causes of smartphone use in situations where contextual cues trigger interactions, and bearing in mind that participants do keep their phones readily accessible at most times.

We have explored in depth the rich, ethnographic data on smartphone use SEBE has generated in our attempt to explain what drives smartphone use in naturally occurring contexts. We find evidence for parts of all three possible explanations that emerged from the literature, but no single explanation is cogent or comprehensive on its own. Some of our findings, further, contradict H2 and we cannot fully support H1 and H3 either. The data, moreover, does not allow us to give either hypothesis precedence over the others for all situations. For any given smartphone interaction, there seem to be many overlapping motivations and drives pulling and pushing participants simultaneously. If anything, smartphone use appears to look more like eating candy, than like smoking cigarettes as an addiction. If it has some similarities to cigarettes, it is (except for some extreme cases perhaps where there is actually addiction to some functions of the smartphone), more because the cigarette can also act as an affordance for distraction. This is well described by one of the participants:

> *I'm a smoker. It's kind of similar to that a little bit. Sometimes I get an urge to smoke, but most of the time I kind of want to smoke because I'm idle. Like, if I'm waiting for a bus, then I'll have a cigarette. I don't really get, like, a strong nicotine urge because I know how those feel. Like sometimes I'll get a strong nicotine urge. But then, you know, I'm just waiting for the bus and I'm like, when the fuck is it going to come?*

> *And so I just I'm like: "You know what? I probably have ten minutes". So I roll myself a cigarette. And that's kind of the same thing. I think with the phone, it's not so much that I feel compelled to do it. At least I don't feel like it's that. But it's definitely a mechanism, you know, certainly there is a habit there. And I'm like: "Oh, I'm bored." There is something that I know I can do when I'm bored, but then I think I'm fairly aware of it, so. (P42)*

Smartphone users interact with their devices to satisfy their appetite for communicative and social needs, as well as for distraction and displacement (inter alia). And while interacting with the device appears to be 'scratching an itch' for participants, this does not conclusively lead to the automatic or hydraulic discharge of such behaviours in the sense of fixed action patterns, and even less in the sense of addiction.

9 Limitations

We have employed a mixed-methods approach to triangulate our findings, but this study is ultimately based on data from 37 participants. While quantitative approaches using device and application logs would not have been able to obtain some of the findings of our study, they produce more reliable data on usage patterns, which is needed to consolidate the evidence we have found. This, in combination with the mixture of conforming and contrasting results from previous studies substantiates the case for replication of smartphone use studies that has been argued in the mobile HCI community in recent years (Banovic, 2016; Church et al., 2015; Wilson & Mackay, 2011). It is important to bear in mind that, while the differences in results may be due to the different study populations, there also might be a gradual shift in usage that may occur over the years, which is then reflected in differences between the 'snapshots' that individual studies take.

10 Conclusion

In this paper, we have investigated the antecedents of smartphone use in naturally occurring contexts with an unprecedentedly detailed dataset. We find nine different categories of contextual antecedents that lead users to pick up their devices. Overall, it appears that the device itself only appears to play an active role in a small share of these interactions; contextual cues and deeply embodied and habitualised routines seemed to be the main driver that initiates smartphone interactions.

We have tested three general hypotheses; smartphone use as satisfying appetite, smartphone use as addiction, smartphone use as habit triggered by availability. From our data, we were not able to fully support any of these three hypotheses, or come up with a single, comprehensive model that works in all cases. The data and the statements of our participants seem to support the idea that several overlapping mechanisms are at play simultaneously:

- There is reactive behaviour: users reach for the phone when there are notifications. In only very few instances they do not, for social reasons. They also react to contextual cues and breaks in the flow of their ongoing activity.
- There are, indeed, uses of the phone as a displacement activity, as made explicit by participant comments (*I'm trying to concentrate on the statistics here, but every few minutes I check my phone. Can someone take me out of my misery?*, P18).
- Accessibility does trigger phone use, especially in 'moments of vulnerability' where external cues leave participants unfocused for a moment or trigger automatic engagement behaviours.
- There even are occasions where the users reach for the phone without any prompts, and do not even 'consume' (behaviour in vacuum), such as fidgeting or short proactive glances.

