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Do drives drive the train of thought?—Effects of hunger and sexual arousal on mind-wandering behavior☆

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ABSTRACT

Physiological needs that are currently unfulfilled are known to affect human cognition and behavior. The present study investigates whether and how the temporary activation of two primary physiological needs, namely hunger and sexual arousal, influence both the frequency and the contents of mind-wandering episodes. To induce hunger, one group of participants fasted for a minimum of five hours whereas another group of participants was exposed to audio material with explicit sexual content to provoke sexual arousal. Both groups as well as an additional control group, which had not received hunger instructions and had not been exposed to arousing material of any kind beforehand, performed a reading task during which mind wandering was assessed using a standard experience-sampling method. Results showed that acute hunger but not elevated sexual arousal renders the occurrence of mind-wandering episodes more likely. Induction of both hunger and sexual arousal rendered the occurrence of need-related off-task thoughts more likely and changed time orientations of mind wandering. The present findings are well in line with the assumption that unfulfilled needs regularly achieve cognitive priority and extend the cognitive-priority idea to self-generated thoughts.

1. Introduction

Physiological needs, such as thirst, hunger, or sexual desire are considered innate biological underpinnings of motivational states in humans (Kenrick, Griskevicius, Neuberg, & Schaller, 2010). Drive Reduction Theory states that needs which are currently not satisfied constitute behavioral drives working towards their satisfaction (Hull, 1943). According to Maslow's (1943) seminal work on the hierarchy of human needs, physiological needs (or drives) form the base of the need pyramid. More recent versions of the need pyramid suggest somewhat different pyramid structures and consider additional need levels such as "affiliation" and "parenting." Nevertheless, immediate physiological needs remain the pyramid base also in the updated versions, implying that physiological needs will receive *cognitive priority* whenever they remain unfulfilled (Kenrick et al., 2010). Similarly, based on need-related changes in neural activation patterns, it has been argued that unfulfilled needs cause primordial emotions that *dominate* the stream of consciousness (Denton, McKinley, Farrell, & Egan, 2009). More generally, self-regulation researchers consider unfulfilled needs special forms of desire which—because need satisfaction has a very high reward value for the individual—are especially likely to *hijack* cognitive capacity, at a cost to other currently to-be-pursued goals (Hofmann & Van Dillen, 2012).

In the present article, we further investigate the cognitive-priority assumption of physiological needs inherent to all these

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theoretical frameworks by examining how acute hunger and elevated sexual arousal affect mind wandering. Mind wandering describes the experience of one's attention drifting away from the current mental context, such as the text one is currently reading, to other contexts which are independent of current surroundings, such as food options for the upcoming lunch break (Smallwood & Schooler, 2015). Especially during reading, mind wandering has been shown to occur relatively frequently and to come at a cost for reading comprehension (Kopp, D'Mello, & Mills, 2015; Reichle, Reineberg, & Schooler, 2010; Unsworth & McMillan, 2013; see also Schooler et al., 2014, for an overview). It is important to note that Unsworth and McMillan (2013) found that the motivation to perform well in a reading task was also negatively associated with mind wandering frequency—a finding in favor of our assumption that motivational factors, such as currently predominant physiological needs, may influence mind-wandering behavior. Furthermore, it has been shown that personal states such as variations in mood (Smallwood, Fitzgerald, Miles, & Phillips, 2009), current concerns (Stawarczyk, Majerus, & D'Argembeau, 2013), stress level (Engert, Smallwood, & Singer, 2014; Vinski & Watter, 2013), blood alcohol (Sayette, Reichle, & Schooler, 2009), and mindfulness (Banks, Welhaf, & Srour, 2015) affect mind wandering considerably. However, little is known about whether and how mind wandering is affected by the activation of physiological needs (but see Sayette, Schooler, & Reichle, 2010, for a study on how mind wandering is affected by nicotine cravings).

