Revisiting Embodied Approach and Avoidance Effects on Behavior: The Influence of Sitting Posture on Purchases of Rewarding Foods

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Abstract

The body is central to theoretical understanding of approach and avoidance, but previous research comprehensively investigated the embodiment of the two motivational orientations only in relation to basic motor reactions such as push and pull, and psychological processes such as attitudes. Our research addresses the neglected impact on more sophisticated behaviors that go beyond psychological processes or basic motor responses. Specifically, in the present research we probed how leaning (approach) versus reclining (avoidance) influence a representative motivated behavior—purchases of rewarding foods—in the context of an online grocery shopping task. We also examined a personality—Behavioral Activation System (BAS)—and a situational—construal level—moderator of this effect. Across Studies 1 and 2, it was established that leaning made people spend more on rewarding foods compared to reclining, but only for individuals high in the drive component of BAS. In Study 3, leaning again enhanced purchases of rewarding foods, but only in a situation that induced low construal level. The moderated effects had strong evidential value across all three studies (as indicated by a p-curve analysis), yet the main effects were significant only in Studies 1 and 3. These findings underline the importance of adding personality and situational factors when examining the impact of bodily positions that activate approach and avoidance on motivated behavior such as food choice.

Keywords: motivation, embodiment, food, personality, construal level

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1. Introduction

Approach and avoidance are amongst the central constructs in psychology—they have been used to understand attitude formation (Centerbar & Clore, 2006; Van Dessel, Gawronski, Smith, & De Houwer, 2017), social behavior (Strack & Deutsch, 2004), information processing (Neumann & Strack, 2000), and to offer an integrative explanation of personality (Elliot & Thrash, 2002). These two motivational orientations are usually defined with reference to the relationship between the body and an object in the external environment (Elliot & Covington, 2001; Strack & Deutsch, 2004): Approach (vs. avoidance) is a tendency to decrease (vs. increase) the distance between oneself and the object. Distance can be decreased (vs. increased) in a range of ways, from basic motor reactions such as pulling (vs. pushing) the object, to more complex everyday behaviors such as consuming the object (vs. getting rid of it by throwing it into the garbage bin).

Because the body is central to theoretical understanding of approach and avoidance (Price & Harmon-Jones, 2016; Strack & Deutsch, 2004), various researchers investigated its relationship with these motivational orientations. Previous research primarily focused on *basic* approach and avoidance motor reactions to stimuli such as positive and negative words (e.g. Chen & Bargh, 1999; Phaf et al., 2014; Solarz, 1960), and on how bodily positions that activate the two motivational tendencies (e.g. arm flexion versus extension; Cacioppo, Priester, & Berntson, 1993) impact psychological processes such as attitudes (e.g. Centerbar & Clore, 2006), categorization of information (e.g. Neumann & Strack, 2000), or self-evaluation (Fayant, Muller, Nurra, Alexopoulos, & Palluel-Germain, 2011). For example, in a computerized task, people

were faster to initiate virtual movement toward (approach) versus away from (avoidance) positive words displayed inside a realistic digital environment on the screen, whereas the effect reversed for the negative ones (Rougier et al., 2018). Moreover, when approach motivational tendency was activated via arm flexion—an arm position that simulates pulling an object toward oneself—people categorized positive words more quickly than negative words, whereas the effect reversed when avoidance was activated via arm flexion—an arm position that simulates pushing an object away (Neumann & Strack, 2000).

Relatively few studies, however, went beyond basic motor responses and psychological processes to investigate how and when bodily positions that evoke approach and avoidance impact *complex everyday behaviors* such as food purchases and consumption. This lack of research into meaningful behavior is not unique to approach and avoidance research and reflects a broader trend in social psychology that senior researchers and journal editors have been attempting to reverse (Baumeister, Vohs, & Funder, 2007; Doliński, 2018; Fiedler, 2018).

The main aim of our research was therefore to undertake a comprehensive investigation of when and why reliable effects of embodied approach versus avoidance on a representative everyday behavior occur. We focused on food choice because this is the behavior that has been examined by the very few existing studies that investigated the impact of approach and avoidance on everyday behaviors (Förster, 2003; Streicher & Estes, 2016; Van den Bergh, Schmitt, & Warlop, 2011). Therefore, rather than researching previously uninvestigated behaviors, we targeted the same behavior in order to advance earlier theoretical conclusions by building upon the strengths of these few previous studies and overcoming their limitations.

More precisely, we investigated how leaning (approach) versus reclining (avoidance) bodily positions influence online grocery shopping. This experimental paradigm allowed us to

approach the selection of the food stimuli in a way that maximizes the generalizability and theoretical implications of our findings. We also aimed to establish relevant personality and situational moderators of the impact of posture on online grocery purchases to advance theoretical understanding of this effect but also to more clearly grasp the circumstances in which it is likely to replicate. To outline the advantages and novel contributions of our approach in greater depth and state the hypotheses, we first review the limited existing research on approach versus avoidance and food-related behavior.

1.1. Embodied Approach versus Avoidance and Food-Related Behavior

Previous theorizing on the link between the body and the two motivational orientations (Cacioppo, et al., 1993; Körner, Topolinski, & Strack, 2015; Price & Harmon-Jones, 2016; Strack & Deutsch, 2004) posited that certain bodily positions that simulate decreasing (vs. increasing) the distance between an object and the self can directly induce the motivational state of approach (vs. avoidance). Examples of such bodily positions would be arm flexion (vs. extension; Förster, 2003) or leaning forward (vs. reclining; Harmon-Jones, Gable, & Price, 2011). Because approach is linked to acquisition of appetitive stimuli (e.g. sugary foods such as chocolate), inducing this state via relevant bodily positions should increase the consumption or choice of such stimuli relative to avoidance (Hofmann, Friese, & Strack, 2009; Price & Harmon-Jones, 2016; Strack & Deutsch, 2004).

Theoretical predictions regarding the impact of approach and avoidance on food-related behavior were tested in three articles that probed how arm positions shape purchasing, consumption, and choice of appetitive foods (Förster, 2003; Streicher & Estes, 2016; Van den Bergh et al., 2011). Some of the studies supported previous theorizing: flexion (vs. extension) made people consume more cookies (Förster, 2003) and enhanced purchases of products such as

chocolate bars (Studies 1A and 1B, Van den Bergh et al., 2011; Studies 1 and 2, Streicher & Estes, 2016). Other findings were, however, incompatible with previous theoretical models (Strack & Deutsch, 2004). For example, in Study 3 of Streicher and Estes (2016), arm flexion versus extension did not impact purchases of Red Bull energy drinks per se: the effects depended on the interaction between the arm positions and the movement of the stimuli on the screen to indicate purchase intention. When participants moved (on the screen) the Red Bull cans toward themselves to initiate purchase, arm flexion (vs. extension) increased spending on the energy drinks. However, when participants moved the cans away from themselves, the results reversed.

Based on the existing studies, it therefore remains unclear whether approach (vs. avoidance) increases or decreases purchases or consumption of appetitive food. One of the main limitations of the previous research that may have contributed to this lack of clarity is the type of bodily position used to induce motivational orientations. Although earlier theorizing suggested that arm flexion versus extension directly activates approach versus avoidance states (e.g. Cacioppo et al., 1993; Strack & Deutsch, 2004), subsequent experimentation suggested that this manipulation is ambiguous and may produce either approach or avoidance effects under different circumstances (e.g. Van Dantzig, Pecher, & Zwaan, 2008; for a review of research, see Rougier et al., 2018). The ambiguity lies in the fact that arm extension can be interpreted either as pushing an object away (avoidance) or as reaching toward it (approach); similarly, flexion can be interpreted either as pulling an object toward the self (approach) or as withdrawing one's hand from it (avoidance). The impact of the arm positions on behavior may therefore depend on the interpretation that makes most sense in the context of the action being undertaken (Körner et al., 2015; Rougier et al., 2018). This would explain why in Streicher and Estes (2016, Study 3) the

effect of the arm positions depended on the direction in which participants moved the Red Bull cans to initiate the purchase.

In our investigation of how approach and avoidance evoked by bodily positions impact food choice, the first step was to identify a manipulation that directly activates the two motivational orientations and does not involve ambiguous motor (e.g. arm) movements whose interpretation depends on the context of action (Körner et al., 2015). In line with this objective, we selected leaning forward versus reclining as the most appropriate manipulation (Price & Harmon-Jones, 2016). The impact of these postures on food-related behavior has not yet been tested; however, research from different domains provided evidence in support of their direct link with approach and avoidance. First, cutting edge neuroscientific research employing different biological markers showed that leaning (vs. reclining) incites approach (vs. avoidance) orientations in response to various appetitive stimuli (Harmon-Jones & Gable, 2018; Harmon-Jones et al., 2011; Kelley, Hortensius, Schutter, & Harmon-Jones, 2017; Maxwell & Davidson, 2007; McGregor, Nash, Mann, & Phills, 2010; Price, Dieckman, & Harmon-Jones, 2012; Price & Harmon-Jones, 2011). Second, research showed that people bend their upper body forward when faced with stimuli linked to approach (Brunyé et al., 2013; Eerland, Guadalupe, Franken, & Zwaan, 2012). Finally, Rougier et al. (2018) established that visual impression of moving the whole body forward (vs. backward), which is comparable to leaning forward (vs. reclining), produces more consistent approach (vs. avoidance) effects than arm flexion (vs. extension).

Because leaning (vs. reclining) activates approach versus avoidance, this posture may also increase consumption or purchases of appetitive foods (Hofmann et al., 2009; Strack & Deutsch, 2004). However, before making concrete predictions, our second step was to clearly define the appetitive foods, which in the previous literature have not been operationalized with rigor.

1.2. Operationalization of Appetitive Foods

A second major limitation of the existing research on the impact of embodied approach versus avoidance on food-related behavior is that the "appetitive" foods employed were typically vaguely defined, and their operationalization was inconsistent across studies. Förster (2003), for example, focused on food valence and used deliciousness (Study 1) and tastiness (Study 2) as different aspects of this construct to select food stimuli for the studies. In contrast, Van den Bergh et al. (2011) used vice foods as stimuli. The operationalization of "vice" was imprecise: "We classified the vice products bought at the cash register as chocolate bars, candy, and chewing gum. These products provide immediate benefits and can be consumed instantly" (Van den Bergh et al., 2011, p. 1036). Streicher and Estes (2016) also used vice foods, although they had a more systematic way of operationalizing these foods—they selected food stimuli in a pretest where participants rated, on a 9-point scale, the extent to which the different foods represented a vice or virtue to them.

It is possible that this conceptual inconsistency across the studies may have occurred because theoretical models concerning embodiment of approach and avoidance (e.g. Price & Harmon-Jones, 2016; Strack & Deutsch, 2004) did not clearly specify the characteristics of appetitive food stimuli. This lack of precise operationalization has several disadvantages. First, from a theoretical perspective, it makes it difficult to understand which food qualities determine whether behavior toward the foods will be shaped by approach versus avoidance. Second, constructs such as "valence" and "vice" are subjective and depend on people's preferences, which may limit the generalizability of the findings. For example, if a study shows that approach and avoidance impact consumption of some positively valenced or vice foods, one cannot easily identify all foods to which this insight may apply based on some objective nutritional

information and, instead, one first needs to assess valence and vice values of a variety of different items. Moreover, valence also has ambiguous link with approach and avoidance. Whereas approach is typically directed at positively valenced stimuli, food liking and motivation do not always go hand in hand (Berridge, 1996; Berridge & Robinson, 2016; Berridge, Robinson, & Aldridge, 2009; Berkman & Lieberman, 2010; Harmon-Jones, Harmon-Jones, & Price, 2013). People may, for example, be attracted to unhealthy substances or foods which they no longer associate with pleasure (Balcetis, 2016; Berridge et al., 2009).