It is abundantly clear, however that phones are major cognitive attractors and that participants have an appetite to interact with their devices; a combination of internal drive, opportunism, and external stimulation seem to be at play. This probably relies on the extrinsic rewards that smartphone use produces (entertainment, social grooming). Thus looking into smartphone use from a neurological angle, and particularly into dopamine response (see Haynes, 2018; Parkin, 2018; Weinschenk, 2012), as well as controlling our findings regarding visibility and accessibility under experimental conditions is required in the next step. In general, we believe it is problematic to speak of addiction when it comes to smartphones; if smartphone use needs to be likened to other pleasures we overindulge in, it appears more appropriate to think of it as eating candy, than as smoking cigarettes.

It is difficult to tease out these different hypotheses since, as said above, we find some evidence in favour of each, but no conclusive evidence that would favour one over the other; there may be several reasons. The first is that participants may have acquired, between subjects, different embodied propensions for EBs: some may only have a mild habit, others some degree of addiction. For example, they could be addicted to gaming, porn, or social networking and use the phone for this - although no such behaviour appeared in our sample. Then they could, within subject, perform EBs for different causes at different times. This is obvious when comparing notifications and proactive use; but it may also be the case within different types of proactive use; and we saw that the same participants can indeed explain different occurrences of EB differently. Finally, as mentioned earlier, the hypotheses we investigated are not mutually exclusive, and one single EB may have multiple causes - as it frequently is in human behaviour.

While these conclusions obviously are frustrating and call for more research, we are able to draw some operational conclusions to address problematic smartphone use already, and also venture a more generic hypothesis that is compatible with H1, H2 and H3.

Let us start with the hypothesis: What fills the reservoir of release potential for the EB? There may be different causes that lead to a similar state of polymorph “desire for distraction”. Indeed, there might be many reasons that build a release potential for “something else that I am doing right now”: a boring task, a task about to end, a stressful or awkward situation, idleness, tiredness, exhaustion of interest in the present task, and so on. This also applies when the upcoming task is not perceived as engaging, for similar reasons, which can tempt the user to try to escape it or to procrastinate. In all these cases, there is an undirected drive to do “something else”, anything else. Typically, in those moments, the psychological processes that direct the activity are vulnerable to any attractor that is present and salient. And the smartphone is precisely such an attractor, because it is an affordance for distraction: it offers many easy possibilities of short actions with quick reward, literally at the tip of one’s fingers.

And we do observe proactive EB in these moments, because of the crux with the device's valence: Unlike in Lewin’s mailbox example, whose valence emerges only at rare intervals with the need to post a letter, the appetite for distraction is likely to emerge many times a day. It is not surprising then that an affordance that responds well to satisfying an appetite for distraction (therefore having high valence at frequent intervals) and that is within arm’s reach almost continuously, is seized by the users for release. So, whatever the state of the individual propension for EB, and the specific reasons that have led to a state of appetite for distraction (boredom, stress, end of task), the polyvalent affordance for distraction of the smartphone may constitute a cognitive attractor, which combined with the appetite for distraction, trigger the constellation of subject + smartphone + context as an installation (Lahlou, 2017) for distraction, releasing EB as an FAP or a habit.

Let us note in passing that this effect of attention capture in the moments of vulnerability to distraction of the subject is not purely accidental. A whole industry is working behind the smartphone to attract the user into various apps, to catch her attention and resell it in the media model; and there are sophisticated systems keeping the user “caught in the loop” and in a state of fomo, leveraging social motives, gamification etc. This industry is working hard to increase the affordance for distraction of the phone, and an important part of the intense use of the device is to be credited to this industry.

