The impacts of

media *multitasking*

on children's learning & development

Report from a research seminar

By Claudia Wallis
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The impacts of media multitasking on children's learning & development:
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advancing
children's learning
in a digital age

the Joan Ganz Cooney Center
at Sesame Workshop

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1 Preface

New technology sometimes brings change that is so swift and so sweeping, that the impact and implications are hard to grasp. So it is with the rapid expansion of media use by children and adults—at work and at play, alone and in groups, for ever larger portions of their waking hours. Media multitasking—engaging in more than one media activity at a time—has rapidly become a way of life for American youth, according to a 2005 report from the Kaiser Family Foundation (Roberts, Foehr, & Rideout, 2005), and yet little is known about how this behavior affects their learning and development, their ability to attend, to plan, to think, and to relate to other people. The same may be said for adults, many of whom have taken to media multitasking to the point of "crackBerry" obsession. Aside from the recent alarming reports about the dangers of cell phone use while driving[1] or the impact of web surfing on worker productivity, little is known about the larger implications of this now ubiquitous behavior.

To begin to address this gap in knowledge and to frame a coherent research agenda, a multidisciplinary group of scholars in the emerging field of multitasking assembled for a one-day seminar on media multitasking and its impact on children's learning and development at Stanford University on July 15, 2009. With grants from the National Science Foundation and the Spencer Foundation, the seminar was jointly organized by Principal Investigator Clifford Nass, the CHIME (Communication between Humans and Interactive Media) Lab Director and the Thomas M. Storke Professor at Stanford University; co-Principal Investigator Roy Pea, representing the LIFE (Learning in Informal and Formal Environments) Center and Professor of Education at Stanford University; and co-Principal Investigator Michael Levine, Executive Director of the Joan Ganz Cooney Center at Sesame Workshop. Participants included recognized scholars from neuroscience, child development, cognitive science, communication, and education fields, along with business, policy, and advocacy leaders.

This report summarizes the ideas brought to light at the seminar, including an agenda for next steps by participants and for the larger research community. A glossary of terms, list of seminar participants, a background paper, and a list of questions generated at the seminar appear in the Appendices. Brief memos written by seminar participants on media multitasking in advance of the seminar may be downloaded from http://multitasking.stanford.edu/artifacts.html#memos and http://www.joanganzcooneycenter.org/.

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1 See the *New York Times*' 2009 series "Driven to Distraction" at http://topics.nytimes.com/top/news/technology/series/driven_to_distraction/index.html

2 The Seminar

Media multitasking is a young area of inquiry. It lacks a common language and agreed-upon definitions of the most basic terms—including multitasking itself. And yet the phenomenon has become ubiquitous so fast that there is an anxious, urgent demand for guidance and understanding coming from many quarters: parents, educators, employers, workers, marketers. "If you mention multitasking, people go insane—it's all they want to talk about," observed Stanford's Clifford Nass, in his opening remarks at the Seminar on the Impact of Media Multitasking, convened at Stanford University's Wallenberg Hall on July 15, 2009.

Roy Pea of Stanford University and the LIFE Center perceives a "moral panic about the evolution of norms." Children are texting at the dinner table; serious professionals are checking BlackBerrys during meetings and at the wheel of a car—behaviors that evolved rapidly and for which there is no common etiquette or even common sense. As individuals, we all contribute to this tidal wave of change and yet, collectively, we often feel pulled along with little control over the devices, messages, and 24/7 tasks and expectations that compete for attention. Indeed, as Pea pointed out, attention seems to be the scarcest resource of the Information Age: it is pulled, stretched, split, and scattered.

The daylong seminar brought together three dozen professionals from a variety of academic disciplines, as well as the business, education, and advocacy sectors. Not surprisingly, participants brought a variety of perspectives[2]. While some focused on new opportunities for efficiency, shared experience, and creativity, others pointed to potential threats to child development and learning, to unreasonable expectations for workers, and to the broader fraying of the social fabric. The meeting proceeded with a series of overview remarks and topical sessions designed to elicit ideas and identify critical issues and research questions concerning media multitasking (MM) and, in particular, its educational significance for children. The sessions included:

♦ Cognitive and social effects of media multitasking

♦ Media multitasking in informal and formal learning environments

♦ Designing educational tools that leverage media multitasking and multitaskers

♦ Building a research agenda: Funding and policy discussion

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2 These perspectives are captured in short memos that participants wrote in preparation for the seminar. You may access these memos at the seminar website (http://multitasking.stanford.edu/artifacts.html#memos) or from the Joan Ganz Cooney Center's website (http://www.joanganzcooneycenter.org).

Five themes emerged from the seminar discussions:

1. There is a need for clearer definitions and a common vocabulary in this emerging, multi-disciplinary field to facilitate both research and public discussion.

2. Panic and fear should not be permitted to obscure the upsides and creative potential unleashed by multitasking technology. Research must look at all sides.

3. Media multitasking is changing childhood and changing the workplace. Both present challenges that schools have yet to meet. Research can help fill the gap.

4. New tools and research methodologies must be developed. Current survey techniques don't adequately capture fast-evolving behaviors and current dual-task studies do not adequately represent real-life multitasking.

