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The Benefits of Simply Observing: Mindful Attention Modulates the Link Between Motivation and Behavior

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Mindful attention, a central component of mindfulness meditation, can be conceived as becoming aware of one's thoughts and experiences and being able to observe them as transient mental events. Here, we present a series of studies demonstrating the effects of applying this metacognitive perspective to one's spontaneous reward responses when encountering attractive stimuli. Taking a grounded cognition perspective, we argue that reward simulations in response to attractive stimuli contribute to appetitive behavior and that motivational states and traits enhance these simulations. Directing mindful attention at these thoughts and seeing them as mere mental events should break this link, such that motivational states and traits no longer affect reward simulations and appetitive behavior. To test this account, we trained participants to observe their thoughts in reaction to appetitive stimuli as mental events, using a brief procedure designed for nonmeditators. Across 3 experiments, we found that adopting the mindful attention perspective reduced the effects of motivational states and traits on appetitive behavior in 2 domains, in both the laboratory and the field. Specifically, after applying mindful attention, participants' sexual motivation no longer made opposite-sex others seem more attractive and thus desirable as partners. Similarly, participants' levels of hunger no longer boosted the attractiveness of unhealthy foods, resulting in healthier eating choices. We discuss these results in the context of mechanisms and applications of mindful attention and explore how mindfulness and mindful attention can be conceptualized in psychological research more generally.

Keywords: mindfulness, decentering, grounded cognition, eating behavior, interpersonal attraction

The concept of mindfulness has attracted a lot of interest in psychology and neuroscience over the past decades and has been suggested as a tool to ameliorate various problems including stress, anxiety, chronic pain, eating disorders, nicotine dependence, and the like (e.g., Brewer et al., 2011; Grossman, Niemann, Schmidt, & Walach, 2004; Hölzel et al., 2013; Kabat-Zinn, 1982; Kristeller, Baer, & Quillian-Wolever, 2006). More generally, mindfulness meditation has been suggested as a means of changing how we relate to our thoughts and mental experiences, such that we can take an observing, decentered perspective on them and experience them as less vivid, real, and compelling (e.g., Bishop et al., 2004; Fresco et al., 2007; Safran & Segal, 1990; Shapiro, Carlson, Astin, & Freedman, 2006). This change in perspective makes mindfulness particularly interesting for personality and social psychology, where research addresses the subtle role of thoughts in regulating individuals' behavior in response to external cues, even outside their conscious awareness. Thus, the present article brings these two areas of research together, examining whether changing one's relationship to mental experiences can modulate how we think and act in response to external cues.

The effect of external cues on thoughts and behavior is particularly striking in the domain of appetitive behavior. Here, even subtle cues, such as the sight of a tasty food or an attractive person, can easily trigger desires that shape behavior simply by triggering rewarding simulations about pleasures that similar things have brought us in the past (e.g., Aharon et al., 2001; Nederkoorn, Smulders, & Jansen, 2000; Papies & Barsalou, in press; Stroebe, van Koningsbruggen, Papies, & Aarts, 2013). Such reactions are especially likely to be triggered when the cues that we encounter match our current motives, such as being highly motivated to eat or find a partner. Typically, our motivational states and traits are translated into desires and behavior without much awareness of how the things we seek became desirable. Acting on our motivations in a less automatic and more conscious way, however, might often be beneficial for the pursuit of long-term goals, such as a healthy body weight and a healthy relationship. We suggest that

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such effects can be achieved by applying insights from mindfulness and, specifically, utilizing the uniquely human faculty of being able to observe one's mental processes. More specifically, consistent with Buddhist philosophy, we suggest that a crucial aspect of mindfulness is simply observing one's thoughts and experiences and recognizing their transient nature as mere mental events. We propose that applying this perspective to reward simulations that produce appetitive behavior—especially those enhanced by motivational states and traits—reduces subsequent appetitive behaviors, thereby ultimately increasing self-control and well-being.

In this article, then, we introduce mindfulness as a novel tool for modulating how motivational states and traits are translated into appetitive behavior. Our mindfulness approach builds on the insights and practices that Buddhist practitioners have developed over thousands of years and that have become integrated into Western mindfulness practices. Although mindfulness is typically studied in lengthy, multicomponent interventions, we focus on *mindful attention* as the crucial metacognitive component of mindfulness that allows one to see one's own thoughts as mere mental events. This novel approach of examining separate components of mindfulness in experimental research may be essential for gaining a better understanding of mindfulness effects and their underlying mechanisms. In addition, we aim to show that the effects of mindfulness rely on basic processes (e.g., attention, metacognition) that are also widely studied in psychological research more generally, and thus, we hope to contribute a firm grounding for mindfulness in existing research, particularly in research on grounded cognition, motivation, and self-regulation.

Overview

Before presenting our empirical studies, we first outline in more detail the reward simulations that often lead to appetitive behavior and address how they interact with individual differences in motivation. We then introduce the concept of mindfulness and its components, focusing on the specific component of mindful attention that we used to target reward simulations. We then present three experiments, each showing that applying mindful attention to reward simulations reduces the effect of motivational states and traits on the perceived attractiveness of appetitive stimuli, thereby changing appetitive behavior. Specifically, Experiments 1 and 2 show that mindful attention reduces the degree to which differences in trait and state motivation boost the attractiveness of faces and food, respectively, and, consequently, appetitive behavior toward them. Experiment 3 then extends this to a field setting, showing that mindful attention prevents the effect of hunger on excess calorie intake in a cafeteria and initiates healthier lunch choices overall. Together, these three experiments demonstrate the potential of mindful attention for changing how people think and act in response to stimuli that match their current motives, in potentially powerful and healthy ways.

The Nature and Roles of Reward Simulations in Appetitive Behavior

Attractive cues in our living environment have a strong potential to trigger appetitive behavior. Merely seeing, smelling, or thinking about a fresh cappuccino or a warm scone, for example, can trigger pleasant thoughts of consuming these items and can increase our motivation to obtain them (for reviews, see Kavanagh, Andrade, & May, 2005; Papies & Barsalou, in press). From a grounded cognition perspective, we suggest that such spontaneous reward simulations in response to external cues play an important role in the development of appetitive behavior.

Research on grounded cognition has shown that when encountering a potentially relevant stimulus, one spontaneously simulates interacting with it based on earlier experiences with similar stimuli (Barsalou, 2008, 2009; Barsalou, Niedenthal, Barbey, & Ruppert, 2003; Decety & Grèzes, 2006; Niedenthal, Barsalou, Winkielman, Krauth-Gruber, & Ric, 2005). Such spontaneous simulations have been argued to lie at the basis of knowledge representation more generally, originating in one's earlier sensory and affective experiences in the relevant modalities, so that simply thinking about a stimulus activates brain areas similar to those active when processing the stimulus perceptually or interacting with it motorically (e.g., Martin, Wiggs, Ungerleider, & Haxby, 1996; Pulvermüller & Fadiga, 2010). We suggest that these same mechanisms underlie how we process attractive stimuli: We spontaneously simulate potential pleasurable interactions, relying heavily on vivid information from earlier experiences, thereby making these stimuli seem highly attractive and guiding our subsequent behavior toward them (Papies & Barsalou, in press).

Consistent with this simulation account of appetitive behavior, increasing research shows that merely reading about or viewing attractive food cues triggers activations in the gustatory and reward areas in the brain, as well as increased salivation, suggesting that perceivers process the food cue as if they were actually eating the food (e.g., Barrós-Loscertales et al., 2012; Nederkoorn et al., 2000; Simmons, Martin, & Barsalou, 2005). Similarly, when listing features of a food (e.g., *chips*), participants typically think about its taste and texture (e.g., *salty, crunchy*), situations for eating it (e.g., *movie, on the sofa*), and hedonic experiences (e.g., *tasty, delicious*; Papies, 2013). Such reward simulations are also observed in interpersonal relations, showing, for example, that eye contact with photographs of attractive people activates reward areas in the brain (Kampe, Frith, Dolan, & Frith, 2001). Similarly, viewing erotic photographs of opposite-sex others induces sexual arousal and reward activity in both men and women, as if they were about to have sex (e.g., Hamann, Herman, Nolan, & Wallen, 2004). As a result of the overlap in neural processes between perception and thought (e.g., Barrós-Loscertales et al., 2012; Decety & Grèzes, 2006; Simmons et al., 2005), simulations of objects or experiences in their absence can seem vivid and real, even triggering the associated bodily responses (see Papies & Barsalou, in press). The *subjective realism* of these experiences (Papies, Barsalou, & Custers, 2012) can feed into desire and thus contribute to motivated behavior for satisfying it. Importantly, even though such reward simulations can enter conscious awareness and be elaborated with vivid mental imagery (see also Kavanagh et al., 2005), they can also influence appetitive behavior outside awareness (Papies & Barsalou, in press).

Individual Differences in Reward Simulations

How do vivid realistic reward simulations interact with individual differences in motivational states and traits? On encountering a particular appetitive stimulus, we assume that the reward simu-

lation constructed takes an individual's current motivational state into account (Papies & Barsalou, in press). On encountering a pizza, for example, different eating simulations result depending on whether an individual is hungry or not. When an individual is hungry, situated memories of previously eating when hungry are retrieved, simulating highly rewarding experiences of satisfying hunger. When an individual is not hungry, situated memories of previously eating when not hungry are retrieved, simulating less rewarding experiences of eating. Thus, an individual's current motivational state acts as a cue for retrieving relevant consumptive memories, which then simulate the likely consumptive and reward experience in the current situation (cf. Barsalou, 2003, 2009; Barsalou et al., 2003).

Our account of reward simulations explains trait differences in reward simulations similarly (Papies & Barsalou, in press). When one individual has more rewarding experiences stored in memory than another individual, the first individual is more likely to retrieve a rewarding simulation of consuming pizza on encountering it (holding their current states of hunger constant). Analogously, if the first individual has generally experienced more intense reward when consuming pizza than the second, the first individual is more likely to generate intense reward simulations on encountering it. In summary, we argue that state differences result from matches between an individual's current motivational state and the reward simulation retrieved (highly vs. weakly motivating simulations), and trait differences in reward simulations result from the frequency of reward simulations stored in memory, along with their overall intensity.

Previous findings are consistent with our account of state differences in motivation. Specifically, much work shows that individual differences in temporary motivational states affect people's preferences for food, drink, and social interactions. Being hungry increases one's desire for food, especially high-calorie foods (e.g., Seibt, Häfner, & Deutsch, 2007; Siep et al., 2009); being thirsty increases the attractiveness of water and other thirst-quenching substances (Cabanac, 1971; Ferguson & Bargh, 2004; Veltkamp, Aarts, & Custers, 2008); sexual arousal increases attention for attractive opposite-sex others (Nordgren & Chou, 2011). From our theoretical perspective, the temporary increases in motivated behavior demonstrated in the literature often result from a match occurring between a currently highly motivational state and past memories of consumption when also highly motivated. Once one of these past memories becomes active, it produces a vivid, highly rewarding consumption simulation, thereby endowing a relevant stimulus with special attractiveness.

More enduring traits shape reward simulations and their downstream behavioral effects in similar ways. Consider an individual with a chronically strong interest in casual sex who has many intense memories of past sexual pleasure. On encountering an attractive potential partner, frequent and intensely rewarding memories of sexual interactions may become active, motivating sexual behavior. Conversely, an individual with much less interest in sex may be less likely to have stored rewarding memories of sexual interaction and thus to simulate intensely rewarding sex on encountering potential partners. Indeed, research in the interpersonal domain shows that individuals with an unrestricted sociosexual orientation (i.e., a heightened interest in casual sex) have more attention for potentially available opposite-sex others and find them more attractive (Maner, Gailliot, Rouby, & Miller, 2007; Provost, Kormos, Kosakoski, & Quinsey, 2006). Similarly, individuals high in reward sensitivity respond more strongly to food cues, develop food cravings more easily, and are more likely to be overweight (Beaver et al., 2006; Franken & Muris, 2005).

Reducing the Effects of Reward Simulations

While the appetitive behavior triggered by one's reward simulations can be highly pleasant in the short term, it can also have undesired consequences, as when engaging too freely in interpersonal interactions harms one's physical health or long-term relationship or when giving in to the allure of high-calorie foods interferes with the goal of a slim figure. These potentially undesirable consequences raise the question of whether the effects of reward simulations can be reduced.