And now the recommendation. The affordance of the phone is not only necessary to execute the behaviour; accessibility of the device leads to an increased chance that contextual triggers and situational cues lead to a discharge of engagement behaviours when participants are in a state of appetite for distraction. The solution is pretty clear: Suppress the affordance, increase the cost of access. When we do not want to engage with the phone, the device should be kept out of sight, and more importantly out of immediate arm’s reach, so that we do not run the risk of picking it up in moments of vulnerability. Just putting the phone facing downwards, or a bit farther away on the desk is not sufficient for this. And while hiding it under a book or in a drawer may help a little bit, it is best to keep the phone out of one’s immediate sphere of both reach and awareness. In this spirit, we want to echo the conclusion of the study by Painter and colleagues:

> *"While it must be underscored that a visible and convenient food will also be a food that one will tend to over-consume, a significant deterrent to over-consumption is convenience. If a product is out of sight, it is not always out of mind. However, if it is out of reach, we are less likely to overeat it."* (Painter et al., 2002, p. 7)

Whatever the cause, we need to put the phone away. Let us not allow the smartphone and the media-model of the attention trading industry to overly feed on our appetite for distraction.

G. ETHICS APPROVAL FORM

Ethics Application

Department of Psychological and Behavioural Science

Title of project: Smartphones as steady Companions. ICT Use in Everyday Life and the Attention Economy. Name of Researcher(s): Maxi Heitmayer Email Address: m.a.heitmayer@lse.ac.uk Name of Supervisor (for MSc/PhD projects): Saadi Lahlou Date: 08.11.2017

		Yes	No	N/A
1	Will the proposed research entail any risk to the researcher(s)? (e.g., entail travel to unstable regions, exposure to environmental risks, collection of sensitive data, or lone working in an unfamiliar context)		x	

If you ticked **Yes** to Q1, you should complete a **risk assessment form**

		Yes	No	N/A
2	Will you describe the main experimental procedures to participants in advance, so that they are informed about what to expect?	X		
3	Will you tell participants that their participation is voluntary?	X		
4	Will you obtain written consent for participation?	X		
5	If the research is observational, will you ask participants for their consent to being observed?			X
6	Will you tell participants that they may withdraw at any time and for any reason?	X		
7	With questionnaires, will you give participants the option of omitting any questions they do not want to answer?			X
8	Will you tell participants that their data will be treated with full confidentiality and that, if published, it will not be identifiable as theirs?	X		
9	Will you debrief participants at the end of their participation (i.e. given them a brief explanation of the study)?	X		

If you ticked **No** to any of Q2-9, you should **tick box B** overleaf.

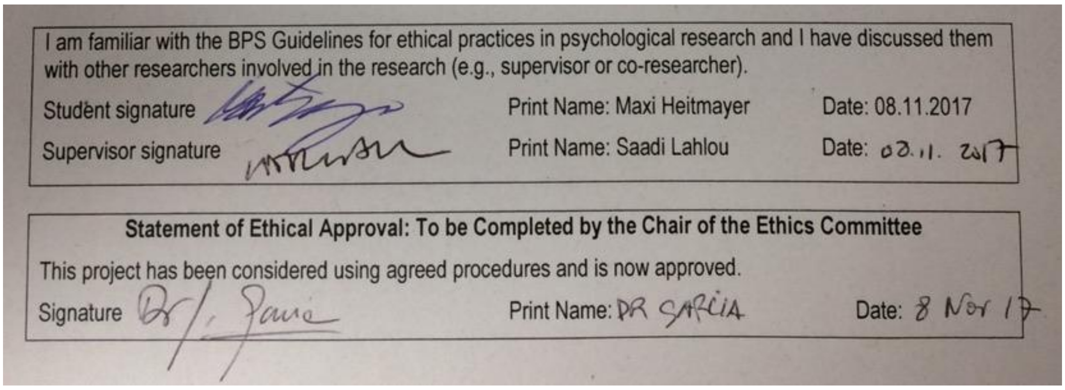
			Yes	No	N/A
10	Will your project involve deliberately misleading participants in any way?			X	
11	Is there any realistic risk of you or any participants experiencing either physical or psychological distress or discomfort? If **Yes,** give details on a separate sheet and state what you will tell them to do if they should experience any problems (e.g., who they can contact for help).		X		
12	Does your project involve work with animals?			X	
13	Do participants fall into any of the following special groups?	Schoolchildren (under age 18)		X	
		People with learning or communication difficulties		X	
	Note that you may also need to obtain satisfactory CRB clearance (or equivalent for overseas students).	Parents		X	
		People in custody		X	
		People engaged in illegal activities (e.g. drug taking)		X	

If you have ticked **Yes** to any of Q10-13 you should **tick box B** overleaf.

