Chapter 1
The Environmental and Technological Factors of Multitasking

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ABSTRACT

Research on multitasking, that is, conducting two or more tasks simultaneously or switching quickly between two or more tasks, has focused mostly on a human’s capacity to do so inside their brain. However, our daily life experience indicates that our ability to multitask is not only dependent on our brain capacity, but is also related to other factors such as our environments and available resources. Different individuals may have different abilities to multitask due to their expertise, situational awareness, or ability to plan ahead. This chapter discusses the environmental and technological factors of multitasking based on a prior study. The goal is to expand interdisciplinary dialogues and research methodologies to better understand this prevalent phenomenon in our society.

INTRODUCTION

Multitasking has been around for as long as humans have had competing needs, for instance, doing housework while watching a baby. The demands of post-modern lifestyles and the work force have increased pressure on people to do more things in less time, resulting in more of an impetus to multitask or do several things in the same span of time. Interruptions, which require at least some multitasking to be handled, are commonplace for many jobs including managers, physicians, administrative assistants, and small office workers (Fleishman, Costanza, & Marshall-Mies, 1999). Given its commonality in our daily lives and jobs, not surprisingly, multitasking has attracted interest of basic and applied research.

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The rapid development of technologies has continued to raise our expectation to do things faster. For instance, we eat, talk with friends, make phone calls, or do housework while watching TV. When we work on a computer, we switch immediately to doing something different if the computer is rebooting or buffering. We have changed our habits of reading, searching, and obtaining information from print media such as books or magazines. Increasingly, we surf the Internet for information, follow the hyperlinks from one link to another, one site to another, and click on the graphics and videos as soon as they call on our attention (Zumback, 2006). These are just some examples of common multitasking behaviors and activities. We do not wish to waste even one second of our precious time, so we try to do things concurrently or switch quickly from one task to another!

This current chapter focuses on the environmental and technological factors of people’s multitasking behaviors, with the goal to expand interdisciplinary dialogue and research methodologies to better understand this prevalent phenomenon in our society. The chapter will begin by providing an overview of relevant research on multitasking to date. It will then discuss the environmental and technological factors that affect individuals’ multitasking behaviors based on themes from a qualitative study. The chapter will conclude by suggesting implications and future research directions.

LITERATURE ON MULTITASKING

In this section, we will provide an overview of research on multitasking through the following lens: 1) limited brain capacity for multitasking; 2) partial attention or rapid switch; 3) cognitive load, automation, and expertise; 4) cultural perceptions of time and individual differences; 5) technological changes; and 6) the perceived new skills, needs and demands.

**Limited Brain Capacity for Multitasking**

Multitasking has been defined as doing several things at the same time, or as switching quickly between several different tasks (Baddeley, 1996; Meyer & Kieras, 1997). Depending on variations of beliefs in multitasking attitudes and behaviors in different disciplines, different terms have been used to describe and research this phenomenon, including, for example, dual task, task switching, multitasking, and polychronicity (Baddeley, 1996; Bluedorn, 2002; Hall, 1959; Meyer & Kieras, 1997; Monsell, 2003; Spink & Park, 2005).

Most studies in cognition, psychology, information science, and neuroscience have shown that our ability to engage in concurrent tasks is rather limited (Baddeley, 1996; Broadbent, 1958; Fisch, 2000; Just et al., 2001; Lang, 2001; Spink & Park, 2005). Research shows that multitasking over different types of tasks reduces productivity (Just et al., 2001; Rubinstein, Meyer & Evans, 2001), and that our ability to perform concurrent mental operations is limited by the capacity of the brain’s central mechanism (Schweickert & Boggs, 1984). Wickens’ Multiple Resource Theory Model (1984) proposed that humans have limited capability in processing information, although several different pools of resources rather than one single source can be tapped. This is because cognitive resources are limited in a finite amount of time and a supply and demand problem may occur when an individual performs two or more tasks that require the same resource in the same time interval.
Both theoretical and empirical studies show that our prefrontal lobes control the executive functions of our brain. Generalized functions include: 1) working memory, 2) self-regulation, 3) internalization of speech, and 4) reconstitution (behavior analysis and synthesis) (Barkley, 1997). According to Barkley (1997), improper development of the self-regulation function is one of the possible causes of Attention Deficit Hyperactivity Disorder (ADHD) with particular emphasis on deficient inhibition development, but this supposition must be taken in the context of the collateral development of all four of the executive functions. In addition, improper development of the four executive functions creates deficiencies on a fifth function, namely motor control-fluency-syntax.

**Partial Attention or Rapid Switch**

Obviously, multitasking has a lot to do with how we dedicate, focus or divide our attention: does one multitask because one splits one’s attention or shifts one’s attention between tasks? To what extent does one have control over the attention splits or attention shifts during multitasking? That is, does one multitask because one cannot focus one’s attention on a single task for a period time, because one lacks self-discipline, or because one does this intentionally in order to focus or meet certain external or environmental needs at a particular time?

