Computers & Education 99 (2016) 81–93

Contents lists available at ScienceDirect

Computers & Education

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

Examining the influence of saliency of peer-induced distractions on direction of gaze and lecture recall

Natalie E. Phillips, Brandon C.W. Ralph*, Jonathan S.A. Carriere, Daniel Smilek

Department of Psychology, University of Waterloo, Canada

A R T I C L E I N F O

Article history:
Received 5 October 2015
Received in revised form 13 April 2016
Accepted 16 April 2016
Available online 19 April 2016

Keywords:
Attention
Multitasking
Classroom
Learning

A B S T R A C T

In two experiments, we recorded participants' direction of gaze as they watched a lecture video while a nearby researcher (sitting in-view of the participant) either: (a) attentively watched the lecture video with their laptop turned off (no distraction), (b) read through a research article on their laptop (Low Saliency distraction), or (c) watched a soccer match on their laptop with muted volume (High Saliency distraction). After the lecture video, a test was given to gauge memory of lecture content. In Experiment 1, an analysis of direction of gaze revealed that participants were objectively more distracted with increasing levels of distractor saliency. However, no differences between saliency conditions were found in retention for lecture content. These results were replicated in Experiment 2, in which we administered a different repertoire of lecture-content questions. Findings are discussed in terms of the ability to strategically and opportunistically engage with lecture content, the availability of multiple cognitive-resource pools, and the varying impact that multitasking in the classroom might have on the user and nearby peers.

1. Introduction

Imagine you are a university or college student, sitting in a lecture-hall. Trying to attend to the lecture, you look around and notice that several of your peers have their laptops open. Not every one of those peers is engaging in lecture-related activities, such as taking notes. You notice several students checking their email, browsing Facebook, playing web-based games, or watching online-videos (perhaps an exciting soccer game). As you might imagine, students engaging in non-lecture related activities on their laptops might not only distract themselves from the ongoing lecture material, but may impair your learning as well. Indeed, scenarios such as this represent some of the challenges to attention that technology has brought into the classroom. As a result of these growing concerns, several studies have recently been devoted to better understand the impact that laptop-afforded multitasking might have on learning, both for the user (Barak, Lipson, & Lerman, 2006; Fried, 2008; Gaudreau, Miranda, & Gareau, 2014; Hembrooke & Gay, 2003; Junco, 2012; Ravizza, Hambrick, & Fenn, 2014; Risko, Buchanan, Medimorec, & Kingstone, 2013; Wood et al., 2012), and those around them (Sana, Weston, & Cepeda, 2013).

In terms of the impact on the user, there is growing evidence that laptop use and multitasking has a negative impact on learning, particularly when they are used for non-lecture related activities (Barak et al., 2006; Fried, 2008; Gaudreau et al., 2014; Hembrooke & Gay, 2003; Junco, 2012; Ravizza et al., 2014; Risko et al., 2013; Sana et al., 2013; Wood et al., 2012).

* Corresponding author. Department of Psychology, University of Waterloo, 200 University Ave. West, Waterloo, ON, N2L3G1, Canada.
E-mail address: bcwralph@uwaterloo.ca (B.C.W. Ralph).

http://dx.doi.org/10.1016/j.compedu.2016.04.006
0360-1315/

For instance, Risko et al. (2013) had participants watch an hour-long lecture video while: (a) completing simple tasks on a laptop intended to mimic the sorts of typical activities engaged by students (e.g., posting Facebook messages or responding to emails), or (b) without engaging in secondary tasks. The results revealed that individuals who were required to multitask performed significantly worse on a subsequent retention test of the lecture content than their non-multitasking peers, a finding that has been demonstrated in several other studies as well (Gaudreau et al., 2014; Hembrooke & Gay, 2003; Ravizza et al., 2014; Sana et al., 2013; Wood et al., 2012).

In addition to distracting the user, laptop use and multitasking has been found to negatively affect the learning of nearby students. Indeed, Fried (2008) described "…laptop use by fellow students was the single most reported distractor … accounting for 64% of all responses" (pg. 911). These subjective reports of feelings of distraction by the laptop use of fellow students has been corroborated with experimental data. In a laboratory study, Sana et al. (2013) manipulated whether or not participants were in direct view of a peer engaging in multitasking on their laptop. Relative to those with a distraction-free view, participants who were in direct view of a multitasking peer scored significantly lower on a subsequent comprehension test.