Previous work in the domain of self-control has shown that some people are better able to resist interpersonal or food temptations, for example, when they possess more executive control (Hofmann, Friese, & Roefs, 2009; Pronk, Karremans, & Wigboldus, 2011). Additionally, on finding attractive stimuli tempting, people spontaneously use cognitive strategies to reinforce pursuit of their long-term goals, such as activating competing goals or inhibiting one's desires (Fishbach, Friedman, & Kruglanski, 2003; Papies, Stroebe, & Aarts, 2008b; Shah, Friedman, & Kruglanski, 2002). All these strategies, however, seek to affect behavior *after* the motivational effects of reward simulations have already developed fully, namely, once one is already strongly attracted to the relevant stimulus. Under these conditions, the simulations of pleasure and reward that typically trigger appetitive behavior remain undisturbed. Here, we suggest that the effect of external stimuli on appetitive behavior can be prevented at an early point in the process. Specifically, we propose that using mindfulness to construe one's reward simulations as mere mental events can deconstruct the vivid appeal of reward simulations and reduce their effects on appetitive behavior.

Mindfulness

The term *mindfulness* is widely used to denote a variety of psychological states and processes in the psychological, contemplative, and popular science literatures (see Bergomi, Tschacher, & Kupper, 2013; Hayes & Shenk, 2004; Hölzel et al., 2011; Lutz, Dunne, & Davidson, 2007; Roemer & Orsillo, 2003). Bishop et al. (2004), however, offered a useful operational definition that covers many of these uses. Specifically, Bishop et al. suggested that the main components of mindfulness are (a) the regulation of attention and (b) a specific nonjudgmental orientation toward one's present-moment experiences that includes learning to see one's thoughts and feelings as "passing events in the mind" (p. 234). This component of mindfulness is also referred to as *decentering*, *reperceiving*, and *cognitive insight* (Bishop et al., 2004; Chambers, Gullone, & Allen, 2009; Shapiro et al., 2006) and, as we show below, is of special relevance to dealing with attractive cues and the reward simulations they can trigger.

A considerable amount of research has tested the effects of mindfulness practice, in which both the regulation of attention and the metacognitive awareness of one's experiences are practiced (most notably the 8-week program for mindfulness-based stress reduction; Kabat-Zinn, 1982). A major part of such programs is

sitting meditation, in which the practitioner focuses attention on a chosen object, typically the breath, for an extended period of time. Whenever a thought, emotion, or sensation distracts attention from the focal object, attention is simply brought back to the object again, with this process iterating for the duration of the practice. During group sessions, teachings, and meditation practice, practitioners also learn to view their distracting thoughts as mental events. Thus, rather than getting immersed in these thoughts as usual, they are simply to be noted and observed as transitory mental events, instead of being judged, evaluated, and responded to. As a result, disengaging and returning attention to the breath become increasingly easy (Baer, 2003; Kabat-Zinn, 1982).

Both comprehensive mindfulness training and meditation practice to regulate attention (the first component) have been shown to improve attention regulation and executive control processes (for reviews, see Chiesa, Calati, & Serretti, 2011; Gard, Hölzel, & Lazar, 2014), as well as benefiting physical and mental health, reducing stress and pain, and facilitating emotion regulation, smoking cessation, and weight regulation (e.g., Alberts, Thewissen, & Raes, 2012; Brewer et al., 2011; Chambers, Lo, & Allen, 2008; Davidson et al., 2003; Delgado et al., 2010; Jha, Stanley, Kiyonaga, Wong, & Gelfand, 2010; Kabat-Zinn, 1982; Kabat-Zinn et al., 1998; Shapiro, Schwartz, & Bonner, 1998; Teasdale et al., 2002; Wadlinger & Isaacowitz, 2011). Overall, compelling evidence is accumulating that mindfulness training including both the attentional and perspectival components has beneficial effects on a variety of processes central to health and well-being (for reviews, see Baer, 2003; Grossman et al., 2004).

The Perspective of Mindful Attention

Interestingly, relatively little work has systematically assessed the second component of mindfulness: learning to adopt the orientation of viewing one's spontaneous simulations, thoughts, and emotions as transient events in one's mind. We refer to this second component as *mindful attention* and define it as the metacognitive awareness that one's experiences are in essence no more than mental events, with experiences including spontaneous reward simulations, full-blown emotions, engrossing mind wanderings, and so forth. In other words, mindful attention refers to the insight that even the most compelling simulations, emotions, and thoughts occur only in one's mind, inevitably arising and dissipating naturally. Because this insight reduces the vividness and subjective realism of compelling mental states, it plays a central role in contemplative practices.

Specifically, Buddhist theory and practice assume that thoughts have the illusory status of appearing so realistic that they have the potential to cause mental distress and problems (such as cravings for food and sex, along with the motivated behaviors that follow). As an antidote, Buddhism further assumes that various meditation practices, including mindfulness, can make thoughts empty such they simply appear as mental states that arise and dissipate, rather than seeming so real that they cause overwhelming desires, psychological distress, and unhealthy or dysfunctional behavior. In line with this perspective, the experiments reported here teach participants to view their reward simulations as mere mental events, thereby reducing their motivational power.

We recently developed a simple laboratory procedure for teaching the perspectival component of mindfulness to nonmeditators for use in experimental research (Papies et al., 2012). In this brief 12-min training, participants view a series of pictures and are instructed to simply observe their mental responses to them. Most importantly, participants are instructed to view these responses as passing mental events that arise and dissipate while viewing each picture. Participants are further instructed that such responses might include thoughts about being in the scene that a photograph depicts, wanting to be there, experiencing what a depicted object would taste or feel like, liking a photograph, disliking it, and so forth. Thus, participants are instructed to simply observe all of their responses, without avoiding or suppressing them, and to observe how they arise and possibly dissipate as passing mental states. After learning about the mindful attention perspective, participants then practice it by applying it to the critical experimental stimuli (e.g., pictures of attractive sexual partners, pictures of tasty but unhealthy foods).

It is useful at this point to describe a number of important features that distinguish mindful attention training from existing manipulations in self-regulation research. First of all, the training procedure makes no mention of participants' short-term or long-term goals, health implications of the critical stimuli, or any other implications, distinguishing it from goal priming and construal-level approaches that direct attention toward long-term consequences of appetitive behavior (e.g., Fujita & Han, 2009; Papies & Hamstra, 2010). Similarly, nothing is said to participants about changing their responses, or changing the subjective meaning of the stimuli (i.e., participants are not instructed to apply reappraisal or reconstruct the reward stimulus; Gross, 1998; Metcalfe & Mischel, 1999). Importantly, participants are not distracted from their reward thoughts (Van Dillen, Papies, & Hofmann, 2013) but, on the contrary, are made aware of them and are then instructed to observe them as mental events. Specifically, the instructions provide many examples of sensory and desire thoughts that could be triggered by a stimulus, and they ask participants to attend to these while keeping in mind that they are mere mental events. Finally, mindfulness and meditation are not mentioned, to preclude expectancies about the potential effects of the procedure.

Initial work on the effects of this training found that applying mindful attention to attractive food pictures reduced the implicit automatic approach reactions that these items typically trigger (Papies et al., 2012). After participants learned to perform mindful attention while viewing pictures of attractive and neutral food items, their approach responses toward these items were assessed in a reaction-time-based approach–avoidance task. Although participants in various control conditions were faster to approach than to avoid tasty food items in this task, this approach tendency toward tasty foods disappeared completely after applying mindful attention to them earlier during training. However, overall response times were not slowed down, suggesting that the reduction of the approach bias was not due to effortful regulation. Related work examining the neural bases of a similar mindful attention training has shown that this perspective reduces craving-related activity in the brain as smokers view cigarette pictures (Westbrook et al., 2013).

Although this initial work on mindful attention strategies is encouraging, it remains to be established whether mindful attention can actually reduce the effect that motivational states and traits typically have on cognition and behavior. In addition, it remains to be established whether mindful attention can reduce the

subjective attractiveness of appetitive stimuli, whether it affects actual behavior, especially in real-life situations outside the laboratory, and whether using mindful attention is effective in other, especially interpersonal domains. In the current research, we therefore examined systematically whether directing mindful attention at reward simulations can reduce the effects that state and trait motivations have on individuals' cognition and behavior to appetitive stimuli in the domains of food and interpersonal attraction.

Overview of Experiments

We report three experiments to test our account in the domains of interpersonal attraction and eating behavior. Across experiments, motivation was included as an individual difference taking the form of both traits (sexual motivation in Experiment 1) and states (hunger in Experiments 2 and 3). We predicted that typically, as trait or state motivation increased, both the attractiveness of appetitive stimuli and appetitive behavior toward them would increase as well. As dependent measures, we therefore assessed the rated attractiveness of the appetitive stimuli, as well as choices to consume them, in both the laboratory (Experiments 1 and 2) and the field (Experiment 3). All experiments then contrasted a group of participants who learned the mindful attention procedure with control groups who performed a comparable training or no training at all.

Our central hypothesis was that mindful attention would reduce the effects of motivation on perceived attractiveness as well as on appetitive behavior. Once mindful attention had been applied to attractive, unhealthy food stimuli, for example, hunger would no longer boost the perceived attractiveness of these foods or choices to consume them.

Experiment 1 tested our general hypothesis among heterosexual participants in the domain of interpersonal attraction. Earlier research has shown that the motivation to engage in casual sexual relationships boosts the perceived attractiveness of potentially available, opposite-sex others and increases the likelihood of engaging in sexual relationships. Here, we examined whether applying mindful attention to reward simulations of attractive opposite-sex others reduces this motivational effect and, as a consequence, makes opposite-sex others less relevant as potential partners. In addition, we explored whether the effect of trait sexual motivation on choosing opposite-sex others as potential partners is mediated by their perceived attractiveness and, furthermore, whether mindful attention modulates this mediation pattern.

In Experiment 2, we tested the same general hypothesis in the domain of eating behavior, assessing participants' current hunger level as a state measure of motivation. Being hungry typically boosts the attractiveness of food, particularly of attractive but unhealthy food. Here, we examined whether applying mindful attention to reward simulations of attractive, unhealthy foods reduces this motivational effect, reducing choices of such foods. Again, we also assessed whether the effect of state hunger on choosing unhealthy foods is mediated by their perceived attractiveness and, furthermore, whether mindful attention modulates this mediation. We further tested whether mindful attention reduces participants' subjective experience of food cravings.

In Experiment 3, we extended the results of Experiment 2 to a real-world setting and assessed whether mindful attention prevented the unhealthy effects of feeling hungry on eating behavior in a cafeteria. Specifically, we hypothesized that mindful attention would prevent the effects of hunger on unhealthy calorie intake, reducing the unhealthy snacks chosen from a lunch buffet.

Together, these studies examined whether adopting the metacognitive perspective that one's reward simulations are mere mental events can reduce the degree to which motivation affects behavior. If so, then this metacognitive insight has the potential to modulate powerful processes that typically affect individuals in unconscious and sometimes undesirable ways.

Experiment 1: Mindful Attention and the Effects of Sexual Motivation

Interacting with members of the same or the opposite sex, depending on one's sexual orientation, is often a highly rewarding activity for humans. Indeed, a number of neuroimaging studies have shown that among heterosexuals, merely viewing photographs of opposite-sex others activates reward areas in the brain, especially when one finds the presented person attractive (Aharon et al., 2001; O'Doherty et al., 2003) and when their gaze is directed at the perceiver (Kampe et al., 2001). When confronted with sexually relevant others, people spontaneously simulate and prepare for potential interactions with them. When we find others attractive, a desire for short-term mating can become active, along with wanting to impress the other, which can cost significant cognitive resources, especially among men (e.g., Karremans, Verwijmeren, Pronk, & Reitsma, 2009; Van Straaten, Engels, Finkenauer, & Holland, 2008). Individuals also spend more time looking at the faces of people they find appealing, especially when these others are potentially relevant as partners and when rewarding thoughts become more vivid and compelling (Maner et al., 2007; O'Doherty et al., 2003). These findings suggest that encountering potential sexual partners can trigger pleasant simulations of interacting with them.

Importantly, however, these effects seem to vary with individual attitudes toward romantic and sexual relationships. One dimension that has been found to increase the reward responses to opposite-sex others in heterosexuals is people's willingness to engage in short-term, uncommitted sexual relations, as captured by Simpson and Gangestad's (1991) Sociosexual Orientation Inventory (SOI). This scale assesses the number of actual and preferred partners, frequency of polygamous sexual fantasies, and attitudes toward engaging in uncommitted sexual relations. Individuals with high scores on this scale are often referred to as individuals with an unrestricted sociosexual orientation, who endorse casual sex (Yost & Zurbriggen, 2006). Indeed, motivation to engage in casual sexual relationships has been found to correlate with finding the physical attractiveness of a potential partner more important than their reliability (Simpson & Gangestad, 1992) and with behaviors such as having more than one sexual partner at the same time and being in less committed and loving relationships (Barta & Kiene, 2005; Jones, 1998; Simpson & Gangestad, 1991). Individuals with a strong motivation for casual sex exhibit increased visual attention to potential partners when a mating goal is salient (Maner et al., 2007) and evaluate sexually relevant others as more attractive (Provost et al., 2006; Swami, Miller, Furnham, Penke, & Tovée, 2008; Wilbur & Campbell, 2010). These individuals also report more often fantasizing about having sex with someone other than their current or most recent partner (Simpson & Gangestad, 1991).