Johnson (2006) describes one kind of multitasking, “It usually involves skimming the surface of the incoming data, picking out the relevant details, and moving on to the next stream. You’re paying attention, but only partially. That lets you cast a wider net, but it also runs the risk of keeping you from really studying the fish” (p. 61). Jackson (2008) warned that attention, the key to recapturing our ability to connect, reflect, and relax, is missing in our new world. Ophir, Nass, & Wagner (2009) found that heavy media multitaskers performed worse on task switching than light media multitaskers, possibly due to the fact that the heavy media multitaskers constantly pay attention to all stimuli, resulting in difficulty filtering out irrelevant stimuli in memory (Lin, 2009).

Scholars believe that switching between tasks wastes precious time because the brain is compelled to restart and refocus (Meyer and Kieras, 1997). According to Meyer and Kieras (1997), each time one has this alternation, there is a period in which one will make no progress on either task. The result is that it takes longer to finish any one chore, and that one doesn’t do it nearly as well as one would, if one had given it one’s full attention. Studies conducted on distracted driving have shown serious consequences when people are distracted or try to multitasking while driving (Just, Keller, & Cynkar, 2008).

**Cognitive Load, Automation, and Expertise**

Cognitive load plays an important role in both hindering performance and enhancing experience (Ang, Zaphiris, and Mahmood, 2007). Some tasks such as learning new skills may place higher cognitive loads on the brain while other tasks more familiar and automatic, such as typing and driving, may require lower cognitive loads. Poldrack & Foerde (2007) found that people had a harder time learning new things when their brains were distracted by another activity. The functional magnetic resonance imaging (fMRIs) used by researchers showed that learning while distracted or multitasking alters the brain’s learning processes and changes the way people learn (Poldrack & Foerde, 2007). Foerde, Knowlton, & Poldrack (2006) found that learning new things is dependent on working memory, while learning based on habit or conditioning, is not as sensitive to working memory.
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Tasks can be transferred from a categorization as high cognitive loads to low cognitive loads through repetition (Ang, Zaphiris, & Mahmood, 2007). Just, Keller, and Cynkar (2008) found that novice drivers need all the brain participation they can get for driving, but the level of focus required changes with experience. Over time, the brain re-wires itself. Driving becomes automatic. Scientists call this phenomenon “automaticity” (Just, Keller, & Cynkar, 2008). Automation allows us to do one thing while focusing on something else. In other words, learning to do one task well automatically helps us to multitask. The executive processes of our brains allow us to exert some sort of voluntary control over our behaviors, and help us achieve a goal by ignoring distractions (Weissman, Gopalakrishnan, Hazlett, & Woldorff, 2005). For instance, “if we’re performing a task where we want to watch TV and ignore voices that are coming from, say, our children nearby, our frontal region brain may configure the brain to prioritize visual information and dampen down auditory information,” said Weissman (NPR, October 2, 2008). Studies have discovered that a non-intrusive background did not affect students’ learning performance; and that different background content, intentions or efforts towards the goal had different effects on students’ learning performance (Lee, Lin, & Robertson, 2011; Lin, Lee, & Robertson, 2011; Lin, Robertson, & Lee, 2009; Lin, Robertson, & Lee, 2012). In addition, experts are able to flexibly retrieve important aspects of their knowledge with little attentional effort (Bransford et al., 1999).

Cultural Perceptions of Time and Individual Differences

Hall (1959) introduced the concept of polychronicity based on how people in various cultures perceived time. Polychronicity refers to the “extent to which people prefer to engage in two or more tasks or events simultaneously and believe that their preference is the correct way to do things” (Bluedorn, 2001, p. 119). Polychronicity is a continuum, and preferences exist for degrees of engagement. At one extreme is the pattern of focusing on one task at a time, interpreting other potential tasks and events as interruptions. The other extreme is open-ended, involving engagement in several tasks simultaneously (Bluedorn, 2002). According to Hall, people who live in monochronic cultures view time as a linear concept and prefer to complete one task at a time. In contrast, people who live in polychronic cultures view time as cyclical and prefer to engage in more than one task simultaneously. Much has changed since Hall’s initial work on cultural perception of time and task. Since it can be seen that this work pre-dated the birth of the Internet, we can rightly assume that the time to complete any given routine task has been greatly compressed.

