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Brief article

Driven to distraction: A lack of change gives rise to mind wandering

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ABSTRACT

How does the dynamic structure of the external world direct attention? We examined the relationship between event structure and attention to test the hypothesis that narrative shifts (both theoretical and perceived) negatively predict attentional lapses. Self-caught instances of mind wandering were collected while 108 participants watched a 32.5 min film called *The Red Balloon*. We used theoretical codings of situational change and human perceptions of event boundaries to predict mind wandering in 5-s intervals. Our findings suggest a temporal alignment between the structural dynamics of the film and mind wandering reports. Specifically, the number of situational changes and likelihood of perceiving event boundaries in the prior 0–15 s interval negatively predicted mind wandering net of low-level audiovisual features. Thus, mind wandering is less likely to occur when there is more event change, suggesting that narrative shifts keep attention from drifting inwards.

1. Introduction

We frequently find ourselves thinking about things other than what we were trying to focus on. Our minds spontaneously self-generate thoughts that are decoupled from the external environment. For instance, we think about our internal state (e.g., feeling hungry), current and future concerns (e.g., having to do something later), and our past (e.g., ruminating) (Smallwood & Schooler, 2015). The general trait to engage in self-generated thoughts has been associated with creativity and other positive outcomes (Mooneyham & Schooler, 2013). However, experiencing one type of self-generated thought (i.e., mind wandering) while completing tasks that require cognitive engagement has been consistently linked with lower task performance (see meta-analysis by Randall, Oswald, & Beier, 2014). One reason for this negative relationship is that mind wandering engenders a form of perceptual decoupling (Mills, Graesser, Risko, & D'Mello, 2017; Smallwood, Beach, Schooler, & Handy, 2008), manifested by a breakdown between the external environment and internal thoughts. But how does the dynamic unfolding of the external environment constrain or facilitate mind wandering? We addressed this question by exploring the relationship between the unfolding of a dynamic stimulus (a film) and the occurrence of mind wandering using indices of stimulus structure: the amount of *situational change* and the likelihood of perceiving *event boundaries*. By doing so we take initial steps towards integrating two disparate literatures—event cognition and self-generated thought.

Our work is grounded in theoretical perspective that we segment the world into discrete events, which guide our perception and encoding of ongoing activity (Radvansky & Zacks, 2014; Zacks & Tversky, 2001; Zacks et al., 2001). The perception of boundaries between events (i.e. one event ending and another beginning) is related to changes in space, time, and causality as well as changes in characters, their interactions, and their goals (Radvansky & Zacks, 2014; Zacks, Speer, & Reynolds, 2009; Zwaan & Radvansky, 1998). We hypothesize that change in event structure is related to less mind wandering as such shifts might direct attention to stimulus processing (Swallow, Zacks, & Abrams, 2009) and mental model updating (Magliano, Zwaan, & Graesser, 1999). We tested this hypothesis by investigating whether event structure predicted mind wandering in a narrative film comprehension task. In doing so, this study is the first to shed light on whether and how the structural dynamics of ongoing events direct attentional focus to external stimuli and away from self-generated thoughts—as measured by mind wandering—over time.

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2. Data analysis

2.1. Mind wandering data

2.1.1. Participants

We obtained mind wandering data from 108 college students who participated in a study investigating the occurrence of mind wandering while watching a narrative film (see Kopp, Mills, & D'Mello, 2015). Students attended either a private Midwestern university (n = 65) or a public university in the southern United States (n = 43), and participated for partial course credit (66% female; average age = 20.1 years). All 108 participants were included in the analyses.

2.1.2. Film

Participants viewed the narrative film *The Red Balloon* (Lamorisse, 1956). This short (32.5 min) French film (with English subtitles) is about a young boy in Paris who finds a red balloon that follows him wherever he goes. This film has been widely used in event perception research because it has many situational changes and little dialogue (Zacks, Speer, Swallow, & Maley, 2010; Zacks et al., 2009). Furthermore, because it is an older film, the likelihood that college-age participants would be familiar with it is low.

2.1.3. Procedure

Participants were randomly assigned to a prior knowledge or control condition. These conditions were part of a larger research project aimed at establishing whether prior knowledge suppresses mind wandering (Kopp et al., 2015). Before participants were informed that they would watch *The Red Balloon*, they either read a text version of *The Red Balloon* (Lamorisse, 1956) (prior knowledge, n = 56) or an unrelated story (*Bernie the Early Bloomer*, Smith, 1999) (control, n = 52).