One interpretation of these findings is that individuals highly interested in casual sex are likely to spontaneously activate highly vivid, rewarding simulations of having sex with attractive others and, as a result, feel attraction to them and see them as potential partners more so than individuals with lower sexual motivation.

In the current study, we suggest that adopting mindful attention to one's thoughts in response to sexually relevant others may prevent the motivation for casual sex from boosting the perceived attractiveness of these individuals. As one learns to see one's thoughts of pleasure and reward as mere fleeting mental events, one's simulations in response to sexually relevant others may be less likely to make these individuals seem particularly attractive.

Thus, we predicted that mindful attention would reduce the effect of sexual motivation on rated attractiveness. We further hypothesized that mindful attention would affect the degree to which participants see opposite-sex others as potential partners. Although other factors could come into play, the other person's attractiveness should be an important determinant of whether, at first sight, someone seems like a good potential partner or not. Because we predicted that mindful attention would decrease the effect of sexual motivation on rated attractiveness, we conducted moderated mediation analysis to explore whether mindful attention reduces the indirect effect of sexual motivation on potential partner judgments via attractiveness.

Importantly, across our dependent measures, we did not expect these effects of mindful attention to be the result of conscious deliberation. Thus, consistent with earlier findings (Papies et al., 2012), we did not expect that mindful attention would slow participants' responses relative to the control condition.

Method

Participants and design. Seventy-eight heterosexual students (24 men, 54 women) of the Free University, Amsterdam, participated in exchange for €3.50 or course credit.[1] Mean age was 20.9 years ($SD = 4.18$). Participants were randomly assigned to the mindful attention ($N = 40$) or control training ($N = 38$), and participants' motivation for casual sex was included as a continuous predictor. Dependent variables included attractiveness ratings and potential partner judgments.

Procedure. Participants were greeted by the experimenter and guided to individual cubicles, in which all tasks and materials were presented on a computer. First, various demographics were assessed, including age, gender, relationship status, and sexual orientation. Participants then performed the mindful attention or a control training, which took about 12 min to complete. Next, they completed a potential partner judgment task and rated the attractiveness of pictures of opposite-sex others. Participants then saw an overview of these pictures and were asked which potential partner they would like to meet most and how much they would like to meet this person. Finally, participants completed the SOI (Simpson & Gangestad, 1991) as the individual-differences measure of sexual motivation. This assessment occurred at the end of the study to prevent participants from being suspicious about our research question. Romantically involved participants also answered a number of questions on the duration and quality of their current relationship. Finally, participants were debriefed, paid, and thanked.

Mindful attention training. Participants in the mindful attention training group completed a brief training for observing their reactions to others' faces as passing mental events. The mindful attention training started with an instruction phase that explained to participants the general notion of one's reactions to stimuli being passing mental events. Participants were told that they would be presented with photographs of other individuals and that they might experience various reactions to them, such as thinking about what the person was like, interacting with the person, liking or disliking the person, and so on. We asked participants to observe all these reactions and to consider them as momentary constructions of their minds, which arise and pass as transient mental events. We briefly checked whether participants understood what we meant by this notion of thoughts as transient mental events and to what degree they could imagine their own thoughts this way (both on 9-point scales). Participants' understanding was very high ($M = 7.85$, $SD = 1.21$, and $M = 7.53$, $SD = 1.68$).

Participants then applied the mindful attention perspective while viewing a first block displaying pictures of 20 men, women, and children in random order. Pictures were presented one at a time for at least 5 s (before participants could press the space bar to go on), with a brief summary of the instructions above each picture (i.e., to observe one's reactions to the displayed picture as mental events). A blank screen then appeared for 1 s, followed by the next picture. After this first block of 20 pictures, participants received a short break in which the instructions were repeated briefly. The second training block then presented the critical pictures, and participants again applied mindful attention. These 20 pictures displayed opposite-sex others, ranging from average to high attractiveness, randomly intermixed (Langner et al., 2010; Maner et al., 2007), all with their gaze directed at the perceiver (Kampe et al., 2001). Following this block, we briefly checked to what degree participants felt that they had succeeded in observing their thoughts and in seeing their thoughts as transient mental events (both on 9-point scales). Again, participants' ratings were high ($M = 7.27$, $SD = 1.28$, and $M = 6.58$, $SD = 1.36$).

Control training. Participants in the control group completed a control training that included viewing the same pictures, but with different instructions. Again, participants were told that they would see pictures of other individuals but were asked to view the pictures closely and to immerse themselves in them completely. Presented in similar style and length as the mindful attention instructions, the immersion instructions asked participants to take the pictures in by completely experiencing them. After a brief check of whether participants understood what was meant by completely experiencing a picture and to what degree they thought they were able to do this ($M = 7.05$, $SD = 1.41$, and $M = 6.79$, $SD = 1.23$), participants applied this procedure to the first block of pictures and to the second, critical block of pictures (opposite-sex others), with both picture sets being the same as for the mindful attention training. Finally, participants' sense of success was again measured by two brief questions ($M = 6.21$, $SD = 1.34$, and $M = 5.82$, $SD = 1.39$).

[1] Two additional participants indicated being homosexual and were therefore not included in the analyses. In addition, one participant did not complete the SOI scale and could therefore not be included.

Potential partner judgments. Participants were instructed to indicate as quickly as possible whether the person presented in each picture would be a potential partner for them, using two designated keys on the keyboard for their *yes* or *no* answers (Ritter, Karremans, & van Schie, 2010). Forty pictures of opposite-sex others were presented, all ranging from relatively neutral to very attractive, including the 20 pictures from the second training phase. Each picture was presented in the center of the screen for 1 s, with response latencies recorded from picture onset. Participants were instructed to provide their answer within the 1-s presentation window, and delayed responses were not included, thereby ensuring relatively fast intuitive responses. After each trial, a break of 1 s occurred before the next picture appeared. All pictures were presented in a different random order for each participant.

Attractiveness ratings. Participants were asked to rate the attractiveness of each person displayed by moving a visual slider from 0 (*very unattractive*) to 100 (*very attractive*). They were shown the same 40 pictures as in the potential partner judgments task. Each picture was presented in the center of the screen until participants responded. All pictures were presented in a different random order for each participant.

Individual differences in sexual motivation. To assess participants' motivation for casual sexual relationships, we asked them to complete the SOI (Simpson & Gangestad, 1991). This questionnaire consists of three subscales measuring sexual behavior (three items; e.g., "How many sexual partners did you have last year?"), sexual desire (three items; e.g., "How often do you fantasize about having sex?"), and sexual attitude (three items; e.g., "Sex without love is OK"). Participants indicated their answers on 9-point Likert-type scales ($\alpha = .69$).

Results

Sexual motivation scores did not differ between control and mindful attention participants ($p > .23$). Table 1 displays descriptive statistics for the sexual motivation scale, attractiveness ratings, and potential partner judgments, as well as their correlations. As expected, potential partner judgments as a measure of appetitive behavior were strongly correlated with attractiveness ratings, and both of these measures were positively associated with sexual motivation.

Potential partner judgments. We predicted that, in general, increasing sexual motivation would be translated into a greater likelihood of viewing opposite-sex others as potential partners but that this overall effect would be attenuated by mindful attention. To test this hypothesized interaction, we conducted a hierarchical regression analysis on mean potential partner judgments, with sexual motivation and training condition (mindful attention vs. control) entered in Step 1 and their interaction in Step 2.

As predicted, sexual motivation was associated with higher scores on the partner judgment task, $\beta = .26$, $t(75) = 2.31$, $p = .02$. As Figure 1 shows, however, and as simple slope analyses corroborate, this increase occurred only in the control condition, $\beta = .44$, $t(36) = 2.94$, $p = .006$, not in the mindful attention condition, $\beta = .15$, $t(38) = 0.95$, $p = .35$. Although these simple slopes support our hypothesized interaction between motivation and training condition, the omnibus interaction term itself was not statistically significant, $\beta = .17$, $t(74) = 1.24$, $p = .22$, $\Delta R^2 = .02$.

We supported these analyses with Bayesian statistics to test the null hypothesis that after applying mindful attention, sexual motivation did not affect the potential partner judgments.[2] These analyses revealed a Bayes factor of $Bf_{1,0} = 5.64$ in the control condition, but a Bayes factor of $Bf_{1,0} = 0.19$ in the mindful attention condition, supporting the null hypothesis that sexual motivation does not affect partner judgments following mindful attention. Thus, Bayesian tests confirmed the predicted effect that sexual motivation was translated into judging opposite-sex others as potentially relevant in the control condition, but not after applying mindful attention.

Response latencies did not differ between mindful attention ($M = 618$ ms, $SD = 64$) and control participants ($M = 630$ ms, $SD = 69$; $p > .42$), consistent with our hypothesis that the effects of mindful attention would not result from slower, deliberate judgments of opposite-sex others.

Attractiveness ratings. To test whether sexual motivation also affected perceived attractiveness as a potential mediator and whether this effect was moderated by mindful attention, we repeated the same analyses on the mean attractiveness ratings of the opposite-sex others. This first analysis revealed that, as expected, individuals having a strong motivation toward casual sex rated opposite-sex others as more attractive, as evidenced by a main effect of sexual motivation, $\beta = .27$, $t(75) = 2.42$, $p = .018$. As Figure 1 shows, however, this effect occurred only among participants in the control condition, $\beta = .51$, $t(36) = 3.57$, $p = .001$, not among participants in the mindful attention condition, $\beta = .08$, $t(38) = 0.48$, $p = .64$. The significant interaction term, $\beta = .34$, $t(74) = 2.46$, $p = .016$, $\Delta R^2 = .07$, indicates that the regression slopes of sexual motivation differed significantly between the two conditions.[3]

Bayesian statistics again supported that sexual motivation had a strong effect on attractiveness ratings in the control condition ($Bf_{1,0} = 25.99$), and that this effect was absent in the mindful attention condition ($Bf_{1,0} = 0.14$). These results suggest that directing mindful attention at one's spontaneous simulations in response to viewing opposite-sex others reduces the effect of sexual motivation on interpersonal cognition and behavior.

Moderated mediation of sexual motivation on partner judgments. Finally, we explored whether sexual motivation boosted potential partner judgments via increased attractiveness ratings and whether this indirect effect was reduced by mindful attention. This model is displayed graphically in Figure 2 and

[2] In typical null hypothesis significance testing, one can only test whether the null can be rejected, not whether there is support for it (Gallistel, 2009). To test the null hypothesis that sexual motivation does not affect attractiveness after applying mindful attention, we used a web-based application to compute the Bayes factor, which indicates the amount of support for the null hypothesis or for an alternative hypothesis (Liang, Paulo, Molina, Clyde, & Berger, 2008; Rouder & Morey, 2012). For these tests, a 1 indicates equal support for both hypotheses, a value greater than 1 indicates support for the alternative hypothesis, and a value less than 1 indicates support for the null hypothesis. Values farther from 1 indicate stronger support for a hypothesis (for an interpretation of the Bayes factor, see, e.g., Kass & Raftery, 1995). In all later analyses, testing null hypotheses was performed using the same Bayesian approach.

[3] These effects of mindful attention and sexual motivation on both perceived attractiveness and partner choices were not qualified by participants' relationship status, that is, by whether participants were single or currently in an intimate relationship ($p \geq .50$).

Table 1
Descriptive Statistics in Experiment 1 for the Sexual Motivation Scale, Attractiveness Ratings, and Potential Partner Judgments, Along With the Correlations Between Them

Measure	Sexual motivation (SOI; $M = 3.55$, $SD = 1.19$)	Potential partner judgments
Attractiveness ratings ($M = 39.29$, $SD = 11.34$)	.25*	.70**
Potential partner judgments ($M = 12.68$, $SD = 5.90$)	.24*	—

Note. SOI = Sociosexual Orientation Inventory.
* $p < .05$. ** $p < .01$.

corresponds to a Model 2 moderated mediation (Preacher & Hayes, 2008; Preacher, Rucker, & Hayes, 2007). Thus, sexual motivation was the independent variable, partner judgments the dependent variable, attractiveness ratings the mediator, and mindful attention the moderator of the relationship between sexual motivation and attractiveness ratings.