To avoid these limitations in the present research, we set out to objectively define and operationalize appetitive food stimuli by relying on their nutritional content rather than on how people perceive them in terms of dimensions such as valence or vice. The main rationale behind our approach was to first identify the brain regions that shape approach motivation, and then determine nutritional characteristics of foods whose consumptions is potentiated by these regions. The seat of approach in the brain is typically referred to as the reward system and involves the regions such as frontal, ventral striatal, amygdala, and midbrain—the approach motivational state can therefore be operationalized as the heightened activity of the reward system (Beaver et al., 2006; Berridge, 1996; Berridge & Robinson, 2016; Berridge et al., 2009; Gray & McNaughton, 2000; Robbins & Everitt, 1996). Research showed that stimulation of this system typically leads to increased intake of foods which are high in sugar, fat, and salt (Alonso-Alonso et al., 2015; Blumenthal & Gold, 2010; Kelley, 2004; Kelley, Baldo, Pratt, & Will, 2005; Ziauddeen, Alonso-Alonso, Hill, Kelley, & Khan, 2015). High quantities of one or more of these nutrients are therefore essential characteristics of appetitive foods. This is consistent with previous research on embodied approach versus avoidance and food choice (Förster, 2003; Streicher & Estes, 2016; Van den Bergh et al., 2011), given that, even if the food stimuli in this

research were not selected based on their nutritional content but based on valence or vice, they typically score high on fat, sugar, and/or salt (Department of Health, 2016).

Although no single study has specified the cut-off points that can be used to operationalize appetitive foods based on the quantities of these nutrients, policy makers have created the "traffic lights" system (Department of Health, 2016) that relies on various available evidence to classify foods as either red (=high), amber (=medium), or green (=low) on sugar, salt, fat (this comprises all the types of fat found in a product), and saturated fat specifically. Foods that are labelled as red on one or more of these nutrients are those that have strong links with the reward system and can therefore lead to dependency, which may eventually result in health problems (Alonso-Alonso et al., 2015; Finardi & Tognon, 2014; Blumenthal & Gold, 2010). We therefore used this classification to operationalize appetitive foods whose consumption and choice may be impacted by approach (vs. avoidance) motivational states—in this article we refer to these foods as "rewarding" to emphasize their link with the reward system.[1]

Our next step was to choose a specific paradigm to test behavior toward rewarding foods, and we opted for online grocery shopping. This paradigm allowed us to present participants with a large number of rewarding foods to ensure our findings are not a methodological artefact of the few products tested, as well as to minimize the risk of idiosyncratic liking or disliking of a specific product (say, chocolate bar). These were the limitations of the previous studies, which typically used a small number of positively valenced or vice products, with 12 being the largest (Study 2, Streicher & Estes, 2016). The online setting was preferred over the display of the food items in physical form so that participants could be exposed to a large assortment of products while at the same time sitting in the posture required (Harmon-Jones et al., 2011) to manipulate approach versus avoidance. Online grocery shopping is also preferable to other more artificial

methods of product choice on the screen (see Benartzi & Lehrer, 2015) from the perspective of ecological validity because it is a real-world behavior that is becoming widely adopted and naturally occurs on the screen (Food Marketing Institute, 2018; Stern, 2018).

1.3. Personality and Situational Moderators: Behavioral Activation System and Construal Level

Based on the notion that approach corresponds to the heightened activity of the reward system that potentiates consumption of appetitive (i.e. rewarding) foods (Beaver et al., 2006; Kelley, 2004), one would expect that any manipulations which activate approach (vs. avoidance), including leaning (vs. reclining), should impact behavior toward them. However, research at the intersection of neuroscience, personality, and social psychology indicated that not all individuals have the same capacity to experience approach motivation (Beaver et al., 2006; Van den Bergh et al., 2011). In other words, whereas for some people experimental manipulations may considerably boost this motivation, thus reinforcing approach-consistent behaviors, for other individuals the impact may be minor because they simply cannot experience strong approach motivational states due to their personality or situation. For such people, behavior may be influenced by reflective forces such as reasoning rather than by approach (vs. avoidance) motivation (Strack & Deutsch, 2004). The effect of leaning versus reclining on online grocery shopping of rewarding foods should therefore depend on personality and situational moderators that bound people's capacity to experience approach (Hofmann et al., 2009). No previous research has clearly established the moderators of embodied motivational orientations and food choice, but here we review evidence in closely related domains.

A personality trait that has been linked to people's capacity to experience approach motivation in the closely related domain of present-biased preferences (Van den Bergh et al.,

2011) is the behavioral activation system (BAS) reactivity (Carver & White, 1994; Beaver et al., 2006; Elliot & Thrash, 2002). More specifically, activating approach (vs. avoidance) via arm flexion (vs. extension) increased preferences for smaller but sooner over larger but later monetary rewards, but only for people who were high, rather than low in BAS (Van den Bergh et al., 2011). The researchers argued that this moderating effect occurred because low-BAS individuals lack the capacity to experience strong approach motivation and are not easily impacted by various manipulations to prefer choices consistent with this motivation. In contrast, individuals who score high on BAS have this capacity, which can therefore be experimentally activated or attenuated to accordingly shape preferences and behavior. In line with this argumentation, it is plausible to expect that leaning (vs. reclining) would boost online purchases of rewarding foods only for high, but not low BAS individuals.

In the research by Van den Bergh et al. (2011), BAS was treated as a unitary construct (Torrubia, Avila, Moltó, & Caseras, 2001). However, to further advance theoretical understanding of the moderation, we decided to focus on the more multilayered conceptualization by Carver and White (1994), according to which BAS consists of three components: “BAS drive”, which refers to how easily people are driven to action toward rewards; “BAS reward responsiveness,” which comprises propensity to experience strong emotions when faced with rewards; and “BAS fun seeking”, which captures how inclined people are to have fun and experience excitement and new sensations. Given that BAS drive is conceptualized in terms of action toward rewards, whereas reward responsiveness and fun seeking are linked to affective experiences to rewards and the need for excitement and fun, we expected that the drive component should be the most relevant BAS moderator in the present

research, considering that we are researching action toward rewarding foods (i.e. their purchases) rather than affective reactions to them or how fun people experience online grocery shopping.

This notion is supported by neuroscientific research that investigated whether the three components of BAS determine the strength of people's tendency to approach rewards (Beaver et al., 2006). More precisely, Beaver et al. (2006) demonstrated that the drive component of BAS is the strongest determinant of a person's capacity to experience approach, operationalized as the heightened activity of the brain's reward system. In the presence of rewarding foods, higher (vs. lower) BAS drive scores predicted stronger activation in five main regions of the reward system. BAS reward responsiveness was a partial predictor because it was linked to only two of the regions, and BAS fun seeking was not correlated with any of the regions. Based on these findings, it is plausible that people with low BAS drive have a weak capacity to experience approach and cannot be easily nudged via experimental manipulations to exhibit approach-consistent behavior. For individuals high in BAS drive, the capacity is high, and various experimental manipulations that activate approach (vs. avoidance) may simply actualize this natural capacity and produce approach-consistent behavior. We therefore hypothesize that leaning (vs. reclining) should make people high in BAS drive spend more on rewarding foods, whereas no effect should occur for people low in BAS drive. This pattern of influence is also consistent with previous findings by Van den Bergh et al. (2011) who explored the moderating effects of unidimensional BAS on reward-related outcomes.

In addition to the personality moderator, we aimed to establish a situational moderator. The emphasis was on identifying a variable that can change a person's capacity to experience approach (vs. avoidance) tendencies toward rewarding foods in a given situation. In line with this notion, we focused on construal level (Liberman, Trope, & Wakslak, 2007) as a potential

moderator. According to construal level theory (Trope & Liberman, 2010), people mentally represent their world using either an abstract (e.g. focusing on "the forest") or a concrete (e.g. focusing on "the trees") mindset. The former is known as high construal level (HCL), and the latter as low construal level (LCL). Although LCL is a considerably broader construct than approach motivation and should increase people's attention to all kinds of immediate affective considerations compared to HCL (Trope & Liberman, 2010), research showed that, amongst its various effects, LCL raises people's capacity to experience approach toward rewarding foods because it activates a present-oriented thinking mode during which the reward system is highly reactive (Peters & Büchel, 2011; Stillman et al., 2017; Trope & Liberman, 2010; Volkow & Baler, 2015). For example, inducing LCL (vs. HCL) increased consumption of candies, willingness to pay for rewarding products, and choice of candies over apples (Fujita & Han, 2009; Mehta, Zhu, & Meyers-Levy, 2014). Therefore, because LCL boosts people's capacity to approach rewarding foods, leaning (vs. reclining) should activate sufficiently strong motivational state of approach that can increase online purchases of rewarding foods only under this mindset. In contrast, HCL should attenuate the impact of this posture on approach motivational states and thus prevent its impact on approach-consistent behavior.

1.4. Overview of Hypotheses

In sum, we predicted that the impact of posture on purchases of rewarding foods would be moderated by BAS (Beaver et al., 2006; Carver & White, 1994) as a personality trait (Hypothesis 1), and by construal level (Fujita & Han, 2009) as a situational state (Hypothesis 2). Regarding BAS, we more specifically expected that its component BAS drive would be the most robust moderator, given that it is conceptualized in terms of action toward rewards and is also the strongest predictor of the activity of the reward system that shapes approach motivation. We did

not have a clear prediction regarding BAS reward responsiveness due to its weaker relationship with the reward system activity and because this construct is conceptualized in terms of emotional rather than behavioral responses to rewards. Moreover, we did not expect that BAS fun seeking would be a significant moderator because it is neither conceptualized specifically in terms of action toward rewards nor it predicts the activity of the reward system. Overall, leaning (vs. reclining) should make people spend more money on rewarding foods only under high BAS drive or LCL, but not under low BAS drive or HCL. Considering that a moderated effect does not imply the existence of a main effect because the latter may depend on the distribution of the moderator in the population being tested, on exact moderator values at which the effect of posture occurs, etc. (Hayes, 2018), we did not have specific predictions about the main effect.

2. Study 1

In Study 1, we used a realistic online store (Figure 1) to test Hypothesis 1. Although our focus was on rewarding foods that are at the core of our theorizing, the store also contained products that have either intermediate (=amber) or low (=green) quantities of the nutrients we used to classify rewarding foods based on the criteria by the Department of Health (2016; see Section 2.1. for specifics). We referred to the former foods as intermediate, and to the latter as healthy, although these names should not be taken too literally because we acknowledge that the perception of food healthiness varies across people (Ronteltap, Sijtsema, Dagevos, & de Winter, 2012). These product categories were included for three reasons. Most importantly, because the bodily effects on food purchases we formulated in Hypotheses 1 and 2 should apply specifically to rewarding products given their compatibility with approach (e.g. Price & Harmon-Jones, 2016), in exploratory analyses for each of our studies (see Supplementary Materials, pp. 7, 11, 20) we also tested the hypotheses in relation to intermediate and healthy items to establish

whether they are indeed specific to rewarding foods. Second, we wanted to make the store ecologically valid, and all commercial online grocery shops contain a combination of rewarding, intermediate, and healthy foods. Third, we wanted to ensure the robustness of our findings by creating different store designs with different displays of foods from all the three categories across the studies.

In the present study, products were arranged in such a way that rewarding foods were displayed on salient locations, whereas intermediate and healthy products were displayed less conspicuously (Figure 1). Previous research showed that items (in this case rewarding foods) are selected more frequently when displayed on salient (vs. inconspicuous) positions on the screen (Breugelmans, Campo, & Gijsbrechts, 2007; Reutskaja, Nagel, Camerer, & Rangel, 2011). In the first study, our store design was therefore grounded upon this research insight because we expected that the hypothesized effects would be most likely to occur when products are displayed in a way that makes people highly susceptible to rewarding foods.

The present study also measured additional variables to test alternative explanations and eliminate confounds. Concerning alternative explanations, previous research showed that BAS is linked to another similar construct—impulsiveness—and the BAS scale developed by Carver and White (1994) has also been used to measure this construct alongside other impulsiveness measures (Dawe, Gullo, & Loxton, 2004; May, Irmak, & Lamberton, 2018; Mukhopadhyay, Sengupta, & Ramanathan, 2008; Puri, 1996). If the two constructs are indeed linked, then it is possible that the moderating effects we predicted for BAS may also apply to impulsiveness. Hence, we assessed impulsiveness to examine whether our predictions apply specifically to BAS or can also be extended to this closely related construct. Moreover, to eliminate potential confounds, we probed variables that are either known to play a role in food consumption or that

we thought could have potentially confounded the findings in the context of our research setup (for details, see Section 2.1.5.).