Bluedorn (2002) summarized earlier research and stated that “polychronic people appear to have more of the following: extraversion, favorable inclination toward change, tolerance of ambiguity, formal education, striving for achievement, impatience and irritability, and frequency of lateness and absenteeism. Those same people appear to have less of the following: conscientiousness or stress. However, König, Buhner, and Murling (2005) found that there was no significant correlation between polychronicity and extraversion, nor were they predictors of multitasking performance. Instead, attention, fluid intelligence (i.e., the ability to reason and to solve novel problems), and working memory (i.e., the system of the brain that permits the storage and processing of information needed in the execution of tasks) were the most important predictors of multitasking performance.

Goonetilleke and Luximon (2010) found that there were significant differences in the performance and strategy between monochronic and polychronic individuals in the selective attention test. Monochronic individuals focused their attention on the primary task and achieved higher performance. Polychronic individuals had somewhat better total performance in more than one task under time-constrained con-
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Ishizaka, Marshall and Conte (2010) concluded from their study that employees high in list making should be given prioritized work schedules and tasks and that employees high in achievement strivings may be assigned to a work environment where prioritization of multiple tasks is appropriate as compared to a situation where employees are required to be flexible in deciding which task to focus on from time to time.

Technological Changes

As stated by Hembrooke & Gay, “the ubiquity, pervasiveness and mobility of new technologies encourage a simultaneity of activities that goes beyond anything our culture has heretofore ever known. Indeed, the ability to engage in multiple tasks concurrently seems to be the very essence or core motivation for the development of such technologies” (2003, p. 1). People who have grown up with the convenience of technologies are surrounded by portable media (Oblinger & Oblinger, 2005; Foehr, 2006; Roberts & Foehr, 2008). Such media provide constant connectivity to friends, families, school and work. As a result of the hyper-connectivity, we are layering media in between activities or on top of other activities (Freitas & Griffiths, 2008; Gardner, 2008). Several studies (Foehr, 2006; Roberts & Foehr, 2008; Rideout, Foehr, & Roberts, 2010) reported that children and teens spend an increasing amount of time multitasking, and they manage to pack increasing amounts of media content into the same amount of time each day, for instance, surfing online while watching TV. Nearly one-third of the 8 to 18-year-old children and teenagers in the U.S. talk on the phone, instant message, watch TV, listen to music, or surf the Web while they are doing their homework (Foehr, 2006; Roberts & Foehr, 2008).

Each new media adds itself to what we already are, creating both “amputations and extensions” to our senses and bodies, shaping them into a new technical form (McLuhan, 2002; Ong, 2002). McLuhan stated that by continuously embracing technologies, we became automatic devices used to provide error-sensing feedback for the technologies and correct the performance of technologies and that it was this dependency and linkage to technologies that make them an integral part of our lives. As such, whether intentional or not, we have become one large “bio-mechanical” system (McLuhan, 2002; The Matrix, 1999).

Carr (2011) discusses the undeniable re-wiring of the human brain as a function of newly adopted technologies. Tracing back to 8000 BC, Carr discusses the re-wiring of the brain’s synaptic connections through such technological changes as movement from oral to written cultures with the introduction of both cuneiform and hieroglyphs, the introduction of the Greek and Roman alphabets, and the eventual adaptation of the printing press. Carr cited the work of developmental psychologist Maryanne Wolf (2008), who made a case for the history of the re-wiring process and gave evidence of the evolutionary states as they related to logographic systems. Today we can extend the trajectory of this evolution to the thousands of software applications that continue to manipulate both text and pictures on our millions of mobile devices.

As greater numbers of software and mobile applications compete for our time, oftentimes our connections with family or friends appear to be on the losing side of the equation. In an environment where information is highly available and digitally pushed to most of us, many people have “the fear of missing out,” that is, a fear that if we did not check out what was pushed to us, we might lose some critical information and might suffer some unknown consequence or negative impact on our lives. Our behavior is being dramatically modified by emerging technologies. As Turkle (2011) suggested in her book Alone Together, this indicates that our relationship with technology has not yet fully matured.
Perceived New Skills, Needs, and Demands

Some scholars believe that the skills promoted by the convergence of new technologies, including creativity, peer-to-peer learning and multitasking are becoming necessary for success in today’s world. Prensky (2001) claimed that younger generations growing up with new media and technologies are comfortable and capable of parallel rather than sequential or linear access to information and are capable of multitasking. The concept of “metatasking” was also suggested as a focused multitasking behavior (Zimmerman, 2007). Metatasking involves simultaneously undertaking any number of tasks that ultimately accomplish one primary objective. Zimmerman (2007) states that as we continue to seek information online and encourage online collaboration, it seems to make sense to encourage a deep focused multitasking, to accomplish as much as we can, and to use these technologies to our advantages. However, claims as the above are far from being documented in research. For instance, Carrier, et al., (2009) compared multitasking skills between younger and older generations and they found that the younger generation exhibited similar mental limitations in multitasking as the older generation did, although members of the younger generation reported more multitasking activities. Hartley, Jonides, and Sylvester’s study (2011) showed no difference in managing dual tasks between older and younger adults.