Bootstrapping analyses with 5,000 resamples showed that the direct effect of sexual motivation on partner judgments was mediated by attractiveness in the control condition, as the confidence interval for the conditional indirect effect (bias corrected and accelerated) did not contain 0 ($b = 2.52$, 95% CI [0.90, 4.24], $Z = 3.12$, $p = .002$). Figure 2 displays the mediation effect in the control condition, showing that sexual motivation increased potential partner judgments ($\beta = .44$) by boosting attractiveness ratings ($\beta = .51$), which had a strong effect on partner judgments ($\beta = .68$). As we have seen above, however, mindful attention moderated the effect of sexual motivation on attractiveness ($\beta = .34$), such that in the mindful attention condition, sexual motivation did not increase rated attractiveness ($\beta = .08$). As a result, no mediation occurred in the mindful attention condition, as the bias-corrected and accelerated confidence interval for the conditional indirect effect contained 0 ($b = 0.27$, 95% CI [−0.87, 1.51], $Z = 0.49$, $p = .63$).

As the moderated mediation analysis demonstrates, sexual motivation increasingly made opposite-sex others seem like potential partners by increasing their perceived attractiveness. Following mindful attention, however, the mediating effect of attractiveness no longer occurred, thereby blocking the effect of sexual motivation on partner judgments.

Summary and Discussion

Experiment 1 provides the first evidence that mindful attention can break the link between motivation and behavior in the domain of interpersonal attraction. In the control condition, participants with a strong motivation for casual sex rated faces of opposite-sex others as more attractive than did participants with a weaker sexual motivation, and they more often viewed them as potential partners. This pattern is consistent with our account that highly motivated individuals have more rewarding simulations of interacting with these members of the opposite sex. This pattern is also consistent with earlier studies showing that individuals having a so-called unrestricted sociosexual orientation are highly interested in uncommitted, short-term relationships (Seal, Agostinelli, & Hannett, 1994; Simpson & Gangestad, 1991), which affects how they perceive and process images of possible sexual partners (Maner et al., 2007; Provost et al., 2006).

Importantly, however, when participants applied mindful attention to the simulations that occurred while viewing opposite-sex others, their motivation for casual sex no longer predicted perceived attractiveness. As a consequence, sexual motivation no longer predicted the likelihood of choosing opposite-sex others as potential partners. Essentially, mindful attention decoupled participants' sexual motivation from their behavior toward potential

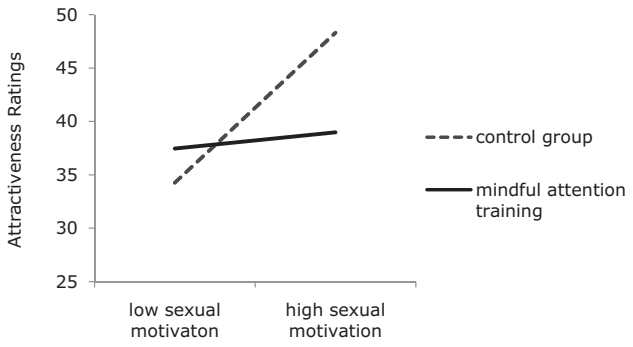

Figure 1. Effect of sexual motivation in Experiment 1 on attractiveness ratings of opposite-sex others in the control group and after applying mindful attention (low and high values represent one standard deviation below vs. above the mean of the sexual motivation measure, respectively; see Cohen, Cohen, West, & Aiken, 2003).

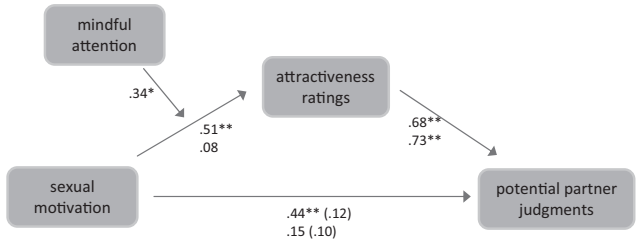

Figure 2. Coefficients in Experiment 1 for the effect of sexual motivation on potential partner judgments. Attractiveness ratings mediated the relation between sexual motivation and partner judgments, with mindful attention moderating this mediation effect. Coefficients displayed are standardized regression coefficients obtained in ordinary least squares regression analyses, with the top coefficient denoting the effect in the control condition and the bottom coefficient the effect in the mindful attention condition. The coefficients in parentheses denote the coefficient for the direct effect of sexual motivation on partner judgments when attractiveness ratings are controlled for. * $p < .05$. ** $p < .01$.

partners by reducing the impact of sexual motivation on perceived attractiveness (see Figure 2). As one learns to perceive spontaneous pleasurable reactions to opposite-sex others as mere mental events, their effect on choice behavior via perceived attractiveness no longer occurs. Finally, mindful attention also exhibited a trend toward reducing the direct effect of sexual motivation on partner judgments (from .44 to .15 in Figure 2, $p = .22$).

To our knowledge, this is the first research on mindfulness or mindful attention in the domain of interpersonal attraction. Our findings seem highly promising for decoupling motivation from appetitive behavior, for example, to curb undesirable consequences of an unrestricted sociosexual orientation (e.g., risky sexual behavior).

Experiment 2: Mindful Attention and the Effects of Hunger

Experiment 2 was designed to replicate and extend the findings of Experiment 1 in several important ways. First, we examined whether mindful attention could reduce the link between motivation and behavior in the domain of food, similar to its effect on this link for interpersonal attraction. Second, we focused on state (instead of trait) individual differences in motivation, testing whether mindful attention reduces the effect of immediate hunger on unhealthy food attractiveness and choices. Third, we also assessed whether applying mindful attention reduced participants' conscious experiences of cravings. Finally and importantly, we included a different control condition in which we no longer asked participants to fully immerse themselves into the presented stimuli. Because fully immersing oneself may not reflect participants' natural way of processing the stimuli, we now asked them simply to observe the stimuli in a relaxed way.

The Effect of Hunger on Unhealthy Eating Behavior

For most people, foods high in fat and sugar are also high in sensory appeal (Birch, 1999; Drewnowski, 1995; Papies, 2013; Pinel, Assanand, & Lehman, 2000; Simmons et al., 2005). According to the grounded cognition perspective described earlier, encountering attractive foods triggers simulations of eating and enjoying these foods. Being hungry further boosts the motivation to consume them. When hungry, one is likely to retrieve especially rewarding simulations (based on earlier, highly rewarding eating experiences), in contrast to retrieving less rewarding simulations when satiated. Consistent with this account, research has repeatedly shown that food deprivation and feeling hungry increase reward responses to food, especially to high-calorie food, in both behavioral and neuroimaging studies (Berridge, 1996; Cabanac, 1971; Lavy & van den Hout, 1993; Lozano, Crites, & Aikman, 1999; Raynor & Epstein, 2003; Seibt et al., 2007; Siep et al., 2009; van der Laan, de Ridder, Viergever, & Smeets, 2011). In short, by triggering more rewarding simulations, hunger boosts the perceived attractiveness and choices of palatable, high-calorie foods.

Importantly, we suggest that mindful attention may diminish the effect of hunger on the unhealthy desires that often motivate food consumption. When encountering attractive foods, mindful attention may help participants see that the resultant eating simulations are mere mental events, thereby diminishing anticipated pleasure and reward. As a consequence, these foods may appear less attractive, such that they become less likely food choices.

In the current laboratory experiment, we assessed both food attractiveness and food choice as dependent variables in computer-based tasks. In the control condition, we predicted that hunger would boost both the attractiveness of unhealthy foods and the likelihood of choosing them. As in Experiment 1, we further explored whether attractiveness mediated the effect of hunger on food choices. Importantly, however, we predicted that mindful attention would reduce these effects on attractiveness and choices, as participants learned to see that reward simulations triggered by unhealthy foods are merely passing mental states. Thus, we also explored whether mindful attention reduced the effect of hunger on unhealthy choices mediated by attractiveness.

We used a spontaneous food-choice task to assess participants' appetitive behavior. On each trial, participants quickly indicated whether they wanted to eat a pictured food at the current moment, with the overall proportion of *yes* responses being the dependent measure. This task has been shown to reflect impulsive food choices and to be sensitive to individual differences (Custers & Aarts, 2005; Finlayson, King, & Blundell, 2007; Ouwehand & Papies, 2010). We included both healthy and unhealthy foods so that we could assess whether participants' preferences and choices shifted toward healthier options after applying mindful attention.

Food Cravings

As an additional question, we examined the effect of mindful attention on participants' conscious experience of craving. Cravings directly reflect conscious thoughts about the anticipated reward experience that appetitive stimuli potentially provide, based on earlier experiences. Although physiological needs can trigger cravings, cognitive processes such as simulation and mental imagery strongly feed into craving and motivate behavior to satisfy one's desires (for reviews, see Kavanagh et al., 2005; Papies & Barsalou, in press). Thus, we again predicted that applying mindful attention to attractive foods may reduce food cravings, as participants see that the underlying simulations are merely passing mental states.

Cravings for food are typically assessed with a self-report instrument, such as the Food Cravings Questionnaire-State (FCQ-S; Cepeda-Benito, Gleaves, Williams, & Erath, 2000). Because this instrument does not differentiate between different types of food that a participant might be craving (see Cepeda-Benito et al., 2000, p. 169), it does not assess whether hunger makes mindful attention participants crave healthier foods than control participants. Thus, we expected two independent effects: (a) Increasing hunger will be associated with stronger food cravings overall (across food types), and (b) mindful attention will reduce these cravings.

Relaxed Viewing Control Training

An important methodological difference with Experiment 1 is in the specific content of the control training used in Experiment 2. In Experiment 1, we had asked participants to fully immerse themselves in the presented stimuli, which may have increased their motivational effects. In addition, a possible by-product of our mindful attention procedure is that it induces relaxation because it trains participants to accept whatever thoughts and reactions they experience. As a result, mindful attention could yield healthier, more controlled preferences and choices than the immersion control condition in Experiment 1.

To address both of these potential problems, we used a novel control procedure in Experiment 2, instructing participants to view all pictures closely and in a relaxed manner. By instructing participants to view the stimuli closely, deep processing was encouraged (as likely to be present for the mindful attention training) while not mentioning immersion. By asking participants to view the pictures in a relaxed way, we further attempted to make the control condition more like the mindful attention condition. If the effects of mindful attention found earlier did not result from immersion or relaxation, then we should again find differences between conditions.

Method

Participants and design. Seventy-five students at Utrecht University participated in exchange for course credit or €3.[4] The experiment had a 2 (training: mindful attention vs. control) × 2 (food type: unhealthy vs. healthy) mixed design. In addition, participants' current hunger was included as a continuous variable. Dependent variables included attractiveness ratings, food choice, and craving.

Procedure. Participants were greeted by the experimenter and guided to individual cubicles, in which all tasks and materials were provided on a computer. Participants were randomly assigned to the mindful attention training ($N = 36$) or the control training ($N = 39$), which took about 12 min to complete. They then performed the food-choice task, completed the food cravings measure, rated the attractiveness of the food pictures (on a 9-point scale), and completed brief dieting motivation measures (Herman & Polivy, 1980; Papies et al., 2008b) and the hunger measure. Again, hunger was measured at the end to avoid sensitizing participants to the food-related focus of our study and to preclude demand effects. Participants then answered a couple of questions about how they thought about the training procedure they received. Finally, they were paid, thanked, and dismissed.

Mindful attention training. Participants in the mindful attention condition completed the mindful attention training as in Papies et al. (2012), observing their reactions to various pictures as passing mental events. In the first training block, they applied mindful attention to five attractive but unhealthy food items (e.g., M&M's, ice cream), five healthy items (e.g., pear, broccoli), five positive International Affective Picture System (IAPS) pictures (e.g., bunny, Mickey Mouse), and five negative IAPS pictures (e.g., snake, spider). In the second block, they applied mindful attention to the five critical pictures of unhealthy food (fries, apple cake, chocolate cake, cheeseburger, pizza) and to the five critical pictures of healthy food (fish soup, porridge, toast, herring, crackers). Again, each picture was presented once, appearing on the screen for 5 s, before participants could press the space bar to see the next picture.

Control training. Participants in the control training group were also instructed that they would view a number of pictures. However, they were simply asked to look at these pictures closely and in a very relaxed manner. These instructions were presented in similar style and length as the mindful attention instructions, and the procedure contained the same pictures as the mindful attention training.