5. A careful, long-term research agenda must be balanced with the demand for timely guidance for parents, educators, and businesses.

The mixed blessings of digital multitasking, as well as different angles of vision represented by the commercial and academic sectors, were succinctly captured in a few choice phrases at the seminar. To Pea, today's multitaskers are "*always elsewhere*"; they are continuously "distracted from the physical presence of the here and now." To Don Roberts, emeritus professor of Communication, they are "*never alone*" and never unoccupied, perhaps missing out on vital contemplative experiences. But to Tico Ballagas of Nokia Research Center, media multitaskers are "*always together*"—continuously enjoying the support, companionship, and creative input of others in their mediated social network.

Weighing the costs and benefits of media multitasking inevitably involves value judgments, noted Matt Dye of the University of Rochester, and reasonable people can disagree. Dye pointed out that to some people, doing one thing really well is the highest value. Others may value getting more things done less well. Context matters. For an air traffic controller, for instance, work quality cannot be compromised by secondary tasks.

A day of lively exchange made it clear that there are far more questions than answers about media multitasking. There were frequent calls for more longitudinal research, more studies that look at child development and that leverage brain imaging technology and, especially, research methodologies that more accurately replicate real-life multitasking. And yet amid the expected calls for more and better research, there were repeated pleas to help a public worried about the impact of media multitasking on child development, learning, family life, office productivity, the communication of vital information on public health, safety, and other civic matters. "We can't wait for the longitudinal research. We need guidance now," insisted Rebecca Randall of Common Sense Media. Parents are most concerned, she believes, when kids are multitasking during homework. "What are the best practices around multitasking, how does that inform schools, homes, game design? We need some answers."

Other participants, including Milton Chen of the George Lucas Educational Foundation and Susan Schilling of the New Technology Foundation, argued that schools need help adapting to the multitasking world. They must teach students better management of time and attention, how to make creative use of multitasking technology without getting lost in distractions, while also making school more appropriately engaging to a generation accustomed to a multi-channel level of stimulation.

Participants from industry were eager to play a role. "Technology is finally ready to help in learning," said Dennis Frezzo of Cisco Systems. They were also eager for research to guide product develop-

ment. Better user interfaces could, for instance, leverage cognitive research on the limits of human attention. Demand for this sort of research comes from some surprising quarters: the automobile has already become an information medium. Thus the car industry needs guidance just as do makers of devices explicitly designed for multitasking such as PDAs and smart phones. Indeed, our safety on the road may depend upon it.

What follows is a detailed and thematically organized account of the key conversations and recurring calls for action heard throughout the day.

Media Multitasking: Defining & Tracking an Information Age Phenomenon

Cliff Nass opened the seminar by offering several telling examples of the ways that multitasking has changed commonplace behavior and norms. He described watching a student at Stanford lend an ear to a distressed friend, while keeping an eye on the open windows of her laptop. He described consulting to companies like AOL, where employees were required to keep chat windows open, whether or not it suited their personal work habits. He observed that car companies report ever increasing demand for "content"—music, Bluetooth, GPS, and other data—in automobiles because their customers "no longer describe driving as the primary task."

Indeed, Nass wonders if the notion of a primary task and secondary tasks is vanishing in the multitasking era. He noted that when he asks his students if instant messaging is a distraction from writing a paper, they answer, "only insomuch as the paper is a distraction from instant messaging." Studies that have examined the impact on family interactions when there's a television on "in the background" also raise questions about hierarchies of attention. Nass raised the intriguing question: "Is anything really in the background?"

With so much digital stimuli surrounding youth in this Information Age, it seems nearly impossible for them *not to* multitask. But how do we know, empirically, that the phenomenon has grown common enough to warrant our attention and concern? Learning Environments Session Chair Donald Roberts discussed findings from the 2005 Kaiser Family Foundation (KFF) report, which was one of the first surveys to track the growth of media multitasking among 8- to 18-year-olds. Indeed,

it introduced the term "media multitasking." The key finding of the study was that time spent with media by American children was holding steady at 6.5 hours a day, but that kids were packing in 8.5 hours of media exposure within those 6.5 hours by engaging with more than one medium at a time. An updated report will be out in 2010. Roberts, a co-author of the report, noted that the rapid evolution of media has meant that these surveys are always "a technology behind." Thus, the 2005 survey failed to ask about cell phone use; a new one, scheduled for release in early 2010, includes cell phones but doesn't ask about Twitter. Fast-evolving media will inevitably pose a challenge to any longitudinal studies.

Ulla Foehr, who also worked on the 2005 KFF survey, reviewed some of its findings: Eighty percent of young people engage in media multitasking. And, whereas television is the least multitasked medium—only 17 percent of TV time is paired with another medium—computers, predictably, are the most multitasked medium. In fact, two-thirds of the time kids are on computers, they are engaged with other media, and those who have a computer and can see a TV from that computer do more media multitasking. Foehr noted that it will be interesting to see if this distinction is maintained as TV and computer converge. Finally, a significant minority of youth—15 to 20 percent—do not engage in media multitasking. Roberts urged that this group be studied: "Let's not forget them."

