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The relations between executive functions, media multitasking and polychronicity



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ABSTRACT

Excessive media multitasking has been associated in a series of laboratory studies, with deficits in executive functions. Given that the levels of laboratory and everyday functioning do not always correspond, it is unclear whether media multitasking is associated with limitations in everyday executive functions as well. The current study examined the relationships between media multitasking and ecological self-report measures of executive functions, attention and a measure of individual preference for multitasking. The results demonstrated that participants who reported more deficits with different aspects of everyday executive functions and attention were engaged more frequently in media multitasking. Media multitasking was correlated most strongly with limitations in self-monitoring, emotional control, planning, task monitoring and inattention. Additionally, individuals who reported more deficits in executive functions and attention also reported a higher preference for multitasking over single-tasking. Taken together, the present study demonstrates that frequent media multitasking is associated with deficits in many aspects of everyday goal-directed behavior. The results generalize previous findings to self-report ecological measures of executive functions, and associate media multitasking with impairments in additional yet unexplored aspects of executive functions.

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1. Introduction

Decades of research on dual-task processing have demonstrated that people are essentially limited in performing more than one task concurrently (Meyer & Kieras, 1997; Pashler, 1994; Welford, 1952). Given these limitations, it is surprising that performing multiple tasks concurrently (i.e., multitasking) has become so prevalent in recent years, especially while engaging with different forms of media (i.e., media multitasking) (Carrier, Cheever, Rosen, Benitez, & Chang, 2009; Rideout, Foehr, & Roberts, 2010). These puzzling observations have led a growing number of researchers to investigate the unique behavior of media multitasking, to characterize those who are more prone to it, and to explore the immediate and long-term effects of media multitasking on cognitive, emotional and social functioning.

The extent of media multitasking is related to media ownership, socio-demographic variables and emotional and cognitive factors (e.g., Becker, Alzahabi, & Hopwood, 2013; Carrier et al., 2009; Kononova & Chiang, 2015; Ophir, Nass, & Wagner, 2009; Xu,

Wang, & David, 2016). Within the cognitive domain, several studies demonstrated that excessive media multitasking was generally correlated with poorer performance on laboratory tasks measuring executive control (e.g., Ophir et al., 2009; Sanbonmatsu, Strayer, Medeiros-Ward, & Watson, 2013). Although these studies were correlational in nature, they suggested that individuals with lesser executive control abilities were more prone to interference from multiple media streams and therefore engaged more frequently in media multitasking. Nevertheless, these relations were not consistent across studies, and subsequent investigations failed to show a relationship between media multitasking and executive control (e.g., Minear, Brasher, McCurdy, Lewis, & Younggren, 2013).

Uncovering the links between excessive media multitasking and limitations in executive functions provided an important insight into this unique behavior. Nevertheless, the research so far has been limited to a narrow range of executive functions that were only evaluated in laboratory tasks. Identifying individuals who are more prone to media multitasking and understanding the effects of media multitasking on behavior must consider how media multitasking is related to cognition as it is manifested in everyday behavior. Additionally, the relation between media multitasking

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and cognition should be explored from a wider perspective. Specifically, it is important to explore whether media multitasking is closely related to a personal preference to multitask or whether it is the result of constraints imposed by the environment. Thus, the current study evaluated the correlation between media multitasking (measured by the Media Use Questionnaire (Ophir et al., 2009)), and two ecological self-report measures of executive functions and attention (measured by the Behavior Rating Index of Executive Functions - Adult version (BRIEF-A) (Roth, Isquith, & Gioia, 2005), and the adult Attention deficit and hyperactivity disorder (ADHD) self-report scale (ASRS) V1.1. (Kessler et al., 2005), respectively). In addition, the extent of media multitasking was correlated with each participant's personal preference towards multitasking (measured by the Multitasking Preference Inventory (Poposki & Oswald, 2010)).

2. Literature review

2.1. Media multitasking and cognitive functioning

Ophir et al. (2009) developed the Media Use Questionnaire to measure the extent of everyday media multitasking in a group of college students. The questionnaire evaluated the habitual usage of 12 forms of media and the amount of time the students spent multitasking with those media. For each media, participants rated how much time they spent using that media during a typical week (e.g., watching computer-based video, listening to music, reading printed materials). Subsequently, participants rated for each media the amount of time they spent multitasking with each of the other 11 forms of media. Participants rated the amount of multitasking on a four point Likert scale, ranging from “never” to “most of the time”.