Food-choice task. Participants were instructed to indicate as quickly as possible whether they would like to eat the presented food, at that moment, using two designated keys on the keyboard for their *yes* or *no* answers. Participants were asked to react quickly but also to make sure that their reaction accurately reflected their choice at that moment. Each trial started with a screen that contained only the empty frame in which the food picture would appear. This frame was presented for 100 ms, followed by the food picture, which remained until participants responded. After the response, a 600-ms break followed before the next trial began. The food-choice task contained 10 attractive, unhealthy food items and 10 neutral, healthy items, including those used during the experimental manipulation, plus similar items from the same food categories (e.g., chips, cheesecake as unhealthy items; raisin crackers, rice wafers as healthy items). All items were presented in a different random order for each participant, with latencies recorded from picture onset.

Food cravings. We assessed participants' food cravings by means of the FCQ-S (Cepeda-Benito et al., 2000), which contains 15 items (e.g., "I would feel more alert if I could satisfy my craving"; "If I were to eat what I am craving, I am sure my mood would improve"; $\alpha = .91$). These questions were answered on a 5-point scale, from 1 (*do not agree at all*) to 5 (*agree completely*).

Current hunger. Participants indicated their current hunger by answering the questions "How hungry do you feel at the moment?" (on a 7-point scale) and "How long ago did you last eat?" (on a 5-point scale). Participants' hunger scores were computed as the mean of the standardized scores on these two questions (see Table 2).

Results

Table 2 displays descriptive statistics and correlations between participants' hunger, food choices, and attractiveness ratings for both healthy and unhealthy food. Hunger did not differ between control and mindful attention participants ($p > .60$).

Food choices. To test our hypothesis that mindful attention reduces the impact of hunger on unhealthy choices, we examined the effects of training condition and hunger on unhealthy food choices in regression analyses as in Experiment 1. As the left panel of Figure 3 illustrates, these analyses revealed that hunger strongly increased the choices of unhealthy foods in the control condition, $\beta = .43$, $t(37) = 2.92$, $p = .006$, but not in the mindful attention condition, $\beta = -.007$, $t(34) = -0.04$, $p = .97$, as further indicated by the predicted interaction of hunger and condition, $\beta = .29$, $t(71) = 1.89$, $p = .06$, $\Delta R^2 = .04$. Bayesian statistics supported the effect of hunger on unhealthy choices in the control condition ($Bf_{1,0} = 5.43$) and also showed that this effect was absent in the mindful attention condition ($Bf_{1,0} = 0.13$).

To further assess whether hunger led to different appetitive behavior after mindful attention than after control training, we also examined healthy food choices. In the control condition, hunger only weakly increased choices for healthy foods, $\beta = .30$, $t(37) = 1.93$, $p = .06$, but it strongly increased healthy choices in the mindful attention condition, $\beta = .56$, $t(34) = 3.95$, $p < .001$ (see the right panel of Figure 3). Although these simple effects suggest an interaction, the omnibus interaction term was not statistically significant, $\beta = -.19$, $t(71) = -1.28$, $p = .21$, $\Delta R^2 = .02$.

[4] One additional participant had to be excluded for not following the instructions.

Table 2
Descriptive Statistics in Experiment 2 for Hunger Scores, Attractiveness Ratings, and Proportions of Food Choices, Along With the Correlations Between Them

Measure	*M* (*SD*)	Composite hunger scores	1	2	3	4
1. Attractiveness healthy food (1–9)	3.71 (1.01)	.29*	—			
2. Attractiveness unhealthy food (1–9)	5.61 (1.61)	.13	.12	—		
3. Choices healthy food (0–1)	0.31 (0.20)	.43*	.57**	.04	—	
4. Choices unhealthy food (0–1)	0.58 (0.29)	.21†	.03	.83**	.19	—
Experienced hunger (1–7)	4.22 (1.91)	.83**				
Food deprivation (1–5)	2.55 (1.38)	.83**				

Note. Composite hunger scores are the mean of the standardized scores on the questions of experienced hunger and food deprivation.
† $p < .10$. * $p < .05$. ** $p < .01$.

To assess both unhealthy and healthy foods together, we performed an additional repeated-measures regression analysis using the general linear model, in which we entered condition, standardized hunger scores, and their interaction as predictors of the mean proportion of *yes* answers to both healthy and unhealthy food. In this analysis, the three-way interaction between hunger, training condition, and food type was significant, $F(1, 71) = 6.07$, $p = .02$, $\eta_p^2 = .08$, suggesting that hunger affected choices of healthy and unhealthy foods differently in the mindful attention condition than in the control condition. Whereas hunger especially motivated participants toward unhealthy food items in the control condition, this effect was eliminated after applying mindful attention, with preferences shifting slightly toward healthy food items. Figure 3 displays the complete pattern of results.

None of the effects for mindful attention were moderated by participants' dieting motivation (all *p*s $> .29$). Also, participants' self-reported dieting motivation was not affected by the mindful attention training ($p = .97$).

Response latencies in the choice task. As in Experiment 1, we examined response latencies to rule out the possibility that participants simply became more cautious and deliberate after applying mindful attention or corrected their initial preferences for unhealthy food to choose healthy food instead. As expected, however, training condition did not affect response latencies (all *p*s for main and interaction effects $> .15$). Although no response window was used, participants' mean choice responses were relatively fast ($M = 878$ ms, $SD = 277$), suggesting that they followed our instructions to indicate their momentary wanting spontaneously.

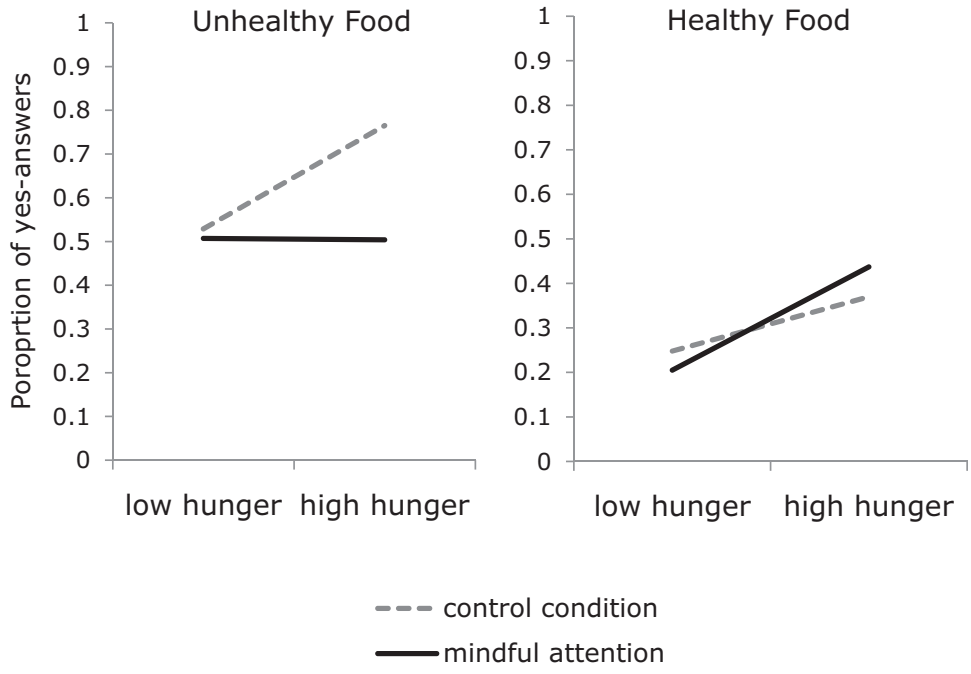

Figure 3. The effect of hunger in Experiment 2 on the proportion of unhealthy and healthy food items chosen in the control and mindful attention conditions (low and high values represent one standard deviation below vs. above the mean of the hunger measure, respectively; see Cohen et al., 2003).

Food attractiveness. Examining attractiveness ratings of healthy and unhealthy foods as a function of participants' hunger scores and training condition revealed that, analogous to food choices, hunger affected the preferences for unhealthy and healthy food differently across training groups. Hunger slightly increased the attractiveness of unhealthy foods among control participants, $\beta = .29$, $t(37) = 1.80$, $p = .077$, but not among mindful attention participants, $\beta = -.04$, $t(34) = -0.23$, $p = .82$, who rated the unhealthy foods as less attractive overall, $\beta = .28$, $t(72) = 2.47$, $p = .02$. The omnibus interaction of hunger and condition approached significance, at $\beta = .22$, $t(71) = 1.40$, $p = .17$, $\Delta R^2 = .024$. In this case, Bayesian statistics did not support the effect of hunger on perceived attractiveness in the control condition ($Bf_{1,0} = 0.059$) and also showed that this effect was absent in the mindful attention condition ($Bf_{1,0} = 0.013$).

Hunger clearly boosted the attractiveness of healthy food among mindful attention participants, $\beta = .37$, $t(34) = 2.35$, $p = .025$, and less so among control participants, $\beta = .23$, $t(37) = 1.46$, $p = .15$. The interaction term was not significant ($p = .64$).

Moderated mediation analysis. Although the interaction of hunger and training condition on the mediator (attractiveness ratings) only approached significance, we explored the moderated meditation effect parallel to Experiment 1. Thus, we tested whether hunger boosted unhealthy food choices via increased attractiveness in the control condition, but not in the mindful attention condition. Figure 4 displays the moderated mediation model. Bootstrapping analyses with 5,000 resamples showed that the direct effect of hunger on food choices was mediated by attractiveness in the control condition, as the confidence interval for the conditional indirect effect (bias corrected and accelerated) did not contain 0 ($b = 0.06$, 95% CI [0.01, 0.13], $Z = 1.70$, $p = .088$). As Figure 4 illustrates, hunger increased unhealthy choices ($\beta = .43$), partially by increasing the attractiveness of unhealthy food ($\beta = .29$). Perceived food attractiveness was strongly related to unhealthy food choices ($\beta = .78$). In contrast, no mediation occurred in the mindful attention condition, as the confidence interval for the conditional indirect effect contained 0 ($b = -0.009$, 95% CI [−0.09, 0.07], $Z = -0.24$, $p = .81$).

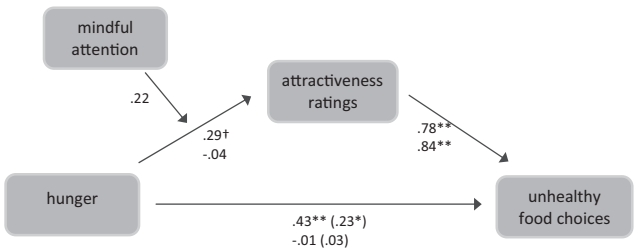

Figure 4. Coefficients in Experiment 2 for the effect of hunger on unhealthy food choices. Attractiveness judgments mediated the relation between hunger and food choices, with mindful attention moderating this mediation effect. Coefficients displayed are standardized regression coefficients obtained in ordinary least squares regression analyses, with the top coefficient denoting the effect in the control condition and the bottom coefficient the effect in the mindful attention condition. The coefficients in parentheses denote the coefficient for the direct effect of hunger on unhealthy food choices when attractiveness ratings are controlled for. $^{\dagger}p < .10$. $^{*}p < .05$. $^{**}p < .01$.

These findings show that while hunger typically boosts unhealthy food choices, partially by making these foods seem more attractive, mindful attention prevented this effect by reducing the effect of hunger on perceived attractiveness.

Experienced cravings. Finally, we tested the hypothesis that mindful attention would reduce participants' experiences of general food cravings, as reflected in their scores on the FCQ-S. Specifically, we conducted hierarchical regression analysis with condition, hunger scores, and their interaction as predictors of experienced cravings. Hunger strongly predicted cravings, $\beta = .56$, $t(72) = 5.89$, $p < .001$. More importantly, however, cravings were lower among mindful attention participants ($M = 2.67$, $SE = .11$) than among control participants ($M = 3.00$, $SE = .10$) as indicated by a main effect of condition, $\beta = -.18$, $t(72) = -1.93$, $p = .058$. Hunger and condition did not interact ($\beta = -.01$, $p = .92$).

Summary and Discussion

The results of Experiment 2 demonstrate that mindful attention can change the impact of hunger on appetitive behavior toward food. In the control group, as hunger increased for an individual, the perceived attractiveness of unhealthy foods increased as well and in turn increased the number of unhealthy foods chosen. This pattern is consistent with much earlier research (e.g., Lozano et al., 1999; Seibt et al., 2007). At the same time, other factors besides hunger likely affect attractiveness ratings of food (e.g., familiarity with a food, idiosyncratic preferences, perceived healthiness), potentially explaining why the effect of hunger on attractiveness ratings was only marginally significant. Analogously, other factors besides attractiveness influence food choices when hungry, such that the effect of hunger on food choices was only partially mediated by attractiveness in the control condition.

