Computers & Education 54 (2010) 927–931

Contents lists available at ScienceDirect

Computers & Education

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

Can students really multitask? An experimental study of instant messaging while reading

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ARTICLE INFO

Article history:
Received 24 June 2009
Received in revised form 17 September 2009
Accepted 18 September 2009

Keywords:
Adult learning
Media in education
Pedagogical issues
Post-secondary education

ABSTRACT

Students often "multitask" with electronic media while doing schoolwork. We examined the effects of one form of media often used in such multitasking, instant messaging (IM). We predicted that students who engaged in IMing while reading a typical academic psychology passage online would take longer to read the passage and would perform more poorly on a test of comprehension of the passage. Participants were randomly assigned to one of three conditions (IM before reading, IM during reading, or no IM). We found that students took significantly longer to read the passage when they IMed during reading (not including time taken to IM) than in other conditions. However, test performance did not differ by condition. Students who are managing busy lives may think they are accomplishing more by multitasking, but our findings suggest they will actually need more time to achieve the same level of performance on an academic task.

1. Introduction

The constantly changing array of new media has contributed to a way of life based on multitasking and "continuous partial attention" (Friedman, 2006). Young people in particular demonstrate their belief that they can pay attention to several things at the same time by text messaging while in class, talking on the cell phone while driving, or instant messaging while doing homework. Basic research has demonstrated the difficulty of performing certain tasks simultaneously (Rogers & Monsell, 1995) and the impact task switching has on time to complete tasks (Rubinstein, Meyer, & Evans, 2001). Applied research has focused on the everyday consequences of attempting to do so. For example, Strayer and colleagues have found that drivers' focused attention on their surroundings is reduced when they are talking on a cell phone (Strayer & Drews, 2007; Strayer, Drews, & Johnston, 2003; Strayer & Johnston, 2001).

Students often believe that they can listen to music, watch TV and/or communicate with friends online while doing school work without any detriment to performance. In one study, students who used laptops in the classroom reported that they often checked email and sent instant messages while listening to a lecture. Frequent multitaskers reported paying less attention to lectures and performed more poorly than others in the class (Fried, 2008).

Instant messaging (IMing) has increased in popularity among young adults as a communication tool (Quan-Haase, 2007; Roberts, Foehr, & Rideout, 2005). Students often leave IM capabilities on while performing academic activities (Jones & Madden, 2002), especially when using the computer, and most students report that they usually answer IMs immediately (Levine, Waite, & Bowman, 2007). Users believe that use of IM gives them more control over their communication because they can compose their responses rather than responding immediately, as in face to face interaction (Madell & Muncer, 2007). However, they have little control over when they will receive IM messages unless they turn off their IM program. Therefore it seems highly likely that students are interrupting their academic work in order to read and respond to IMs that are social in content.

When students use IM to help with their academic work, some studies have found that it enhances online participation in classes (Hrastinski, 2006). However, other studies have shown that students use IM mainly for social, rather than educational purposes, even when its use is built into their course structure (Contreras-Castillo, Pérez-Fragoso, & Favela, 2006).

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doi:10.1016/j.compedu.2009.09.024

There is evidence that heavy use of synchronous communication applications for general, nonacademic purposes is correlated with impaired academic performance (Fox, Rosen, & Crawford, 2009; Kubey, Lavin, & Barrows, 2001) and with distractibility for academic reading and impulsiveness (Levine et al., 2007; Waite, Bowman, & Levine, 2006).

The cognitive literature clearly indicates that competing cognitive tasks affect performance. Early and more modern researchers of attention (e.g., Broadbent, 1958; Deutsch & Deutsch, 1963; Kahneman, 1973; Pashler, Johnston, & Ruthruff, 2001; Treisman, 1960) have agreed that attentional capacities are limited and that dividing attention among one or more different tasks leads to decrements in performance. The features of the distracter and target activities as well as the intentions, motivations, and expectations of the individual play a part in distractibility (Hillstrom & Chai, 2006). IMing might affect reading comprehension for any or all of these reasons.