2.1. Method

2.1.1. *Classification of rewarding, intermediate, and healthy foods*

As previously discussed, these three food types were determined based on the "traffic lights" system, according to which a product can be classified as either red (=high), amber (=medium), or green (=low) on fat, saturated fat, sugar, and salt (for exact criteria per 100g of food or per 100ml of drinks, see Department of Health, 2016, pp. 19-20). We define foods that are labelled as red on at least one of the nutrients as "rewarding", whereas "healthy" foods are characterized as green on all nutrients. Finally, "intermediate" foods are classified as amber on at least one of the nutrients but do not have any red labels.

2.1.2. Online grocery shop

The online grocery shop (see Figure 1) was built using Shopify (www.shopify.com), a leading e-commerce platform. The first step in constructing the store was researching popular e-commerce food websites in the UK to determine most plausible product assortments. In the end, we opted for 180 products taken mostly from Tesco's Online Grocery Shop and organized them into 15 categories representative of everyday diet (Figure 1). We used only products that tend to be popular and are frequently purchased to ensure that our participants were familiar with them. Our store therefore consisted of 70 rewarding, 80 intermediate, and 30 healthy products (for the complete product inventory with nutritional information, see Supplementary Materials, p. 25). As on Tesco's website, shoppers could add a product to the basket from the main category page and click on any product to open a page with its dietary information. Dietary information of all items was taken from Tesco's Online Grocery Shop.

The design of the online store (Figure 1) was characterized by two important features related to salience of the products. Categories with the highest number of rewarding foods were placed at the top of the category menu on the left-hand side of the screen, and three items from the category that contained the highest proportion of rewarding products—*Chocolate and Sweets*—by default appeared at the central location of the screen, known as the hotspot (Benartzi & Lehrer, 2015; Reutskaja et al., 2011). Moreover, whenever participants opened a specific category, the unhealthiest products from that category by default appeared in the hotspot locations. Healthier options were therefore harder to reach because participants had to scroll down to see them.

2.1.3. Sample size: power analyses

To determine the sample size needed to obtain a significant interaction effect between posture as a categorical independent variable and BAS drive as a continuous moderator (Hypothesis 1), we implemented the approach by Faul, Erdfelder, Buchner, and Lang (2009) based on linear multiple regression using G*Power (Faul, Erdfelder, Lang, & Buchner, 2007). We focused on a medium effect size (Cohen's $f^2 = .15$), given that such effects are most frequent in psychology research (Richard, Bond, & Stokes-Zoota, 2003). Also, we implemented a standard power criterion (80%) and a conservative significance level ($\alpha = .01$). The computed sample size was 82. However, given that we were probing multiple BAS components as moderators, and considering recent replication failures in psychology (Open Science Collaboration, 2015), we decided to be more conservative and test the maximum number of participants we could obtain from our participant pool.[2] Sensitivity power analysis (Faul et al., 2009) indicated that, with the 208 participants who were eventually included in statistical

analyses (see Section 2.2.1.), the study had a power of 80% (α = .01) to detect Cohen's f^2 of 0.057, which is close to the small effect size of 0.020.

2.1.4. Design and procedure

Two hundred and thirty participants (146 women, Age range: 18-29) were recruited from a participant pool of the Behavioral Research Lab at LSE and paid at the standard rate of £10/hour.[3] We tested only participants who were 18 to 29 years old and were citizens of the UK, Europe, Canada, US, Australia or New Zealand to minimize potential confounding effects of age or diet preference due to nationality. All participants were tested in a lab consisting of 20 computers, each in a cubicle of its own. After arriving to the lab, they were given a short introduction by the experimenter, and seated at the computers.

Participants first read the consent form, after which they received the sitting instructions that described the required posture verbally and contained the photo of a person depicting how they should sit throughout the study. All participants were randomly allocated to either the leaning (approach) or reclining (avoidance) condition. Those in the leaning condition were asked to lean the upper part of their body toward the computer screen, whereas those in the reclining condition were asked to lean against the back of their chair, which had been already adjusted and tilted at an angle of approximately 50-55° in relation to the ground (Figure 2). Because physical distance to an object can influence people's responses to it (Wansink, Painter, & Lee, 2006), we adjusted the experimental environment in such a way that participants' heads in both the leaning and reclining condition were at a similar distance from the screen to avoid its potential confounding effects.

After reading the sitting guidelines, participants received the instructions describing the grocery shopping task as well as how to use the online store. Importantly, they were asked to

shop for foods they would like to eat on the day of the experiment and during the following few days. They were allowed to spend up to £50. This amount was chosen because it is the average amount European shoppers spend when purchasing foods online (SyndicatePlus, 2014). Furthermore, participants were told that 10 lucky individuals would win the foods they added to the shopping cart. This approach was used to make the shopping task realistic and ensure that participants selected the foods they would actually eat.

Then they undertook the shopping task. There was no time limit, but most of them finished the shopping in 5-15 minutes. After completing the shopping task, they received a survey containing various questions that were used to assess the moderator, potential confounds, alternative explanations, some exploratory measures, and compliance with experimental instructions (see Section 2.1.5.).[4] We also asked them to report any food allergies to identify participants with severe allergies for whom the store assortment would be particularly restrictive to exclude them from analyses. Finally, all participants were informed they would be contacted within 2 weeks if they were amongst the 10 lucky winners of the shopping basket (the winners received £50 Tesco gift cards to purchase the desired foods), compensated for their time, and debriefed.

2.1.5. Measures

Moderators. To assess the three BAS components that we aimed to probe as moderators—drive, reward responsiveness, and fun seeking—we used the Behavioral Inhibition (BIS) and Activation (BAS) Systems scale (Carver & White, 1994). The response options ranged from "1=Strongly disagree" to "4=Strongly agree". Higher scores indicate that participants have higher BAS drive, reward responsiveness, or fun seeking.

Potential confounds. To ensure that the hypothesized effects were not confounded by other factors that may impact food consumption and choice, we measured several variables. *Gender* (male vs. female vs. other) was assessed because women were found to avoid rewarding foods (e.g. fatty products) more than men (Wardle et al., 2004), but also because this variable was used in confound testing in previous research on body and food choice (Streicher & Estes, 2016). Moreover, because we suspected that some of our participants may not purchase the groceries to consume them on their own but to share them with one or more other individuals (e.g. friends, household members, etc.), which may shape the type and quantity of products they buy, we measured the *tendency to share the foods purchased in the study* ("Did you purchase the foods in the present study to consume them on your own or to share them with others?") on a scale from "0=I purchased the foods to consume them on my own" to "6=I purchased the foods to share them with more than 5 other persons". We also assessed whether participants were *vegetarian/vegan* (vegetarians or vegans were coded as 0, whereas the rest were coded as 1) because these participants by default avoid certain food categories from our store that contain rewarding products (e.g. meats) and their choices of rewarding foods may therefore be different than for other participants. *Body Mass Index* (BMI; Frankel & Staeheli, 1992), which required participants to report their weight and height, was tested because of its association with the consumption of rewarding foods (e.g. Newby et al., 2003). Moreover, because affective states are an important determinant of food choice (Macht, 2008) and were also used as covariates in previous research on body and food-related behavior (Förster, 2003), we assessed three dimensions of core affect—*pleasure-displeasure*, *awake-tiredness*, and *tension-relaxation*—using the scale by Schimmack and Grob (2000).

We further measured taste preference for *sweet, fatty, salty, sour,* or *spicy* foods ("How much do you like the following types of food: sweet, fatty, salty, sour, or spicy", using a slider from "0=Dislike a lot" to "10=Like a lot") to ensure that any effects we obtained did not occur because of participants' default preferences for different food types. We also assessed *cooking frequency* ("How frequently do you usually cook", on a scale from "1 day per week" to "7 days per week") because we suspected that participants who cook more may be more likely to select products whose preparation requires effort that may in some cases belong to healthier categories such as *vegetables*. Given that hunger was previously found to change attitudes and physiological responses to rewarding foods (e.g. Hoefling et al., 2009; Lozano, Crites, & Aikman, 1999), we assessed this variable ("How hungry do you feel at the moment?") using a slider from "0=Not hungry at all" to "10=Very hungry". Finally, to ensure that leaning did not impact purchases of rewarding foods because it generally made people spend more money on all products relative to reclining, we assessed the *total value of the shopping basket*.

Compliance with instructions. To validate compliance with the sitting instructions, participants were asked to answer the following question: "While you were shopping for groceries, did you assume the sitting position that was described to you at the beginning of the study? Please answer honestly—you will receive the payment regardless of your answer." The response options were "Yes, I did", "No, I did not", and "I do not remember." The experimenter also observed participants unbeknownst to them during the shopping task and noted down those who were not sitting appropriately and validated his observations against their self-reports. All participants who did not comply with the sitting instructions were excluded from statistical analyses.

Alternative explanations and exploratory variables. Impulsiveness as an alternative explanation was measured using the consumer impulsiveness scale by Puri (1996) that comprises two components—*hedonic* and *prudent* impulsiveness. The responses were assessed using a slider ranging from "0=Seldom would describe me" to "10=Usually would describe me". Higher scores on the hedonic subscale indicate more hedonic consumers, whereas higher scores on the prudent subscale indicate more prudent consumers. For exploratory variables, see Supplementary Materials, p. 3.

2.2. *Results*

Data file, details of data, and analyses codes in R for this study can be found on the Open Science Framework (https://osf.io/nmabe/).

2.2.1. Excluded data

Out of 230 participants, data from 22 were excluded from statistical analyses. One participant failed to submit any data (shopping data or post-shopping survey), one participant did not submit the shopping data, and one participant failed to submit the post-shopping survey. Furthermore, sixteen participants failed to assume the required sitting positions. Finally, two participants reported allergies that could have severely impacted their choices in the context of rewarding foods (sugar intolerance), and one participant exceeded the £50 limit. Therefore, data from 208 participants were included in statistical analyses—103 in the leaning and 105 in the reclining condition.[5]

2.2.2. Testing hypothesis 1

We conducted an analysis of simple slopes (Aiken & West, 1991) for each of the three BAS components separately. More precisely, using multiple regressions, we computed the interactions between sitting posture as a between-subjects factor and each BAS component as a

continuous moderator, and inspected the impact of leaning versus reclining on the amount of money spent on rewarding foods across low (−1 *SD*) and high (+1 *SD*) levels of the moderator (Hayes, 2018).[6]

As predicted, the analysis (*Multiple* R^2 = 0.12) showed that BAS drive significantly interacted with posture, $t(204) = 3.88$, $b = 8.18$, 95% CI [4.02, 12.33], $p < .001$, *Cohen's* f^2 = 0.074: leaning (vs. reclining) made people spend £8.24 more on rewarding foods when BAS Drive was high, $t(204) = 5.18$, $b = 8.24$, 95% CI [5.11, 11.38], $p < .001$, *Cohen's* $f^2 = 0.132$, but not when it was low, $t(204) = -0.32$, $b = -0.51$, 95% CI [−3.64, 2.63], $p = .750$, *Cohen's* $f^2 <$ 0.001 (Figure 3A). BAS reward responsiveness, for which we did not have a clear prediction, also interacted with posture (*Multiple* $R^2 = 0.09$), $t(204) = 2.71$, $b = 8.28$, 95% CI [2.25, 14.31], $p = .007$, *Cohen's* $f^2 = 0.036$: leaning (vs. reclining) made people spend £6.99 more on rewarding foods under high, $t(204) = 4.33$, $b = 6.99$, 95% CI [3.81, 10.18], $p < .001$, *Cohen's* $f^2 = 0.092$, but not low BAS reward responsiveness, $t(204) = 0.48$, $b = 0.77$, 95% CI [−2.42, 3.96], $p = .634$, *Cohen's* $f^2 = 0.001$ (Figure 3B). As expected, posture did not interact with BAS fun seeking (*Multiple* $R^2 = 0.06$), $t(204) = 1.54$, $b = 3.42$, 95% CI [−0.95, 7.79], $p = .124$, *Cohen's* $f^2 = 0.012$ (Figure 3C). To compute the main effect of posture, we also performed a t-test, which showed that leaning ($M = 17.72$, $SD = 9.54$) overall made people spend more money on rewarding foods compared to reclining ($M = 13.87$, $SD = 7.00$), $t(206) = -3.33$, $p = .001$, $d = 0.46$. The significant results did not change after controlling for potential confounds. For confound tests and correlations between the main and alternative moderators analyzed in Study 1, see Supplementary Materials, pp. 4-6.