While seminar participants agreed on the prevalence of media multitasking, definitional concerns surfaced throughout the day. Do you need to use more than one medium to be engaged in media multitasking? In one important respect, this idea seems dated in that video, radio, music, and chat have converged on the computer and on smart phones. Indeed, as a representational technology *par excellence*, the computer is a *meta*-medium, in which all previously disparate media can be replicated,

connected, and even integrated: text, video/film, photos, animation, graphics, diagrams, simulations, and more (Pea & Gomez, 1992). Perhaps the term "media multitasking" should give way to "digital multitasking" or simply "multitasking." Another definitional question: does multitasking necessarily entail many goals—say, doing your holiday shopping online, while working on a project and chatting with friends? Or, are you also multitasking when pursuing a single task in multiple ways—for example, surfing the web for information, reading a document or book, and checking emails that are relevant to the task at hand?

To frame the discussion on the cognitive and social effects of the behavior, session chair and UCLA professor Patricia Greenfield identified three types of media multitasking. The first is combining a mediated task with a real-life interaction, such as texting while at the dinner table. The second is combining tasks on two or more media, as when one listens to the radio while text messaging. The third is when one engages in multiple tasks within a single medium, such as listening to iTunes while checking email and doing research online. University of Oregon's Ulrich Mayr, presenting a different perspective, emphasized that multitasking is actually rapid task switching, since the human brain does just one thing at a time.

Media Multitasking Website

Visit the Media Multitasking website to read the bios of seminar participants, download their pre-seminar memos, see the agenda for the day, and learn more about individual sessions.

http://multitasking.stanford.edu

Cause for Alarm? Media Multitasking, Learning, & Development

Juggling multiple streams of media has become a norm of 21st century work and play, for adults and young people alike. How does it affect the way we think, learn, remember, and otherwise process information? According to Mayr, rapid task switching has significant costs in speed and accuracy: there are costs to trying to track multiple tasks, there are costs to switching between tasks, and there are "global switch costs" to merely having the option of multitasking. In other words, just knowing that you've got new emails awaiting your attention can distract you and slow down your work, even if you don't actually stop to read them. Research indicates that, with practice, people can become more proficient at task switching. These improvements occur in the ability to resume an earlier task, according to Priti Shah of the University of Michigan. Still, there is a reduction of performance with all multitasking, and there is a cognitive fatigue[3] factor.

Greenfield reviewed the pluses and minuses of media multitasking based on a review of literature, panelists' memos, and some anecdotal accounts. Her list of positives was shorter than her list of negatives. On the plus side, research shows that people who acquire expertise at video games have an enhanced ability to divide their attention on certain visual tasks. Kearney (2005), for example, showed that two hours of a shooting game improved performance on four simultaneous tasks that are useful in the military job of standing guard. Psychologist Edward Hallowell, on the other hand, has observed that constant task juggling can cause situationally-

3 For a definition of "cognitive fatigue" and other technical terms, see the Glossary on page 8.

based attention deficit disorder (irritability, declining productivity, disorganization). Greenfield cited additional studies that suggest that children who are deeply engaged in media multitasking become less engaged in family life (e.g., Ling & Yttri, 2002; Ochs as reported in Wallis, 2006).

Other seminar participants have also shown that dividing attention takes a toll on learning and metacognition, or the awareness of one's learning. Lori Bergen, for example, demonstrated that people retain less information from a CNN broadcast that includes a news crawl at the bottom of the screen than from one that doesn't. Multitasking while learning appears to affect both the quality of learning and where we later process the lesson in the brain, according to research by psychologist Karin Foerde of Columbia University. fMRI scans indicated that subjects who learned a weather prediction task while performing another task did more processing in the striatum and less in the medial temporal lobes compared with subjects who were not forced to multitask. The single-task learners also had a deeper, more flexible understanding of the weather prediction task. This sort of research raises interesting questions about the impact of, say, chatting with Facebook friends while doing homework or texting during a lecture. In her seminar memo, Foerde noted that one could not discern the difference in the quality of learning merely by measuring performance: both groups performed the weather prediction task equally well. Only metacognitive evaluation revealed the deeper understanding gained in the non-multitasking condition—a finding that has implications for educational assessment.

Brief presentations by Georgetown University's Sandra Calvert and Brown University's Marilyn Jager Adams were relevant to learning in the formal environment of school. In her seminar memo, developmental psychologist Calvert described a study that found that college students who multitasked more took much longer to write an assigned critique

than those who multitasked less, but the quality of the work was not significantly different (Calvert & Wells, 2007). Early literacy scholar Adams discussed the importance of reading as a foundational skill for academic work. Reading is self-paced and allows for reflection. The question is whether engaging with streaming media or multitasking while reading could possibly allow for that kind of deep, reflective thought.

Glossary of Terms

Active multitasking vs. passive multitasking
Activities involving creating versus just watching. Alternately, lean-forward and lean-back media multitasking.

Cognitive fatigue
Loss of focus and mental energy, a potential consequence of task juggling. (Of course, lack of sleep, tiredness, and other causes can lead to such fatigue, too.)

