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STUDENT PERSPECTIVES ON MULTITASKING

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Abstract:

People, and in particularly students, are immersed in a technology-enabled world that encourages human multitasking. Yet referent research indicates multitasking behaviors usually result in non-desirable outcomes such as reduced productivity and increased errors. The current survey research was conducted to determine perceptions of college students regarding the impact of multitasking. Do they frequently multitask, do they think multitasking improves their performance, and are there gender differences in their perceptions? The overall results are 'yes' to all of the above. Unfortunately, referent research suggests this is an undesirable perspective that will lead to lower performance behaviors. Females tend to believe more strongly that women are better than men at multitasking, although no known empirical research supports this belief. Students view multitasking as relatively more acceptable in a classroom environment than in a business meeting setting, which has potential implications for course administration.

Keywords: mono-tasking, multi-tasking, switch-tasking, distraction, divided attention

I. INTRODUCTION

The pervasiveness and mobility of new information and communication technology devices encourage a lifestyle including simultaneity of activities. Perhaps you talk on a cell phone while driving or email while concurrently conversing on the telephone. I multitask. Do you multitask? Do your students multitask (during class)? Should we, should they, multitask? Technology enabled multitasking has become an accepted way of life for many, if not most, in our society over the past few decades. While multitasking seems to have become common in contemporary life, there exists a body of research suggesting that multitasking for important tasks is generally a poor decision. Common outcomes of multitasking include reduced productivity, increased error rate, and both diminished and shallow learning associated with ineffective processing and memory storage of encountered stimuli. Are these the type of outcomes we desire or expect? Are students aware that multitasking behaviors may be interfering with their educational performance? Are people aware that their attempts to get two projects done concurrently typically will result in lower quality and increased time/effort on both projects?

What do we mean by multitasking? If you ask people what they mean they will generally say that multitasking is doing two or more things concurrently. Despite the widespread acceptance of multitasking as a virtual necessity in today's distracted society, considerable research shows that we do not actually "multi-task" because our brains are unable to do so except when performing subconscious tasks that are essentially automatic, such as breathing, or to a lesser extent walking. Instead, humans "switch-task"; that is, we switch back and forth between two or more tasks. Each time we switch between tasks, we lose time on the task most recently vacated. Cognitive science and neural science researchers (Medina, Brain Rules, 2008) have determined that true human multitasking is not possible. Just as a single computer processor can only concurrently work on one task at a time, the thinking component (hippocampus) of the human brain can only engage actively on one focus. Just as a single computer processor can quickly switch among tasks to perform multi-tasking, the human brain can switch between tasks (dual-task) or among tasks (task switching) to the point that we consider ourselves to be multitasking. Nonetheless, in both computer and human processing scenarios there is an overhead cost and some process loss in the switching from one active task to another.

For the purposes of this manuscript, human multitasking can be described as the ability to "accomplish multiple tasks goals in the same general time period by engaging in frequent switches between individual tasks" [Delbridge, 2000, p. 1]. Additionally, this paper frames multitasking as requiring hippocampus related active thought processes for simple or complex tasks – but makes no attempt to dissuade folks from accomplishing learned habitual, or natural activities simultaneously (thus, feel free to walk and chew gum concurrently – and please do continue to breathe while concurrently reading this article – but please don't attempt to read this article while driving). Such habitual activities are regulated by a separate component of the brain (striatum) and do not require active thought processes known as 'executive control'.

II. Literature Review

Multitasking takes more time and involves more errors than does sequential focus on completing one task at a time [Rubinstein, Meyer, and Evans, 2001]. Similarly, Delbridge (2000) found that focusing on one task and one goal results in fewer errors and more productivity than when attempting to focus on multiple tasks and multiple goals at the same time. Generally, completing multiple tasks sequentially results in overall faster completion, higher quality and fewer errors. Task switching from one task to another requires some time to cognitively "switch gears" since different parts of the brain and neural circuitry are needed for each separate activity [Medina, Brain Rules, 2008].

While humans are generally are less productive when multitasking, there are individual differences that enable some people to be 'less bad' in a multitasking context. Attempts to multitask result in divided, rather than focused, attention. Those who can focus their attention and expand working memory have been found to be more intelligent [Schweizer and Moosbrugger, 2004], and correspondingly, working memory, ability to focus attention, and fluid intelligence were found to positively correlate with performance in a multitasking context [Konig, Buhner, and Murling, 2005].