For each of the participants, Ophir et al. derived an index based on their level of media multitasking (i.e., the Media Multitasking Index (MMI)), and used the index to define two groups of light and heavy media multitaskers. When Ophir et al. compared the performance of light and heavy media multitaskers on laboratory tasks that required the filtering of irrelevant information or task switching, they discovered that heavy media multitaskers performed more poorly than light media multitaskers. Heavy media multitaskers compared to light media multitaskers were unable to filter irrelevant information, and showed larger costs when switching between tasks. This latter result was particularly surprising given that heavy media multitaskers' everyday behavior consisted of extensive practice in task switching between different streams of media. Ophir et al. suggested that light media multitaskers were better able to exert top-down attentional control, which allowed them to focus on relevant targets and tasks in laboratory experimental tasks, as well as concentrate on one media stream at a time in their everyday behavior. Heavy media multitaskers, on the other hand, who exhibited poorer attentional control, were more prone to interference from distractors in laboratory tasks and from additional media streams in their natural environment.

The media multitasking index has been used extensively to explore the relation between media multitasking and cognitive abilities. In agreement with Ophir et al. (2009), Cain and Mitroff (2011) showed that heavy media multitaskers processed more irrelevant and often distracting information than light media multitaskers during an attentional demanding task. Cain and Mitroff suggested that heavy compared to light media multitaskers employed a wider attentional focus during task performance, which explained why they processed distractors in addition to targets. Lui and Wong (2012) speculated that the wider attentional window employed by heavy media multitaskers, which resulted in poorer performance in some conditions, could be beneficial in

other conditions that required the integration of relevant and irrelevant information. Indeed, they found that heavy media multitaskers were better than light media multitaskers, at multisensory integration of auditory and visual information in a visual search task. Presumably, the wider attentional focus of heavy media multitaskers resulted in more efficient processing of the auditory information, which although was deemed irrelevant in the task was still beneficial for the processing of the visual targets. Along the same lines, Yap and Lim (2013) demonstrated that light and heavy media multitaskers deploy their attention differently, such that when two different locations were cued in a spatial attention task, heavy media multitaskers tended to split their attention between the two cued areas, whereas light media multitaskers maintained a unitary attentional focus.

The poorer performance by heavy media multitaskers was also observed for more complex tasks that tapped higher order mechanisms of executive functions. Sanbonmatsu et al. (2013) compared the performance of heavy and light media multitaskers on the Operation Span task, a dual-task paradigm that taxes both working memory and executive functions (Kane et al., 2007). In agreement with the general conclusions of Ophir et al. (2009), Sanbonmatsu et al. found that heavy media multitaskers performed worse than light media multitaskers on the Operation Span task. Additionally, Sanbonmatsu et al. observed that heavy multitaskers obtained higher scores on impulsivity and sensation seeking scales using self-report measures. Taken together, these results suggest that heavy multitaskers may be less able to exercise executive control than light multitaskers in laboratory tasks as well as in everyday behavior.

However, contrary to the findings reviewed thus far, other studies failed to show a difference in cognitive performance between light and heavy media multitaskers, with some indications of improved performance by heavy media multitaskers. For instance, Alzhabi and Becker (2013) found smaller task-switching costs in heavy media multitaskers compared to light media multitaskers and equal performance in a dual-task paradigm. Minear et al. (2013) found that light and heavy multitaskers performed similarly on task switching, working memory and on tasks requiring filtering of irrelevant information. They did find however, differences between the two groups on self-report measures of impulsivity and self-control. Heavy media multitaskers, compared to light media multitaskers, rated themselves as being more impulsive and as having lower self-control. Ralph, Thomson, Seli, Carriere, and Smilek (2015) also failed to find a correlation between the everyday behavior of media multitasking and laboratory measures of sustained attention and several variations of a go/no-go task. However, in an earlier study, Ralph, Thomson, Cheyne, and Smilek (2014) found that higher scores on the media multitasking index were correlated with higher levels of self-reported failures of everyday attentional functions. These failures included loss of attention and awareness to events in the environment, errors caused by attentional failures and self-reported intentional and unintentional mind wandering.

The literature review suggests, although not consistently, that excessive media multitasking is correlated with deficits in several aspects of cognitive control and executive functions. The main evidence for this relationship is based on laboratory measures, with little indication of whether this correlation extends to ecological aspects of executive functions. One reason for the inconsistent results from laboratory studies, may lie in the gap between the laboratory measures that were used to evaluate cognitive functioning and the everyday behavior of media multitasking, given that laboratory and ecological measures do not always correspond (Barkley & Murphy, 2011; Toplak, West, & Stanovich, 2013). Indeed, even when light and heavy media multitaskers performed equally well

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