Executive function
The set of cognitive abilities used in goal-directed behavior to monitor and control thoughts, actions, and emotions. Includes memory, impulse control, planning, error detection, and correction.

Global switch costs
The cost of merely having the option of multitasking available as a potential distracter even if you don't avail yourself.

Macro-multitasking
Juggling numerous projects, assignments, or tasks with overlapping due dates.

Media multitasking
At least three types: (a) between medium and face-to-face interaction; (b) between two or more media; and (c) within a single medium.

Medium
A modality of representing information, e.g., text, photos, music, diagrams, animations, and video. The computer is not a single medium, but a meta-medium in which previous media can be represented, connected, and integrated in new ways.

Metacognition
Thinking about thinking; awareness of one's thought processes, as well as how to regulate them.

Micro-multitasking
Switching attention to deal with email, phone calls, background music, personal interruptions, etc. while working on one primary task.

Social multitasking vs. solo multitasking
Solo multitasking is doing so on one's own. Social multitasking is in concert with one or more other persons at least some of whose tasks involved in multitasking overlap with one another (e.g., two adolescents side by side in a movie, texting with one another and with friends while also watching the movie they have gone to see).

Switch costs
Costs in time and efficiency of toggling between tasks.

Trait multitasking
A marked preference for multitasking over single-tasking. It is not clear how much this is an acquired preference or an inherent preference.

Given that infants are now born into a media-rich, multitasking world, the psychologists present were concerned with the developmental implications of media multitasking. Anderson cited his fascinating 2008 study, which showed that toddler play is interrupted when a television is on in the background—even for children too young to actually watch TV. By age two, Anderson says, children commonly watch TV while they play with toys or engage in social interactions, learning how to monitor TV audio for cues. This, Anderson suggests, may be the earliest form of media multitasking. Other recent research by Dmitri Christakis at the University of Washington has shown that background TV reduces the number of vocal exchanges between parent and child as well as toddler vocalizations (Christakis, 2009).

Developmental psychologist Stephanie Carlson of the University of Minnesota studies the basic developmental processes in executive function—memory, allocation of attention, cognitive flexibility, impulse control—in very young children, and is interested in exploring the impact of media multitasking on the acquisition of these critical cognitive skills. Her research shows that a make-believe context makes it easier for young children to exhibit these skills, a finding that may be relevant to media multitasking. Among the many research questions Carlson proposed was a broad and critical issue: How does our multitasking environment affect the primary learning tasks of childhood—empathy, language learning, motor development, and executive function?

Carlson also helped put the phenomenon in context: "We need to consider that media multitasking is a fact of life for youth and part of a dynamic system in development. Access to it, its appeal, and its effects are likely to change over time. We need to be open to the possibility that at least for some individuals in some settings and at some points in development, multitasking is consciousness-expanding and likely to foster a sense of choice and volition over one's actions."

Setting Research Priorities

Seminar participants agreed that the research to date suggests that multitasking may be hindering children's ability to absorb the educational content they need to absorb, and develop the skills and dispositions required to become good learners. To inform strategies for helping students better recognize and manage the distractions they face, Victoria Rideout, co-author of the 2005 Kaiser Family Foundation Study, recommends that researchers go out into the field to observe how much and in what ways students are media multitasking during class or homework time. Other panel members were interested in exploring the role of motivation while multitasking. Do we multitask more when work is boring? What is the role of motivation in the successful allocation of attention while multitasking? It was proposed that more research is needed to determine whether and how effective multitasking can be learned beginning in the early years.

Cliff Nass urged researchers to study not only the act of multitasking, but also the trait of being a habitual multitasker. Clearly, some people prefer multitasking while others seem to avoid it. It's not clear how gender, age, experience, and other factors might influence this. A recent study by Stanford student Eyal Ophir (Ophir et al, 2009) indicates that people who describe themselves as habitual multitaskers have impaired performance on tests of attention and cognitive control. The results, said Nass, show "enormous differences between people who multitask all the time and those who don't." Mayr asked if efficient task jugglers are the ones who seek out multitask environments or if, instead, people who are drawn to multitasking are those who have difficulty focusing. Ophir et al (2009) suggest the latter, though it's not yet clear if this difficulty focusing is the cause or the effect of their multitasking habits. Some people seem to become habitual or even compulsive multitaskers, which raises questions

about how MM activates reward structures in the brain. Is multitasking addictive only for some or for everyone? Wagner noted the emergence of "trait-like effects" and suggested that researchers could explore this trait with longitudinal studies and even withdrawal studies. Another area for neuroscience: examining reward properties of various media.

There was much discussion about methods used in researching media multitasking: questions of design and of practical application. Mayr and others raised concerns about whether the forced multitasking situations typically used in research settings are relevant to real-world MM, which is more volitional. This line of reasoning points to a need for more naturalistic study designs. Neuroscientists at the seminar called for greater use of imaging techniques in the study of MM. And Bergen stressed the urgency of bringing research findings to those who work in relevant industries. Broadcasters, she observed, need to know that they may be conveying less *remembered* information, not more, by adding visual bells and whistles to a news broadcast. Car manufacturers also need to understand cognitive issues. Bergen asked, "Are we translating our work" to guide these industries?