In addition to the overhead associated with process switching and refocusing one's attention there is also the potential to miss or misinterpret important stimuli related to task A while one's attention is focused on task B. Distractions (other stimuli) have the potential to interfere substantially with what information a person receives, processes and stores in memory. A person cannot process unlimited stimuli simultaneously and thus "attention switching" is invoked in deciding which task and stimuli is actively engaged at any particular moment in time [Delbridge, 2000]. The impact of distractions does vary depending on the nature of the distraction. Some distractions are active (e.g. having a conversation) while others are passive (e.g. listening to background music). Not surprisingly, active distractions have the potential of being more disruptive and to interfere more significantly with what is processed and stored in one's memory [Delbridge, 2000].

The effectiveness of multitasking can also be impacted by task complexity and the extent to which we are familiar with the tasks. Rubinstein and colleagues (2001) conducted experiments involving problem solving, classifying geometric objects, and numerical manipulations. Performance was measured as a function of whether the tasks were familiar or unfamiliar, the rules were simple or complex, and visual cues were present or absent about which tasks should be performed. Measurements revealed that for all types of tasks that subjects lost time when they had to switch between tasks. Task alternation yielded switching-time costs that increased with rule complexity but decreased with task cuing. Factor effects were additive, supporting a model of executive control that has goal-shifting and rule-activation stages for task switching. Not too surprisingly, it appears that rule activation takes more time for switching from familiar to unfamiliar tasks, and for handling complex tasks. Accordingly, continual practice can improve human ability to sufficiently handle multiple concurrent stimuli in occupations that require concurrent processing and behavioral response to varied stimuli. For example, airline pilots spend substantial time in training so that they can effectively communicate with air traffic control while concurrently monitoring multiple gauges and manipulating the pitch, roll, and yaw of their aircraft. Nonetheless, pilots are taught to minimize the distractions of vocal communication during more complex portions of task execution such as during takeoffs and landings. [A pilot must simultaneously control his aircraft, plan maneuvers, navigate, communicate with copilot and/or ATC, control sensors, and monitor and manage other aircraft systems]

Correspondingly, divided attention and the distraction of vocal or other communication during activities as routine as driving a car are now known to be fraught with danger. Several studies have recently been released that show 'driving while distracted' creates a hazardous condition; for example, researchers at Virginia Tech Transportation Institute and the U.S. Department of Transportation have found that drivers who are talking on the phone or texting have slower reaction times than someone who is legally drunk. Furthermore, 80% of all crashes and 65% of all near crashes (recorded during their study) involved the driver looking away from the road within 3 seconds of the event. Moreover, the distraction that most frequently preceded an incident involved use of information technology enabled mobile-wireless communication devices [Bagg, 2006; U.S. Department of Transportation, 2003].

More directly related to the impacts of multitasking while studying and learning, Naveh-Benjamin, et al , (2000) studied the impact of divided attention during learning and recall of information. Learning is the process of perceptual processing of stimuli, modifying the stimuli for one's

purposes and background experiences, and then storing the processed stimuli in one's memory for later retrieval. Their research revealed marked differences between the encoding and retrieval activities during attempted multitasking. They found the encoding processes require more focused attention and are more vulnerable to the effects of competing demands. Divided attention during attempts to learn (receiving, processing, and storing stimuli) was shown to significantly, negatively impact memory (ability to recall).

Along these lines, Hembrooke and Gay (2003) conducted a controlled quasi-experiment to determine whether student learning and recall were impacted by multitasking in a classroom environment. Two randomly assigned groups of students from the same class heard exactly the same lecture from the same faculty member during separate lecture sessions on the same day. One group was encouraged to use their laptops during lecture (per the course to-date norm) and the second group was required to close their laptops for the lecture session. In a post lecture surprise quiz the 'open laptop' group performed significantly poorer on a lecture focused test of what they had learned. Two months later the group roles were reversed, those students in the first control group became the intervention subjects in the second round of experimentation. Again the control group was allowed to have 'open laptops' and to use them during class (per course norm) to visit online lecture notes, course related websites, or potentially non-course related materials. Again the intervention group was asked to 'close their laptops' during this specific lecture. Similar to the outcomes of the first experiment the 'closed laptop' group significantly outperformed the 'open laptop' group on a post lecture surprise quiz of lecture related material. The online browsing distraction had a negative impact on learning the lecture materials even for those students who had used their laptop freedom to visit online course related materials during the lecture.