2.2.3. Alternative explanations and exploratory analyses

To probe impulsiveness (Puri, 1996) as an alternative moderator, we conducted the interactions between each of its two components as continuous moderators and sitting posture as the independent variable using separate multiple regressions. Neither the hedonic (*Multiple* R^2 = 0.05), $t(204) = -0.36$, $b = -0.28$, 95% CI [−1.82, 1.25], $p = .717$, *Cohen's* $f^2 = 0.001$, nor the prudent component (*Multiple* $R^2 = 0.06$), $t(204) = 1.15$, $b = 1.05$, 95% CI [−0.76, 2.86], $p = .253$, *Cohen's* $f^2 = 0.006$, interacted with posture in influencing rewarding food purchases, thus indicating that the moderating effects we obtained for BAS drive and reward responsiveness do not extend to impulsiveness. For correlations between prudent and hedonic impulsiveness and the three BAS components, as well as for exploratory analyses, see Supplementary Materials, pp. 6-7.

2.3. Discussion

Study 1 supported Hypothesis 1 by showing that leaning increased spending on rewarding foods relative to reclining under high, but not low BAS drive. This finding supports the theorizing that approach postures (i.e. leaning) should make people more susceptible to rewarding products relative to avoidance postures (i.e. reclining) only for people who have high, but not low capacity to experience approach tendencies (Beaver et al., 2006; Van den Bergh et al., 2011). BAS reward responsiveness, for which we did not have a clear expectation, similarly moderated the effect of posture on food purchases, whereas BAS fun seeking did not produce a significant moderating effect as predicted. In addition, posture exerted a main effect on shopping choices: leaning made people spend more on rewarding foods relative to reclining across the entire participant sample. Because exploratory analyses failed to show any moderated effects of posture on intermediate or healthy food choices, Study 1 demonstrated that Hypothesis 1 applies specifically to rewarding foods, in line with previous theorizing (Price & Harmon Jones, 2016).

Finally, in the present study, we also showed that Hypothesis 1 does not extend to impulsiveness as a construct that has been linked to BAS in the literature (Mukhopadhyay et al., 2008; Puri, 1996), given that neither its hedonic nor its prudent component moderated the effects of posture on rewarding foods. It is therefore important to discuss why exactly the moderating effects may have failed to occur, and the implications this has for understanding the link between BAS and impulsiveness. One possibility that may explain the absence of the moderating effects is that impulsiveness does not share similarities with the drive component of BAS that we expected to be the most relevant moderator in the present research. Indeed, correlation analyses reported in the Supplementary Materials (see Tables 1 and 2 on p. 6) showed that impulsiveness was mostly related to the BAS component least relevant in the context of the present research—fun seeking. In particular, the similarity between BAS and impulsiveness may primarily be accounted for by the similarity between BAS fun seeking and hedonic impulsiveness, given that only the correlations between the two variables were significant in either the approach or avoidance conditions and were also largest in magnitude. These correlations also make sense on a conceptual level, considering that hedonic impulsiveness tackles personality aspects that are similar to fun seeking (e.g. being careless, easily tempted, etc.; Puri, 1996). Overall, the relationship between BAS fun seeking and hedonic impulsiveness (see Supplementary Materials, Tables 1 and 2 on p. 6) would clarify why impulsiveness could be linked to BAS as the literature suggests (e.g. Mukhopadhyay et al., 2008) while at the same time failing to moderate the effects of posture on food choices. Future research will need to further disentangle the link between the two personality traits by approaching BAS as a multilayered rather than unitary construct.

3. Study 2

In Study 1, we probed Hypothesis 1 using the store design that favors the choice of rewarding products, given their salient display (Benartzi & Lehrer, 2015; Breugelmans et al., 2007; Reutskaja et al., 2011). In Study 2 we therefore wanted to ensure that our predictions generalize beyond this and similar store designs and we implemented a product arrangement that is substantially different. We tested whether Hypothesis 1 replicates when rewarding foods are presented in inconspicuous locations, and visual primacy is given to healthier items instead (Figure 4).

In the present study, we also probed another alternative moderator: eating restraint. Previous food research frequently implemented this variable as a moderator and demonstrated that only restrained eaters, but not the unrestrained ones, can be influenced by various cues that evoke eating desire (e.g. food smell) to consume rewarding foods, presumably because they have stronger approach tendencies toward such foods, which can propel them to act once their ability to restrain themselves is impaired by these cues (Fedoroff, Polivy, & Herman, 1997, 2003; Heatherton, Herman, & Polivy, 1991; Polivy, Coleman, & Herman, 2005; Veenstra & de Jong, 2010). To examine whether leaning (vs. reclining) therefore similarly influences online shopping of rewarding foods only for restrained eaters, we tested eating restraint as an alternative moderator. Together with the alternative moderator probed in Study 1, this allowed us to accumulate additional evidence addressing whether the moderated effects we hypothesized apply specifically to BAS or extend to other personality variables linked to motivated food choice.

Finally, in Study 2 we also included additional confounds to further minimize the chances that our findings can be accounted for by other variables that play a role in food choice rather than by the experimental manipulations used (for details, see Section 3.1.4.). Most importantly, we wanted to ensure that the effects predicted by Hypothesis 1 are not confounded by people's

awareness of the role of posture in their shopping choices. Beyond asking people whether they did versus did not think that posture influenced their shopping, we allowed those who answered positively to this question to further clarify how exactly they thought that posture shaped their choices. This variable also allowed us to obtain further insights about the route through which leaning versus reclining impacted purchases of rewarding products. More precisely, according to Price and Harmon-Jones (2016), the influence of posture on motivational states of approach versus avoidance should be direct rather than mediated by some higher cognitive mechanisms such as inference or attribution (see Körner et al., 2015). In other words, this impact should happen because leaning (vs. reclining) activates brain mechanisms associated with approach motivation (e.g. Harmon-Jones et al., 2011), and not because people infer how they should act based on the way they sit or attribute their motivational states to this bodily position. If our participants were generally able to accurately make these inferences or attributions, this would indicate that posture did not activate motivational orientations via a direct route.

3.1. Method

3.1.1. Online grocery shop

The shop contained the same products and categories as in Study 1. However, in the present version, the website was constructed so that healthier categories were placed at the top of the category menu, and the unhealthiest ones were placed at the bottom (Figure 4). By default, the category that contained the highest proportion of healthy items—*Vegetables*—was displayed prominently to participants when they entered the store. Furthermore, whenever participants opened a category, the three healthiest products from that category would appear in the hotspot (Benartzi & Lehrer, 2015) and unhealthier options could be reached only by scrolling down and making more effort.

3.1.2. Sample size: power analyses

Given that Study 2 had the same design as the previous study, the sample size was based on the same a priori power analysis and considerations as for Study 1. Sensitivity power analysis (Faul et al., 2009) indicated that, with the 274 participants who were eventually included in statistical analyses (see Section 3.2.1.), the study had a power of 80% ($\alpha = .01$) to detect Cohen's f^2 of 0.043, which is close to the small effect size of 0.020.

3.1.3. Design and Procedure

Three hundred and twelve participants (189 women, Age range: 18-29) were recruited using identical criteria as in Study 1. The experimental design and procedure were also identical, except that the arrangement of products in the online shop was changed as described, and we probed some additional exploratory variables, confounds, and alternative explanations (see the "Measures" section below).

3.1.4. Measures

Moderators and Potential Confounds. We assessed the three BAS components—drive, reward responsiveness, and fun seeking—that were used as moderators as in Study 1. Moreover, we adopted all confound measures from Study 1, except for the three dimensions of core affect (*pleasure-displeasure*, *awake-tiredness*, and *tension-relaxation*) and taste preference for *sour* and *spicy* foods.

We also measured some additional confounds. *Comfortable sitting* (How comfortable do you find sitting in this position?) was assessed on a scale from "1=Not at all" to "5=A great degree" because previous research testing the impact of bodily positions on food-related behavior (e.g. Streicher & Estes, 2016) typically probed whether the difficulty, strenuousness, or comfort associated with the positions confounded the effects. *Frequency of eating sugary foods*

("How frequently do you consume foods high in sugar?"), *frequency of eating fatty foods* ("How frequently do you consume foods high in fat?"), *frequency of eating salty foods* ("How frequently do you consume foods high in salt?"), and *frequency of eating caloric foods* ("How frequently do you consume high calorie foods?") were assessed on a scale from "0=Never" to "7=Seven days per week". We measured these variables because they capture how frequently people consume rewarding foods in their daily life, and we wanted to ensure that the present effects cannot be attributed to their everyday eating preferences.

Importantly, to ensure that the results were not confounded by participants' assumptions about the impact of posture on their shopping behavior (e.g. participants who formed an expectation concerning how their sitting posture should shape their purchases may have acted in line with this expectation), we measured *awareness of the role of posture in their shopping choices* (Do you think the sitting position influenced your shopping choices? If yes, in what way?) using a dichotomous (no vs. yes) scale. We also measured *perceived hunger influence* (Do you think that hunger influenced your shopping choices? If yes, in what way?) using a dichotomous (no vs. yes) scale. We allowed participants who answered positively to the items assessing *perceived hunger influence* and *awareness of the role of posture in their shopping choices* to further explain the rationale behind their answers by completing an open-ended answer. Participants' responses for the latter item were used to gain additional insights into psychological and behavioral effects they associated with the posture as indicated in the introduction (for analyses see Section 3.2.4.).

Alternative Explanations, compliance with instructions, and exploratory variables. Eating restraint as an alternative moderator was measured using the restraint subscale from the three-factor eating questionnaire (Stunkard & Messick, 1985). The responses were measured and

scored as described by Stunkard and Messick (1985)—higher scores indicate higher eating restraint. Compliance with instructions was assessed similar to Study 1, with some alterations. More specifically, whereas in Study 1 participants were asked whether they assumed the required sitting position while shopping for groceries, in Study 2 they were also asked whether they assumed the sitting position while answering the post-study questionnaire. The following response options were therefore used: "Yes I did, both while shopping and completing the post-study questionnaire"; "Yes I did, but only while shopping"; "Yes I did, but only while completing the post-study questionnaire"; "I did not at all"; and "I do not remember." The additional response options involving the sitting posture while answering the post-study questionnaire were added given that for some exploratory variables that we measured in Study 2 (i.e. we wanted to see whether leaning versus reclining influences participants' scores on the cognitive reflection test, Frederick, 2005; see Supplementary Materials, p. 8) it was relevant to understand how participants were sitting. For all exploratory variables, see Supplementary Materials, pp. 8-9.

3.2. Results

Data file, details of data, and analyses codes in R for this study can be found on the Open Science Framework (https://osf.io/nmabe/).

3.2.1. Excluded data

Out of 312 study participants, data from 38 were excluded from statistical analyses: twenty-five of these failed to assume the appropriate sitting positions during the online grocery shopping task; three participated in the previous study; five exceeded the £50 limit; and five failed to follow the instructions and did not complete a large proportion of the post-study survey including the questions that probed the moderators, compliance with instructions, etc. Therefore,

data from 274 participants were eventually used in statistical analyses—137 in the leaning and 137 in the reclining condition.

