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Effects of multitasking on retention and topic interest

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ABSTRACT

A recent and pervasive “urban legend” in education describes contemporary students as digital natives and effective multitaskers. The current study investigated the effects of sequential and concurrent multitasking scenarios on content retention and topic interest in a multimedia learning environment. Five hundred and seventy two undergraduate students were randomly assigned to one of the seven conditions in which either sequential or concurrent multitasking scenarios were simulated through a web-based system. While the sequential conditions either required switching between instructional and distractive videos or between two instructional videos, the concurrent multitasking scenarios involved online chatting while watching the videos. The relationships between digital device experience, daily media exposure, current multitasking habits, working memory components, and content retention were also investigated. Findings revealed that sequential multitasking did not interfere with retention whereas concurrent multitasking interfered with both retention and topic interest. Digital device experience and daily multitasking habits were not related with retention. Furthermore, daily media exposure was negatively associated with the retention, particularly in the longer sequential multitasking scenarios. Finally, different types of multitasking were related with different working memory constructs.

1. Introduction

In today's technology-rich world, where Internet connections and mobile devices are increasingly available, individuals' interaction with digital media begins at very early ages (Tandon, Zhou, Lozano, & Christakis, 2011). This interaction reaches particularly high levels among adolescents and young adults (Davies & Eynon, 2013). Several terms such as digital natives (Prensky, 2001) are used to describe individuals who are surrounded by these digital technologies. The ability to multitask across various multimedia environments is regarded as a significant characteristic of digital natives (Prensky, 2001; Veen & Vrakking, 2006). Other common features include effective communication, self-directed learning, and digital thinking (Prensky, 2001; Veen & Vrakking, 2006).

Observing children doing their homework, surfing the web, and instant messaging simultaneously may lead one to assume that they are skillful multitaskers. However, this can also be an urban legend in education (Kirschner & van Merrienböer, 2013). The current study aims to challenge this assumption through an experiment, which investigates the effects of different multitasking conditions on content retention and topic interest. Additional variables, such as digital device experience, daily media exposure, current multitasking habits, and two different working memory constructs were also investigated.

1.1. Multitasking defined

Multitasking can be defined as being exposed to different information sources and switching between different media (Ophir, Nass, & Wagner, 2009). Watching TV while texting or listening to music while surfing the web can be examples of this behavior, also called as media multitasking (Foehr, 2006). In another approach, multitasking is classified as either CPU- or human-based multitasking (Adler, 2012). The CPU-based multitasking refers to computer processors switching between tasks, during which the execution of tasks is perceived as simultaneous. The human-based multitasking occurs when people use their cognitive or psychomotor resources simultaneously to handle multiple habitual activities (e.g., eating and watching TV) or to switch between different PC applications (Adler, 2012). Online information seeking behavior as an iterative process of handling multiple searches can also be labeled under information-driven multitasking (Spink, 2004).

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On the other hand, Kraushaar and Novak (2010) focus on task efficiency and define multitasking as either productive or distractive. Productive multitasking involves multiple acts of listening, watching, formulating, and taking notes while studying, whereas distractive multitasking includes activities that are unnecessary for learning and deplete the limited cognitive resources. In this regard, switching between different information resources using search engines can be a productive activity whereas switching between searching and informal chatting can be distractive.

There is a comprehensive literature on multitasking, which extends back to contexts where digital media were not available (Meyer & Kieras, 1997). Recently, Salvucci, Taatgen, and Borst (2009) proposed the domain-free Unified Theory of Multitasking. Their theory is strongly based on empirical findings in psychology. Salvucci et al. (2009) categorize multitasking as either sequential or concurrent based on the time spent on each task before switching to another. If the switching between the tasks is very short in duration (e.g., driving and talking on the phone), it is considered as concurrent multitasking. However, if the switches occur in longer durations (e.g., cooking and reading), it is regarded as sequential multitasking (Salvucci et al., 2009). The theory explains concurrent multitasking through Anderson's (2007) Adaptive Control of Thought-Rational (ACT-R) model, which posits that human cognitive architecture is comprised of interacting but independent modules. Each module can keep an active set of task, which is called a *thread*. Although threads can operate in parallel, only one task can be executed at a time (Salvucci et al., 2009). Active threads use available cognitive resources in a "greedy but polite manner", that is, tasks on a longer hold are given priority (Salvucci & Taatgen, 2008). Previously, the sequential multitasking has been explained with the Memory for Goals Theory (Altman & Trafton, 2002) and Threaded Cognition Theory (Salvucci & Taatgen, 2008). By reformulating these theories, Salvucci et al. (2009) stated that a goal in one's mind should be strengthened until it surpasses all other possible goals, and becomes the primary source of attention. Otherwise, the goal decays and requires more time to resume if interrupted. Hence, when a task is interrupted and another task is initiated, the interrupted task should be rehearsed in an active thread. This should continue until the next resumption in order to minimize the decrease of performance in the interrupted task (Salvucci et al., 2009).