In summary, substantial and consistent research findings suggest that people in general do not perform as well when there are distractions and divided attention among many tasks, as is common during attempts to multitask. The current research is intended to determine whether people (in this case students) are aware of the limitations typically associated with multitasking, or whether in accord with some computer analogous time management suggestions [Britton and Tesser, 1991] they are more likely to perceive multitasking as a way to do more with less; that is, does the typical student think people in general, and they in particular, are more productive when multitasking?

III. Methods and Results

Students participated in a short survey during class time. The survey was aimed at assessing perceptions regarding the frequency with which they tend to multitask, perceptions as to multitasking effectiveness, and to assess the frequency of a few common types of tasks they might perform while multitasking. The survey sample included students from several MBA/MIS classes and an upper level accounting class. Of the total 130 students, fifty-two were female, while 77 were male, and one did not indicate a gender. The proportion of females relative to males is somewhat lower than the norm in this college of business; nonetheless, the proportion was consistent with the gender enrollment in the class sections that were surveyed. The mean age was 21.6 with ninety percent of respondents indicating 25 years of age or less and the other 10% ranging from 26 to 48. This corresponds well with the typical age make-up of the MBA

classes polled where most student are full-time and a smaller portion tend to be early/mid career professionals who are trying to enhance their professional credentials. Therefore, the participant pool consisted predominately of traditional-aged college students and was mostly consistent with the overall student body at the university and college where the students were enrolled.

Table 1 shows overall mean responses to the questions asked of students in this survey. Each item used a five-point scale from 1 (agree strongly) to 5 (disagree strongly), with "3" indicating "neutral".

Table 1. Perceptions of Multitasking

Statement	Mean Response
1. I frequently multi-task.	**1.84**
2. I am a productive person.	**1.88**
3. I am a busy person.	**1.86**
4. Multi-tasking generally makes people more productive.	**2.47**
5. Multi-tasking makes me more productive.	**2.43**
6. Multi-tasking makes me more effective.	**2.65**
7. Humans are generally good at multi-tasking.	**3.27**
8. Women are better than men at multi-tasking.	**2.60**
9. Men are better than women at multi-tasking.	**3.59**
10. Women need to multi-task more than men do.	**3.00**
11. Men need to multi-task more than women do.	**3.41**
12. I frequently text-message or email while multi-tasking.	**1.87**
13. I have accidentally sent a controversial or romantic message to the wrong person while I was multi-tasking.	**3.53**
14. If I were in a classroom environment where everyone had a PC with internet connection, I would multi-task.	**2.16**
15. If I were in a business meeting where everyone had a PC with internet connection, I would multi-task.	**3.31**
16. If I need to drive somewhere while "on company business", I would likely talk on my cell phone while driving to my destination.	**2.28**

As shown in Table 1, student respondents generally agree that they multitask quite often. In fact, frequency statistics revealed that 46 of the respondents strongly agreed with the statement that they "frequently" multitask. To a lesser extent, they believe that multi-tasking makes them and others more productive. The responses are less enthusiastic when the issue becomes whether humans are generally good at multitasking, possibly because they view it only as a necessity in today's environment. There is some agreement that women are better than men at multi-tasking, and that they need to do so more than men, although the response to the latter is somewhere more "moderate" and leans somewhat toward a neutral response. Not surprisingly, and perhaps related to common cultural beliefs, there is little agreement that men need to multi-task more than women do, or that they are better at it.

In terms of specific tasks that one might take on while attempting to multi-task, students indicate a tendency to email or send a text message while multi-tasking. Of the total, frequency statistics show that 86% at least "agreed" with this statement that texting or emailing were frequently involved in their multitasking behavior.

These students did not indicate strongly that they have sent a controversial or romantic message to the wrong person while multi-tasking, although there certainly wasn't strong disagreement with this statement either. Frequency statistics showed that 38 of the respondents did agree (nineteen strongly agreed) with the statement. The latter statistic highlights the potential for multitasking to cause students to send a message that they later find to have been unintended and regrettable. The students did indicate a willingness to talk on the cell phone while driving, which is perhaps not surprising given the prevalence of such tendencies in today's society. However, the tendency perhaps takes on more seriousness if they are driving while on company business; perhaps company policies mitigate the use of mobile communication devices while driving.

An item that has implications for education is that students would be likely to multi-task if in a classroom with a PC connection, while they appear less likely to do so in a business setting. Ninety of the respondents at least 'agreed' that they would multitask if they were in a room where everyone had a PC with Internet connection. If students are performing (irrelevant) internet searches, either due to boredom or to work on another course, such behaviors will almost certainly detract from their ability to notice and encode important information relayed by the instructor; furthermore, they may further distract those around them who can view and be distracted by the browser's computer.