There is an obligation on the lead researcher or supervisor to bring to the attention of the Departmental Ethics Committee any issues with ethical implications not clearly covered by the above checklist.

PLEASE TICK **EITHER** BOX A OR BOX B BELOW AND **PROVIDE THE DETAILS REQUIRED** IN SUPPORT OF YOUR APPLICATION. THEN SIGN THE FORM.

A. I consider that this project has **no** significant ethical implications to be brought before the Departmental Ethics Committee	
Give a brief description of participants and procedure (methods, tests used etc.) in up to 150 words. *If you have ticked box A, then sign and submit this form (and any attachments) to the ISP Ethics Committee.*	



I am familiar with the BPS Guidelines for ethical practices in psychological research and I have discussed them with other researchers involved in the research (e.g., supervisor or co-researcher).

Student signature Print Name: Maxi Heitmayer Date: 08.11.2017

Supervisor signature Print Name: Saadi Lahlou Date: 02.11. 2017

Statement of Ethical Approval: To be Completed by the Chair of the Ethics Committee

This project has been considered using agreed procedures and is now approved.

Signature Print Name: DR GARCIA Date: 8 Nov 17

B. I consider that this project **may** have ethical implications that should be brought before the Departmental committee, and/or it will be carried out with children or other vulnerable populations	

Please provide all the further information listed below on a separate attachment.

1. Title of project
2. Purpose of project and its academic rationale
3. Brief description of methods and measurements
4. Participants: recruitment methods, number, age, gender, exclusion/inclusion criteria
5. Consent, participant information, debriefing (***attach information, consent, & debrief sheets**)
6. A clear concise statement of ethical issues raised by the project and how you intend to deal with them.
7. Estimated start date and duration of the project.

If any of the above information is missing, your application will be returned to you.

If you have ticked box B, then sign and submit this form along with a separate document providing the above information (and any attachments) to the ISP Ethics Committee.

Participant Information Sheet

You are being invited to take part in a research study. Before deciding to participate it is important for you to understand why the research is being done and what it will involve. Please take time to read the following information. Feel free to discuss issues with anyone, and if there is anything which is not clear or any questions you have, feel free to ask. Take your time reading, and don't feel rushed.

What is this research about?

In this project, I want to analyse the use of smartphones and social media behaviour. I want to look at how you use your Smartphone, Tablet, Computer, or other devices to connect to the Internet, and particularly to Social Media, to find out how you interact with your devices and your Social Media profiles.

Who is doing this research?

My name is Maxi Heitmayer, I am a PhD candidate in the Department of Psychological and Behavioural Science at the London School of Economics. My dissertation project is supervised by Prof. Saadi Lahlou.

m.a.heitmayer@lse.ac.uk
s.lahlou@lse.ac.uk

Why have you asked me to participate?

I have asked you to participate in my study because you are a young adult and an active user of social media and modern communication devices, particularly smartphones.

What will participation involve?

You will be given an introduction on how to use the Subcam. You will then be asked to wear your Subcams throughout the day doing casual activities like studying, doing groceries, cooking, commuting, etc. You will then watch the video material you have gathered together with the researcher to explain what is going on in the Subfilm. If you are interested, you can also participate in a focus group to watch other participants' activities and exchange your views on the use of communication devices and social media, as well as the method used for this study.

How long will participation take?

I would like to ask you to record yourself and your everyday activities with your Subcam for several hours a day over a few days. It is important that you film yourself for a longer period (5h +) at least once. You will then be asked to participate in a Replay-interview of about an hour. Additionally, you can participate in a focus group discussion of about two hours.

