Learning and Individual Differences xxx (2016) xxx–xxx

Contents lists available at ScienceDirect

Learning and Individual Differences

journal homepage: www.elsevier.com/locate/lindif

Examining the influence of mind wandering and metacognition on creativity in university and vocational students☆

David D. Preiss *, Diego Cosmelli, Valeska Grau, Dominga Ortiz

Escuela de Psicología, Pontificia Universidad Catolica de Chile, Santiago, Chile

ARTICLE INFO

Article history:
Received 17 March 2015
Received in revised form 19 July 2016
Accepted 27 July 2016
Available online xxxx

Keywords:
Mind wandering
Metacognition
Creativity
Reading
Intelligence

ABSTRACT

We examined the relationship between mind wandering, metacognition and creativity in 116 university and 117 vocational Chilean students. They took a test of divergent thinking, a test of creative problem solving and a fluid intelligence test. Additionally, they answered mind wandering, metacognition, and reading difficulties self-report scales. We performed multivariate analyses of variance, hierarchical regression models and tests of moderation. Fluid intelligence predicted performance on both creativity tests. The reading difficulties scale predicted the test of creative problem solving but not the test of divergent thinking. Mind wandering significantly predicted both creativity measures above the contribution of fluid intelligence and reading difficulties. Metacognition did not significantly predict the measures of creativity. The type of school where the participants studied moderated the effect of metacognition on creativity. We discuss the implications of these results for research and assessment on mind wandering, metacognition and creativity.

1. Introduction

During the last decade there has been an increased interest in investigating the nature of mind wandering, its biological foundations and its impact on cognitive processing (Smallwood & Schooler, 2006; Smallwood, Schooler, & Fiske, 2015). Despite these advances, the educational consequences of mind wandering are yet to be fully recognized and explored (Immordino-Yang, Christodoulou, & Singh, 2012). Most of the educational research on mind wandering has emphasized its negative consequences, especially on academic tasks requiring a strong attentional component (Smallwood, Fishman, & Schooler, 2007). That is not surprising. School learning is highly dependent on focused and sustained attention and mind wandering is "a situation in which executive control shifts away from a primary task to the processing of personal goals" (Smallwood & Schooler, 2006, p. 946). When mind wandering, the student's attentional focus shifts away from those stimuli relevant for learning or assessment.

Since mind wandering is more frequent during instruction than other activities, several studies have explored the impact of mind wandering on learning from a lecture (Szpunar, Moulton, & Schacter, 2013). As the time passes during a lesson, mind wandering increases and memory for content diminishes (Risko, Anderson, Sarwal, Engelhardt, & Kingstone, 2012). And as the frequency of self-reported task unrelated images and thoughts augments during lectures, students display worse academic performance in course examinations (Lindquist & McLean, 2011). Learning from a lecture is not the only educational process affected by mind wandering. It negatively impacts performance on standardized academic achievement tests (Mrazek et al., 2012), affects the ability to build a mental model of a narrative (Smallwood, McSpadden, & Schooler, 2008) and impairs reading comprehension, especially of difficult texts (Feng, D'Mello, & Graesser, 2013). Specifically, the detrimental effects of mind wandering on reading are heightened in situations where participants lack comprehension-monitoring strategies (Smallwood et al., 2007).

This view of mind wandering as harming educational performance is consequence of a bias associated with the study of cognition in terms of information processing in analytical tasks, which is characteristic of the study of human abilities (Sternberg, 1999; Sternberg & Grigorenko, 2000). As noted below, this emphasis on the impact of mind wandering on analytical tasks ignores its deep neurobiological roots, its prevalence, and its role in creativity (Baird et al., 2012). Depending on both the nature of the task and the individuals' meta-cognitive and regulatory capacities, mind wandering not only has costs but also potential benefits (McMillan, Kaufman, & Singer, 2013; Schooler et al., 2011). Unless a more diverse picture of relevant educational tasks and activities considered, our knowledge of the impact of mind wandering will remain

☆ This research was supported by grant FONDECYT 1130836 from CONICYT. We acknowledge and thank help from Catalina Mourgues in the development of the measures and from Héctor Carvacho in data analysis.

* Corresponding author at: Escuela de Psicología, Pontificia Universidad Catolica de Chile, Av Vicuña Mackenna 4860, Macul, Santiago 7820436, Chile.
E-mail address: davidpreiss@uc.cl (D.D. Preiss).

http://dx.doi.org/10.1016/j.lindif.2016.07.010
1041-6080/

limited. In order to contribute to the growing literature addressing its educational consequences, this study investigates the impact of mind wandering on divergent thinking and creative problem solving. Additionally, it assesses whether this impact is similar or opposite to that of metacognition.

1.1. Mind wandering and creativity

Mind wandering is not a monolithic phenomenon with purely negative consequences. Thus, a number of researchers have begun to uncover positive aspects of this process (e.g., Baird, Smallwood, & Schooler, 2011; Baird et al., 2012; Cosmelli & Preiss, 2014; Feng et al., 2013; Mooneyham & Schooler, 2013). Emphasis on the constructive dimension of mind wandering is not new. It was initially highlighted by work advanced during the 60s and 70s by Jerome Singer and his colleagues (McMillan et al., 2013). Today, three lines of research show that mind wandering is not simply a disruptive process or a mere epiphenomenon of mental life. Quite the contrary, they show that it plays an adaptive psychological role. These include work on its neurobiological roots, its resilience in everyday life, and its positive consequences on creativity.