Does Gender Matter?

Whether due to cultural beliefs, time pressures, or some other factor, it is quite possible that perceptions about multitasking will differ between male and female students. Therefore, we were further interested in whether males and females differ in their perceptions of their own and the opposite gender in terms of the need to multitask, and the relative ability to do so effectively. Table 2 shows the mean responses to these items with the same 1-5 response scale, where 1=strongly agree.

Table 2. Gender Segmented Perceptions of Multitasking (mean response)

Statement	**Females**	**Males**
1. I frequently multi-task.**	1.62	2.00
2. I am a productive person.	1.86	1.89
3. I am a busy person.*	1.53	2.08
4. Multi-tasking generally makes people more productive.	2.42	2.50
5. Multi-tasking makes me more productive.	2.28	2.54
6. Multi-tasking makes me more effective.***	2.46	2.78
7. Humans are generally good at multi-tasking.	3.18	3.33
8. Women are better than men at multi-tasking.*	2.10	2.96
9. Men are better than women at multi-tasking.	3.74	3.48
10. Women need to multi-task more than men do.*	2.70	3.21
11. Men need to multi-task more than women do.	3.45	3.39
12. I frequently text-message or email while multi-tasking.***	1.68	2.00
13. I have accidentally sent a controversial or romantic message to the wrong person while I was multi-tasking.	3.30	3.69
14. If I were in a classroom environment where everyone had a PC with internet connection, I would multi-task.	2.16	2.15

15. If I were in a business meeting where everyone had a PC with internet connection, I would multi-task.	3.24	3.36
16. If I need to drive somewhere while "on company business", I would likely talk on my cell phone while driving to my destination.	2.24	2.31

*Between-group difference in means is significant at p<.001.
**Between-group difference in means is significant at p<.05
***Between-group difference in means is significant at p<.10

As shown in Table 2, both males and females agree that they frequently multi-task. They also tend to agree that they are busy and productive, although females agreed significantly more strongly that they are busy people and that they frequently multitask. The two groups did not differ in their beliefs about whether multi-tasking makes them and others more productive. Neither group appears to believe that humans are generally good at multitasking, although interestingly, both groups demonstrate some agreement that multitasking makes people more productive. Females agreed significantly more strongly than did their male counterparts that they are more effective when multitasking, that women are better than men at multi-tasking, and that they need to do so more than men, with the men apparently driving the "moderate" response indicated earlier in Table 1. In other words men do not perceive women as needing to multitask more than men do but women significantly view themselves as having more need to multitask. Neither group appears to believe that men need to multi-task more than women do.

Both genders indicate a tendency to email or send a text message while multi-tasking, although females are moderately more likely to exhibit this tendency. Both groups indicated a willingness to talk on the cell phone while driving, and to multi-task if in a classroom with a PC internet connection, and the responses did not differ significantly on these tendencies. Consistent with the conclusion from Table 1, both groups appear less likely to multitask in a business meeting than in a classroom. Likewise, they did not differ in terms of whether they have sent a "controversial or romantic message" to the wrong person while multi-tasking.

IV. Conclusions and Implications

The current authors are not adverse to the use of information technology to enhance learning. There are likely to be many lab-based and 'active learning' approaches where student online access using laptops is beneficial to deeper learning through concept application. Nonetheless, substantial and consistent referent research findings suggest that people in general do not perform as well when there are distractions and divided attention among many tasks, as is common during attempts to multitask. Furthermore, some research indicates that less classroom learning takes place when students use online internet access during lecture classroom sessions. The current research was intended to determine whether people (in this case students) are aware of the limitations typically associated with multitasking, or whether in accord with some time management suggestions [Britton and Tesser, 1991] they are more likely to perceive multitasking as a way to do more with less; that is, does the typical student think people in general, and they in particular, are more productive when multitasking?

The results of our study confirm that students accept multitasking as a part of their lives and believe that it helps people to be more productive, although they are less convinced that people are actually good at it. These students generally viewed themselves as productive people who frequently multitask and, to a lesser extent, they believe multitasking helps them to be more productive and effective. Based on the preponderance of research showing its ineffectiveness

and deleterious effects on productivity, however, their perceptions may not match the reality. Not surprising, but no less disturbing nonetheless, is that students are quite willing to drive while talking on the cell phone, a now-classic example of the potential risk and harm associated with multitasking. A non-trivial number admitted that they had made the non-trivial mistake of sending an email with potentially controversial (or even romantic) content to the wrong person while multitasking.