Importantly, however, both the direct effect and the indirect effect of hunger completely disappeared in the mindful attention condition. After applying mindful attention, participants' hunger had no effect on the perceived attractiveness of unhealthy food items. Thus, to the extent that hunger boosted the attractiveness of unhealthy food in the control condition and therefore boosted unhealthy choices, this effect was eliminated by applying mindful attention. Again, parallel to Experiment 1, mindful attention also moderated the direct effect of hunger on food choices. Furthermore, when looking at the effect of mindful attention across the domains of interpersonal attraction (Experiment 1) and food (Experiment 2), the overall moderated mediation pattern is highly consistent across studies: To the extent that attractiveness affects partner judgments and food choices, this effect is completely eliminated by applying mindful attention.

Again, as in Experiment 1, the effects of mindful attention were not associated with longer response latencies on choice behavior, indicating that participants' reduced choices for unhealthy foods did not result from more deliberate responding. Consistent with our hypothesis, participants need not effortfully prevent themselves from making unhealthy choices. Instead, the unhealthy food no longer appeared particularly attractive, so that they were less likely to spontaneously choose it. Consistent with this interpretation, food cravings were similarly reduced by applying mindful attention. Participants appeared less likely to elaborate on their

reward simulations and turn them into conscious experiences of desire.

In this experiment, hunger was a slightly stronger predictor of healthy food choices among mindful attention than among control participants. This trend suggests that after applying mindful attention, participants still acted on their increased need for food but translated it into healthier behavior. Similarly, although mindful attention reduced cravings overall, cravings were still stronger when participants were hungry compared with when they were not hungry. Thus, after applying mindful attention, participants' hunger still motivated them to eat.

Future research should examine in more detail the specific processes that motivate choices for healthy food after a mindfulness intervention, when hunger is less likely to be translated into unhealthy desires. Possibly, mindful attention participants are more likely to make healthy choices for composing a nutritious meal while being less tempted by unhealthy foods that become less attractive. Experiment 2, however, only assessed momentary wanting for individual items by means of a computerized food-choice task, rather than assessing the composition of a real meal in an actual eating situation. Therefore, Experiment 3 was designed to examine the impact of mindful attention on how hunger affects real-life food choices in a field setting, where participants composed a meal from a lunch buffet.

Experiment 3: Mindful Attention in the Field

In this final experiment, we assessed whether applying mindful attention to food modulates the potentially unhealthy effects of feeling hungry in a field setting. Here, participants were trained in applying mindful attention to attractive food stimuli before they entered the campus cafeteria for lunch. Importantly, participants believed that the main part of the experiment was finished after completing the training and answering some evaluative questions. Later, once participants purchased their lunch but before they consumed it, we assessed hunger and their choices of unhealthy versus healthy food (high-fat snacks vs. salad) and compared these to the choices of control participants.

An important difference with Experiment 2 lies in the context of the choices participants made. First of all, in this field setting, participants chose food items for a meal that they were actually going to consume, which may have constrained participants' choices in ways not relevant for their more hypothetical food choices in Experiment 2. In addition, the choice set of foods that participants considered in the cafeteria buffet differed from the experimental choice set in Experiment 2, mostly because fewer different unhealthy food items were available.

Similar to Experiment 2, Experiment 3 continued to explore different control conditions. Across Experiments 1 and 2, we found consistent effects of mindful attention compared to two different control procedures (immersion and relaxed viewing control, respectively). Both procedures were designed to achieve exposure and thorough processing of the same stimuli presented in the mindful attention training, thereby controlling for these aspects of the training. Nevertheless, we cannot rule out that simple exposure to foods in these control conditions produced effects that differ from natural responses to foods when simply encountering them in the world (i.e., with no previous training procedure). Therefore, Experiment 3 included a no-intervention control condition so that we could study the effects of mindful attention in comparison to the most natural control situation. This contrast allowed us to test the important hypothesis that mindful attention produces healthier food choices relative to participants' usual choice behavior (i.e., with no preceding intervention).

To rule out the possibility that simply exposing participants to food pictures leads to healthier food choices, we also included a relaxed viewing control condition, as in Experiment 2. For all three groups, we assessed participants' hunger right after they made their food choices but before they ate. Thus, we obtained an assessment of hunger as close as possible to the food choices and before participants had quieted their hunger, but without drawing attention to their hunger before making food choices and without alerting them to the true nature of our study.

To test the hypothesis that hunger is translated into healthier behavior after applying mindful attention, we first examined the overall number of calories across the food choices that participants made from the lunch buffet. Restricting one's calorie intake is of major importance for healthy eating. In addition, the calorie count likely reflects unhealthy food choices, as unhealthy foods (e.g., fried snacks) typically contain more calories than healthy foods (e.g., salads). In addition, analogous to Experiment 2, we tested whether mindful attention decreased the likelihood of choosing a high-calorie snack and increased the likelihood of choosing a healthy salad, especially when hungry, compared to the no-intervention control group. Finally, to assess whether simply viewing food was responsible for these predicted effects, we also assessed choices in the relaxed viewing control condition, in which participants were exposed to the same food items but without mindful attention practice.

Method

Participants and design. Undergraduates of University College Utrecht were approached for the study when they were about to enter the cafeteria on their campus, for which all students of this residential college have a meal plan that includes breakfast, lunch, and dinner. One hundred fourteen undergraduates agreed to participate and were semirandomly assigned to the mindful attention group or relaxed viewing control group (both completed on laptop computers) or to the no-intervention control group.[5] Group assignment was not fully random because we used the following procedure to prevent reactivity: When participants who agreed to participate entered the cafeteria in a group, they were all assigned randomly as a group either to one of the two computer tasks or to the no-intervention control condition. As a result, participants were less likely to notice that there were different experimental groups, thereby avoiding expectations about the experiment. Participants who entered individually were assigned randomly. After making their food choices in the cafeteria, all participants' experienced hunger was measured by means of a questionnaire. Thus, the experiment had a 3 (training group: mindful attention vs. relaxed viewing control vs. no intervention) $\times$ 2 (food type: snacks vs.

[5] Two additional participants had to be excluded because, contrary to instructions, they only approached the experimenter and completed the postexperimental questionnaire, including the hunger measure, after finishing lunch (not before eating). In addition, four participants did not contact the experimenter at all to complete the questionnaire.

salad) mixed design. In addition, participants' experienced hunger was included as a continuous variable.

Procedure. Participants were approached in the entrance hall of the cafeteria, before entering the actual buffet and dining area. After agreeing to participate, participants signed an informed-consent form administered by the first experimenter. Participants in the mindful attention and relaxed viewing control groups were led to a conference room adjacent to the main buffet and dining area where they first answered a few demographic questions on the computer and then completed the mindful attention or relaxed viewing control training. Training was performed on one of four individual laptop computers, separated from each other by wooden panels mounted on tables so that participants could not see each other. After completing the training, these participants received three brief questions to evaluate it (e.g., how pleasant they found it), giving the impression that the experiment had ended. These participants then left the conference room and returned to the first experimenter, who gave them a reward coupon for participating. Participants in the no-intervention control did not enter the conference room but answered the demographic questions directly to the first experimenter and then received the reward coupon.

All participants were then told that they could later exchange their coupon for the €4 reward by handing it to the second experimenter, who would be in the main dining area, behind the buffet area, and would also ask them some final questions. The coupon enabled the second experimenter to recognize the participants among the nonparticipating students exiting the buffet area. In addition, the first experimenter noted the participant number on each coupon, so that we could later match pre- and postexperiment questionnaires. The second experimenter was blind to conditions.

Once participants received the coupon, they entered the buffet area and chose their lunch as usual. When they exited the buffet area to sit in the main dining room, they were approached by the second experimenter, who asked them to fill in the postexperiment questionnaire. In the meantime, with participants' explicit consent, the second experimenter noted all lunch choices on a prepared form. Finally, participants received their financial compensation and were thanked, debriefed, asked not to talk with fellow students about the ongoing study, and dismissed.

Mindful attention training. Participants in the mindful attention condition received the mindful attention training with the instructions now referring to thoughts about objects. Specifically, participants were told that they would be presented with photographs and that they might experience reactions to each of them, such as thinking about what kind of object was displayed, what one could do with it, how it would feel to touch or taste, how the object would make them feel, or any other thoughts, including thoughts of liking or disliking it. Then, participants applied the mindful attention perspective to two training blocks of 16 pictures. In the first block, participants viewed four attractive food pictures, four neutral food pictures, four positive IAPS pictures, and four negative IAPS pictures. In the second block, participants applied mindful attention while viewing eight pictures of attractive snack foods typically available in the cafeteria for lunch (hot dog, fried croquette, muffin, etc.) and eight pictures of neutral nonfood objects (chair, plant, stack of books, etc.). Again, all pictures were presented in random order, each presented once for at least 5 s.

Control training. Control training participants viewed the same pictures in the two training blocks as mindful attention participants. As in Experiment 2, they were asked to view each picture closely and in a very relaxed manner. Both training procedures took about 10 min to complete.

Postexperiment questionnaire. After getting their lunch, participants were first asked a number of questions to probe their suspicion about the experiment and to determine whether expectations about the experiment could have influenced their lunch choices. Specifically, participants were asked what they thought the study was about, what they had been thinking about when making their lunch choices, whether they had thought back to the computer task (if they had performed it), and whether they believed that this had influenced their choices. None of the participants guessed the hypotheses as to how the mindful attention procedure might have been related to food choices.

The next page of the questionnaire contained the Concern for Dieting Questionnaire of the Restraint Scale (Herman & Polivy, 1980), three questions about dieting success (Papies et al., 2008b) and whether they were currently dieting. Participants were asked how hungry they were at the moment, if they had eaten breakfast and at what time,[6] if they had eaten between breakfast and lunch, and what their weight and height were. Finally, they answered a couple of questions about their eating habits and experiences in the cafeteria.

Dependent variables. We calculated the total number of calories in each participant's lunch by retrieving the calories of each item from the calorie checker on the website of the Netherlands Nutrition Center. In follow-up analyses, we then focused on choices of unhealthy and healthy food, analogous to Experiment 2. Specifically, we measured whether a participant chose an unhealthy snack item from the buffet (e.g., fried croquette, cheese puff pastry, donut, muffin, ranging from 116 kcal to 273 kcal) and whether a participant took a bowl of salad from the salad bar (including various greens and vegetables, approximately 15 kcal per bowl).

Results

Descriptive statistics can be found in Table 3. Scores of experienced hunger were higher in mindful attention ($M = 5.51$, $SD = 1.46$, $N = 33$) and relaxed viewing participants ($M = 5.18$, $SD = 1.85$, $N = 39$) compared to no-intervention control participants ($M = 4.38$, $SD = 1.62$, $N = 42$), $F(1, 111) = 4.73$, $p = .01$, $\eta_p^2 = .08$, possibly because these participants had been exposed to attractive food items during the training procedure.

Of primary interest was whether practicing mindful attention before entering the cafeteria would lead participants to eat more healthily than they would if they had not practiced mindful attention, as they would be less likely to translate their hunger into unhealthy eating behavior. Thus, we examined whether mindful attention, compared to the no-intervention control group, decreased the unhealthy effects of hunger by reducing the number of calories of participants' lunches, specifically by reducing the like-

[6] These questions were designed to obtain deprivation scores similar to Experiment 2. Many participants, however, did not provide information on their time of breakfast ($N = 20$) or indicated not having eaten breakfast ($N = 21$). Therefore, we only used the current reports of experienced hunger as a predictor in this experiment.

lihood of choosing a high-calorie snack and increasing the likelihood of choosing a healthy salad.

Again, to assess whether simply viewing food was responsible for these predicted effects, we also examined food choices in the relaxed viewing control condition, in which participants were exposed to the same food items but without mindful attention practice.

Overall calories. Total calories of the foods taken from the buffet were regressed onto standardized hunger scores, training condition (mindful attention vs. no-intervention control), and their interaction. This regression revealed a main effect of hunger, with feeling hungrier being associated with taking more calories, $\beta = .43$, $t(72) = 3.81$, $p < .001$. Additionally, a main effect of training condition indicated that mindful attention participants took fewer calories overall than no-intervention control participants, $\beta = -.22$, $t(72) = -1.96$, $p = .05$. Most importantly, however, the predicted interaction effect of hunger and training condition occurred, $\beta = -.31$, $t(71) = -2.24$, $p = .03$, $\Delta R^2 = .06$. Figure 5 displays this interaction, which was not moderated by chronic dieting motivation ($p > .26$). Simple slope analyses showed that hunger led to taking more calories from the buffet only in the no-intervention control condition, $\beta = .55$, $t(40) = 4.21$, $p < .001$, but not in the mindful attention condition, $\beta = .13$, $t(31) = 0.74$, $p = .46$. Again, a Bayesian test supported the hypothesis that hunger was a strong predictor of caloric intake in the control condition ($Bf_{1,0} = 159.21$), with this effect being absent in the mindful attention condition ($Bf_{1,0} = 0.18$).