What about confidentiality?

You will gather first person view, audio-visual material (Subfilms) with your Subcam, with the possibility to interrupt the recording whenever you might wish to do so. You will be able to preview the material before submitting it to the researcher, with the possibility of editing out unwanted passages or abandoning the entire tape altogether. It is furthermore possible to blur faces and distort or erase voices of any person that might appear in the Subfilms and wishes no to.

If you are willing to participate, then please sign a Consent Form.

You can keep this Information Sheet for your records.

Informed Consent

Project: Smartphones as steady Companions. ICT use in Everyday Life and the Attention Economy

Researcher: Maxi Heitmayer, m.a.heitmayer@lse.ac.uk

Supervisor: Saadi Lahlou, s.lahlou@lse.ac.uk

____

To be completed by the Research Participant

Please answer each of the following questions:

Do you feel you have been given sufficient information about the research to enable you to decide whether or not to participate in the research?	**Yes**	**No**
Have you had an opportunity to ask questions about the research?	**Yes**	**No**
Do you understand that your participation is voluntary, and that you are free to withdraw at any time, without giving a reason, and without penalty?	**Yes**	**No**
Are you willing to take part in the research?	**Yes**	**No**
Are you aware that the interview/focus group will be audio/video recorded?	**Yes**	**No**
Will you allow the researcher to use anonymized quotes in presentations and publications?	**Yes**	**No**
Will you allow the anonymized data to be archived, to enable secondary analysis and training future researchers?	**Yes**	**No**

Participants Name:_______________________________

Participant's Signature: ___________________________ **Date:**__________

If you would like a copy of the research report, please provide your email or postal address:

Attachment B

1. Title of Project

Smartphones as steady Companions. ICT Use in Everyday Life and the Attention Economy

2. Purpose of project and its academic rationale

Smartphones and social media have become pervasive societal phenomena. The increased use of social media and modern communication devices has changed the daily routines of users. Given the general access to the Internet, especially young adults are now in constant negotiation between using their time for online or offline activities, and attention is becoming an increasingly ‘scarce resource’ for them. Therefore, understanding the complex processes involved in the use of social media and ICTs, and their effects on the users’ perception of self is paramount. The detailed and complete data I will be able to collect with Subjective Evidence Based Ethnography (SEBE) will allow me to take an in-depth look at how users domesticate technologies, and which habits and routines they have developed.

3. Brief description of methods and measurements

I am going to use the SEBE method, which entails the use of miniature cameras to gather first-person view, audio-visual data. Participant data will be discussed in individual interviews and focus groups.

4. Participants: recruitment methods, number, age, gender, exclusion/inclusion criteria

SAMPLING FRAME

CRITERTION	EXPLANATION
Intended Sample Size:	45 Individuals
Gender:	The final sample should be as balanced as possible with regard to gender
Age:	Young and emerging adults between 20 and 29

Most of today’s largest social media platforms like facebook, Twitter, Instagram, or VKontakte became popular in the 2000s and quickly attained “significant cultural resonance” among teenagers (boyd, 2008, p. 119). Consequently, today’s young adults are the first generation that was exposed to social media during the formative years of their lives before adulthood. The defining, “hegemonic” self then develops in the early to mid-twenties (Baumeister, 1999, p. 269-274). Arnett has furthermore shown that during this phase of *emerging adulthood*, individuals “examine the life possibilities open to them and gradually arrive at more enduring choices in love, work, and worldviews” (Arnett, 2000, p. 479; see also: Erikson, 1968). I have therefore decided to focus on *young and emerging adults between 20 and 29* in this dissertation. To preclude any gender-specific bias, I will pay attention to creating a *balanced sample,* both during recruitment and data collection.

As online privacy has become a mainstream issue, most people do not readily share all their information with strangers. I will therefore use my personal contacts, the DPSB student population, as well as my social media accounts as a starting point to recruit participants, and then use snowball sampling with the help of participants who were enthusiastic about the method.