3.2.2. Testing hypothesis 1

To test the hypothesis, identical analyses as in Study 1 were performed.[7] As predicted, a multiple regression (*Multiple* $R^2 = 0.06$) showed that the interaction between BAS drive and sitting posture was significant, $t(270) = 3.44$, $b = 5.96$, 95% CI [2.55, 9.37], $p = .001$, *Cohen's* $f^2 = 0.044$: leaning (vs. reclining) made people spend £4.21 more on rewarding foods under high, $t(270) = 3.47$, $b = 4.21$, 95% CI [1.82, 6.60], $p = .001$, *Cohen's* $f^2 = 0.045$, but not low BAS drive, $t(270) = -1.41$, $b = -1.70$, $p = .161$, 95% CI [−4.09, 0.68], $p = .161$, *Cohen's* $f^2 = 0.007$ (Figure 5A). This time, neither BAS reward responsiveness (*Multiple* $R^2 = 0.01$), $t(270) = 0.93$, $b = 2.18$, 95% CI [−2.46, 6.82], $p = .355$, *Cohen's* $f^2 = 0.003$, nor BAS fun seeking (*Multiple* $R^2 = 0.02$), $t(270) = 0.53$, $b = 0.95$, 95% CI [−2.58, 4.48], $p = .598$, *Cohen's* $f^2 = 0.001$, significantly interacted with posture (Figures 5B and 5C). Finally, a t-test showed that leaning ($M = 15.20$, $SD = 7.80$) did not produce a main effect on rewarding food purchases versus reclining ($M = 13.92$, $SD = 6.67$), $t(272) = -1.46$, $p = .146$, $d = 0.18$. The significant results did not change after controlling for potential confounds. For confound tests and correlations between the main and alternative moderators analyzed in Study 2, see Supplementary Materials, pp. 9-10.

3.2.3. Alternative explanations and exploratory analyses

To probe eating restraint (Stunkard & Messick, 1985) as an alternative moderator, we computed the interaction between this variable and sitting posture using multiple regression. The interaction term was not significant (*Multiple* $R^2 = 0.07$), $t(270) = 0.17$, $b = 0.03$, 95% CI [−0.31, 0.37], $p = .869$, *Cohen's* $f^2 < 0.001$, thus indicating that the moderating effect we obtained for BAS drive does not extend to eating restraint. For correlations between eating restraint and the

three BAS components, as well as for exploratory analyses, see Supplementary Materials, pp. 10-12.

3.2.4. Rationale behind the role of posture in participants' shopping choices

Out of 274 participants who were included in statistical analyses, 39 (14%) answered the question regarding the *awareness of the role of posture in their shopping choices* positively and provided a rationale regarding how the posture may have influenced them. Nineteen of them were in the leaning and 20 in the reclining group. We first coded how many of these participants associated the posture with a psychological and/or behavioral effect linked to the themes at the core of our theorizing (e.g. desire toward foods, health, attraction to rewarding foods, etc.)—six participants in total (2%), one in the leaning and five in the reclining condition, did so (see Table 5, pp. 12-14, in Supplementary Materials for specifics). Moreover, we also coded whether the psychological and/or behavioral effects these participants evoked corresponded to the predictions we had regarding the postures they assumed (e.g. that leaning made them feel more desire toward rewarding foods). Only one participant (from the leaning condition) provided a statement that to some degree accurately linked her/his sitting posture with the corresponding motivational effect ("when sitting closer to the screen, fast-food becomes more appealing"; see Table 5, pp. 12-14, in Supplementary Materials). Overall, based on these data most participants were unable to accurately infer a psychological and/or behavioral effect from their posture.

3.3. Discussion

Overall, Study 2 established that BAS drive is the most robust BAS moderator of the influence of leaning versus reclining on purchases of rewarding foods, given that Hypothesis 1 was supported regardless of the store design that differed between Studies 1 and 2. Importantly, the moderating effect of BAS drive persisted even after strict confound testing. In contrast, BAS

reward responsiveness was not a significant moderator in Study 2, whereas BAS fun seeking was not significant in either of the studies. Moreover, unlike Study 1, the present study failed to obtain the main effect of posture on rewarding food purchases. Exploratory analyses for Study 2 showed that BAS drive also interacted with posture in influencing purchases of intermediate foods, but this effect was different than for the rewarding foods, given that at high levels of BAS drive leaning (vs. reclining) made people spend less rather than more on intermediate products. Therefore, as in Study 1, Hypothesis 1 again applied specifically to rewarding foods.

In addition, eating restraint (Stunkard & Messick, 1985) as a variable that moderated the impact of various desire-related cues (e.g. smell; Fedoroff et al., 2003) on behavior to rewarding foods did not moderate the postural effects in Study 2. One possibility is that this absence of moderation is due to the grocery shopping paradigm we used. Questions assessing eating restraint (Stunkard & Messick, 1985) indeed predominantly focus on how much participants restrain themselves from eating in a given situation rather than on purchasing foods they are about to eat later. The moderating effects of eating restraint may in that case be confined to actual eating behavior, and studies that found these effects indeed used actual food consumption as the dependent variable (e.g. Polivy et al., 2005). It is also possible that, in the absence of immediate consumption possibility, the attraction that restrained eaters felt toward rewarding foods was insufficient to weaken their ability to restrain their desires and order these foods. The negative correlations between eating restraint and purchases of rewarding products (see Supplementary Materials, Tables 3 & 4, p. 10) indeed show that restrained eaters did not abandon their intention to restrict the intake of such foods because they spent less money on them than unrestrained eaters, even in the leaning condition that was supposed to weaken their restraint goals. Overall, the results of Studies 1 and 2 indicate that the moderated effects we

hypothesized apply specifically to BAS and do not extend to other personality variables that have been linked to motivated food choice.

Finally, participants' verbal responses regarding the awareness of the role of posture in their shopping choices indicated that only six out of 274 participants associated their posture with a psychological and/or behavioral effect linked to the themes at the core of our research (e.g. desire toward foods). Out of these participants, only one accurately linked her/his sitting posture to the motivational effect predicted by our theorizing. Therefore, it is plausible that for most participants posture did not produce motivational or behavioral effects via higher cognitive mechanisms (e.g. their conscious attribution of these effects to the posture) but by directly activating approach and avoidance (i.e. "direct" route to embodiment; Körner et al., 2015).

4. Study 3

The objective of Study 3 was to test Hypothesis 2, according to which the impact of posture on food choices should be moderated by construal level and occur only for participants in the state of LCL. We focused on construal level as a moderator because we argued that, even if it is a much broader construct than approach motivation and can change a variety of different affective and motivational considerations, one of the effects of LCL (vs. HCL) should involve increasing people's capacity to experience approach toward rewarding foods because it activates a present-oriented thinking mode during which the reward system is highly reactive (Peters & Büchel, 2011; Stillman et al., 2017; Trope & Liberman, 2010; Volkow & Baler, 2015). Experimentally manipulating construal levels to situationally change the capacity to experience approach also has various methodological advantages compared to capturing individual differences in this capacity, which we did in the earlier studies via the trait measure of BAS drive (Carver & White, 1994). Most importantly, this allows us to provide causal evidence for our

argument that the impact of posture on rewarding foods depends on people's capacity to experience approach motivation. Indeed, only by experimentally manipulating this capacity we can establish that its different levels cause the impact of posture on rewarding foods to change (i.e. that decreasing the capacity by evoking HCL vs. LCL should make the influence of posture on food purchases disappear).

To test the assumption that LCL (vs. HCL) increases people's capacity to experience approach motivation, we implemented a manipulation check that measures the situational change in this capacity by employing the drive subscale of the BAS scale (Carver & White, 1994) that was used in the previous studies as a trait measure. More precisely, although BAS drive is usually employed in psychological research as a trait measure (Carver & White, 1994), research (e.g. Schmeichel, Harmon-Jones, & Harmon-Jones, 2010; Smith & Bargh, 2008) showed that it can also be influenced by relevant experimental manipulations and therefore capture situational changes in people's potential to approach rewards. When the BAS drive subscale is utilized for this purpose and used as a state measure, the focus is not on specific score that participants yield but on average group differences between experimental conditions, which indicate that a situational change in the capacity to approach rewards occurred. If the LCL (vs. HCL) condition indeed increases this capacity, then participants in this condition should on average report higher BAS drive. To ensure that the findings are not confounded by a specific online grocery store design used, in Study 3 we randomized the presentation of categories and products in the store (see Section 4.1.1.).

4.1. Method

4.1.1. Online grocery shop: randomized store design

The shop contained the same products as in Studies 1 and 2 but used a random design, which was created by randomizing the order of foods in each of the 15 product categories, and by further randomizing the order of the categories themselves (for an example, see Figure 6). The online store therefore had a different randomly determined order of categories and products within the categories for all participants who completed the study in different participation slots. There were 35 slots in total, so 35 different random shop designs were used.

4.1.2. Sample size: power analyses

In Study 3, we aimed to recruit a similar number of participants as in Study 2. Sensitivity power analysis (Faul et al., 2009) indicated that, with the 292 participants who were eventually included in statistical analyses (see Section 4.2.1.), the study had a power of 80% (α = .01) to detect an interaction effect with Cohen's f^2 of 0.040, which is close to the small effect size of 0.020.

4.1.3. Experimental manipulation of the moderator: construal level

To induce high versus low construal level we employed the common category versus exemplar task (Fujita & Han, 2009). All participants were provided with a list of 40 words (e.g. soda, computer, newspaper, professor, etc.). In the high construal level condition, participants were asked to generate *categories* for each word (e.g. for soda a category is *liquids*), whereas in the low construal level condition, participants were asked to generate an *exemplar* for each word (e.g. for soda an exemplar is *Coke*).

4.1.4. Design and procedure

Three hundred and thirty-seven participants (216 women, Age range: 18-36) were recruited from the same participant pool as in the previous two studies, with the main difference being that we changed the sampling criteria. More precisely, in addition to recruiting participants from the

countries represented in Studies 1 and 2, we sampled participants from India, Malaysia, Columbia, Brazil, and Chile and increased the age limit to 36 because we wanted to ensure that our findings are applicable across a wide variety of individuals, and not just across those coming from Western, Educated, Industrialized, Rich and Democratic (WEIRD) societies who typically form the participant pool in psychological research (Henrich, Heine, & Norenzayan, 2010). The study design involved sitting position (leaning vs. reclining) and construal level (high vs. low) as between-subjects variables. The study therefore contained four conditions: leaning and HCL, leaning and LCL, reclining and HCL, and reclining and LCL. Participants were tested in the same lab that was used in the previous studies and were paid at the same rate. All participant first read the consent form and then received the instructions regarding the leaning or reclining sitting postures to which they were randomly allocated. Next, they read the shopping instructions as in the previous study and then received the low or high construal level manipulation to which they were randomly allocated. Immediately thereafter they started the shopping task. The remaining part of the experiment was identical to Study 2, except that some additional variables were measured after participants completed the shopping task and some variables were omitted (see the "Measures" section below for specifics).

4.1.5. Measures

Manipulation check, compliance with instructions, potential confounds, and exploratory variables. The manipulation check was measured using the drive component of the BAS scale (Carver & White, 1994). The item assessing compliance with instructions was taken from Study 1. We also adopted all confound measures from Study 2, except for the following four variables: frequency of eating *sugary*, *fatty*, *salty* and *caloric* foods. For exploratory variables, see Supplementary Materials, p. 15.

Seriousness check. We concluded the study with a seriousness check (Aust, Diedenhofen, Ullrich, & Musch, 2013) to identify and exclude participants who did not take the study seriously. The seriousness check was the following item: "It would be very helpful if you could tell us at this point whether you have taken part in this experiment seriously, so that we can use your answers for our scientific analysis, or whether you were just clicking through and did not take the shopping task seriously? Please answer honestly—you will receive the payment regardless of your answer." Response options were "I have taken part seriously" and "I have not taken part seriously, please throw my data away."

4.2. Results

Data file, details of data, and analyses codes in R for this study can be found on the Open Science Framework (https://osf.io/nmabe/).

4.2.1. Excluded data

Out of 337 study participants, data from 45 were excluded from statistical analyses: 30 of these failed to assume the appropriate sitting positions, nine exceeded the £50 limit, two failed to check out and submit the shopping data, and four failed to follow the instructions and complete the post-shopping survey and thus did not respond to items concerning compliance with instructions and seriousness check. Therefore, 292 participants were included in statistical analyses—70 in the leaning with LCL, 72 in the leaning with HCL, 74 in the reclining with LCL, and 76 in the reclining with HCL conditions. All these participants indicated that they had taken part seriously.