The degree of distraction, in part, is a function of distracter stimulus properties. Pashler et al. (2001) concluded that stimuli that are novel, have an abrupt onset, change over time, or are distinctive compared to other stimuli are likely to attract attention. Therefore, the pop-ups announcing delivery of a message from an IM "buddy" would likely lure attention away from the target activity.

Attention is also affected by voluntary allocation of cognitive effort towards a task (Kahneman, 1973). Students expecting to receive an exciting or important instant message might be more motivated to check incoming messages, interrupting ongoing target activities, particularly if the target activities are considered dull (e.g., studying for an exam). In cases where people are selectively attending to one of multiple messages, the potentially distracting messages can be selectively "tuned out" (Cherry, 1953), especially when distracters are not relevant to the target activity (Gibson & Jiang, 1988). Presumably, if one is absorbed in an activity, such as writing a paper or studying for an exam, the distracting properties of the receipt of an IM would be reduced. However, when competing tasks are engaging, require mental activity, or are similar to the target activity, it is more difficult to focus attention. For example, Strayer and Johnston (2001) found that cell phone use impaired performance on a second task, especially when the task required mental effort.

Research on task switching, where one alternates back and forth between activities, indicates performance (reaction time) is impaired when the competing and target activities share features (Rogers & Monsell, 1995). Presumably, if one is alternating between writing a history paper and writing instant messages, it might prove to be costly in terms of overall amount of time devoted to the target task.

Though there is some evidence for benefits of automaticity (Schneider & Shiffrin, 1977), more recent work has indicated that the effects of practice are not as robust as previously thought (Logan & Etherton, 1994). When people are asked to perform two sequentially presented tasks that occur in temporal proximity, the result is slower reaction time to the second task. This effect is known as the psychological refractory period (PRP) and occurs even for tasks that do not share similar features (Pashler, 1994). This suggests that IMing while performing other academic tasks would be detrimental and that experience over time with IM might not mitigate its effect.

Research by Poldrack and his colleagues has shed light on the mechanisms by which learning may be disrupted by distraction (e.g., Foerde, Knowlton, & Poldrack, 2006; Poldrack et al., 2005). In their procedure, participants are presented with a single task, such as locating a visual target on a screen or learning the relationship between specific cues and responses. During a dual-task activity, participants were engaged in a task, while they also counted the number of auditory tones. Poldrack and associates found that though one can learn new information while being distracted, the mechanisms involved in encoding the information are different and the speed with which one can learn and access that material is impaired. They suggest that different areas of the brain are involved in the processing of dual- versus single-task activities and that the type of activity produces different types of learning. Dual-task activities produce habit learning or a procedural code whereby participants rely on acquisition of automatic behavioral tendencies. Single-task activities produce declarative memory or flexible, explicit knowledge. Therefore, learning new material while engaged in other activities creates a more superficial permanent code. Students who study while instant messaging friends might be unable to elaborate on the material studied and could develop a self-defeating set of study habits based on superficial processing of the material they are studying.

Applied research has provided some evidence of the means by which other media, particularly background television, interferes with academic performance. In an experimental study, Pool, Koolstra, and van der Voort (2003) found that high school students who did academic work while soap operas were shown on television took longer to carry out the task than those with no distractions, largely because they would look up from their work to watch the program. Although students spent equivalent amounts of time actually looking at their assignments in each condition, those with the television in the background performed more poorly on tests of their understanding and memory. Pool et al. (2003) argue that the sounds and images of television evoke an orienting response, which pulls attention away from an ongoing task to novel stimuli. This response can interfere with processing material that requires ongoing integration of material to understand current processing of information. Therefore, understanding may be kept at a more superficial level. Foerde et al. (2006) argue that a distracting task engages working memory, reducing its capacity to process other information, so that less information is encoded into the declarative memory system.

In the work world, use of IM has been linked to slower time to complete tasks, forgetting of target activities, and more errors in carrying out those activities (Bailey & Konstan, 2006; Cutrell, Czerwinski, & Horvitz, 2001). In one example of the difficulties that can result, when sailors on the Navy's Tomahawk missile control received IM messages from researchers, their involvement in the IM process interfered with their ability to respond quickly and accurately to commands to redirect the missiles (Cummings, 2004).

