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Growing up multitasking: The costs and benefits for cognitive development

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ABSTRACT

Current work, play, and learning environments require multitasking activities from children, adolescents and adults. Advances in web-enabled and multi-function devices have created a perceived need to stay "wired" to multiple media sources. The increased demand that these activities place on information processing resources has raised concerns about the quality of learning and performance under multitasking conditions. Young children, whose attention systems and executive functions are immature, are seen to be especially at risk. To evaluate these concerns the costs and benefits of "everyday" multitasking (e.g., driving, studying, multimedia learning) are examined in relation to the classic experimental literatures on divided attention in task-switching and dual-task performance. These literatures indicate that multitasking is almost always less efficient (time, accuracy) and can result in a more superficial learning than single-task performance. Alternatively, when the cognitive, perceptual, and response requirements of the tasks are controlled by the individual, when learning platforms are developmentally appropriate, and when practice is permitted, multitasking strategies can not only be successful but can result in enhanced visual and perceptual skills and knowledge acquisition. Future progress will come from advances in cognitive and computational modelling, from training attention and brain networks, and from the neuroergonomic evaluation of performance that will enable the design of work and learning environments that are optimized for multitasking.

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Introduction

In our fast-paced, electronic world multi-tasking has become the "new normal". The pressure to process more information, solve more problems, deliver more results, and to do so faster and in tandem with other activities is a growing expectation of children and adults alike. Examples abound as students take notes while listening to a lecture and keeping track of incoming instant messages; office workers talk on the phone while managing emails and reading documents; academics fine-tune a grant application while preparing for an imminent class; doctors listen to patients while checking their medical records on-line; drivers negotiate through traffic while texting or talking on cell phones; and children and teens do their homework as they listen to music and browse the web or keep an eye on social media. Even infants and toddlers interrupt their play with frequent glances to a background television program as elements of the content draw their attention. To some extent this is not new. Individuals have been multitasking for eons – as any parent, ER physician, air traffic controller, or short-order cook can confirm. As long as the activities are neither physically incompatible nor mentally demanding, multitasking can even seem effortless. What is new is the suddenness with which the multitasking phenomenon has accelerated over the past decade and come to pervade the way we work and play. Moreover, the widespread availability of high-speed information and communication technology (ICT) has fuelled the expectation that the human cognitive system can simultaneously process, integrate, organize, and respond to multiple sources of information efficiently and productively. This expectation is not limited to media multitasking but includes juggling any sequence of tasks including those in which media are combined with real life interactions (see Greenfield, 2009; Rosen, Carrier, & Cheever, 2010; Small & Vorgan, 2008).

The growing requirement for multitasking has generated debate in the popular media and has motivated researchers to examine the impact of multitasking on performance directly. One view is that multitasking enables (and is necessary for) the high-level efficiency and productivity that are essential for successful competition in contemporary work and learning environments. The gist of this argument is that multitasking promotes mental flexibility that can actually change the manner in which we learn and retain information, especially among children and youth whose neural plasticity is relatively high (Dye, Green, & Bavelier, 2009a, 2009b; Green & Bavelier, 2008; Lui & Wong, 2012; Maclin et al., 2011; Small, Moody, Siddarth, & Bookheimer, 2009; Small & Vorgan, 2008; Sparrow, Liu, & Wegner, 2011). Alternatively, the case has been made that multitasking diminishes performance, especially when task juggling produces interference, distraction, and ultimately errors, lost time, and mental stress (e.g., Abate, 2008; Bowman, Levine, Wait, & Gendron, 2010; Gupta, Bhoomika, & Srinivasan, 2009; Ophir, Nass, & Wagner, 2009; Rosen, 2008; Strayer & Drews, 2007). The roots of that argument go back to experimental literatures on divided attention, dual-task performance, and task switching dating at least to the 1930s – well before multitasking emerged as a cognitive and socially significant phenomenon. That literature indicated that the human information processing system has a limited capacity and that sharing resources among tasks usually comes at a cost for performance and productivity (e.g., Kahneman, 1973; Telford, 1931; Welford, 1952, 1967). This issue remains active and contentious, with much depending on the perceptual, cognitive and response requirements of the tasks involved (e.g., Levy, Pashler, & Boer, 2006; Monsell, 2003; Pashler, Johnston, & Ruthruff, 2001; Strayer, Drews, & Johnston, 2003) and also on a number of individual differences (Buchweitz, Keller, Meyler, & Just, 2012; Green & Bavelier, 2003; Ophir et al., 2009; Parasuraman, 2011; Watson & Strayer, 2010).

The goal of this review is to provide a synthesis of that literature with emphasis on the increasing expectation for multitasking among young children and youth. While the context for multitasking in toddlers and preschoolers is typically play, observation suggests that their use of individual media types (e.g., computers, hand-held games, TV, print) is increasing (Calvert, Rideout, Woolard, Barr, & Strouse, 2005; Lee, 2009), though estimates of multimedia usage are undocumented. Among older children, a recent report from the Kaiser Family Foundation (Rideout, Foehr, & Roberts, 2010) indicated that children and youth between 8 and 18 years of age spend about 8.5 hours per day using entertainment media – reading, watching television or video, listening to music, playing computer games, looking at websites, or messaging. During nearly two-thirds of that time they are also doing something else such as eating, doing chores, talking on the phone, completing homework, or using other media. Consistent with this trend, schools are increasingly incorporating multimedia and e-learning protocols

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