It is obvious that this research area, in particular as multitasking behaviors emerging with new technologies, is ripe for investigation. In addition, much research on multitasking has been done in the lab using quantitative methods, and takes a strongly positivist stance with controlled experiments to identify the optimum distribution of tasks across input and output modality. Clearly, what happens in lab experiments does not often represent a complete picture of what happens in real life. For instance, the media multitaskers in real life may be more internally driven or directed on what to focus and when to switch between the tasks than those who are told what to focus on and when to switch in a lab environment, and as a result, may be better at multitasking (Lin, 2009). Such discrepancies naturally lead to disconnection between research and practice, and reduce the impact of research on practice. Therefore, the goal of this chapter is to look into people’s daily experiences so as to better understand the complexity involved in people’s daily multitasking activities and to better understand the human capacity for multitasking in natural settings. A qualitative method was incorporated to explore the environmental and technological factors involved in multitasking.

INDIVIDUAL STORIES BEHIND MULTITASKING ACTIVITIES

Methodology

This study used a qualitative approach (Creswell, 1998; Patton, 2001). As researchers, we were interested in what young people do when they multitask. According to van Manen (1990), phenomenology serves as the rationale behind the efforts to understand individuals by entering into their field of perception in order to see life as these individuals see it. In order to ascertain the experiences of multitasking, phenomenology appeared to be an appropriate approach because the researchers were primarily interested in understanding young people’s experiences from the perspective of those being studied, by learning directly from those who tell their stories.
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The phenomenological method is composed of three research processes: investigation of the phenomena, identification of general themes/essences of the phenomena, and comprehension of essential relationships among these themes (Spiegelberg, 1982; van Manen, 1990). In phenomenology, the researcher first details the individual statements of informants about experiences with the phenomenon before moving to meanings and clusters of meanings. This inductive approach to developing the qualitative narrative shows that the process is one that depends on an emerging design. The purpose of phenomenological inquiry is to discover the essential meaning or existential experience of what it is like to live through a certain experience, although the “meaning or essence of a phenomenon is never simple or one-dimensional. Meaning is multi-dimensional and multi-layered” (van Manen, 1990, p. 78). According to van Manen, “in order to come to grips with the structure of meaning it is helpful to think of the phenomenon described in the text as approachable in terms of meaning units, structure of meaning, or themes” (p. 78).

An important part of this research is devoted to understanding the experiences and discovering the reasons behind multitasking experiences. To find the reasons, it is best to allow the participants to speak for themselves. The following questions led the researchers to start the inquiry: 1) what is involved when one multitasks? 2) why do people multitask? and 3) what role does technology play in multitasking?

The researchers collected stories from 43 undergraduate students majoring in education (ages 21 to 29) at a southern university in the US, and 30 elementary school students (ages 6 to 11) close to the university in the same state. The population selection was decided by availability and relevance (i.e., the younger generations who are relatively more immersed in new media and technologies). Of the 43 undergraduate participants, there was one Caucasian male student. The rest were female students, composed of 40 Caucasian and two African-American female students. All the undergraduate students plan to be K-12 teachers in subjects such as math, science, English, art, and music after they graduate. Of the 30 elementary school children, there were 15 boys and 15 girls.

All the participants contributed their stories to the following questions: “Reflect on an incidence when you were sure that you were multitasking. What were you doing?” In addition, the researchers had discussions with the undergraduate participants about characteristics of multitasking, senses involved in multitasking, and the relationship between multitasking, learning, and technology. The collected stories were initially grouped by activities and contexts, for instance, combining all stories about watching TV while doing homework in one category. Afterwards, the patterns, meanings and themes behind the activities were identified and consolidated. Bracketing experiences enabled the concepts found in the data to be clarified and the categories to emerge. It helped to create an understanding based on the participants’ own descriptions.

Findings

Several themes emerged from the study. They are: 1) habit or impulse; 2) need for background noise; 3) conflicting needs over a short period of time; 4) perceived efficiency of multitasking; 5) ubiquitous technologies; 6) individual differences. We will explain these themes with individual comments or stories below.

Habit and Impulse

Ellen, an undergraduate, found herself constantly surfing online, responding to emails, or looking for something to eat while writing a paper. As much as she wanted to focus and complete the paper before doing anything else, Ellen found it almost impossible not to change her attention to other things in the process. She called her behavior impulsive.
Kara also described an impulsive behavior she had when she had to focus on writing a paper to meet a deadline. The more she wanted to focus, the more distracted she became. As soon as she started to work on the paper, she saw many other things she needed to do here and there. A day passed. She found herself writing little; although she did many other things she did not plan to do. Several students echoed Kara’s experience. Such an impulsive behavior can be dangerous and life-threatening sometimes. For instance, Carrie described an accident she had while driving:

_I remember a multitasking situation where I was driving my car but I got stuck behind a stopped truck. I was going to go around the truck, but a car was on the other side so I couldn’t. The truck started moving again so I also started moving. At the same time I looked at the radio to change the song and the truck in front of me had stopped again and I ended up rear-ending him. From now on I just keep my eyes on the road as I change the radio! Lesson learned!_

It appears that Carrie has formed a habit of changing radio channels while driving. This may be fine in some occasions; however, in this situation, it caused distraction and interfered with Carrie’s response to a sudden urgent situation, resulting in the accident.