Roberts, Rideout, and Foehr's 2005 KFF survey was based on self-reports, and only a self-selected sample of participants kept media diaries. Furthermore, the survey did not distinguish between using two media and using more. Though the KFF report was foundational to the field, Roberts would like to see better methodologies moving forward, including longitudinal studies designed to track the performance and development of multitaskers over several years. But Common Sense Media's Rebecca Randall reminded participants that parents are "in a panic" about how to manage their children's digital habits and how to keep them focused on academic skills in a world of distraction. "We can't wait for the longitudinal research," she emphasized. "We need guidance now."

Designs for a Multitasking Age

Studying media multitasking is one thing; taking action on the challenges and opportunities it poses is another, and one that many in the room were willing to take on. Is multitasking an essential workplace skill for the 21st century? The consensus of participants was that it is, but not enough is known about how to help workers to multitask effectively and how to prepare young people to master this skill. A Basex study, for example, found that information workers spend a mean of just three minutes on task before being interrupted—a pattern that is highly inefficient (Spira & Feintuch, 2005). Ophir suggested a distinction between "macro multitasking"—managing multiple assignments and "micro-multitasking," managing small interruptions. "Juggling many assignments is absolutely necessary in the 21st century workplace," he said, "but perhaps we can learn to limit the tiny task interruptions." Foehr suggested that teaching students such skills could become a vital part of media literacy programs in schools. Rideout believes that we "should make it a priority to teach kids how *not* to media multitask in a learning situation. Perhaps schools should be the place we carve out for kids to concentrate on one thing at a time and learn the value of putting aside media to concentrate deeply, when necessary."

Others had ideas for redesigning the classroom experience to engage a generation of students who enjoy the stimulation of simultaneous streams of entertainment and information. Milton Chen of the George Lucas Education Foundation proposed a vision for this. Schools, he said, should become more like the modern workplace and revolve less around the single stream of information delivered by the teacher or textbook. Learning would be project-based, productive use of digital tools would be encouraged, kids would spend less time in the classroom, lectures would be online, classroom activity

would be discussion-based, and adults would play a wider range of roles: teacher, mentor, career coach, etc. Kids might find this type of environment to be at least as invigorating as their media lives at home.

Jim Gray of Leapfrog, Dennis Frezzo of Cisco, and Coe Leta Stafford of IDEO said that their companies were eager to develop products that would promote this kind of digital creativity and learning. "Technology is finally ready to help in learning," said Frezzo, who is interested in how multi-user games could be used in school. But Stafford also noted frankly that businesses take their cues from the market, not from ideals. "We designers are pretty responsive to what people want, as opposed to whether it's good for them," she said.

Pea suggested that educators and designers think about media multitasking as a continuum of engagement ranging from passive (listening to music, watching video), to active (surfing the web, selecting content), to the creative (editing and uploading video, managing one's identity on Facebook). Educators are clearly most interested in promoting creative engagement. The Oracle Education Foundation's Bernie Trilling cited Singapore's new motto for educators: "Teach less, learn more." He suggested that U.S. schools leverage MM technology to achieve a better mix "between direct instruction and media-rich, student-driven learning."

The New Technology Foundation's Susan Schilling mentioned the New Technology Foundation's work with 50 schools around the country that do exactly what Trilling is suggesting. The curriculum, she said, is "wall-to-wall project-based learning." Kids learn how to manage digital tools and their own attentional habits because it is part of the curriculum and assessment. "They are graded on critical thinking, collaboration, and time management. We blur the line between school and what comes next."

On a more philosophical note, Roy Pea asked the group to consider "where the values and norms that control our world come from." We are called upon to adapt to a buzzing, distracting world of 24/7 multitasking, but there may be a need to push back rather than hop on board. Consider the long-term effects of "commercial exploitation—a new Taylorism—to squeeze out every available bit of value from a worker across every hour of the day. Consider personalized attention marketing from media and advertising designed to be intensely customized to your data on histories of web browsing and media use." Projecting out current trends, Pea suggests that we may be heading toward a world in which individuals are "always elsewhere"—always distracted or distractible "from the social and physical presence of here and now to a more appealing attentional target."

The ensuing discussion picked up on this theme. Tico Ballagas of Nokia was quick to see a positive in the always-mediated world. "Instead of always elsewhere," he said, "how about always together?" Ballagas gave the example of a parent using Skype to share a book with a child when the two were physically apart. Communications technologies, he noted, can enhance social interactions, which is a big part of their allure. "Kids want to make everything social"—homework as well as the dinner table. That observation prompted Don Roberts to ask about the implications of being "never alone" and "never down time." Said Roberts, "Maybe the most important time that kids have is down time, when they are sitting staring at a wall."