Correlational studies have indicated that use of interruptive media is related to lowered academic performance, but experimental research has been limited largely to the effects of television (Pool et al., 2003). There is little research on the process by which instant messaging interferes with academic performance. However, in a recent experiment, Fox et al. (2009) found that participants who IMed while reading a textbook did not score differently on comprehension tests than those who did not IM while reading. On the other hand, those who IMed took significantly longer to read a passage in a textbook and to complete comprehension tests than those who did not IM while reading. The meaning of this latter finding is obscured by the fact that it was not clear whether the time taken to IM was subtracted from the reading time.

In the current study, we used an experimental design to examine the effects of instant messaging while reading a textbook. We created a situation in which college students read a passage from a textbook online while receiving and responding to instant messages. We tracked the time it took them to read the passage, then tested their understanding of the passage and compared their performance to that of students who were not interrupted by IMs (one group received IMs before reading the passage, while another received no IMs). As multitasking has been found to interfere with both length of time needed to complete a task and comprehension and memory for material learned, we hypothesized that students who were interrupted by IMs would take longer to read the passage (with IMing time removed) and would perform more poorly on a test of their understanding.

2. Method

2.1. Participants

Eighty-nine college students (46 men and 43 women) aged 17–46 years (M = 20.17, SD = 4.29) participated. The majority of students were in their first (46%) or second-year of college (33%), White/European (74%), and attended school full time (91%). Thirty-one percent lived in on-campus housing and 50% lived at home with parents. Student academic majors were well distributed and came from all the schools in the University. Students were enrolled in general psychology classes and received course credit for their participation.

2.2. Materials

A computer program written in Visual Basic was designed to simulate an environment in which students would read an academic source while concurrently receiving simulated instant messages online. A 3828 word passage on personality disorders edited from an Abnormal Psychology textbook (Durand & Barlow, 2005) was displayed on an 18 in. computer monitor. The passage appeared on a total of five consecutive computer screens (pages). Students used the computer mouse to scroll through to read material presented on each page and advanced to the subsequent page by clicking a "next" icon which appeared at the bottom of the screen. Five instant messages were framed as questions that students would typically ask of one another in a first encounter, such as "What do you like to do in your spare time?" IMs were accompanied by a sound and appeared in the mid-section of the screen.

Reading comprehension and retention was tested using 25 multiple choice test questions developed by the authors and administered using the same computer. Difficulty of test items was balanced (skewness Sk = 0.224, S.E. (Sk) = 0.225). Overall mean performance was 13.16 (SD = 3.90) or 53% correct, Cronbach's alpha = 0.66. We also tested an independent sample of students (n = 36) enrolled in a general psychology classes to determine baseline knowledge about personality disorders. These students did not read the passage, but did take the comprehension test revealing an average performance of 7.75 (31%) correct.

Students completed a demographic questionnaire and reported their IM use during a typical week on a seven-point scale corresponding to the following intervals: 0, 1–7, 8–14, 15–21, 22–28, 29–35, 36 or more hours (coded 0–6). They also reported how often their IM software was on when their computer was on and how frequently they use IM while studying, both scaled from "never" (1) to "very often" (5).

After responding to the questions online, participants were given a paper-and-pencil task which included five questions measuring whether or not they found the instructions to be clear, believed the task to be representative of their typical IM experiences, and whether they found the readings to be interesting and similar to actual coursework. Students responded by circling "strongly agree, agree, neutral, disagree, or strongly disagree". Participants were also given the opportunity to make written comments about the experience.

2.3. Procedure

Participants were randomly assigned to one of three conditions (IM before reading, IM during reading, or no IMs). Students were told if they did receive IMs, to respond with complete sentences or phrases to equalize response styles across individuals and conditions. Students who IMed before reading received and responded to all IMs before the passage became available. Students who IMed while reading the passage received one IM per page. The onset of each IM varied for each page, but was constant across participants. On the first page, all students received an IM after 17 s. On the second, third, fourth, and fifth pages all students received an IM after 15, 29, 20, and 26 s, respectively. Students took as much time as needed to respond to IMs and to read the passage. After reading the passage, participants responded to the test questions, demographic, and media questions online. Time taken to read the passage, read and respond to IMs, and answer test, demographic, and media questions was recorded by the software. In order to avoid inflated reading times, time from receipt of each IM to response to that IM was subtracted from total reading time for participants who responded to IMs during reading. Students responded to the additional questions measuring their assessments of the task on a separate sheet of paper after completing online tasks.