4.2.2. Testing hypothesis 2

To test Hypothesis 2, we undertook identical analyses as in Studies 1 and 2, this time with construal level as a moderator. As predicted, posture interacted with this variable (*Multiple* R^2 =

0.08) in influencing purchases of rewarding foods, $t(288) = -3.53$, $b = -5.59$, 95% CI [−8.71, −2.47], $p < .001$, *Cohen's* $f^2 = 0.043$: leaning (vs. reclining) made people spend £5.80 more on these foods under LCL, $t(288) = 5.14$, $b = 5.80$, 95% CI [3.58, 8.02], $p < .001$, *Cohen's* $f^2 = 0.092$, but not under HCL, $t(288) = 0.19$, $b = 0.21$, 95% CI [−1.98, 2.41], $p = .847$, *Cohen's* $f^2 < 0.001$ (Figure 7). Finally, a t-test showed that leaning ($M = 17.52$, $SD = 6.85$) exerted a main effect on rewarding food purchases relative to reclining ($M = 14.55$, $SD = 6.92$), $t(290) = -3.68$, $p < .001$, $d = 0.43$. The significant results did not change after controlling for potential confounds (see Supplementary Materials, p. 17).

4.2.3. Manipulation check and exploratory analyses

A t-test showed that, in line with our expectations, construal level impacted participants' BAS drive scores: In the LCL condition ($M = 2.84$, $SD = 0.54$), they reported higher BAS drive than in the HCL condition ($M = 2.65$, $SD = 0.52$), $t(290) = 3.17$, $p = .002$, $d = 0.37$. This finding did not change after controlling for potential confounds (Supplementary Materials, p. 17). For exploratory analyses, see Supplementary Materials, p. 20.

4.2.4. Rationale behind the role of posture in participants' shopping choices

Out of 292 participants included in statistical analyses, 35 (12%) positively answered the question regarding the *awareness of the role of posture in their shopping choices* and provided a rationale regarding how the posture may have influenced them. Seventeen of them were in the leaning and 18 in the reclining group. Seven participants in total (2%), one in the leaning and six in the reclining condition, associated the posture with a psychological and/or behavioral effect linked to the themes at the core of our research (e.g. desire toward foods, health, attraction to rewarding foods, etc.; see Table 10, p. 21, in Supplementary Materials for specifics). Moreover, only two participants (one from the leaning condition and one from the reclining condition)

provided a statement that, although not with full accuracy, linked their sitting posture with the behavioral or motivational effects that could broadly be associated with our predictions (leaning: "made my choices more impulsive"; reclining: "Feel slouched/relaxed, more inclined/attracted to healthy foods"; see Table 10, p. 21, in Supplementary Materials). Therefore, most participants were unable to accurately infer a psychological and/or behavioral effect from their posture.

4.3. Discussion

Study 3 supported Hypothesis 2 by showing that construal level moderated the impact of posture on food choices: leaning (vs. reclining) made people spend more on rewarding products only under LCL. Posture also exerted a main effect on rewarding food purchases, given that the influence of leaning (vs. reclining) was significant across the entire sample. Exploratory analyses failed to show the moderated effects of posture on purchases of intermediate and healthy foods—Study 3 thus demonstrated that Hypothesis 2 applies specifically to rewarding foods, as would be expected based on previous theorizing (Price & Harmon Jones, 2016).

Moreover, the manipulation check confirmed the assumption that construal level changes people's situational propensity to approach rewards (Mehta et al. 2014), given that participants reported higher BAS drive after receiving the LCL (vs. HCL) manipulation. Although this finding supports our theoretical rationale behind choosing the moderator, it should not be used to conceptually conflate LCL and situational tendency to approach rewards—LCL is indeed a broader construct that has a variety of affective and motivational consequences, and this tendency may comprise one of its many effects (Mehta et al. 2014; Trope & Liberman, 2010).

Finally, participants' verbal responses regarding the awareness of the role of posture in their shopping choices again indicated that most participants could not accurately attribute behavioral or cognitive effects associated with approach (vs. avoidance) to their posture.

Therefore, as in Study 2, it is more likely that the postural effects occurred via direct activation of motivational states of approach versus avoidance (i.e. “direct” route to embodiment; Körner et al., 2015) rather than via higher cognitive processes.

5. General Discussion

The present article investigated how approach versus avoidance induced via leaning versus reclining (Price & Harmon-Jones, 2016) influence purchases of rewarding foods in an online shopping paradigm. We argued that this influence should be moderated either by BAS (Beaver et al., 2006; Carver & White, 1994) as a personality trait that determines people’s capacity to experience approach motivation (Hypothesis 1), or by construal level (Fujita & Han, 2009) as a variable that can change this capacity situationally (Hypothesis 2). More precisely, we expected that leaning (vs. reclining) should increase spending on rewarding foods only under high BAS drive or LCL, but not under low BAS drive or HCL.

Our predictions were supported in a series of three robust experiments. Study 1, in which we used an online store with rewarding foods displayed on salient screen locations (Reutskaja et al., 2011), tested Hypothesis 1 and showed that leaning (vs. reclining) made people spend more money on these foods under high, but not low BAS drive. A similar pattern of findings occurred under another BAS component (reward responsiveness), whereas BAS fun seeking did not moderate the effects. In Study 2, we aimed to replicate Study 1 while using a substantially different store design where rewarding foods were displayed on inconspicuous locations and healthier items were made more salient to ensure that our findings generalize beyond one type of product arrangement. BAS drive again moderated the impact of posture on shopping choices as in the previous study, but reward responsiveness and fun seeking did not produce significant moderating effects. In line with our theorizing (Carver & White, 1994; Beaver et al., 2006),

Studies 1 and 2 therefore jointly established BAS drive as the most robust moderator out of the three BAS components, given that its moderating role generalized beyond specific product arrangements. Finally, Study 3, in which the online shop design was randomized across participants, supported Hypothesis 2: leaning (vs reclining) increased spending on rewarding foods only under LCL, but not under HCL.

Importantly, the effects supporting Hypotheses 1 and 2 remained significant after strict confound testing that involved a range of variables that were either linked to food choices by previous research (e.g. gender and body mass index; Newby et al., 2003; Wardle et al., 2004) or that we thought could have potentially confounded the effects in the context of our research setup (e.g. awareness of the role of posture in participants' shopping choices). To explain how the present findings advance previous research and theoretical understanding of approach and avoidance behavioral effects, we next tackle the main contributions of our research.

5.1. Main Contributions

The present research made several important contributions to explaining when and why reliable effects of bodily-induced approach (vs. avoidance) on grocery purchases as a representative motivated behavior might occur. We established that a personality variable that captures people's capacity to initiate approach behaviors to rewards—BAS drive—and a variable that can situationally change this capacity—construal level—determine whether leaning (vs reclining) impacts food purchases. The leaning posture makes people spend more on rewarding foods specifically when they are either naturally high in the capacity to undertake approach behaviors (high BAS drive), or when this capacity is situationally boosted (LCL). In accordance with previous theorizing (Price & Harmon-Jones, 2016; Strack & Deutsch, 2004), the effect applies only to rewarding foods that are linked to approach tendencies, and not to intermediate

and healthy foods that we also explored in the present research. The moderated effects we established therefore provide an important extension of previous knowledge by showing that body posture can influence food-related behavior but only insofar as the personality or the situation allows it.

A second important theoretical contribution is that the moderating effect of BAS drive is more robust relative to the other two BAS components—reward responsiveness and fun seeking—none of which yielded replicable moderating effects. This finding is consistent with the notion that BAS drive specifically targets the capacity to undertake approach behaviors to rewards, whereas the remaining two BAS components target emotional reactions to rewards or the need to engage in exciting and fun experiences marked by new sensations (Beaver et al., 2006; Carver & White 1994). To our knowledge, our research is therefore the first to provide a nuanced examination of BAS as a moderator of bodily-induced approach versus avoidance on reward-related outcomes because previous research focused on BAS as a unidimensional construct and did not examine it in relation to actual behaviors (Van den Bergh et al., 2011).

Next contribution involves overcoming the weaknesses that were present in earlier research on approach versus avoidance and food-related behavior when it comes to operationalization of the food stimuli. One of the main disadvantages of this research is that the appetitive foods used were typically selected based on subjective constructs such as valence (Förster, 2003) and vice (Streicher & Estes, 2016; Van den Bergh et al., 2011) that have ambiguous link with approach and avoidance (Berridge, 1996; Berridge & Robinson, 2016; Berridge et al., 2009; Berkman & Lieberman, 2010). This limitation makes it difficult to grasp which objective food qualities determine whether the behavior toward the stimuli will be increased by approach (vs. avoidance) and why. Therefore, in the present research we adopted a rigorous approach and operationalized

the food stimuli based on their nutritional content. More specifically, considering that the reward system in the brain shapes approach motivation (e.g. Beaver et al., 2006), and that this system typically potentiates consumption of sugary, fatty, and salty foods (e.g. Kelley, 2004), by relying on the criteria established by the Department of Health (2016) we operationalized foods high in sugar, fat, saturated fat, and salt as the rewarding stimuli whose purchases may be increased by approach (vs. avoidance).

Importantly, although the present findings were obtained in the context of online grocery shopping, we argue they should generalize beyond food-related behavior and this context for several reasons. First, because our main criterion in operationalizing the food stimuli was their link to the brain's reward system, and because we used a large number of products (70) representative of this stimuli type, the present effects should generalize to any other stimuli associated with the reward system, ranging from money to sexual stimuli (Alonso-Alonso et al., 2015). More precisely, bodily positions that activate approach (vs. avoidance) should enhance behavior toward these stimuli for people who have a high capacity to experience approach motivation. Second, because the drive to approach rewards is construed in relation to any types of rewards (e.g. "things I want"; Carver & White, 1994, p. 323) rather than in relation to the foods specifically, the moderating effect of this variable should generalize to a variety of rewarding stimuli. Similarly, because LCL (vs. HCL) increases people's capacity to experience approach toward various rewards beyond just foods because it activates a present-oriented thinking mode during which the reward system is highly reactive (Mehta et al., 2014; Peters & Büchel, 2011; Trope & Liberman, 2010), its moderating effect should also generalize across many appetitive stimuli. Overall, considering that in the present research we used a more rigorous and objective operationalization of appetitive foods and a larger number of these stimuli

compared to previous studies (Förster, 2003; Streicher & Estes, 2016; Van den Bergh et al., 2011), we posit that the present results are more likely to generalize across a variety of stimuli relative to the insights that these studies yielded.

Finally, given the recent failures to replicate certain findings regarding the link between the body and approach versus avoidance (e.g. Rotteveel et al., 2015; Wagenmakers et al., 2016), it is necessary to consider the interplay of the moderated and main effects from our paper and examine their implications for future research in this domain. Across the three studies we conducted, the main effect of posture on rewarding food purchases failed to occur in Study 2. In contrast, the hypothesized interactions between leaning versus reclining and the two main moderators—BAS drive and construal level—replicated across all three studies.[8] To probe whether these interactions had evidential value, we conducted a p-curve analysis (see Supplementary Materials, pp. 23-24; Simonsohn, Nelson, & Simmons, 2014; Simonsohn, Simmons, & Nelson, 2015). The analysis showed that the tests for right skew (Full p-curve: $Z = -4.22$, $p < .001$; Half p-curve: $Z = -3.76$, $p < .001$) were highly significant, and that the studies were powered at 94% (90% CI [66%, 99%]) to detect the interactions. Overall, these results indicate that only the hypothesized moderation effects, but not the main effect, had strong evidential value in the present studies. Future research on behavioral effects of bodily positions that activate approach versus avoidance on rewards should therefore not rely only on large sample sizes to obtain robust effects but also include either BAS drive or construal level as moderators.

5.2. Limitations and Future Directions

A critic may argue that not using a neutral posture control condition is one of the limitations of the present research. Because our focus is on the degree to which posture activates

approach versus avoidance motivational orientations, we think that such a "neutral" sitting position may not exist, as desirable as it is from a methodological perspective. Indeed, embodied motivation is a continuum, with reclining marking one of its end-points—avoidance—and leaning the other—approach (Harmon-Jones et al. 2011; Price et al. 2012)—and selecting a certain posture in-between under the assumption that it is motivationally neutral would be conceptually flawed.