3

Next Steps: Building a New Frontier for Media Multitasking Research

The group did not attempt to reach consensus on a comprehensive follow-up plan for research and development initiatives. Instead, participants suggested a set of high-priority next steps for funders, industry leaders, and practitioners to consider:

Research and Development Priorities

The federal research agencies responsible for understanding children's well-being, development, and education should help a multi-disciplinary array of scientists and practitioners study and define the impact of media multitasking. The National Science Foundation, the National Institute for Child Health and Development, and the United States Department of Education should deepen the seminar's initial exploration with their own convening activities and assess areas where research partnerships will be most productive. In addition, research associations such as the National Academies of Science and the National Academy of Education, and professional societies such as the American Educational Research Association and the Society for Research in Child Development, should define new areas of inquiry on the frontiers of research in media multitasking and the underlying developmental, cognitive, and neurobiological functioning.

Seminar participants proposed the following areas as high priorities for government funding agencies and foundations to consider:

♦ *An early childhood research group to examine the roots of multitasking behavior among preschool children.* The group could examine key concerns such as the differences between children growing up in heavy media consumption environments and those with limited early exposure, and how multitasking may offer benefits and/or disadvantages as young children enter school.

♦ *Behavioral and social effects of multitasking.* What are the effects of the three types of multitasking: within-medium (e.g., multiple windows open on the computer), between media (e.g., talking on a cell phone while at the computer), and between media and human beings (e.g., talking on the cell phone when having a family dinner)? How do these behaviors affect social interactions and relationships with family and friends? We also need to empirically assess the costs and benefits of multitasking on cognitive, social, even cultural planes.

♦ *The development of new data systems and instruments to assess media multitasking across developmental periods.* Measurement is the cornerstone of good research: there is currently no gold standard to measure media multitasking across developmental periods. There is also a lack of regularly collected data sets on children's digital

media access and use: a national survey on a bi-annual basis should be added to an appropriate vehicle such as the National Education Longitudinal Study (NELS: http://nces.ed.gov/surveys/NELS88).

♦ *Expanded studies that target the question of causality.* This would include both experimental (e.g., withdrawal designs) and longitudinal study designs. Research is needed to determine cause-and-effect, and in particular how media multitasking may impact core neurobiological systems that support reward-based learning, addictive behavior, and the allocation of attention.

♦ *Brain imaging studies.* Such research would greatly advance understanding of the physiological mechanisms in play during multitasking. Imaging studies would, for example, complement behavioral assessments of impact, of multitasking on attention, and executive function development.

Over the course of the day, participants offered dozens of questions—covering a wide variety of disciplines and methodologies—to drive new research on the media multitasking phenomenon. These questions are listed in Appendix C.

Dissemination and Public Engagement Priorities

As results from longitudinal studies will take a long time to develop, seminar participants, other scholars, and their affiliates should aggressively disseminate what is currently known from cognitive, developmental, and neuroscientific research to provide guidance to parents, teachers, and industry. Among the priorities suggested by participants:

♦ *An online clearinghouse and networking community* for researchers to define study topics, share instruments, review research findings and prepare public engagement strategies, modeled after other research networks convened by government agencies such as NSF and private foundations such as MacArthur, WT Grant, and the Carnegie Corporation.

♦ *Guidance for parents.* Public engagement organizations such as the Joan Ganz Cooney Center and Common Sense Media develop basic "rules of thumb" for children using media, to be vetted by a research advisory board.

♦ *Guidance for educators.* Industry leaders in gaming and mobile platforms should bridge the formal and informal learning environments so that these platforms can be better adapted for use in schools. These industry leaders should work with educators to create curriculum and assessments that leverage the power of media for learning. They should also collaborate on using games and other kid-friendly media to teach time and attention management in a digital age. (For extended analyses of these issues of learning across settings, see publications of the NSF-funded LIFE Center at http://www.life-slc.org.)

♦ *Brief large-scale survey researchers to shape public support for more experimentation in this area.* The Kaiser Family Foundation, for example, updated its baseline assessment of children's media multitasking behaviors in early 2010 and the work of this group can complement the KKF's findings. Participants also called for a more regular, wide-scale accounting of children's digital media habits and its consequences for healthy development and learning.

4 Appendix

Appendix A: Seminar Participants

Marilyn Jager Adams, Ph.D.
Visiting Professor in the Cognitive and
Linguistic Sciences, Brown University

Daniel Anderson, Ph.D.
Emeritus Professor of Psychology,
University of Massachusetts at Amherst

Tico Ballagas, Ph.D.
Interaction Designer & Human-
Computer Interaction Researcher,
Nokia Research Center

Richard Beckwith, Ph.D.
Research Psychologist, Intel Corporation

Lori Bergen, Ph.D.,
Dean of the Diederich College of
Communication, Marquette University

Sandra Calvert, Ph.D.
Professor of Psychology,
Georgetown University
Director, Children's Digital Media Center

Stephanie M. Carlson, Ph.D.
Associate Professor,
University of Minnesota Institute of
Child Development

Milton Chen, Ph.D.
Executive Director,
George Lucas Educational Foundation

Dixie Ching
Senior Manager of Research &
Communications, The Joan Ganz Cooney
Center at Sesame Workshop

Barbara Chow
Education Program Director,
Hewlett Foundation

Matt Dye, Ph.D.
Research Associate in the Brain &
Cognitive Sciences, University of
Rochester Center for Language Sciences

Ulla Foehr, Ph.D.

