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More mind wandering, fewer original ideas: Be not distracted during creative idea generation

Ning Hao [a,*], Mengxia Wu [a], Mark A. Runco [b], Jeremy Pina [b]

[a] School of Psychology and Cognitive Science, East China Normal University, Shanghai, China
[b] American Institute for Behavioral Research and Technology, San Diego, CA, USA

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ABSTRACT

Several studies suggest that mind wandering (MW) benefits creativity when the MW occurs in the incubation period of creative problem solving. The aim of present study was to examine the effects of MW that occurs in the course of creative idea generation. Participants received an Alternative Uses Task (AUT) and were asked to generate ideas for 20 min. Their MW frequencies as time passed were measured by means of probe-caught MW. Comparisons of the AUT performances of high and low MW groups revealed that greater MW was associated with lower fluency and originality scores on the AUT. Furthermore, the high MW group showed greater MW as time passed, while the low MW group's MW was steady during the course of idea generation. Accordingly, the originality of idea generation decreased with time passing for the high MW group but was steady for the low MW group. The findings suggest that the MW during the course of creative idea generation is negatively related to creativity, perhaps because the control processes involved in idea generation are impaired by the mind wandering.

1. Introduction

Mind wandering (MW) refers to the occurrence of stimulus-independent and task-unrelated thoughts (Smallwood, 2013; Smallwood & Schooler, 2006; Stawarczyk, Majerus, Catale, & D'Argembeau, 2014; Stawarczyk, Majerus, Maj, Van der Linden, & D'Argembeau, 2011a; Stawarczyk, Majerus, Maquet, & D'Argembeau, 2011b). As one of the most ubiquitous mental activities (Mooneyham & Schooler, 2013), MW represents a substantial part (15%–50%) of thinking time when working on a particular task; on average 30% of people's conscious experience belongs to mind wandering (Kane et al., 2007; Killingsworth & Gilbert, 2010; Mason et al., 2007; Smallwood, Obonsawin, & Heim, 2003; Song & Wang, 2012). Numerous studies have demonstrated the negative impact of MW on various types of cognitive activity (e.g., reading, sustained attention, working memory, and intelligence testing) (for reviews see Mooneyham & Schooler, 2013). However, some research has suggested that there are benefits of MW for creative cognition. Greater MW could, for instance, be associated with enhanced creativity.

A reasonable hypothesis about the benefits of MW for creativity is suggested by a meta-analysis on incubation effects in creativity (i.e., positive effects of a break on later creative problem solving). Sio and Ormerod (2009) concluded that incubation effects tend to be larger in studies where individuals were engaged in low as compared to high demanding interpolated tasks or a rest task. This was supported by an empirical study (Baird et al., 2012), which directly compared the effects of varying cognitive demands of interpolated tasks within a single experiment. The results showed that a choice-reaction-time task (a low-demanding task) in the incubation period improved creative performance far more than did a one-back working memory task (a highly demanding task) and a rest task (Baird et al., 2012). According to the *Explicit–Implicit Interaction* (*EII*) *model* of creative thinking (Helie & Sun, 2010), incubation involves unconscious and implicit associative processes that demand little attention capacity, rather than conscious, explicit, and rule-governed processes. Empirically, low demanding tasks facilitated MW and prevented focused concentration (Mason et al., 2007; McKiernan, D'Angelo, Kaufman, & Binder, 2006; Smallwood, Nind, & O'Connor, 2009; Smallwood & Schooler, 2006). This may in turn stimulate remote activation in semantic networks during an incubation period, and could thus improve later creative performance (Baird et al., 2012; Sio & Ormerod, 2009). Note, however, that the positive effects of MW on creativity have only been observed when MW occurred in the incubation period (Baird et al., 2012). An interesting question arises: Does the MW that occurs during the course of creative idea generation enhance creativity as well?

Creative idea generation is, according to the *controlled-attention theory* of creative cognition (Beaty, Silvia, Nusbaum, Jauk, & Benedek, 2014), a top-down process that needs the involvement of executive functions (see also Runco, 1994). Previous studies revealed that some control processes affect creative performance, such as fluid intelligence (Benedek, Franz, Heene, & Neubauer, 2012a; Jauk, Benedek, Dunst, & Neubauer, 2013; Jauk, Benedek, & Neubauer, 2014) and working memory capacity

* Corresponding author at: School of Psychology and Cognitive Science, East China Normal University, No. 3663, North Zhong Shan Road, Shanghai 200062, China.
E-mail address: nhao@psy.ecnu.edu.cn (N. Hao).

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(Chein & Weisberg, 2014; De Dreu, Nijstad, Baas, Wolsink, & Roskes, 2012; Lee & Therriault, 2013). Recent studies testified that executive function ("inhibition") plays important roles in creative thinking (Benedek, Jauk, Sommer, Arendasy, & Neubauer, 2014a; Edl, Benedek, Papousek, Weiss, & Fink, 2014; Limb & Braun, 2008). These findings are in line with the results of Electroencephalography (EEG) studies of creativity. Performance of divergent thinking (DT) tasks, for example, is associated with stronger alpha synchronization than the performance of more "convergent" or intelligence-related tasks (Bazanova & Aftanas, 2008; Fink, Benedek, Grabner, Staudt, & Neubauer, 2007; Fink et al., 2009), reflecting the absence of stimulus-driven, external bottom-up stimulation and, thus, a form of top-down control of the brain (Benedek, Bergner, Koenen, Fink, & Neubauer, 2011; Benedek, Schickel, Jauk, Fink, & Neubauer, 2014b; Fink, Schwab, & Papousek, 2011; Handel, Haarmeier, & Jensen, 2011; Jensen & Mazaheri, 2010; Klimesch, Sauseng, & Hanslmayr, 2007; von Stein & Sarnthein, 2000). In short, several lines of research support the important roles of executive functions in creative idea generation.