5. Consent, participant information, debriefing (*attach information, consent, & debrief sheets)

Participants will be given a thorough introduction to the method, and a short user manual for their Subcam (See form A). They will also receive an informed consent and a participant information sheet (see above).

6. A clear concise statement of ethical issues raised by the project and how you intend to deal with them.

The SEBE method, as detailed in its guidelines, is designed to address ethical concerns. Recordings will be anonymised and encrypted (not the subject's name) on a hard disk drive to ensure confidentiality. As soon as possible after original or derived data is created or collected it must be accompanied by sufficient information to identify what it is, who created it, when, and its sensitivity. This information is further needed to guarantee anonymization and to be able to account for any requests made by participants or the cast. The video material (*Subfilms* and Replay-interviews) will be the property of the LSE, which will have all rights and control for public dissemination. The London School of Economics will keep the data and destroy them after the usual time for such research (10 years). Participants will get no royalties whatsoever from the use of the films, which are primarily intended for scientific purposes. However, before the data leave the hands of the participants, they will be able to review the material and delete any part they wish, or abandon parts of the recording altogether. If required, they will be given assistance in doing so. Furthermore, participants will be asked about their opinions of the SEBE procedure in the debrief, and their feedback will be incorporated in the ongoing research. This procedure has already been tested and validated in the *AdoDigitFamX* Marie S. Curie Action conducted by Dr. Everri at the LSE.

In general, researchers who use or create data in the process of their research have a responsibility to manage effectively and securely the data they create, whether original or derived. Primary responsibility for design and implementation of effective research data management lies with the researcher.

I will ask the participants to get in touch with the cast - these are people, who are recorded on the Subfilm because they interact with the participant or they enter the recording field - where possible, to obtain their consent. By experience, most people appearing in the cast are identifiable and accessible to the participants. For those people, which refuse to give consent or cannot be identified, I will blur faces and distort or mute speech (therefore providing full anonymity while keeping the Subfilm understandable).

Furthermore, as part of my dissertation project and the ongoing development of SEBE, I am currently involved in a research project that examines ethical issues and best practices of using video-data for research with Dr. Everri and Prof. Lahlou (first stage to be completed before my data collection begins). This will hopefully set in motion a more general deliberation about best practices and ethics of using video-data for research, and will continuously inform my dissertation project.

Lastly, participants will be given both mail and phone contact data of the researcher, in case they feel uncomfortable about the procedure and want to express their feelings, or have urgent questions regarding their participation. Participants will also receive a copy of their Subfilm and a research report, as a thank you for their participation.

References:

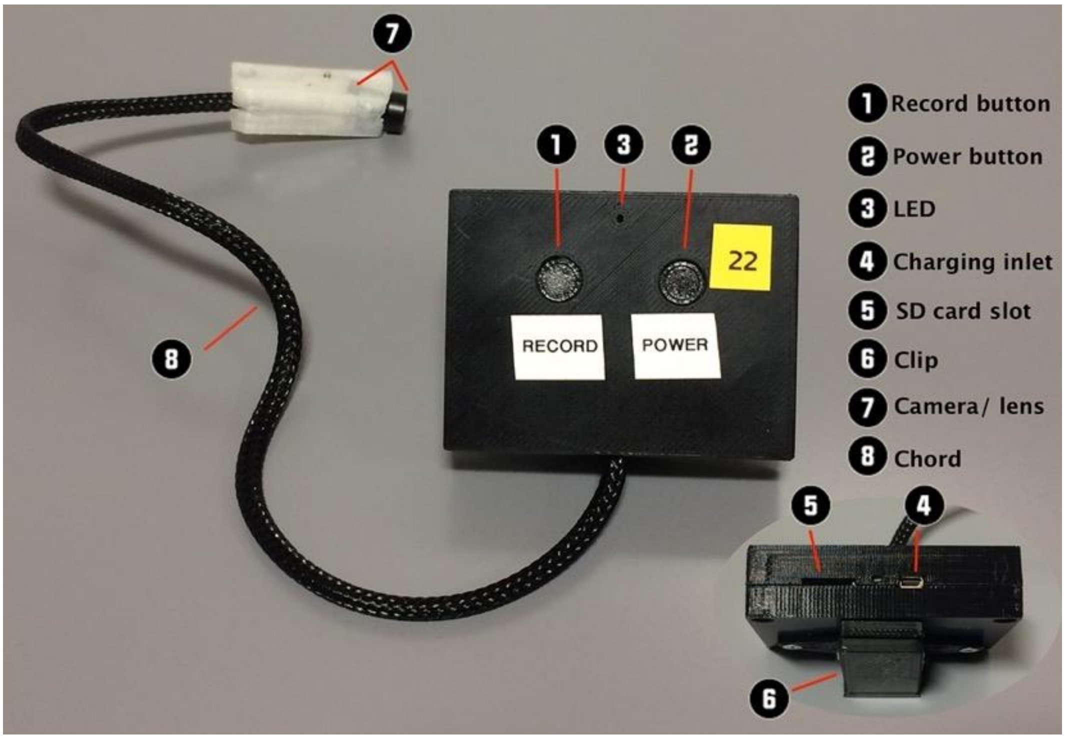
Arnett, J. (2000). Emerging adulthood. A theory of development from the late teens through the twenties. *American Psychologist*, 55 (5), 469-480.