Students in this sample appear to view a difference between classroom and business settings in terms of the appropriateness of multitasking while in meetings, or at least they indicate a somewhat stronger tendency to multitask in a classroom setting. Perhaps they view the classroom setting as one in which they are less likely to get caught, and/or that the "penalty" would be less if caught. This finding has implications for education and suggests that instructors should consider the necessity and desirability of allowing laptops in the classroom. Should computers be banned entirely in the classroom unless there is a specific pedagogical reason for having computer access in class, and everyone is required to use one? Instructors who opt to ban them run the risk that some students who prefer to use computers in the classrooms will rate their instructor negatively. Despite contrary research findings, many students would truly believe the instructor instituted limitation was making them less productive, while correspondingly making class-time less fun. In fairness, it is worth noting that many of us have simply become more efficient and comfortable typing on a computer keyboard than writing notes by hand, and some offended students would otherwise be using their laptop for on-task reinforcement.

Male and female respondents did not differ significantly in many of their perceptions. Neither group was more likely than the other to believe they are generally productive people, or that humans are generally good at multitasking. However, there were a few notable differences. Female students, despite research to the contrary, were significantly more likely than male students to view women as better than men at multitasking. They were also moderately more likely to indicate that multitasking helps to make them more effective, and they strongly believed that women have more need than men to participate in multitasking behavior. Parenthetically, if prior research findings regarding multitasking are correct the reduced productivity associated with multitasking along with the indicated proclivity of women to participate in more multitasking may result in higher stress and yet a higher perceived need to multitask, driven by the misperception that they are more effective when multitasking.

Work on fewer things, concurrently, to accomplish more. That is the consistent finding of cognitive researchers. Yet students, and anecdotally professionals in the business workplace, do not seem to have heard the message since a majority of those surveyed believe they can obtain a productivity edge by multitasking. Interestingly, many respondents in this survey believe people in general are not particularly good at multitasking. Yet most in this survey thought they could improve their own productivity by multi-tasking.

Since this study does not include an experimental manipulation we cannot report with certainty that all of these pro multitasking students' perceptions are faulty. Yet the findings of cognitive and neural research would suggest that those who think they'll gain productivity by multitasking are misguided. Research findings indicate that there is no positive correlation between those who think they are good multi-taskers and actual performance in a multitasking context [Konig, Buhner, Murling, 2005]; that is, polychromic people who think they can effectively multitask are usually misguided in their self assessment. Moreover, recent research suggests that those who most frequently multitask are actually the least effective at multi-tasking; frequent multi-taskers are bad at multitasking [Gorlick, 2009].

Obviously, people do have a need to switch among differing priorities and differing tasks. Students have multiple courses and need to switch their mental focus from one subject to another. They also have social lives and potentially jobs to attend to. Yet, research indicates it is a failed strategy to attempt to work on multiple tasks in unison. A better time management strategy is to segment one's work and to devote full attention to completing one task (or one task segment) before switching attention focus to another task. Both observationally, and extrapolating from survey results, many students are trying to do too much at once. While this may be more enjoyable for them, research suggest this approach results in an inability to block out immaterial distractions, shallow and diminished learning, and potentially diminishes their long term capacity to learn [Ophir**,** Nass, Wagner, 2009; Poldrack, 2006; Shellenbarger, 2003].

V. Research Limitations and Suggestions for Future Research

The current study used a single form of data collection at a single point in time and was based exclusively on student perceptions which may vary from their actual behaviors. Although both genders had reasonable respondent sample sizes, females were under-represented relative to males. Overall, the sample size limited the statistical power in determining significant group differences. For example, in examining gender differences, item 5 was just shy of supporting a statistically significant gender difference in whether respondents felt multitasking makes them more productive.

Based on the relative lack of variance in the age of respondents it is possible that the survey results would have differed for another age group. There are also anecdotal perceptions that women, and younger people, may be better at multitasking. While some referent research suggests there are not age or gender related significant differences in general multitasking performance it would be advisable to experimentally test these conclusions within a student learning environment.

A particular area that warrants further research is the tendency and impact of multitasking relative to online and distance learning. While there is substantial evidence that students often prefer online [Bodomo, 2009], or even mobile, courses there is substantially less support regarding the impact on student learning. If the referent multitasking, and associated divided attention, research studies are correct the new learning channels that are enabled by information technology may be creating environments that are less conducive to student learning.

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