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Everyday attention: Mind wandering and computer use during lectures

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ABSTRACT

The influx of technology into the classroom presents a serious challenge for educators and researchers. One of the greatest challenges is to better understand, given our knowledge of the demands of dual tasking, how the distraction posed by this technology influences educational outcomes. In the present investigation we explore the impact of engaging in computer mediated non-lecture related activities (e.g., email, surfing the web) during a lecture on attention to, and retention of, lecture material. We test a number of predictions derived from existing research on dual tasking. Results demonstrate a significant cost of engaging in computer mediated non-lecture related activities to both attention and retention of lecture material, a reduction in the frequency of mind wandering during the lecture, and evidence for difficulty coordinating attention in lectures with distractions present. Discussion focuses on the theoretical and practical implications of these results for dividing attention in the classroom.

1. Introduction

The rapid proliferation of technology has rendered the scientific investigation of its impact on our cognitive lives an emerging area of inquiry. One of the primary areas of interest has been with the near perpetual dual task environment created by the integration of many of these technologies into our day-to-day activities (e.g., using cell phones while driving; Strayer & Drews, 2007; listening to music devices while crossing the street; Neider, McCarley, Crowell, Kaczmarski, & Kramer, 2010; Walker, Lanthier, Risko, & Kingstone, 2012). This circumstance has provided researchers the opportunity to investigate the act of dividing attention in more naturalistic situations. The modern classroom is replete with students on their laptops, tablets and smart phones (e.g., Brown & Pettito, 2003). While in many cases students might be using these tools to supplement the lecture (e.g., take notes), this is not their only use (Fried, 2008). In the present investigation we provide an experimental assessment of the impact of computer mediated non-lecture related activities (e.g., emailing, web surfing) on attention to, and retention of, lecture material.

2. Attention in the classroom

Attention represents an important part of effective learning (e.g., Hidi, 1995; Posner & Rothbart, 2005; Reynolds, 1992; Wilson, & Korn, 2007). Without paying attention information quickly fades and rarely has a lasting impact. Thus, understanding the contribution of attention to educational outcomes has the potential to provide widespread learning improvements across a range of individual capabilities and educational contexts. Together these ideas coalesce into what we have referred to as the need to develop an attention aware classroom (Risko, Anderson, Sarwal, Engelhardt, & Kingstone, 2012). The goal of the attention aware classroom is to develop a set of principles whose application would enable instructors to maximize each student's opportunity to learn by implementing evidence-based practices that optimize student attention. This idea is based on a similar concept introduced by Gathercole, Lamont, and Alloway (2006) referred to as the memory aware classroom. This latter idea calls for the use of research on memory to structure classroom activities and one-on-one student

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development. A good example of this latter idea is available in recent research focused on the influence of testing on memory and the use of this information to inform instruction (e.g., Roediger & Karpicke, 2006; Rohrer & Pashler, 2010).

Attention allows one to prioritize one source of information at the expense of others. The benefit of attention for encoding has been demonstrated in various domains. For example, in dichotic listening experiments, where messages are played to both ears and participants are instructed to attend to one and ignore the other, memory for the latter is remarkably poor (e.g., Moray, 1959; Treisman, 1964). In addition, when attention is divided between encoding a list of words and a secondary task, a marked decrease in recall is observed (e.g., Craik, Govoni, Naveh-Benjamin, & Anderson, 1996; Rohrer & Pashler, 2003). More recently, the costs of inattention in an educational context were revealed by studies examining mind wandering (i.e., a state of decoupled attention; Smallwood & Schooler, 2006) during lectures (Linquist & McLean, 2011; Risko et al., 2012; Szpunar, Khan, & Schacter, 2013). Specifically, increases in mind wandering during a lecture were negatively correlated with memory for the lecture material (Risko et al., 2012).

The relation between attention and learning has also been discussed in the context of research on academic engagement (e.g., Fredricks, Blumenfeld, & Paris, 2004; Jang, 2008; Jang, Reeve, & Deci, 2010; Ryan & Deci, 2000; Skinner, Furrer, Marchand, & Kindermann, 2008; Skinner, Kindermann, & Furrer, 2009). Academic engagement is a strong predictor of school success (Fredericks et al., 2004). Attention represents a critical part of academic engagement, in particular, behavioral engagement, which is constituted by attentive and effortful behaviors, and behavioral disaffection, which is constituted by inattentive and distracted behaviors. While much basic research on attention focuses on immediate benefits/costs, research on academic engagement adds a longitudinal perspective where inattention can have an impact beyond the short-term by subverting opportunities to develop a level of academic engagement commensurate with long-term school success.