Karin Foerde, Ph.D.
Postdoctoral Researcher of Psychology,
Columbia University

Dennis C. Frezzo, Ph.D.
Senior Manager of Instructional Research
& Technology, Cisco Systems

Jim Gray, Ed.D.
Director of Learning, LeapFrog

Patricia Greenfield, Ph.D.
Distinguished Professor of Psychology,
University of California at Los Angeles
Director, Children's Digital Media Center

Michael H. Levine, Ph.D.
Executive Director, The Joan Ganz
Cooney Center at Sesame Workshop

Ulrich Mayr, Ph.D.
Lewis Professor for Psychology,
University of Oregon

Clifford Nass, Ph.D.
Professor of Communication,
Stanford University
Director of the Stanford CHIME Lab

Eyal Ophir
Recent graduate of Psychology,
Communication, and Symbolic Systems,
Stanford University

Roy Pea, D. Phil., Oxon.
Professor of Education and the Learning
Sciences, Stanford University
Co-Director, Stanford HSTAR
Co-PI of the LIFE Center

Rebecca Randall
Vice President of Outreach,
Common Sense Media

Byron Reeves, Ph.D.
Paul C. Edwards Professor of
Communication, Stanford University
Co-Founder & Faculty Co-Director,
Stanford HSTAR and Media X

Donald Roberts, Ph.D.
Professor Emeritus of Communication,
Stanford University

Susan Schilling
Chief Executive Officer,
New Technology Foundation

Priti Shah, Ph.D.
Associate Professor in Cognition and
Perception and Educational Psychology,
University of Michigan

Coe Leta Stafford, Ph.D.
Senior Design Researcher, IDEO

Kaveri Subrahmanyam, Ph.D.
Professor of Psychology,
California State University, Los Angeles

Lori Takeuchi, Ph.D.
Director of Research, The Joan Ganz
Cooney Center at Sesame Workshop

Bernie Trilling, Ph.D.
Global Director, Oracle Education
Foundation

Vanessa Vega
Doctoral Candidate in Communication,
Stanford University

Anthony Wagner, Ph.D.
Professor of Psychology,
Stanford University
Director, Stanford Memory Lab

Claudia Wallis
Meeting Rapporteur and Journalist

Ellen Wartella, Ph.D.
Distinguished Professor of Psychology,
University of California at Riverside

Appendix B: Background Paper

Prepared for the Seminar on Impacts of
Media Multitasking on Childrens Learning
and Development

By Vanessa Vega, M.A.
Stanford University, June 2009

Executive Summary

Children are growing up in a rapidly changing,
information-rich age in which communication tech-
nology has become more affordable, accessible, and
available than ever before. Today, American children
ages 8 to 18 spend approximately the same amount
of time with media per day as they did before the
recent explosion of digital tools (around 6.5 hours),
but they have increased the amount of media con-
tent they consume by approximately two hours per
day (Roberts, Foehr, & Rideout, 2005). According
to the Kaiser Family Foundation, approximately
one-third of children say they usually absorb some
other medium while watching TV, listening to mu-
sic, using the computer, or reading (Roberts, Foehr,
& Rideout, 2005). The phenomenon of "media mul-
titasking" and its inherent mental habits of dividing
attention, switching attention, and keeping multiple
trains of thought in working memory have signifi-
cant implications for the way young people think,
learn, socialize, and understand the world.

Scholars know a great deal about the mechanisms of
human development that support children's acqui-
sition of new knowledge and skills. As the media
environment that surrounds children grows more
ubiquitous, and children's media activity contin-
ues to grow in terms of exposure and complexity,
it is important to reexamine and reframe existing
theories and practices in the realms of education

and human development. Our intention is to spur
research on media multitasking in youth and adults
by defining key questions for interdisciplinary
research and stimulating the formation of a com-
munity where more coordinated research efforts and
future collaborations can take place.

The purpose of the first NSF-sponsored seminar
on media multitasking in youth, to be held on July
15th, 2009 at Stanford University, in collaboration
with the Joan Ganz Cooney Center, is to:

♦ Create a forum for interdisciplinary explora-
tion of available research and agenda setting for
future inquiry;

♦ Understand the theoretical and experimental
base from which to launch cutting-edge basic
and applied research on media multitasking; and

♦ Increase public awareness and drive policymaker
interest in the implications of media multitask-
ing for children's learning and development.

The purpose of this background paper is to: (1)
briefly describe the current state of knowledge
on media multitasking, as it relates to cognitive
development and learning in children; (2) define
questions and topics for interdisciplinary discussion
and research coordination, focusing on the devel-
opment of new methods, models, and theories for
studying media multitasking effects on learning and
development; and (3) catalyze discussion at the July
15 seminar.

Part 1 of this paper provides a brief overview of
the existing literature on media multitasking, as it
relates to learning and cognition. We suggest three
major categories of research that will benefit greatly
from interdisciplinary knowledge sharing and
coordination of future research efforts: (a) media

multitasking and cognition; (b) media multitasking and learning in informal and formal environments; and (c) designs that leverage media multitaskers. Part 2 discusses the goals of the seminar.