Snack and salad choices. In follow-up analyses, we examined the choices of snacks and salads that might be underlying these differences in calories. Two logistic regression analyses were performed on salad and snack choices, respectively, each including regressors for training condition (mindful attention and no-intervention control), standardized hunger scores, and their interaction.[7] Table 4 presents the results of these analyses.

As predicted, participants made different buffet choices in the mindful attention and no-intervention control conditions. The main effect of training condition showed that mindful attention participants were less likely to choose an unhealthy snack than control participants (45% vs. 63%, $p = .04$). As the bottom half of Table 4 illustrates further, hunger increased the likelihood of selecting an unhealthy snack, but only for control participants ($p = .04$), not for mindful attention participants ($p = .58$). Analogous to Experiment 2, hunger led to unhealthy choices in the control group, but not in the mindful attention group.

A different picture emerged for healthy salad choices. Here, only a main effect of training condition emerged, with mindful attention participants being more likely to choose a salad than control participants (76% vs. 49%), $B = 1.00$, $SE = .54$, χ^2Wald $(1) = 3.50$, $p = .06$, odds ratio (OR) = 2.72. There were no main or interaction effects of hunger (all ps $> .41$).

Table 3
Descriptive Statistics in Experiment 3 for Hunger Scores, Total Calories of the Foods Chosen From the Buffet, and Snack and Salad Choices (Dichotomized as Salad/Snack Chosen or Not Chosen) Across All Three Conditions (Mindful Attention, No-Intervention Control, Relaxed Viewing)

Measure	*M* (*SD*)
Experienced hunger (1–7)	4.98 (1.72)
Total calories	916 (334)
Snack choice	49% (.50)
Salad choice	60% (.49)

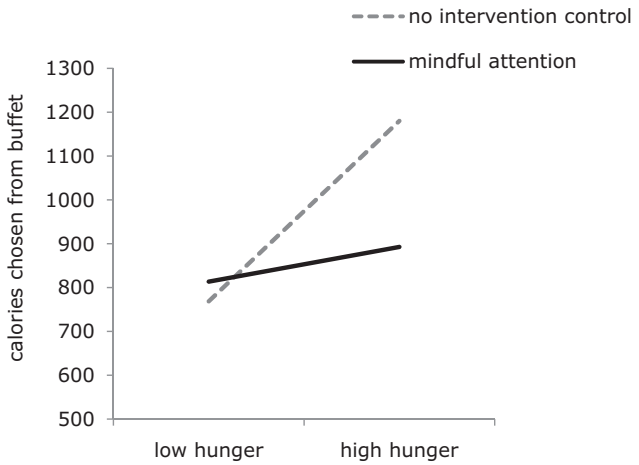

Figure 5. Effect of hunger in Experiment 3 on calories of foods taken from the lunch buffet in the no-intervention control and mindful attention conditions (low and high values represent one standard deviation below vs. above the mean of the hunger measure, respectively; see Cohen et al., 2003).

Analyses of choices *within* each training group showed that mindful attention participants were more likely to choose a salad than a snack. Whereas 76% of mindful attention participants chose one or more salad items, only 45% chose a snack. A McNemar test comparing these proportions found this difference significant ($p = .013$). In contrast, control participants were about equally likely to choose a snack (63%) and a salad (49%; $p = .24$).

As in Experiment 2, mindful attention participants made healthier choices than control participants overall, choosing fewer unhealthy snacks and more salads. As a result, mindful attention participants took fewer calories from the lunch buffet than control participants and were less likely to translate their hunger into excess consumption of unhealthy foods.

Food choices in the relaxed viewing condition. Finally, we examined food choices in the relaxed viewing condition, where a regression analysis showed that hunger had no effect on total calories chosen ($p = .20$). To explore this unexpected finding, we performed further logistic regression analyses that compared food choices in the relaxed viewing and no-intervention control conditions. In these analyses, relaxed viewing participants were equally as likely to choose a salad (56%) as no-intervention control participants (49%; $p = .52$) but were less likely to choose a snack (38% vs. 62%), $B = 0.99$, $SE = .46$, χ^2Wald $(1) = 4.75$, $p = .03$, OR = 2.70.

A possible explanation of this pattern is that exposure to healthy and unhealthy foods before making lunch choices in the relaxed viewing condition activated a dieting goal in some participants. To

[7] Only two participants chose more than one snack, and only 11 participants chose more than one bowl of salad. Thus, we dichotomized these variables and conducted logistic regression analyses on whether or not participants chose a salad and whether or not they chose a snack.

Table 4
Results for Logistic Regressions in Experiment 3 on Choices of Unhealthy Snacks as a Function of Training Condition (Mindful Attention Vs. No-Intervention Control) and Hunger Scores

Predictors	*B* (*SE*)	χ^2Wald (1)	*p*	OR	R^2 (Nagelkerke)
Main effects and interaction on unhealthy snack choices					
Training condition	−1.09 (.54)	4.08	.04	0.34	.11
Hunger	0.58 (.29)	3.99	.046	1.79	
Hunger × Training Condition	−0.58 (.59)	0.97	.32	0.56	.12
Simple slopes of hunger					
No-intervention control condition	0.82 (.40)	4.33	.04	2.28	.15
Mindful attention condition	0.24 (.44)	0.30	.58	1.27	.01

Note. OR = odds ratio.

test this hypothesis, we examined the effect of participants' chronic dieting scores on snack choices within the relaxed viewing condition. In a logistic regression analysis on snack choices, a higher dieting score was associated with a lower likelihood of choosing an unhealthy snack, $B = -1.20$, $SE = .48$, χ^2Wald (1) = 6.30, $p = .01$, OR = 0.30. Consistent with our explanation, simply viewing food pictures appeared to activate the dieting goal in chronic dieters. As these particular individuals viewed healthy and unhealthy food pictures during the training phase, their goal of dieting may have become active, making them less likely to choose a high-calorie snack from the buffet. Conversely, participants less oriented toward dieting appeared less likely to activate a dieting goal (see Fishbach et al., 2003), such that they were more likely to select a snack. This pattern contrasts with the findings in the mindful attention and no-intervention conditions, where chronic dieting had no effect on either snack or salad choices (all *p*s > .32). Although self-reported dieting motivation was the same for all three training groups ($p = .95$), the dieting goal only became active selectively and influenced food choices in relaxed viewing participants.

Summary and Discussion

This field experiment again demonstrated that mindful attention can modulate how motivation is translated into behavior. After performing mindful attention, participants' hunger was less likely to be translated into consuming many calories that typically come from unhealthy snacks. Instead, these participants chose more salads than snacks, and relative to control participants, they chose more salads and fewer snacks.

The finding that participants actually increased their salad choices after applying mindful attention points to a somewhat different pattern than in Experiment 2, where mindful attention mostly affected unhealthy choices. We propose that this may have to do with the real-life setting of the experiment. Participants in Experiment 3 were actually composing a meal, rather than judging each item individually in a laboratory experiment. As a consequence, they may have compensated for the reduction in one component (an unhealthy snack) with an increase in another component (a healthy salad). This is a smart choice, reducing hunger on the one hand while staying healthy on the other.

This finding further explains why mindful attention participants did not translate their hunger into choosing more calories overall, as the salads they chose inherently had fewer calories than the unhealthy snacks. Although it might at first sight seem counterintuitive or even undesirable for hunger to not affect calorie intake, this can be beneficial when healthy salads are consumed instead of high-calorie snacks. People generally know that eating fresh vegetables is associated with a number of significant health benefits. Nevertheless, most people in Western societies, including the Netherlands, still consume less than the recommended daily amounts (Erinosho, Moser, Oh, Nebeling, & Yaroch, 2012; Nebeling, Yaroch, Seymour, & Kimmons, 2007; van Rossum, Fransen, Verkaik-Kloosterman, Buurma-Rethans, & Ocké, 2011). If mindful attention decreases the temptation to consume readily available unhealthy snacks in a food-choice setting, it may in turn support nutritional goals to consume healthier foods that are otherwise less likely to be chosen.

Interestingly, the relaxed viewing condition led to a different pattern of choices, most notably because participants also consumed fewer snacks than in the no-intervention control condition, similar to mindful attention participants. A further analysis, however, revealed that this was only true to the degree that participants held a chronic dieting goal. For dieters, consciously looking at pictures of healthy and unhealthy foods in the context of an experiment before lunch probably activated the dieting goal, leading to more salad choices than snacks (e.g., Fishbach et al., 2003). Thus, although goal priming in dieters is an important effect with healthy consequences (e.g., Papies, 2012; Papies & Hamstra, 2010), it is worth noting that mindful attention led to healthier choice patterns among *all* participants, regardless of their chronic dieting goal.

General Discussion

Mindful attention is a metacognitive perspective for observing one's thoughts as mere mental events. Across three experiments, we found that mindful attention changed the way that trait and state motivations were translated into preferences and choices. In Experiment 1, applying mindful attention curbed the effects of sexual motivation on the perceived attractiveness of opposite-sex others and also on partner judgments. Mindful attention further reduced the mediating effect that perceived attractiveness had on partner choices. Similarly, in Experiment 2, mindful attention curbed the effects of hunger on unhealthy food attractiveness and choices and analogously reduced the mediating effect that perceived attractiveness had on choices. Finally, Experiment 3 showed that applying mindful attention in a field setting prevented hunger from boosting unhealthy calorie intake. Applying mindful attention before making choices from a lunch buffet led to health-

ier meal compositions compared to the standard, no-intervention setting, with mindful attention participants more likely to choose a salad than a high-calorie snack. To our knowledge, this is the first study showing effects of a brief, targeted mindfulness intervention on real-life health behavior.

Across experiments, mindful attention modulated the effect of participants' motivational states and traits on the perceived attractiveness and choice of tempting stimuli. When participants were instructed and trained to see that their experiences of pleasure and reward were mere thoughts, constructed by their own minds, the stimuli themselves became less attractive, and resisting them became easier. While earlier lengthy and multicomponent mindfulness interventions have shown promising results on a variety of effects relevant to self-regulation, the current studies are novel in that they provide a theory-based approach to a specific component of mindfulness and examine its effects on appetitive behavior, in interaction with individual differences in motivation.

We also found that mindful attention reduced the experience of food cravings compared to a relaxed viewing control condition in Experiment 2. Reducing the conscious experience of cravings may have additional benefits over and above the behavioral effects on food choices, reducing the degree to which rewarding food imagery occupies one's thoughts (Kavanagh et al., 2005). Reducing cravings may also free working memory capacity for other tasks (e.g., Meule, Skirde, Freund, Vögele, & Kübler, 2012) and reduce one's implicit attentional bias for food (see Franken, 2003). In addition, cravings are often experienced as negative (e.g., Baker, Piper, McCarthy, Majeskie, & Fiore, 2004), consistent with the Buddhist perspective that cravings are inherent to human suffering. Our general finding that observing the transient nature of one's thoughts can reduce cravings is highly consistent with Buddhist teachings that negative mental states, such as cravings and unhealthy intentions, can be eliminated through insight into their impermanent nature (e.g., Dunne, in press).

We suggest that when participants apply mindful attention to the reward simulations associated with appetitive stimuli, they adopt a decentered perspective and notice that these thoughts and simulations are merely fleeting mental events, such that the appetitive stimuli no longer seem particularly attractive. Especially in domains where short-term rewards often interfere with long-term goals, our findings suggest that mindful attention offers a promising and novel strategy for self-control. Mindful attention works to reduce the attractiveness of stimuli, thereby preventing self-control dilemmas before they become difficult to handle. This strategy tackles the problem of self-control at its very basis, namely, at the anticipation of reward. In other words, mindful attention keeps strong temptations from developing in the first place, making it particularly helpful for individuals predisposed to temptation because of either traits or temporary states.