We used self-caught mind wandering reports rather than periodical thought probing. The latter can inadvertently miss instances of mind wandering, that do not correspond to a probe. Self-caught reporting on the other hand captures each instance that the participant is aware of. Importantly, it preserves the temporal relationship between stimulus unfolding and mind wandering, which is critical for our analyses. Participants received the following instructions:

> "Your primary task is to watch the movie to understand the plot. At some points during the movie, you may realize that you have no idea what you just saw. Not only were you not thinking about the movie, you were thinking about something else altogether. This is called "zoning out". If you catch yourself zoning out at any time during the movie, please indicate what you are thinking about at that moment during the movie. For example, when zoning out, if you are thinking about the task itself (e.g., how long is the movie, this movie is very interesting) or how the task is making you feel (e.g., curious, annoyed) but not the actual content of the movie, please press the key that is labeled TASK. Or, if you are thinking about anything else besides the movie (e.g., what you ate for dinner last night, what you will be doing this weekend) please press the key that is labeled OTHER".

As illustrated by these instructions, participants reported zoning out whenever they found themselves focusing on content-unrelated thoughts, and had no idea of what just happened in the film. "Task" and "Other" responses were therefore conceptually similar in that both reflect self-caught instances of zoning out. They also displayed similar negative relationships with event measures (defined below; see Supplemental Table 1), so we combined them into one mind wandering measure to increase reliability.

As expected, there were more mind wandering reports in the prior knowledge condition (number of mind wandering reports: M = 9.77, SD = 13.3, range = 0–70) compared to the control condition (M = 13.8, SD = 14.9, range = 0–54). Given this difference, we included condition as an interaction term to test whether the relationship between mind wandering and event change is moderated by prior knowledge.

Data for each participant were aggregated into 5 s time windows (as commonly done in event segmentation research; see e.g., Kurby, Asiala, & Mills, 2013; Zacks et al., 2009). This resulted in 390 windows per participant, each containing whether the participant reported mind wandering during that 5 s interval. Data can be found in the Supplementary materials.

2.2. Event change data

We computed measures of event change using theoretical coding and human event segmentation data. Our first measure consisted of situational change coding (from Zacks et al., 2009), which reports (for each video frame) whether there was a change in causal structure, character, goal, object, space or time. The second measure used event segmentation data from 41 college students (Zacks et al., 2009) who reported any perceived boundaries in the film at a coarse and a fine grained level. Perceived boundaries were defined as instances where "one meaningful unit of activity had ended and another had begun" (Zacks et al., 2009, p. 316; cf. Newtson, 1973). For coarse-grained segmentation, participants were instructed to "identify the largest units they found meaningful"; for fine-grained segmentation, they were asked to "identify the smallest units that were meaningful to them" (Zacks et al., 2009, p. 316).

We counted the number of reports of situational change, fine grained, and coarse grained boundaries for each 5 s time window. For the situational change measure, we added all changes in the window (cf. Magliano, Miller, & Zwaan, 2001) and then z-scored the measure. For the human segmentation measure, we first z-scored the coarse and fine grained segmentation measures, and then averaged them. This was done to capitalize on the convergence between coarse and fine grained segmentation (r = 0.575) and is justified due to an overlap in the neural processes that underlie both grain sizes of segmentation (Zacks et al., 2001). We also computed the amount of visual (the average frame-level RGB change) and auditory (the average frame-level volume change) change per 5-s time window to control for these low level perceptual features.

3. Results

We assessed the relationship between mind wandering and event change by fitting mixed effects logistic regression models to predict the binary occurrence of mind wandering in each 5 s window from the event change measures. The measures of low level visual and auditory change were added as control variables. Condition (prior knowledge or not) was added as an interaction term with event change. Participant identity was added as a random intercept.

To explore temporal relationships, we repeated the analysis after lagging or leading the mind wandering time series. This resulted in seven additional analyses, representing the amount of event change in the 25 s before and 10 s after each 5 s time window (divided in seven 5 s time windows, so 25–30 s before and 10–15 s after a time point in each window). Previous work has shown that people experience shifts in thought content every 5–30 s (Klinger, 1978), so we did not expect event change beyond 30 s in the past to be predictive of current thoughts. We did not expect to find a strong predictive relationship between event change in future time windows and mind wandering. Therefore, to avoid spurious relationships, we did not model time points beyond 10–15 s into the future. Bonferroni correction was used to correct for multiple comparisons, resulting in an alpha of 0.00625 (eight time windows per event change variable).

The results, shown in Fig. 1, demonstrated that event structure negatively predicted the occurrence of mind wandering. More event change in the current (i.e., t = 0) time window and two preceding (t − 5 and t − 10) time windows was related to a lower probability of

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