3. Dividing attention in the classroom

The 'computers in classroom' debate has begun to come to a head as universities become ubiquitous computing environments (Brown & Pettito, 2003). The debate has centered on attempting to weigh the potential benefits (e.g., on demand access to supplemental information) and potential costs of computers (e.g., distraction) in the classroom. Here we focus on the latter issue. The majority of research on this issue has relied on self-reports of student perceptions of the benefits/costs of computers in classrooms and correlations between these self-reports and objective indices of learning (e.g., Fried, 2008; Kraushaar & Novak, 2010; Wurst, Smarkola, & Gaffney, 2008). For example, Fried (2008) surveyed students in a large class where computer use was unstructured (i.e., they could use their computers in class but it was not part of the class) and had students report weekly on various measures of use. In addition, Fried (2008) correlated these self-reported use statistics with the student's grade in the course. Results demonstrated that computer use was negatively related to learning. Fried (2008) concluded that unstructured computer use in the classroom should be limited. Using a similar design, Wurst et al. (2008) found no difference in GPA between cohorts who were given a laptop and those that were not.

In an investigation applying an experimental approach, Hembrooke and Gay (2003) compared a group of students given access to a laptop and typical amenities (e.g., internet) and a group of students who did not have access to a laptop during class. The influence of "access" was assessed on retention of lecture material. Results demonstrated that those with access performed less well on the test of lecture retention. In the present investigation, we apply a similar, experimental approach to assess the impact of engaging in computer mediated non-lecture related activities on attention to, and retention of, lecture material. Here we randomly assigned participants to two conditions (1) a condition in which participants had to read and respond to emailed tasks (e.g., web search, post on Facebook) while listening to a lecture and (2) a control condition in which participants only listened to a lecture. In addition to assessing memory for lecture material using a post-lecture retention test (Hembrooke & Gay, 2003), participant's attention to the lecture was measured in situ using a thought probe technique popularized in research on mind wandering (e.g., Christoff, Gordon, Smallwood, Smith, & Schooler, 2009; Killingsworth & Gilbert, 2010; Smallwood & Schooler, 2006; Smallwood, Fishman, & Schooler, 2007; Smallwood, McSpadden, & Schooler, 2008; Smilek, Carrier, & Cheyne, 2010). In this method (i.e., the probe caught method of measuring task unrelated thought) a probe, which typically consists of a screen that pops up and interrupts the ongoing task, asks participants to self report their current focus of attention (e.g., on the task vs. something else). Next we outline four predictions derived from existing research on dual task performance, mind wandering in lectures, and arousal in sustained attention tasks.

Dual task research focusing on laboratory-based tasks has demonstrated clear deficits associated with performing two tasks at the same time (see Meyer & Kieras, 1997; Pashler, 1994 for a review). Indeed, research on dual tasking would seem to leave little hope for the hypothesis that performing two cognitively demanding tasks could be done at the same moment in time in a cost-free manner relative to performing the tasks in isolation (e.g., Lien, Ruthruff, & Johnston, 2006). This work has led to various theories regarding the source of this dual task deficit (Meyer & Kieras, 1997; Navon & Gopher, 1979; Pashler, 1994; Salvucci & Taatgen, 2008; Wickens, 1984). An important idea central to many of these theories is that there exists a 'resource' (or resources) that cannot be shared between tasks (e.g., central processing; Pashler, 1994; declarative and procedural resources; Salvucci & Taatgen, 2008). In other words, once this resource is committed to Task A, Task B (and any other task) must wait until it is finished with that resource in order to commence. Thus, dual task costs arise because two tasks are competing for a resource. Engaging in typical computer mediated non-lecture related activities and trying to attend to a lecture would presumably make demands on these non-sharable resources leading to the straightforward prediction that engaging in computer mediated non-lecture related activities while also trying to attend to a lecture will impair attention to, and retention of, the lecture material. We refer to this account as the *resource competition account*.

While predicting a dual task cost seems intuitive, it is important to emphasize that existing theory and data do permit scenarios wherein dual task performance is as efficient as single task performance. For example, in many everyday dual task scenarios the tasks typically permit individuals some amount of control over the temporal distribution of task related activity. Thus, individuals have the potential to, for example, interleave processing between tasks (Janssen & Brumby, 2010; Payne, Duggan, & Neth, 2007; Salvucci & Taatgen, 2008) and potentially escape dual task deficits. The opportunity to interleave tasks does not, of course, mean that individuals will do so effectively. We consider two predictions based on the general notion of interleaving.

First, participants might be able to selectively attend to important parts of the lecture and disengage at moments when they perceive the cost of inattention to be minimal (e.g., when an instructor is repeating a point). This strategy would lead to a decrease in the amount of