First, substantial evidence points to the deep neurobiological roots of mind wandering. Researchers have described what is now known as the brain's default network, a baseline default mode of brain function during the awake but resting state that shows reduced activity during specific goal-directed behaviors (Gusnard, Akbudak, Shulman, & Raichle, 2001; Raichle & Snyder, 2007; Raichle et al., 2001). The activity of this brain network correlates with self-referential emotionally charged thoughts (Gusnard et al., 2001), is associated to the evaluation of possible future scenarios (Buckner, Andrews-Hanna, & Schacter, 2008) and is increased during periods of mind wandering (Gusnard et al., 2001). Furthermore, it has been observed that neuronal connectivity between these regions correlate positively with general intelligence and creativity (Takeuchi et al., 2011a). Additionally, more creative individuals maintain a higher level of activity in the posterior regions of the brain network when performing working memory tasks (Takeuchi et al., 2011b). Second, mind wandering is extremely resilient in a diversity of conditions, both everyday and experimental. The seminal studies of daydreaming (McMillan et al., 2013; Pope & Singer, 1978; Singer, 1974, 1975) as well as more recent work (Kane et al., 2007), suggest that people are in a state of mind wandering a large part of their waking time. Mind wandering and thoughts unrelated to the task never disappear in experimental conditions where participants must perform complex or demanding tasks (Christoff, Gordon, Smallwood, Smith, & Schooler, 2009; McVay & Kane, 2012).

Yet, “not all mind wandering is created equal” (Seli, Carriere, & Smilek, 2015, p. 750). There are individual differences concerning mind wandering's characteristic contents and these differences are relevant to assess how adaptive mind wandering is. Singer (1975), using the Imaginal Processes Inventory (McMillan et al., 2013), classified mind wandering in three types: two more negative, focused either on tortured self-examination or anxious self-doubting, and one more positive, reflecting an acceptance of inner experience and elaborated imagery and fantasy, probably more related to creativity. A more recent distinction is that between intentional (or deliberate) versus unintentional (or spontaneous) mind wandering (Seli et al., 2015). The former is characteristic of creative work: artists and creative writers are prone to engage in volitional daydreaming (McMillan et al., 2013). Not surprisingly, artists are more open to fantasy and imagination than non-artists (Feist, 1999) and guided imagery has been used to enhance creativity (Singer & Barrios, 2009). Still, not only deliberate mind wandering is linked to creativity. Spontaneous mind wandering is associated to creativity, particularly during the *incubation* of new ideas (Baird et al., 2012). And not only professional creators engage in incubation processes: “people spend more of their daily lives engaged in an incubation-like state than they probably realize: People typically are only consciously aware of one-half of their mind wandering episodes. This suggests an interesting possibility that creativity researchers might study further: these brief episodes of mind wandering may provide the mind with moments of ‘mini incubation’ that contribute to creative thought, by temporarily taking conscious attention away from the problem at hand and providing a brief opportunity for insight to occur” (Sawyer, 2011, p. 146). The positive impact of mind wandering on incubation depends on variables such as the type of the task and the cognitive load. A meta-analysis performed on 117 studies revealed that incubation periods of high or low cognitive demand might have different effects depending on the task type. The incubation process benefits more divergent thinking tasks than linguistic or visual insight tasks. Additionally, longer periods of incubation with a low cognitive load are more beneficial than brief periods of incubation or those involving a demanding task (Sio & Ormerod, 2009). Indeed, participants that go through an incubation stage specially designed to trigger mind wandering have a better performance on creative tasks than those who perseverate in the problem or just rest during that same period (Baird et al., 2012). Yet, there is contradictory evidence. A recent study failed to replicate the relation between probe-caught mind wandering and creativity. Using incubation tasks of varying demand, it found that the rates of self-reported task unrelated thought during those tasks were not correlated with post incubation divergent thinking scores (Smeekens & Kane, 2016).

1.2. Metacognition, mind wandering and creativity

Mind wandering has been related to the concept of meta-awareness or metacognitive awareness, which can be defined as “one's explicit knowledge of the current contents of thought” (Schooler et al., 2011, p. 321). Schooler et al. (2011) theorize that meta-awareness could help to regulate mind wandering and improve the regulation of conscious thought in three possible ways. First, meta-awareness could allow the identification of mind wandering episodes and, therefore, facilitate re-engagement with the primary task. Second, when a lapse of mind wandering finishes because of an external disruption or a low-level monitoring process, it could trigger an illusion of control. The individual realizes that mind wandering is taking place just before the interruption and, therefore, noticing the episode of mind wandering could produce an illusion of control. Third, when we realize we have been mind wandering we could engage in activities that enable us to have more control of our cognitive activity, such as taking a break from work or engaging in meditation. Although mind wandering and metacognitive awareness are related, not enough is known about how mind wandering impacts students with different metacognitive or regulatory capacities. Additionally, metacognition is related to meta-consciousness but is not exactly the same. Schooler (2002) proposes that, although metacognition may involve awareness, it often happens without awareness.

Specifically, research has distinguished three dimensions of metacognition: metacognitive knowledge, metacognitive experiences and metacognitive abilities (Efklides, 2006, 2008). Metacognitive knowledge refers to the declarative knowledge the subject has about him or herself and the others as cognitive subjects (e.g., how good I am at solving equations), tasks (e.g., types of equations and their particular processing requirements), strategies (e.g., what strategies are used to solve them and which are the most appropriate in specific contents) and goals (e.g., to perform well in a university admission test.) In turn, metacognitive experiences refer to the fact that the person is aware when she or he is processing a specific task. Finally, metacognitive abilities are related to procedural knowledge. They involve the deliberate use of strategies to control cognition, helping to regulate performance through monitoring problem solving during a task. All these dimensions

Please cite this article as: Preiss, D.D., et al., Examining the influence of mind wandering and metacognition on creativity in university and vocational students, *Learning and Individual Differences* (2016), http://dx.doi.org/10.1016/j.lindif.2016.07.010