One explanation that has been offered to account for the aforementioned findings is that lecture-unrelated activities afforded by laptops in the classroom coopt attentional resources of nearby peers, which would otherwise be devoted to lecture-related material (Sana et al., 2013). A widely held notion in psychological literature of human performance is that cognitive resources are limited to some degree (e.g., Kahneman, 1973). Cognitive Load Theory (e.g., Van Merrienboer & Sweller, 2005; see also Liu, Lin, Gao, & Kalyuga, 2015), for instance, suggests that information relevant to learning (i.e., intrinsic cognitive load), and information irrelevant to learning or learning distractions (i.e., extraneous cognitive load) both consume some proportion of total available cognitive resources. As noted by Van Merrienboer and Sweller (2005, p. 150), "[e]xtraneous cognitive load and intrinsic cognitive load are additive." For example, the more an individual works to ignore irrelevant information (e.g., distractions), the less cognitive resources they have to commit to the relevant to-be-learned material. Similarly, when to-be-learned material is complex and demands a greater commitment of processing resources, less cognitive resources are available to deal with distractions. Theories of learning such as Cognitive Load Theory thus emphasize processing limitations placed on individuals as a function of material complexity and extraneous distractions. Performance costs to learning are likely to occur when the individual does not have sufficient resources to deal with both intrinsic and extraneous cognitive loads.

The coopting of attentional resources by peers presumably leads students to spend more time looking at the content of their multitasking peers' laptops than if those peers were on-task. In other words, the distracting laptop might attract a nearby student's overt spatial attention. According to Cognitive Load Theory (Van Merrienboer & Sweller, 2005), multitasking peers may increase the extraneous cognitive load of surrounding individuals, and bring about costs to learning when those individuals have insufficient cognitive resources to devote both towards processing the relevant lecture material and to ignoring the irrelevant information on peers' laptops. One limitation of previous research, however, is that no objective measures of *in-the-moment* distraction (such as the direction of gaze of the putatively distracted student) have been obtained, leaving it unclear as to whether overt spatial attention is indeed coopted by the sorts of distracting information that may be afforded by laptops in the classroom. Furthermore, it remains to be explored how the different *types* of non-lecture related laptop activities by *peers* (e.g., watching videos or reading text on the screen) might influence one's level of distraction.

Here, we build on previous research addressing the impact of peer-induced distraction on lecture recall in several ways. In our experiments, participants sat in a teaching room and watched a previously recorded lecture video presented on a large television at the front of the room. Importantly, the researcher sat in front and slightly to the side of the participant with an open laptop. Our two novel innovations were: (1) monitoring participants' direction of gaze (using the webcam on the researcher's laptop), thereby obtaining an objective measure of the moment-to-moment focus of the participants' overt spatial attention; and (2) manipulating the *type* of information that was present on the researcher's laptop (which was within eye-shot of the participant), which allowed us to explore whether the degree of distraction by peer laptop use depends on the type of information the peer is viewing on the laptop. As in previous studies, we also tested participants on their retention of the lecture content at the end of the experimental session.

With regard to the type of information presented on the researcher' laptop, we included three conditions that varied in terms of the overall saliency of the information. In the first condition (Control), the researcher's laptop was open but the screen was turned off and the researcher attentively watched the lecture presented at the front of the room. In the second condition (Low Saliency), the researcher opened and read through a research article (i.e., mostly text) on their laptop during the middle portion of the lecture video. Finally, in the third condition (High Saliency), the researcher watched a video of a soccer game (while wearing earphones) during the middle portion of the lecture video. Given that motion is a salient visual cue (e.g., Abrams & Christ, 2003; Mahapatra, Winkler, & Yen, 2008), we assumed that the video of the soccer match was more visually salient than the static text of the research article. Of course, because there are other factors that might make the soccer match more salient than text (e.g., more colour in the soccer match) our goal was not to attribute any effects of our conditions to specific stimulus features, but to the overall general level of saliency. Aside from examining the influence of distraction saliency on peer attention, including these types of distractions allowed us to capture, in a general sense, the variety of typical distractions that may be present during an actual lecture (e.g., reading email, browsing Facebook, and watching online videos). This allowed us to examine whether different types of distracting information affected participants' objective level of in-the-moment distraction (here, the proportion of time spent looking at the researcher's laptop), as well as their retention of lecture content (obtained via a memory test at the end of the lecture video).