As there is such an amount of theoretical perspectives on multitasking, there is a need for further empirical evidence to fine-tune these existing frameworks (Wallis, 2010). The strong empirical background of the Unified Theory of Multitasking and its domain-free explanations are considered useful in the current study.

1.2. Multitasking and learning among youngsters

Recent large scale studies reveal that multitasking is particularly common among youngsters (Carrier, Cheever, Rosen, Benitez, & Chang, 2009; Voorveld & van de Groot, 2013). Empirical evidence which involves longitudinal observations and interviews (Ragan, Jennings, Massey, & Doolittle, 2014), tracking tools to record learners' digital activities (Moreno, Jelenchick, Koff, Diermyer, & Christakis, 2012), and modern technologies such as eye-tracking (Calderwood, Ackerman, & Conklin, 2014) reveal that learners tend to multitask very often during learning activities. Common multitasking activities during learning are listed as social networking, chatting, texting, listening to music, studying another lesson, e-mailing, video gaming, note-taking, eating, and drinking (Burak, 2012; Fried, 2008).

The pervasiveness of multitasking in learning contexts has triggered numerous studies investigating its instructional consequences. Some scholars studied the implications of concurrent multitasking with mobile phones during lectures (Ellis, Daniels, & Jauregui, 2010; Lawson, 2013; Rosen, Lim, Carrier, & Cheever, 2008), which revealed controversial findings. For instance, Rosen et al. (2008) observed 185 undergraduate students in three experimental conditions where learners were distracted with varying numbers of text messages. Findings showed that learning success decreased as the amount of texting increased. Another experimental study found that using mobile phones during lectures interfered with the learning gains of undergraduate students regardless of the degree of texting (Ellis et al., 2010). On the other hand, Lawson (2013) designed a similar experiment with 120 university students where receiving instant messages or texting during video lectures did not have any effect on performance.

Several researchers investigated whether multitasking with other mobile devices affected learning. In this regard, Coens, Reynvoet, and Clarebout (2011) randomly assigned undergraduate students to four different multitasking situations. While the control group watched a multimedia learning content on their iPods, the intervention groups were asked to tighten bolts and nuts as a secondary task. The first intervention group was told to pay attention to both learning content and the tightening simultaneously. The second group was asked to prioritize the learning content whereas the last group was told to do the opposite while multitasking. The only significant difference was observed between the control group and the group who prioritized tightening bolts and nuts. The difference was in favor of the control group. A second experiment was conducted in the same study where participants practiced tightening bolts and nuts prior to the experiment. Yet, the results remained similar. In another study, Doolittle and Mariano (2008) investigated the role of working memory and mobility in multitasking with audio players (i.e., iPod). Students were randomly assigned to one of two groups in which they either watched a multimedia content in a seated manner or walked around the school. Findings revealed that students in the seated condition learned better than the walkers. In addition, students with lower working memory capacity performed most poorly in the mobile condition.

In a similar study, Coens, Degryse, Senecaut, Cottyn, and Clarebout (2011) investigated how listening to audio podcasts affected learning in different situations where learners were either seated, walking or jogging. In the first experiment, no difference was observed among the three situations. However, in the second experiment, students who were seated outperformed the ones who were jogging. It should be noted that students in the second experiment listened to a learning content of 11 min for once whereas students in the first experiment listened to a learning content of 4 min twice. In addition, students solved a Sudoku puzzle before answering post-test questions in the second experiment. An interesting finding was that prior possession of audio player had partially affected learning outcomes in multitasking conditions.

Another group of scholars investigated whether the use of laptops with Internet connections affected learning outcomes in the classroom. Even though a fully controlled multitasking scenario was not available, interventions in these studies may be considered as examples of concurrent multitasking. For instance, an experiment with university students showed that retention of the course content was significantly worse among laptop users (Hembrooke & Gay, 2003). Other studies have further revealed that students who do not use laptops, but sit close to laptop users show lower performance on content retention (Fried, 2008; Sana, Weston, & Cepeda, 2013).

Scholars have further investigated the effects of online messaging on retention (Bowman, Levine, Waite, & Gendron, 2010; Fox, Rosen, & Crawford, 2009; Pashler, Kang, & Ip, 2013; Tran, 2012)