3. Results

3.1. Preliminary analyses

To obtain a measure of ecological validity we examined students' responses to the additional questions measuring their assessments of the task. A total of 77 students responded to the additional questions. Seventy-one students responded to the question measuring clarity of the instructions, with 70 (99%) agreeing or strongly agreeing that the instructions were clear. Of the 52 students who received IMs, 37 (71%) agreed or strongly agreed that they found the IMs to be realistic and 39 (75%) agreed or strongly agreed that they responded to the IMs in the study similarly to how they usually respond to IMs. Of the 76 students who answered questions about the reading, 62 (82%) agreed or strongly agreed that the passage they read was similar to the experience of reading information for actual coursework and 39 (51%) agreed or strongly agreed that the passage was interesting and engaging. In written comments, most students reported on the realism of the entire task. For example, one student wrote "I responded how I would have to anyone", while another said "They were questions that anyone I don't know might ask."

3.2. Prior IM use

The mean amount of IMing per week reported by students using our IM scale was 1.48 (SD = 1.32) which translates into approximately 7 and one-half hours per week. Sixty-seven percent reported that they "sometimes", "often", or "very often" had their IM software on when their computer was on (M = 3.35, SD = 1.55). Approximately 62% reported that they "sometimes", "often", or "very often" use IM while studying (M = 2.91, SD = 1.34). The three IM use variables were highly intercorrelated (r's ranging from .60 to .76, all $p < .00$). We examined whether prior IM use was related to our dependent measures and needed to be controlled in analyses examining our main experimental

hypotheses. One participant did not report past IM use. None of the IM use variables were significantly correlated at the zero-order with students' performance on the test measuring their understanding of the passage they read in the experimental situation or with the time they took to read the passage. Similarly, multiple regression analyses predicting test performance and reading time from the three IM use variables were not significant, $F(3, 85) = 2.39$, $p = .07$, $R^2 = .08$ and $F(3, 85) = 1.10$, $p = .35$, $R^2 = .04$, respectively. In addition, we conducted three one-factor between-subjects ANOVAs to examine whether our experimental groups might have differed on any of our three IM use variables. Results indicated no significant differences between the groups on hours of IMing, $F(2, 85) = 0.14$, $p > .05$, $\eta^2 = .003$, how often students' IM software was on when their computer was on, $F(2, 85) = 0.55$, $p > .05$, $\eta^2 = .01$, or how frequently students used IM while studying, $F(2, 85) = 1.13$, $p > .05$, $\eta^2 = .03$.

3.3. ANOVAs examining reading time and test performance

Two separate one-factor between-subjects ANOVAs were performed to assess the impact of IM condition on time taken to read the passage (with IM time subtracted) and performance on the test. Results indicated statistically significant differences in time (reported in minutes) among those who IMed before reading ($M = 28.63$, $SD = 16.67$), those who IMed during reading ($M = 45.57$, $SD = 14.11$), and those who did not IM ($M = 37.44$, $SD = 15.78$), $F(2, 86) = 10.69$, $p < .001$, $\eta^2 = .20$. Post hoc (LSD) comparisons revealed that those who IMed during reading, took significantly longer to read the passage compared to those who IMed before reading and those who did not IM, even after the time taken to IM was subtracted. Those who IMed before reading spent the least amount of time reading. No differences in test performance (number correct) were observed for those who IMed before ($M = 12.14$, $SD = 4.27$), those who IMed during ($M = 13.91$, $SD = 3.33$), and those who did not IM ($M = 13.36$, $SD = 4.04$), $F(2, 86) = 1.63$, $p > .05$, $\eta^2 = .04$. A t-test for independent measures was used to compare total time spent IMing for those who IMed before reading ($M = 2.30$, $SD = 1.00$) to those who IMed while reading ($M = 2.79$, $SD = 1.41$) revealing no significant difference, $t(59) = -1.54$, $p > .05$. $d = .40$.