Notably, there are also close relationships between MW and executive function. The *perceptual decoupling theory* of mind wandering (Schooler et al., 2011; Smallwood, 2010, 2013; Smallwood & Schooler, 2006) holds that MW results from a redirection of attentional resources from the task at hand to the processing and maintenance of internal thoughts (Levinson, Smallwood, & Davidson, 2012). In this framework, MW is a resource-consuming activity that competes for control resources with the target task. As a result, MW should impair the performance of the cognitive activities that require large amount of control resources. By contrast, the *control failure theory* (Kane & McVay, 2012; McVay & Kane, 2010a,b; Stawarczyk et al., 2014) suggests that MW does not recruit attentional control resources; instead, the occurrence of MW reflects a temporary breakdown in control processes that are involved in maintaining task focused attention. In this vein, the occurrence of MW absolutely damages the performance on the target task. So, given that executive functions play important roles in creative idea generation, it is predicted that the MW during the course of creative idea generation may have negative effects on creativity, unlike the positive effects of the MW in the incubation period on creativity (Baird et al., 2012).

In the present study, we aimed to examine the effects of the MW that occurs in the course of creative idea generation. Participants were asked to work on an Alternative Uses Task (AUT) problem (Guilford, 1967) for 20 min. This comparatively long period of performance allowed assessment of the changes of MW frequency with time passing. The long period should also benefit original ideation and the discovery of remote associates (Runco & Acar, 2012). The MW frequency during the course of idea generation was measured by means of the probe-caught MW, as in the previous studies (Hu, He, & Xu, 2012; Levinson et al., 2012; Stawarczyk et al., 2014). Participants were then divided into high and low MW groups based on their MW frequencies; afterwards, the creative performances of these two groups were compared. Participants' self-reported MWs were measured by two questionnaires, which were used as an additional means for assessing MW levels (see details in the Method). To check whether inserting thought probes interfered with creative performance, participants in control group were asked to solve the same AUT problems without thought probes being inserted into the course of idea generation. The performance of the control group was then compared with that of the experimental group.

The main hypotheses were as follows. First, low MW individuals would perform better on AUT problem (e.g., generating more original answers) than high MW individuals. This follows from research showing that MW consumes the control resources involved in the target problem or indicates a failure of executive control on the target problem. Second, considering that higher MW individuals (i.e., with low control abilities) are less efficient in maintaining the attention focused on ongoing tasks (McVay & Kane, 2009, 2010a), we predicted that the MW frequency during the course of idea generation would increase with time passing for the high MW group, while remaining steady for the low MW group. Third, consistent with the change tendencies of MW frequency proposed in the second hypothesis, we predicted that originality on the AUT would decrease as time passed for the high MW group, but would remain steady for the low MW group.

2. Method

2.1. Participants

Ninety healthy college students of various academic disciplines participated individually in the study. They were all native Chinese speakers. Data from two participants were discarded due to floor performance and one was excluded for technical errors. The final sample comprised of 87 participants (12 males, 75 females) in the age range between 18 and 25 years ($M = 21.16$, $SD = 2.13$). There were 28, 29, and 30 participants in the high MW, low MW, and control groups, respectively. An ANOVA revealed that the mean age of the three groups did not differ from each other, nor did the mean years of education. Moreover, chi square analysis showed that there was no difference in the gender ratio among the three groups. Participants gave written informed consent prior to the experiment, and received approximately 5 US dollars for their participation after the experiment. The protocol of the experiment was approved by the Institutional Ethics Committee at East China Normal University.

2.2. Experimental task

The Alternative Uses Task (AUT; Guilford, 1967) was used as the target task. It requires respondents to generate as many unusual or original uses as possible for common objects, such as a paperclip ("making a ring", "cleaning fingernails"). The AUT is a well-established test of creative potential (Guilford, 1967; Runco, 1991, 1999; Runco & Mraz, 1992). Performance on this task has been demonstrated to be a reliable predictor of actual, real-world creative performance (Runco & Acar, 2012).

2.3. Experimental procedure

A between-subject design was used. Participants were asked to solve an AUT problem (i.e., "chopstick") during the 20 min experimental condition (with thought probes inserted) or the control condition (without thought probes). In the instruction about how to solve the AUT problem, participants were encouraged to try their best to produce ideas that would be thought of by no one else, as suggested by Harrington (1975); Runco (1999), and Torrance (1995).

Participants' performance on the AUT problem was recorded by a computer. Specifically, a fixation was shown on the screen, which lasted for 800 ms, signaling the start of experiment. Afterwards, the item of "chopstick" was presented on the screen. Participants were asked to press the key of "Enter" once they generated an idea, and then an input box appeared on the screen in which participants input the idea. Thus, the idea and the time point when it was generated were recorded by the software. After inputting the idea, participants pressed the key of "Enter" once more, and then the word of "chopstick" appeared on the screen again. Participants repeated such an operation until the experiment finished.

The 30 participants of the control group were instructed to work on the AUT problem and followed the aforementioned procedure. But for the 60 participants of the experimental group, a total of 12 thought probes were inserted into the period of 20 min (i.e., 3 probes per 5 min) while they worked on the AUT problem. The thought probes were inserted with a pseudorandom distribution of time points in each of four 5-min epochs to avoid expectancy effect. The probes were presented on another computer. Specifically, after a "beep" there was a thought probe: "What were you thinking just now?" Participants pressed "1" if they had been thinking task-related thoughts, that is, more original uses of "chopstick". Conversely, participants pressed "2" for task-unrelated thoughts (e.g., about watching a film tonight). Thus