Baumeister, R. F. (1999). Self-concept, self-esteem, and identity. In V. J. Derlega, B. A. Winstead, & W. H. Jones (Eds.), *Personality: Contemporary theory and research* (2nd edition). Chicago, IL: Nelson-Hall Publishers, 246-280.

boyd, d. (2008). Why youth <3 social network sites: The role of networked publics in teenage social life. In: D. Buckingham (Ed.), *Youth, identity, and digital media.* Cambridge, MA: The MIT Press, 119-142.
Erikson, E. (1968). *Identity: Youth and crisis.* New York, NY: Norton.

Form A

SUBCAM MANUAL



Your Subcam has two buttons and one LED. Please insert an SD card into the SD card slot (5) before using the camera.

- To turn the Subcam on or off, hold the power button (2) for two seconds. While on, the LED will shine an orange light. If the LED is flashing instead, please make sure you have inserted the SD card correctly.
- To record footage or to stop recording, press the record button (1). While recording, the orange LED will flash.
- To charge your Subcam, plug the long-life battery into the charging inlet of your cam (4) and connect the battery to power. While charging the cam, the LED will shine a red light. Fully charged, the internal battery of your Subcam lasts 3 hours (check whether this is correct). The long-life battery lasts an additional 5 hours, which gives you 8 hours of recording time in total.

H. DATA SAMPLES

To provide an insight into how the data gathered for this thesis with SEBE looks like, we provide an example clip from a Replay-interview and two samples of subfilms accessible through the link below. We also include the qualitative coding frame resulting from the QCA.

Clip 1 shows a piece of a conversation from a Replay-Interview (the participant has agreed to not have her face blurred for non-public academic use and presentation). The conversation revolves around smartphone use and notifications. The participant also takes control of forwarding the tape to salient moments, as we have often observed in our interviews once they have become comfortable with the format.

Clip 2 shows Subcam footage of a participant working on a document on a sofa and getting ‘caught in the loop’ by her phone. The footage shows how the participant transitions from working to scrolling through the facebook feed, clicking on an article, watching videos embedded in that article, and then going back to scrolling through the feed and back to work. Pay attention to the movements of her right thumb, and the position of her left hand. Also note the audible deep exhalation when the participant switches to the phone (00:10) and puts it back down (03:35).

Clip 3 shows Subcam footag of a participant surfing the web on a laptop at a desk. The participant repeatedly fidgets with the phone in this clip (00:03; 02:08; 02:44).

The first two interactions occur when the participant switches activities on the laptop. Note the hand movements at (02:00), just before the second phone interaction. The participant seem to be reorienting their attentional focus in that moment. Also note how the participant scratching his head and putting his hand down next to the phone at (02:40) leads to proximity use at (02:44).