The potential benefit of applying mindful attention to reduce the impact of individual differences in motivation may not be limited to individual differences in the domain of reward and may also be relevant in other domains. Consider phobias and anxiety, such as fear of spiders, flying on airplanes, or traumatic events. As anxiety grows for an individual, chronically or temporarily, it is likely that simulations of the feared object or event becoming increasingly rich and compelling (e.g., Hackmann, Ehlers, Speckens, & Clark, 2004). The individual believes increasingly that something catastrophic is likely to happen. Again, mindful attention may reduce the perceived threat of such stimuli by training participants to see that their catastrophic simulations are mere mental events, rather than inherent truths, however vivid and real they may seem (e.g., Teasdale, 1999). The potential of mindful attention to dynamically modulate the impact of individual differences makes it a highly flexible intervention tool that could potentially reduce the impact of detrimental individual differences in various domains. Further research could be devoted to better understanding individual differences in the vividness and subjective realism of one's spontaneous simulations and in the potential for reducing them.

At the same time, the link between motivation and one's spontaneous preferences and behavior is clearly functional in many cases, and reducing this link may not always be beneficial. Much research shows that perceptual and cognitive processes support conscious and nonconscious goal pursuit in effective ways, allowing us to function efficiently in highly complex environments (e.g., Bargh, 1997; Dijksterhuis & Aarts, 2010). When, however, one's short-term goals lead to vivid reward simulations that trigger failures of self-control or to catastrophic simulations that disrupt one's daily life, mindful attention may be a useful strategy for reducing the immediate impact of these simulations on behavior, allowing for more deliberate courses of action. Thus, recent studies have shown that mindfulness interventions reduce the effect of implicit processes on behavior, thereby creating the opportunity for more deliberate processes to guide action (e.g., Ostafin, Bauer, & Myxter, 2012; Ostafin, Kassman, & Wessel, 2013).

Potential Mechanisms of Mindful Attention

Another interesting question that remains to be addressed in future research concerns the precise mechanisms by which mindful attention reduces the effects of motivation on cognition and behavior. It is unlikely that mindful attention simply distracted participants from the temptations of the presented stimuli (see Van Dillen et al., 2013), as the training explicitly draws attention to potential sensory and reward thoughts in response to the pictures and encourages participants to observe them as mental events. This is consistent with other work showing that mindfulness interventions decrease distraction (Jain et al., 2007) and increase awareness of one's ongoing thoughts and experiences (Kerrigan et al., 2011; see also Hölzel et al., 2011). Similarly, participants were not instructed to change the content of their thoughts in response to the tempting stimuli in any way, making this procedure markedly different from reappraisal and cooling approaches (see Gross, 1998; Metcalfe & Mischel, 1999).

Critically, our findings show that mindful attention modulates immediate reactions to appetitive stimuli, given that participants typically responded quickly, without much time for conscious deliberation, and were not slowed down by having undergone the mindful attention procedure. Much previous research shows that subtle manipulations of motivation, such as goal primes or abstract construals, can produce similar effects on such fast or even automatic responses (e.g., Fujita & Han, 2009; Maner et al., 2007; Papies, Stroebe, & Aarts, 2008a). In contrast to these findings, however, the effects of mindful attention do not appear to depend on participants' regulatory goals, suggesting that mindful attention does not work by activating goals. Additionally, when applying mindful attention, participants were not asked to consider their

goals or to control what they thought. Our studies showed further that the mindful attention training did not increase participants' self-reported dieting motivation. Thus, mindful attention does not seem to work by explicitly activating or strengthening participants' long-term goals.

An alternative possibility for understanding the mechanism of mindful attention is that it changes the representation of appetitive stimuli. When viewing tempting stimuli with mindful attention, one sees that thoughts of pleasure and reward are mere mental events. Observing one's thoughts this way may produce decentering, namely, becoming disengaged from the thought rather than being immersed in it (e.g., Bishop et al., 2004; Fresco et al., 2007). Rather than time travelling and getting lost in an imagined situation, one sees it as a passing thought in the current moment. As a consequence of this process of decentering, a changed, less rewarding representation of the stimulus becomes encoded in memory. During later encounters with the stimulus and others like it, participants retrieve these decentered memories, causing the stimulus to seem less attractive, such that resisting it becomes easier.

This memory-based mechanism suggests that mindful attention bears resemblance to extinction learning in exposure therapy, where being exposed to fear-arousing stimuli without one's usual fearful response slowly causes the stimulus to become less threatening. Interestingly, a similar learning mechanism has been suggested to underlie the effects of mindfulness in the treatment of stress and anxiety disorders (Hölzel et al., 2011). Thus, a common underlying mechanism could be that being exposed to either attractive or fearful stimuli without becoming immersed in how rewarding or threatening they are changes their motivational potency, in turn decreasing their effects on behavior. Further work could attempt to establish the mechanisms underlying these changes in greater detail.

Relations Between the Attention and Perspective Components of Mindfulness

Given the benefits of a brief mindful attention training demonstrated here, the question arises as to whether any added value results from the first component of mindfulness briefly addressed earlier—attention regulation. Does regulating attention have any utility when applying mindfulness to one's reactions to external cues above and beyond adopting the decentered perspective that cognitive responses to attractive stimuli are merely mental states, not subjectively real experiences? Clearly, attention training in itself has many unique benefits on attention and executive control processes (e.g., Chiesa et al., 2011; Jha et al., 2010; MacLean et al., 2010) that also benefit self-control. As described next, however, we suggest that the two components of mindfulness may support and enhance each other in crucial ways.

Attention regulation supports mindful attention. First of all, attention training may support the application of mindful attention in daily life. Having good control over one's attention should make it easier to understand how mindful attention works, should make remembering to apply it in crucial situations more likely, and should help maintain metacognitive awareness of one's experiences as mental events over longer periods. Although research participants can be taught the mindful attention perspective in a 12-min training, it may require a better trained mind to retrieve it independently and to apply it when confronted with attractive stimuli in one's daily life. In addition, attractive stimuli in everyday settings often do not disappear as quickly as the stimuli presented in our training (e.g., when one is attending a dinner party with many unhealthy items on the buffet or walking through a shopping mall with various unhealthy but attractive food stalls). In such situations, good attention-regulation skills can help maintain mindful attention over an extended time period, helping one remain aware that reward simulations are merely passing mental events, so that temptation remains curbed.

Mindful attention supports attention regulation. Conversely, we also suggest that mindfully remaining aware that one's experiences are simply mental events may support the successful training and regulation of attention. Becoming distracted from focused attention typically happens when mind wandering occurs, namely, when people have thoughts about task-irrelevant stimuli (e.g., Mrazek et al., 2011; Schooler et al., 2011; Smallwood & Schooler, 2006). Such distractions include, for example, thoughts about an upcoming event (e.g., the dinner party on Saturday), alternatives to a present event (e.g., having chocolate cake rather than working), or cravings for some appetitive object (e.g., a sweet snack; Sayette, Schooler, & Reichle, 2010). Being able to view such experiences as mental events that arise and dissipate can make disengaging from them much easier. In fact, disengagement and dissipation of such thoughts are central to what many meditation practices aim to develop (see, e.g., Dunne, in press; Lutz et al., 2007). Thus, actively training one's attention during mindfulness meditation or maintaining one's attention on a task during the day will be facilitated by being able to view potential distractions as passing mental events, thereby disengaging from them easily (for a similar argument, see Pagnoni, Cekic, & Guo, 2008).

Conceptualizing Mindfulness in Future Research and Applications

Although we have focused primarily on the role of mindful attention for the link between motivation and appetitive behavior, we suggest that our research also has implications for mindfulness research in personality and social psychology more generally. Specifically, we believe that viewing mindfulness as containing two critical components—attention regulation and observing and accepting thoughts as passing mental events (see Bishop et al., 2004)—may help move research on mindfulness in these areas forward. Because definitions of mindfulness often vary widely in the scientific literature, this two-factor conceptualization of mindfulness has potential for sharpening the investigation and use of this construct. Importantly, the main processes by which mindfulness can modulate cognition and behavior rely on faculties that are present in nonmeditators and that are familiar to researchers in psychology more generally, such as the capacity to regulate one's attention and the capacity for metacognition. By integrating mindfulness processes with fundamental processes in grounded cognition, motivation, and self-regulation, we hope that our work can increase our understanding of mindfulness within the context of existing psychological theory and research.

Additionally, the approach developed here may facilitate further experimental research, given that the two central mindfulness components can be manipulated individually, thereby allowing researchers to understand their effects separately from each other and also as they interact systematically. The attention training

component of mindfulness has already been identified and studied as a separate component that demonstrates the benefits of being present (e.g., Brown & Ryan, 2003; Slagter, Davidson, & Lutz, 2011; Wadlinger & Isaacowitz, 2011). Little research, however, has systematically investigated the perspectival component of mindfulness that focuses on the benefits of simply observing. Our mindful attention training paradigm helps bridge this gap and offers a useful experimental tool for studying the metacognitive awareness of thoughts as mental events in nonmeditators, separately from attention training.

Finally, applications of mindfulness in clinical and lay settings may also benefit from our analytic approach to the construct. Rather than always employing comprehensive mindfulness approaches that train both attention regulation and mindful attention perspective simultaneously, systematic research on the effects of each component separately may allow practitioners to use them in more focused ways when targeting specific problems. For instance, a healthy individual wanting to deal more effectively with food temptations in order to eat a balanced diet may benefit most directly from consistently applying mindful attention in relevant situations, without needing extensive attention training (see also Lacaille et al., 2014). In contrast, an adolescent trying to overcome distractions to studying might benefit most from rigorous attention training, with the mindful attention perspective being less relevant. Finally, consider a highly skilled tennis player using mindfulness to prevent choking under pressure. We suggest that, here, benefit may result from both components. On the one hand, attention training may help players remain focused on the task (see Beilock & Can, 2001; Beilock & Gray, 2007). On the other hand, applying mindful attention may be helpful for dealing with distracting thoughts during a match, such as vivid worries about the audience's expectations and the match's importance and implications. Such thoughts can harm performance by reducing the working memory capacity available for making strategic decisions at key points (Beilock & Gray, 2007). Seeing such worries as mere mental events should make it easier to disengage from them and thus help prevent choking effects (cf. Gardner & Moore, 2004).

Mindful Attention in Social Psychology

Finally, we address the relation of mindful attention to social psychological research, in particular, to the issue of how conscious thought and reflection affect unconscious processes and behavior. This issue is particularly interesting given that a variety of past findings have shown that conscious reflection can have detrimental effects on behavior. Specifically, conscious reflection can reduce the quality of choices and postchoice satisfaction (Wilson et al., 1993; Wilson & Schooler, 1991); it can produce suboptimal decisions (Dijksterhuis & Nordgren, 2006); it can overshadow adaptive memory processes (Schooler & Engstler-Schooler, 1990). In addition, conscious reflection hardly seems to help people predict what they will truly enjoy in the future (Gilbert & Wilson, 2009). At best, conscious processes seem to produce outcomes that are neither better nor worse than the outcomes produced by unconscious processes. More recently, though, proponents of conscious thought have started to point out the beneficial ways in which conscious thought affects behavior, often by modulating unconscious processes (e.g., Baumeister, Masicampo, & Vohs, 2011).

We suggest that mindful attention offers a further benefit of conscious thought. Rather than constituting a classic form of explicit deliberation to reach a certain goal or decision, however, mindful attention constitutes a different form of metaconsciousness or meta-awareness (Winkielman & Schooler, 2011) that focuses on the nature of thought itself. Rather than trying to suppress or change the mental experience to achieve a certain state, as in emotion regulation (e.g., suppression, reappraisal; Gross, 1998), mindful attention simply involves becoming aware of one's thoughts and their transient nature, accepting the flow of mental events that arise and dissipate (Lutz, Slagter, Dunne, & Davidson, 2008).

Training this perspective systematically can help one see that even the most troubling thoughts are mental states that dissipate sooner or later. Indeed, mindful attention to one's thoughts is a crucial part of mindfulness-based clinical interventions, which are particularly helpful for disengaging from negative thoughts and rumination, for example, as they occur in depression (Frewen, Evans, Maraj, Dozois, & Partridge, 2008; Hargus, Crane, Barnhofer, & Williams, 2010; Teasdale, 1999; Teasdale et al., 2002). Our current work shows that not just troubling thoughts but also hedonic thoughts lose their grip on our preferences and behavior once viewed from this perspective.

Conclusion

Humans appear to have a unique ability for the simulation of nonpresent events. While this ability may often be highly useful when understanding the past and guiding future behavior, it may also make people miserable when they get stuck ruminating about difficult events or when they cannot stop thinking about desires that lead to unhealthy results. Interestingly, however, people also seem to have a latent ability to return from such alternative realities by seeing them as mere thoughts and disengaging from their content. The current research suggests that this skill can be activated in a simple 12-min training and thus does not appear to always require extensive meditation training. Because we all appear to have the basic ability to view thoughts as simulations of nonpresent events, we always have the potential of returning to the present, being content in the simplicity of the moment.

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