**Need For Background Noise**

Several participants indicated that they needed to multitask in order to focus, particularly when they were doing school work or housework. David, an 8-year-old, said that he would either listen to music or have the TV on so that he wouldn’t be bored doing his homework. Dana, an undergraduate says:

_I prefer having background noise and an occasional distraction when I’m focusing… I personally find it difficult to focus for extended periods of time on a single task – it becomes monotonous, and I sometimes feel discouraged at a lack of progress._

About half of the participants from both age groups in this study talked about doing homework while watching TV, text messaging, or surfing on the web. This phenomenon is also described in the Kaiser Family Foundation studies, which reported that teens claimed that they cannot tolerate the silence when they do homework, and that they must have something to tune out in order to concentrate (Foehr 2006; Roberts & Foehr, 2008).

It is, however, not clear whether these activities distracted the participants from getting their homework done, or helped them to remain awake and interested in completing their homework. Some researchers point out that performance can be affected by workload being too high or too low (Nachreiner, 1995). Sustained low workload (under-load) can lead to boredom, loss of situational awareness and reduced alertness (Andrade, 2010). It is possible that if an individual is aware that they are losing focus on a task, switching tasks may cause a re-focusing of the brain central processing system. In the study conducted by Andrade (2010), when the primary task was monotonous, the phone operators became bored. A secondary task such as doodling helped them to stay active, reduce daydreaming, and improve memory recall of the primary task (Andrade, 2010). Other studies have also discovered that a non-intrusive background did not affect students’ learning performance (Lee, Lin, & Robertson, 2011; Lin, Robertson, & Lee, 2009).
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Conflicting Desires or Needs within the Same Period of Time

Often one decides to multitask because one cannot choose which task to do first. Emma, a 10-year old girl said that she had to multitask because she didn’t want to miss her favorite show on TV, but she had to finish her homework before she went to bed. The following is a similar story from Anna:

*Often, I try to watch TV while I’m doing homework. This usually doesn’t work and I end up watching TV; especially if it is a program that I am really interested in. If I don’t really care for the program, and someone else is in the room watching it, then I can focus on the homework. I usually tend to focus on whatever sounds more appealing; most of the time TV is more appealing than school work. I also focus on how major the assignment is. If it is something that has to be done now, then I will usually do it. Either way, I cannot accomplish both at the same time. I can’t finish my assignment and know everything that happened on a show at the same time.*

In the above story, Anna shifted her attention between her dual tasks: doing homework and watching TV. Anna often found herself paying attention to the more appealing – TV. In the following, Inez’s story described a similar pattern although her multitasking activity appeared to be pressured by the competing demands at work:

*When I am at work I do a lot of multitasking. I am a receptionist, so I have to be answering phones, writing down notes and messages, trying to answer questions, and making sure everyone is helped and greeted when they walk in the door. There are many times when I am helping out a client, and the phone rings. I have to try to help the client with their questions and still manage to answer the phone and try to also help the person on the phone. So I have to switch my focus around throughout the entire time I am at work. One person could need one thing and I have to concentrate on that need, then all of a sudden I have to put my focus on an entirely different task. It can get very stressful dealing with different people’s needs and different tasks that are needed to be done. There are many distractions that make it hard to concentrate on any single task, therefore multitasking takes place.*

Several undergraduate students told their experiences of working at restaurants or offices where they had to keep several tasks (e.g., customers’ orders) in their head while physically doing other things including talking on the phone, working the counter, or refilling coffee cups. The participants did not make any differentiation when it came to holding multiple tasks in queue in their minds and processing them actively. Holding multitasking tasks in mind was perceived as multitasking even when one was not actively carrying out the tasks. This is probably because one experiences an equal amount of mental stress holding tasks in mind as when one tries to conduct a number of tasks physically at the same time.