One limitation of the present research is that we did not more comprehensively investigate the role of store design in shaping food purchases in interaction with the postures and the moderators we probed. Our main rationale behind altering the store designs was to ensure that our hypotheses generalize to various product arrangements and are not limited to a narrow set of circumstances. In that regard, in the first two studies we implemented two store designs that, according to previous research (Reutskaja et al., 2011), have the opposing effects on food choice—one likely to potentiate purchases of rewarding foods given their salient display positions (Study 1), and one that places these foods on inconspicuous locations and is likely to foster purchases of healthier items that are made salient (Study 2). In the final study, we randomized product display across different groups of participants. Whereas these alterations of online store designs allowed us to establish that BAS drive and construal level are robust moderators because they are not constricted to a specific design, we cannot infer with certainty whether the moderating effect of reward responsiveness failed to occur in Study 2 because the design was changed, and which specific psychological process may have led to this. Also, we cannot conclude whether the main effect of posture failed to replicate due to the change of store design. To answer such questions, future research will need to treat store designs as a moderator

in a single study and test whether and why exactly this variable may change the postural effects on food choices.

Another limitation concerns the exact mechanism through which posture impacted purchases of rewarding foods in the present studies. We argued that leaning (vs. reclining) influences purchases of these foods because it directly activates the motivational state of approach (vs. avoidance; see Price & Harmon-Jones, 2016). In other words, this direct route to embodiment (Körner et al., 2015) presumes that the motivational state is activated without the involvement of some higher cognitive mechanisms (e.g. without people inferring their motivations or how they should act based on the way they sit). Considering that previous research established, by using various biological markers, that leaning (vs. reclining) activates approach motivational states (Price & Harmon-Jones, 2016), and that participants' verbal responses regarding the role of posture in their shopping choices (Studies 2 and 3) did not indicate they could accurately infer their motivations or behavior from the posture, it is less likely that the effects in the present research were not embodied or occurred via a less direct mechanism (see Körner et al., 2015).

However, the involvement of the moderators makes the picture more complex and leaves some questions open for future research. Given that the effects of leaning versus reclining on food purchases occurred only under high capacity to experience approach (i.e. high BAS drive or LCL), it remains to be determined in what exact way the low capacity to experience this state (i.e. low BAS drive or HCL) hampered the effects. One possibility is that, under lowered capacity, posture produced weak motivational states that are not sufficiently strong to override reflective influences and change behavior as we argued (see Strack & Deutsch, 2004). However, it is also possible that under lowered capacity posture became "disconnected" from motivation

and ceased to incite any motivational states. This is a subtle issue that may need to be resolved in the future via more sensitive methodological approaches than we used—for example, by probing how posture impacts biological markers of approach motivation in interaction with the drive to approach rewards and construal level.

Whereas in the present research we focused on an objective operationalization of the food stimuli to overcome some of the limitations of the previous studies, one potential area for future research is to investigate how people subjectively evaluate the food categories we established on the dimensions of valence and vice. This would uncover whether the rewarding foods as we operationalized them are also on average perceived as positively valenced or can be classified as vices. In our studies, we did not ask participants to evaluate the products on these two dimensions because this could have either given them an insight into the purpose of our research if done at the beginning of the studies, or their responses could have been biased by their shopping choices if done at the end. However, as part of confound testing, we did evaluate the valence of rewarding foods more generally by asking participants to state their preferences for sweet, fatty, and salty foods (i.e. to indicate how much they like them using a slider from "0=Dislike a lot" to "10=Like a lot"). Across all three studies, the mean score for sweet foods was 6.39 (95% CI [6.22, 6.56]), the mean for fatty foods was 5.20 (95% CI [5.03, 5.36]), and the mean for salty foods was 5.84 (95% CI [5.68, 6.00]). Given that the means in all three cases were higher than the midpoint of five that would indicate neutrality, and that the confidence intervals of the means also did not contain the values of exactly five or lower, it is likely that rewarding foods are on average positively valenced. Future research will need to more specifically investigate whether valence or vice values of specific rewarding foods determine the

propensity of various bodily manipulations of motivation to influence the consumption or purchasing behavior toward them.

5.3. Conclusion

The aim of this work was to undertake a robust examination of the influence of embodied approach and avoidance on a representative motivated behavior—food purchases. To overcome the limitations of previous research, we selected the foods based on objective nutritional information that link these stimuli to the reward system and focused on the two sitting postures—leaning and reclining—rather than on arm movements that have ambiguous relationship with approach and avoidance. Moreover, we examined one personality moderator—BAS—and one situational moderator—construal level. The findings show that leaning versus reclining produce a reliable impact on food choice when these moderators are taken into account. Our research therefore advances knowledge of one of the most central psychological constructs by providing robust evidence for when and why reliable effects of bodily-induced approach and avoidance occur, grounded in state-of-the-art theory and methods.

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Footnotes

[1] Rewarding foods is a term that has also been used by various other food researchers (e.g. van den Bos & de Ridder, 2006; Veling, Aarts, & Stroebe, 2011; Wallace et al., 2015).

[2] We confirm that, in all three studies in this paper, the rationale behind the sample size was determined before any data analysis, and that all the analyses were conducted only after the data collection process has stopped.

[3] Gender information for one participant who was marked by the lab manager as "participated" but neither submitted the shopping data nor completed the post study questionnaire was missing. Moreover, one participant indicated their gender as genderqueer. However, given that all other participants labelled their gender as either male or female, we classified this participant as female based on her sex rather than gender identity for the purpose of statistical analyses.

[4] We confirm that, in all three studies in this paper, we report all measures, manipulations and exclusions.

[5] Importantly, all the significant effects that were predicted by Hypotheses 1 and 2 remained highly significant ($p < .01$) across all three studies even when the excluded data were included in analyses, thus indicating that the exclusions were not an attempt at 'p-hacking'.

[6] T-tests showed that leaning (vs. reclining) did not influence any of the three BAS components (all ps $\geq .785$), thus justifying their use as moderators.

[7] T-tests showed that posture did not influence any of the three BAS components (all ps $\geq .459$), thus justifying their use as moderators.

[8] We confirm that these are the only studies we conducted to test Hypotheses 1 and 2, and we did not conduct any other studies closely resembling those reported in this article.

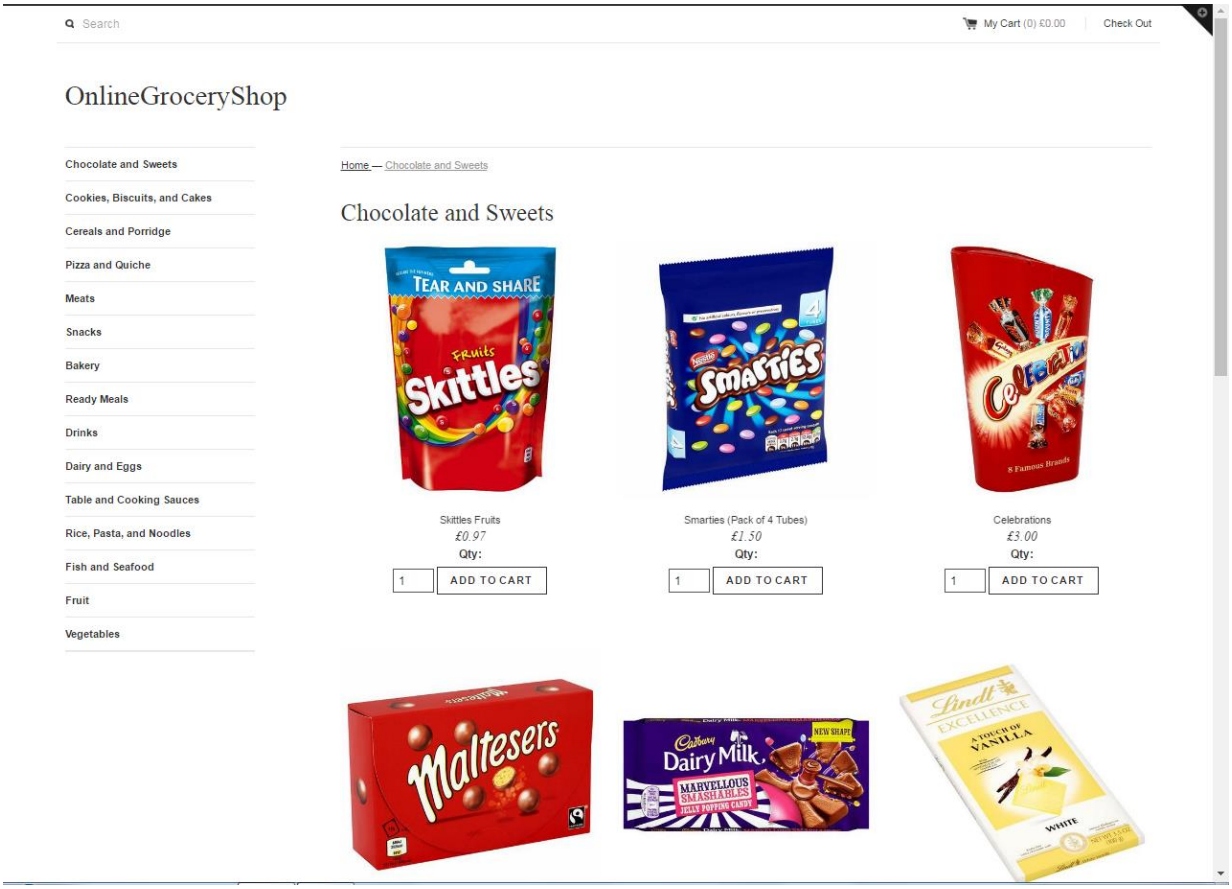

Figure 1. Online grocery shop used in Study 1.

Figure 2. A representative leaning (A) and reclining (B) sitting position that participants assumed in Studies 1, 2, and 3. Because the cubicles in which participants completed the studies were too small to allow taking the image of the full upper body, these two demonstrative photos were taken outside of the cubicles.

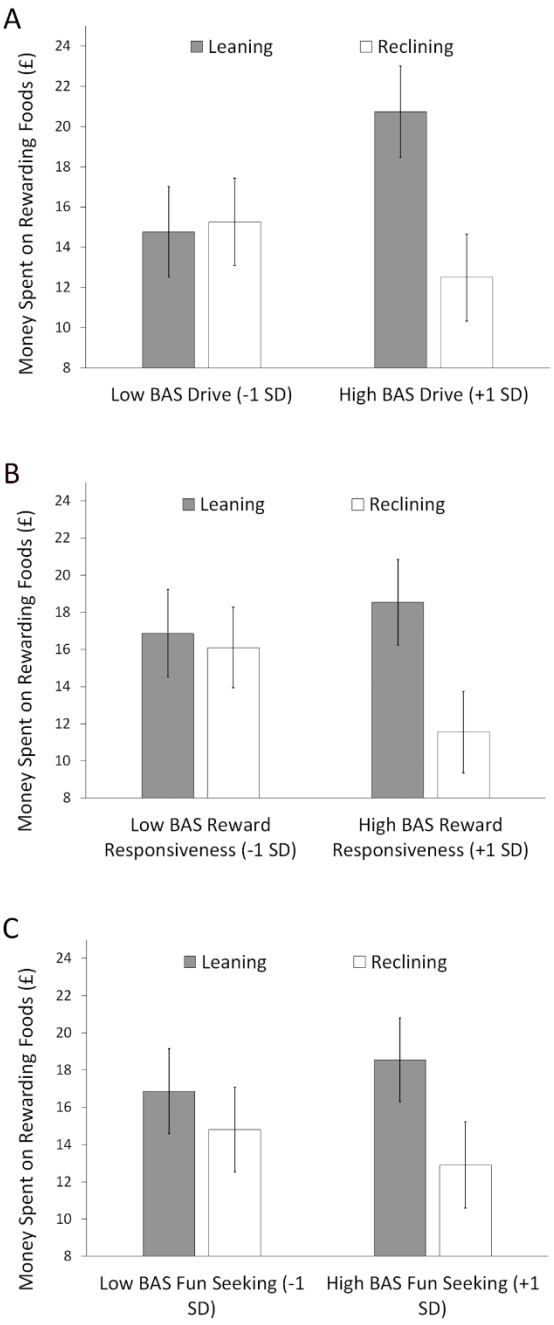

Figure 3. The influence of leaning versus reclining on purchases of rewarding foods at lower (−1SD) and higher (+1SD) levels of BAS drive (A), BAS reward responsiveness (B), and BAS fun seeking (C) in Study 1. Error bars correspond to the 95% Confidence Intervals. Low values (−1SD) of BAS drive, Bas reward responsiveness, and BAS fun seeking are 2.19, 2.97, and 2.33 respectively, and high values (+1SD) are 3.26, 3.72, and 3.38.