With regard to the cognitive underpinnings of mind-wandering behavior, it has been shown that mind wandering tends to be negatively associated with working-memory capacity as assessed with complex span tasks that are considered indicators of attentional control (McVay & Kane, 2012). Although more recent research suggests that the relationship between mind wandering and attentional control is more complex and also depends on various moderating factors, such as current task demands (Rummel & Boywitt, 2014), mind-wandering contents (Smallwood & Andrews-Hanna, 2013), or individual differences in daydreaming styles (Marcusson-Clavertz, Cardena, & Terhune, 2016), it seems plausible that executive functions play a central role for preventing task-unrelated thoughts from occurring (Kane & McVay, 2012). Importantly, states of acute hunger after short-term fasting have been shown to often temporarily reduce executive control as indexed by *set-shifting* performance (e.g., Piech, Hampshire, Owen, & Parkinson, 2009; see also Benau, Orloff, Janke, Serpell, & Timko, 2014, for an overview of fasting effects on cognitive performance). Although the relationship between sexual arousal and basic cognitive functions is less well studied, there is, at least, one study showing that sexual-arousal inductions can hamper performance in a *4-back* working-memory task (Laier, Schulte, & Brand, 2013). Additionally, it has been shown that both men and women are less likely to inhibit risky behavior under sexual arousal (Skakoon-Sparling, Cramer, & Shuper, 2016). In the light of these findings, we assume that states of acute hunger or elevated sexual arousal will affect mind-wandering behavior during reading.

Arguably, hunger and sexual arousal are physiological need states of quite different nature (e.g., most obviously, not eating can lead to death whereas unsatisfied sexual arousal is not life threatening). Nevertheless, both need types are very likely to occupy mental capacity when they remain unfulfilled (Denton et al., 2009). Further, hunger as well as sexual-arousal states are assumed to reflect short-term desires that are likely to acquire cognitive priority and interfere with more long-term goals, according to recent self-regulation theories (Hofmann & Van Dillen, 2012). Finally, need satisfaction can be considered as quite rewarding for most healthy individuals in both cases, suggesting that activation of both need types can impact motivation. Thus, we decided to investigate both hunger and sexual-arousal influences on mind wandering within a single experiment in order to also investigate the generalizability of the cognitive-priority hypothesis.

Smallwood and Schooler (2015) recently pointed out that mind-wandering researchers should not only consider the frequency of mind-wandering episodes but also their content and the level of awareness of mind-wandering. They especially stressed the psychological implications of taking the time perspective of mind wandering into account (e.g., past vs. future-oriented mind wandering). Large parts of future-oriented mind-wandering episodes, for instance, are self-reflective and devoted to personal future goals whereas past oriented mind wandering is less structured (Smallwood et al., 2011; Stawarczyk, Cassol, & D'Argembeau, 2013) and tends to go hand in hand with unhappiness (Smallwood & O'Connor, 2011; Spronken, Holland, Figner, & Dijksterhuis, 2016). Additionally, it has been shown that lacks of mind-wandering awareness are especially harmful to performance on currently ongoing tasks (Smallwood, McSpadden, & Schooler, 2007; Zedelius, Broadway, & Schooler, 2015). Consequently, we formulated our research hypotheses with regard to the frequency, the content, and the time-orientation of mind-wandering episodes and also tested for group differences in mind-wandering awareness.

In the present study, we had two need-induction conditions and a control condition: Hunger-condition participants fasted for at least five hours before they performed a reading task, sexual-arousal-condition participants listened to erotic stories before reading. Control-condition participants did not receive specific instructions regarding food intake and, just as the hunger-condition participants, listened to neutral stories before reading. We expected the frequency of mind-wandering episodes to increase under acute hunger and elevated sexual arousal relative to the control condition. We also considered mind-wandering contents more likely to be need-related after need activation. We assumed these thoughts to be need specific—that is, food-related thoughts should be more likely under hunger conditions and sex-related thoughts under sexual-arousal conditions. Finally, we expected a need-induced change in mind-wandering time-perspective, meaning we expected future-oriented mind wandering to be less centered on distant future goals and more so on the proximate goal of satisfying one's physiological needs.

2. Method

2.1. Participants and study design

The alpha-level was set to 0.05 (two tailed) for all analyses. Sample-size was determined as $N \geq 126$ based on an a pri-ori power analysis with the software G*power (Faul, Erdfelder, Lang, & Buchner, 2007), aiming to detect medium-sized effects ($\eta_p^2 = 0.06$),