People who work in this fashion may tune in and out their focus on different things at different times. While they may increase their probability of sensing something from multiple channels, they may not delve deeply enough into any one area unless they make a conscious decision and take action to focus a particular sense on a particular task, often times to its completion. What is unknown, however, is to what extent we are capable of juggling several tasks at the same time, switching them in a short period of time, or holding them in mind for a longer period of time. Or is it simply a reality that any type of professional skill requires a certain level of multitasking?
Perceived Efficiency of Multitasking

Often, what drives people to do multiple things at the same time is the perceived efficiency, effectiveness and productivity. Multitasking is seen as saving time. Edward, an undergraduate, mentioned that he felt it a waste of time in meetings when he could only listen to the speaker without simultaneously doing other things such as surfing online, chatting with friends using Instant Messenger or replying to emails on his computer. Edward’s comment was echoed by many, although Edward and other students mentioned that this kind of multitasking behavior was sometimes perceived as inattentive and rude to the speaker and others. Yolanda, an undergraduate, states: “I’ve had instances where I’ve had the TV on while studying before. I have also eaten while driving, which is probably not too smart, but I’m always on the go and it saves me time.” Barbara, an undergraduate, indicated that she multitasked because she did not need to pay full attention to any of the tasks that she simultaneously carried out:

The times when I have the best multitasking skills is when I do something like watch TV, be in a conversation and do an assignment. I was able to do all of these at once because I only needed to focus on one thing at a time. I could tune out the conversation while writing a paper or focus on what is on the TV while still getting information from all other sources. I need background noise to work most of the time. When I multitask I am able to do all 3 very effectively because my mind can switch tasks quickly and effectively. I also am more used to it since I have been multi-tasking for many years now, probably since the 6th grade.

Helen, an undergraduate, stated:

I believe that I multitask on a daily basis. As a student, mom, and wife I am constantly doing two or more things at once. For example, I cook dinner every night while watching my 10 month old to make sure she will not get hurt crawling around the house. I feed my daughter while eating and talking with my husband during dinner. I use note cards to study while doing the laundry, playing with my little girl, walking the dog, feeding my daughter a bottle, and watching TV. I listen to music while I study. I chat with friends on the phone while checking emails, looking up information, and doing errands outside the home. If it were not for my multitasking abilities I would not be able to get an ounce of work done in any given day.

Zack’s story seems more convincing. In schools, we are all asked to take notes while listening to the teacher. Zack, an undergraduate, says: “I feel like I always multitask when I’m trying to take notes and listen to a teacher at the same time. It gets a little hard sometimes; depending on how fast she goes through the notes or how fast she talks.”

Taking notes while listening to the teacher is generally accepted as a good practice in schools. Zack’s story led us to the concept of doing multiple tasks or involving one’s multiple senses for one particular learning goal: to learn the subject matter of the lecture. This possibility, afforded by our technological extensions such as the notebook, the pen, or the computer, seems to create a synergy and affect the outcome or the quality of the goal, which is important to note in the teaching and learning environments. With the rapid integration of technologies in the classrooms, teachers and students are encouraged to use new technologies to pull resources from different channels. Such a practice has brought about many benefits for teaching and learning, while at the same time may have also encouraged multitasking activities (Lin & Bigenho, 2011).
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Ubiquitous Technologies

Sixty out of the 73 stories mentioned some form of technology, whether the technology was TV, radio, cell phone, iPod, computer, or other kinds of machines. The following are some examples:

...I will get home; get the internet up as I’m thinking about the order of what to do. At the same time I’m getting paper to print my time sheet and bringing up iTunes. Then lo and behold someone will IM me so I’ll start talking to them while pressing print and switching over to check my e-mail. But I’m only able to juggle all of these things because none of them requires my constant attention.

...I work on homework for my online course, have a few instant messenger boxes open, constantly checking email, either listening to my iPod or listening to online radio, and working on a developer program to create 3-D models for a 3-D gaming environment.

I think my multitasking usually involves the computer. We don’t have cable at home, but we rent tons of movies from Netflix and the public library. When I am at home I am usually reading blogs or other websites or playing on Neopets on my laptop while watching a movie and chatting on instant messenger or talking to my fiancé if he’s home. I have no trouble carrying on a conversation orally with him while typing in a conversation on instant messenger.

As awful as it sounds, I was once driving, talking on the phone, and trying to play my favorite song on my iPod all at once. I got where I intended to go safely, but I couldn’t remember at all how I arrived, because I was involved in too many other things besides driving. It’s scary to think of what could have happened due to my lack of attention.

Clearly, access to and use of social media, multimedia and technologies provided opportunities to multitask (Rosen, Carrier, & Cheever, 2013; Song, Nam, Lim, & Kim, 2013). The demand of our time each day seems to be expanding as well. Technology has been a boon, but also a bust in some regards. We can easily list the collective number of daily events that soak up our time in undesirable ways, things like junk mail, pop-up windows, telemarketer phone calls, commercials on TV and in movie theaters, to name a few. These assaults on our attention have major negative impacts on us every day including, for example, stealing our precious time through distractions, and by collectively de-sensitizing us to our environment.