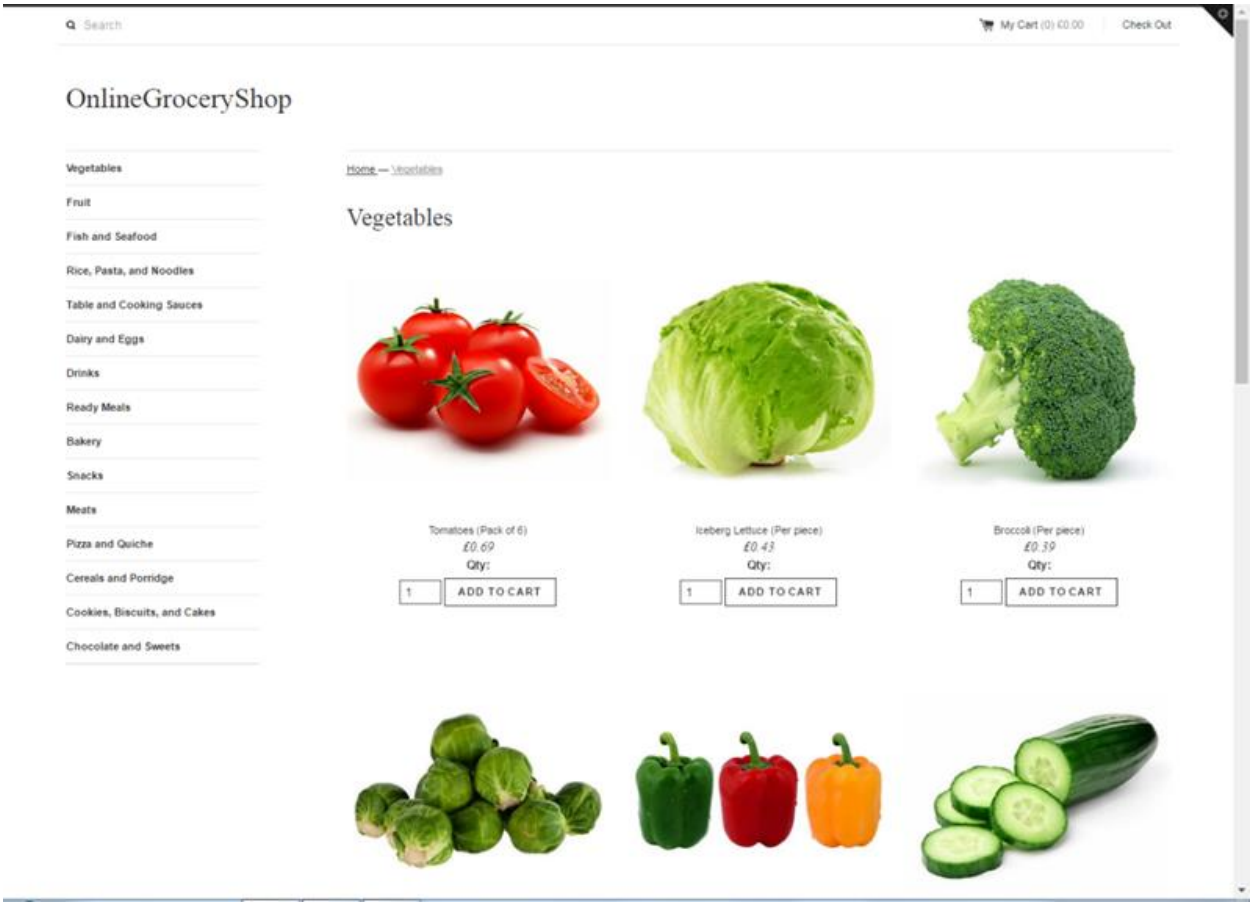

Figure 4. Online grocery shop used in Study 2.

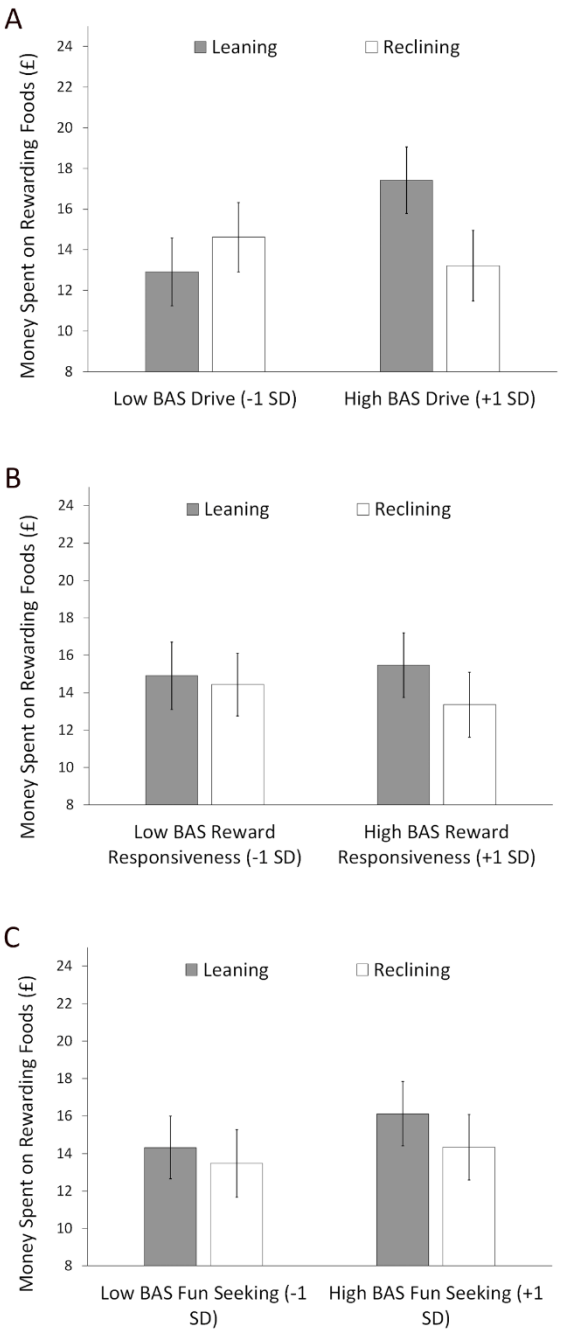

Figure 5. The influence of leaning versus reclining on purchases of rewarding foods at lower (−1SD) and higher (+1SD) levels of BAS drive (A), BAS reward responsiveness (B), and BAS fun seeking (C) in Study 2. Error bars correspond to the 95% Confidence Intervals. Low values (−1SD) of BAS drive, Bas reward responsiveness, and BAS fun seeking are 2.28, 2.96, 2.37 respectively, and high values (+1SD) are 3.27, 3.71, and 3.35.

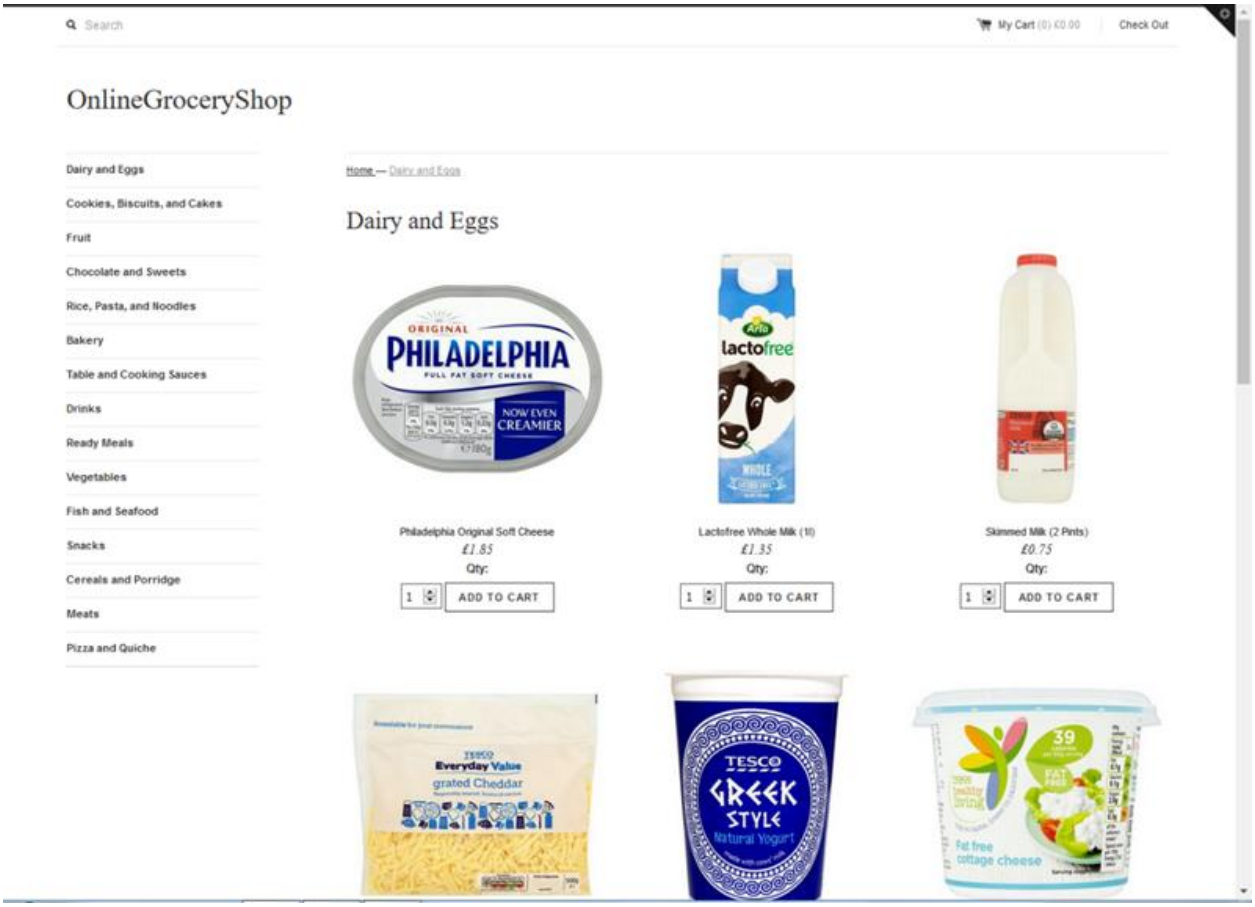

Figure 6. Online grocery shop used in Study 3: An example of randomized design.

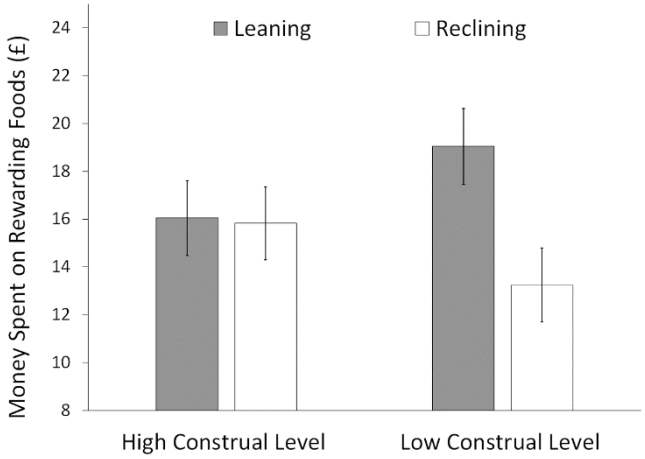

Figure 7. The influence of leaning versus reclining on purchases of rewarding foods at low and high construal level in Study 3. Error bars correspond to the 95% Confidence Intervals.

Appendix

Data files for each of the three studies, details of data, and analyses codes in R for the datasets can be found on the Open Science Framework (https://osf.io/nmabe/).