4. Discussion

Our hypotheses with respect to the impact of IMing on academic performance of young adults were partially supported. Students took significantly longer to read the passage when they IMed during reading than when they IMed before reading or did not IM at all. The additional time to complete the reading for the students who IMed during reading averaged 22–59% greater than the reading time for other students, even after subtracting the time spent IMing. However, there were no significant differences in performance on the test measuring comprehension of the reading as a function of IM condition. Prior IM use patterns did not relate to test performance or reading time.

It is plausible that with each IM interruption, students experienced a delay or bottleneck in alternating attentional resources between IMing and reading, referred to as the psychological refractory period (Pashler, 1993, 1994; Pashler & Johnston, 1998; Pashler et al., 2001). For example, perhaps when switching from reading the passage to reading and responding to IMs and again from reading and responding to IMs back to reading the passage, there was a period of time in which attentional resources were derailed from either task. It is also plausible that the interruptions caused participants to re-read portions of the passage, which increased time to read but made up for deficits in comprehension. We examined total amount of time spent IMing for both groups (IM before and IM during) which revealed no significant differences, implying that the interruptions affected the primary task of reading, not the secondary task of IMing.

Our findings are consistent with those of Fox et al. (2009) who found no test performance differences as a function of IM condition, but did find that those who IMed while reading took more time to read the passage compared to those who did not IM while reading. Fox et al. suggested that IM might not negatively affect test performance because "IM may be viewed as a form of negotiated interruptions" (p. 53) meaning that participants can decide when and if they want to switch tasks and may make preparations before switching tasks. In their study, participants were free to decide when to respond to the IMs. However, in our study, participants were not warned about the onset of a specific IM, were instructed to attend to the IMs, were not able to continue reading until a response to the IM was sent, and did not have voluntary placement of the IM. Therefore, the idea of negotiated interruption cannot explain our findings.

We also found that those who IMed before reading the passage had the shortest reading time of all three groups. This finding was not anticipated, so we can only speculate about the reasons. It is possible that those who IMed beforehand experienced this as a "warm-up" activity that helped them to become more comfortable with the particular computer they were using. Another possibility is that the initial instructions given to the three groups may have had an impact. Each participant was told that they would receive IMs before reading, while reading, or not at all. Those who received the IMs at the beginning may have realized that they would not receive anymore IMs and could attend to the passage they were reading without thinking they might be interrupted. The other two groups would not know whether they were going to be interrupted or not. It would be interesting to explore whether the mere anticipation of interruption was enough to distract readers and increase reading time.

The finding that overall task performance was not impacted was initially surprising, given recent correlational research suggesting relations between media multitasking and academic distractibility (Levine et al., 2007). However, when considered in light of the increase in time required to read the passage, the results are understandable. Future research designed to limit student re-reading or designed with a time limit reflecting many students' real-life limited-time study conditions could examine performance in a "time-crunch" study situation. Future research will also need to examine whether the process responsible for the need for increased reading time may be explained by the psychological refractory period hypothesis or whether it simply reflects the need to re-read after interruptions.

Electronic media in all of its myriad forms holds much promise for educators and students by allowing immediate and wide availability of information previously difficult to access. These media may also allow educators alternate roads to reach more students with the idea of helping students connect better with the topics and other students and making learning more interesting and exciting (Lu, Chiou, Day, Ong, & Hsu, 2006). As educators move in this direction, they must be aware of the risks posed by this new technology. The benefits must be weighed against the tendency students have to use media for irrelevant, social purposes that may distract significantly from the target academic tasks.

5. Conclusions

In conclusion, students commonly instant message while studying and believe they can successfully multitask or switch between tasks without decrements in performance (Lenhart, Rainie, & Lewis, 2001; Rideout, Roberts, & Foehr, 2005). However, it appears that instant messaging and multitasking during academic endeavors carries costs. Students who are managing busy lives may think they are accomplishing more by multitasking. Our findings suggest that they will actually need more time to achieve the same level of performance on an academic task.

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