Individual Differences

Different individuals have varying degrees of situational awareness and may be affected differently while eating, listening, seeing, texting, and playing. As humans, we develop an almost unconscious sense of which of our five senses should take focusing priority on any given task. For example, one might give the sense of sight priority over hearing or the sense of touch, because we know that the task about to be undertaken is more visually oriented. Another task, such as typing or knitting, might be primary focused on haptic functionality. As it is not easy to do two or more tasks at the same time, certain planning and skills are necessary as articulated by Elizabeth, an undergraduate:
I tend to try to get a head start on things, so in the process of that I try to do more than one thing at a time. Sometimes I’m successful, but other times I find myself overwhelmed, but not defeated. I get it done. Multitasking to me requires skill, time, and patience. I can watch television and do work while talking on the phone. I can cook and wash at the same time, but other than that, I think that I would have to do each task individually. I’m not the best at multitasking, but in certain situations I’m good at it.

Experience tells Elizabeth that she can do more than one thing with some tasks but not with others. Such differences may be due to the nature of the tasks and to her familiarity with the tasks at hand. Not only may one’s task priorities and familiarities influence one’s ability or decision to multitask, but one’s learning style and natural intelligences may also have impacts. Gillian Lynne, who is a choreographer and has created some of the most successful musical theater productions in history, was seen as hopeless and as having a learning disorder in school because she could not concentrate (Robinson, 2006). After seeing a specialist, Gillian was advised to go to a dance school, where she met like-minded people who engaged their entire bodies to think (Beilock, & Goldin-Meadow, 2010; Gardner, 1993; Robinson, 2006). There the kinesthetically-inclined Gillian found her personal formula for success. Personal preferences and learning style differences account for many of our inclinations when it comes to dedicating our time and engagements with our environments.

Gloria, a 10-year-old girl told her multitasking story about playing basketball. She said that she was using her hands to dribble, while trying to protect the ball from getting stolen, looking for an open person under the basket, and weaving in and out trying to get closer to the basket. It is easy to surmise from this story that one must be good at splitting and switching one’s attention constantly and rapidly between all the tasks in order to be a good basketball player. Common knowledge tells us that anyone can be a better player through practice. Research has also shown that one can be a better multi-tasker on the trained tasks through repeated practice, although that improved ability does not necessarily transfer when the tasks are changed (Dux, et al., 2009).

Frances, an 8-year-old girl said that she normally looks up her math homework before class and relates the problems for homework to the examples the teacher provides in class. This way she can ask questions about certain problems in the homework not mentioned in the lecture. The fact that Frances was able to plan ahead allowed her to ask additional questions while listening to the teacher, which further advanced her multitasking capability, making her a good student in math. Gus, a 10-year-old boy indicated that he had to multitask when he was playing video games. He had to focus on different aspects of the game and had to press different buttons on the game controller at the same time. Through repeated practice, challenges, and play, Gus had become a good multitasking video game player.

One similarity of Gloria’s, Frances’ and Gus’ stories is that the multitasking skills involved in the tasks – basketball, homework, and video games – can be improved through preparations and repeated practices over time. Rehearsal and planning ahead are skills possessed by chess masters and gifted pianists. Abby, a music teacher indicated that she would try to isolate certain components of taught music and get these components to be “automatic” for her students. Then, as the students learned the next component, they would not need to consciously “think” of the ones now automated. Abby described this practice as doing several things at once, one consciously and one or more subconsciously. This can be seen as one method of reducing cognitive load. And we now know from research on stroke victims, injured football players and military veterans that people can develop strategies to help rehabilitate the brain’s executive functions, even if the brain has suffered injuries and/or repeated trauma (Chapman & Kirkland, 2013).
IMPLICATIONS AND FUTURE RESEARCH DIRECTIONS

The purpose of this chapter was to explore the environmental and technological factors related to multitasking. The multitasking experiences shared by the individual participants showed that our multitasking behaviors, activities and abilities are not only constrained by our brain capacity for carrying out two or more tasks concurrently, but also affected by our daily habits, conflicting needs, perceptions, technologies, and individual differences.

In this study, all the participants were asked to tell their stories. As a result, one limitation of the study could be that the participants were only able to speak for their conscious multitasking activities while not being able to speak about the unconscious multitasking activities (i.e., autonomous multitasking activities). However, the 73 stories told by the participants provided rich and diverse multitasking experiences.

As the stories indicate, many students watch TV or use other media when they do their homework. In this case, homework is held as mundane and boring, and hence is hard to execute without other motivational stimulation taking place simultaneously. If this is the case for some students, then the long-held practice of getting students to focus on a lecture, may be an unproductive effort. The stories about playing basketball and video games indicate that many young people are good at multitasking in extra-curricular activities, especially when technology is involved. The mastery and use of technology such as remote control units, cell phones, tablets, game controller devices, digital recording and imaging devices are occurring at progressively earlier ages as children appropriate complex conventions much earlier than some adults, largely due to their sense of play and free time to investigate these functions.

The perceptions and experiences of multitasking were closely related to our attention. Our attention and focus might be dedicated, distracted, switched, or split. These functional attributes can be as a result of our personal preferences and priorities. Each of us has innate and acquired capabilities which come to us through personal experiences. Individual differences in attentional control have a significant impact on student learning in a multimedia instructional environment (Doolittle & Mariano, 2008). Personalization can bring benefits such as increased learning, greater enjoyment, enhanced motivation, and reduced learning time (Kelly, 2008). As educators, we bear the responsibility of looking into the motivation and skills required to help appropriate, motivate and transfer those skills to newer learning environments.

The participants’ stories in this study also revealed that our multitasking activities do not all remain in our brains. Our abilities to multitask are not only decided by our innate capacities, but also influenced by our experiences, environments, and technologies. The brain or cognitive ability is important; yet, our interaction with the environment may play an equally important, if not more important role in our ability to multitask. We have come to use the media and numerous technologies as extensions of the human body. The connections of multitasking to attention, preference, priority, ability, technology, and environment indicate that it would be difficult to make a broad claim of someone’s ability to multitask without knowing what is involved in a particular multitasking activity. Many of us can handle some multitasking situations more easily while having difficulty or risking our lives multitasking in other situations, as well stated by Saluucci & Taatgen (2008, p.101):

In some situations, multitasking can seem nearly effortless (e.g., walking and talking); for other situations, it can seem extremely difficult if not impossible (e.g., reading and listening to two distinct sentences); for still others, multitasking performance may depend heavily on the individual and/or the environment (e.g., singing while playing an instrument or dialing a phone while driving).
In their most recent book, Salvucci and Taatgen (2011) further presented the concept of “threaded cognition” as a unifying theory of multitasking. They indicated that the key to our multitasking ability is “the ability to take single-task skills and combine them as needed to accomplish a higher-level goal” (p. 7). Therefore, this study leads to further inquiries and investigations such as:

- When does multitasking help attention and when does it impede attention?
- When do new media and technologies enable us and when do they impede us from multitasking?
- To what extent are multitasking skills required in one developing an expertise or professional capacity?
- How does one transfer multitasking abilities in one’s daily life, if any, to newer teaching and learning environments?
- How can we incorporate different research paradigms and methodologies to explore multitasking so that we will have both empirical evidence and in-depth understanding of this phenomenon, including its potentials and challenges?

In researching the literature for this and other recent research projects we have noticed that the research on multitasking, when taken as a whole, is rather asymmetrically weighted toward the empirical methodology. Our recommendation is that researchers and scientists might instead welcome more diverse forms of research using various methodologies and conceptual frameworks. In this way issues of power, gender, educational equity, corporate hegemony, and political or technological determinism might also be uncovered in parallel. As humans we are meaning-making machines. A more diverse stanch on this topic should be openly embraced to better understand its impact on teaching, learning, and quality of life in the 21st century and beyond.

CONCLUSION

With our accelerating lifestyles and the constant pressure for greater efficiency from our workforce leaders, multitasking has become an expected skill. We are continuously encouraged to complete as many tasks as possible, rather than give our full attention to perfecting one particular thing in a limited time frame. Multitasking will continue to be a quality of life concern and non-trivial functionality for humans. The developing mantra has become “Perfection is the enemy of good enough!” Business encourages timely forward movement (i.e., just get it good enough to move to the next step) rather than discoveries of deeply focused, highly-extracted knowledge. This study points to the delicate interplay between multitasking performance measured objectively and the individuals’ real life experiences over time. It is hoped that this study and future investigations on the topic will help us better understand the environmental and technological factors involved in multitasking behaviors and find solutions to treat the problems.

Note: This current chapter is an enhanced version of an article published at the International Journal of Technology and Human Interaction (Lin, 2013) at the invitation of the journal editors. With this update, we have included new literature, discussions, and references.
The Environmental and Technological Factors of Multitasking

REFERENCES


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**ADDITIONAL READING**


KEY TERMS AND DEFINITIONS

Dual Task: A procedure in experimental (neuro) psychology that requires an individual to perform two tasks simultaneously in order to compare performance with single-task conditions (Navon & Gopher, 1979).

Media Multitasking: Media multitasking refers to concurrent use of multiple media (Roberts & Floehr, 2008).

Polychronicity: Polychronicity refers to the “extent to which people prefer to engage in two or more tasks or events simultaneously and believe that their preference is the correct way to do things” (Blue- dorn, 2001, p. 119).

Task Switch: Task switching refers to an executive function and a kind of cognitive flexibility that involves the ability to shift attention between one task and another (Monsell, 2003).