1. Overview of Existing Literature

Media multitasking is defined as engaging in multiple media activities simultaneously, including multiple windows on a single media platform and/or multiple media (e.g., web surfing on a computer while watching TV). Media multitasking behaviors can be measured using an index that quantifies time spent using various media simultaneously relative to total media use (Ophir, Nass, & Wagner, in submission), although the advantages and disadvantages of different measures of multitasking is not understood. Media multitasking can also be classified along a continuum, ranging from concurrent tasks with rapid switching to sequential tasks with longer time between switching (Salvucci, Taatgen & Borst, 2009). In considering the effects of media multitasking on learning and cognition, it is important to consider the educational content of media (Schmidt & Vandewater, 2008), and the extent to which media is semantically related, or requires conflicting information processing resources. Previous research has shown that children with media in their bedrooms, girls, and high sensation seekers are more likely to engage in media multitasking (Foehr, 2006; Jeong & Fishbein, 2007). Thus, media multitasking may be influenced by contextual factors, such as bedroom media and parental mediation, as well as individual differences, such as age, gender, SES, sensation seeking, attention problems, selective exposure, and Internet addiction (Block, 2008). In sum, accurate measurement of media multitasking, and consideration of the content, context, and individual differences involved will aid in understanding the impact of media multitasking on learning and cognitive development in youth.

MEDIA MULTITASKING & COGNITIVE DEVELOPMENT

A significant topic for future study is how media multitasking affects the development of neural structures in children's brains and cognitive abilities, as well as identifying neural structures involved in children's media multitasking performance. Research in the adult population has indicated that multitasking is supported by cognitive and neuroanatomical systems in the pre-frontal cortex region of the brain (Burgess, 2000; Koechlin, Basso, Pietrini, et al., 1999). Depending on the task, additional systems, such as the striatum, likely also support multitasking (Foerde, Knowlton, & Poldrack, 2006). The pre-frontal cortex is broadly associated with "executive control," which refers to "the ability to coordinate thought and action and direct it toward obtaining goals" (Miller & Wallis, 2009). Research has shown that the ability to multitask is limited in adults by numerous cognitive "bottlenecks" that can appear in various stages of perceptual, cognition, and motor processing, depending on particulars of the task domain (Meyer & Kieras, 1997). Multiple-resource theories (e.g. Navon & Gopher, 1979; Wickens, 2002) specify how tasks using separate resources may proceed simultaneously without interference, but when there is a resource conflict, the needed resource can allocate part of its processing time to each task. A key limitation on multitasking is that the ability to perform more than one decision-making process at any given moment is limited by a "response selection bottleneck." When performing concurrent tasks, regions in the pre-frontal cortex involved in response selection seem to queue responses, resulting in task delays (Dux, Ivanoff, Asplund & Marois, 2006). However, there is evidence to suggest that individuals can perform two tasks efficiently if tasks are well-rehearsed or familiar, suggesting a potential for "adaptive executive control," which transforms condition-action production rules into procedural knowledge (Schumacher, Seymour, Glass, et al,

2001). Since people can only handle one decision making process at a time, the way to handle two simultaneous processes is to make one of them automatic (so it requires no decision making). Reducing task interference may require extensive practice with the task, and can also be modulated by instructions about differential task priorities and the (daring) personal preference for scheduling tasks concurrently versus sequentially (cautious) (Schumacher, Seymour, Glass, et al., 2001). When and how such skills in dual task performance are acquired is a significant topic for future inquiry.

Few studies have examined the cognitive mechanisms and neural structures involved in children's media multitasking, or the extent to which cognitive "bottlenecks" exist in children. Recent fMRI studies suggest that children are better at multitasking than adults, presumably due to their enhanced ability to allocate attention and filter out irrelevant information, as compared to middle-aged and older adults (Grady, Springer, Hongwanishkul, et al., 2006; Hamilton, 2008). Limitations in the ability to multitask have been documented among children diagnosed with attention deficit hyperactivity disorder (ADHD) ages 7 - 13, indicating deficits in monitoring ongoing behaviors, goal-directed planning, and generating useful strategies for task completion (Siklos & Kerns 2004; Chan, Guo, Zou, et al., 2006).

Researchers have found evidence for small positive links between heavy electronic media use and mild attention problems among youth, particularly for entertainment content; however, the link between ADHD and electronic media use is complex and requires further research (Schmidt & Vandewater, 2008; Schnabel, 2009). Playing video games has been shown to improve visual attention in youth ages 7 - 22, in terms of allocating attention and filtering out irrelevant information (Dye & Bevalier, in press). In addition, playing video games has been shown to enhance the ability to divide visual atten-

tion in college students (Greenfield, Dewinstanley, & Kaye, 1994; Green & Bavelier, 2003). While the use of electronic visual media may enhance skills of visual attention and visual-spatial processing, it may not adequately cultivate higher order cognitive processing skills (Greenfield, 2009).

A key set of open questions are the causes and effects of long-term and chronic media multitasking with respect to cognitive processing. The results of one study (Ophir, Nass, & Wagner, in submission) showed that heavy media multitaskers are more susceptible to interference from irrelevant environmental stimuli and from irrelevant representations in memory. This led to the surprising result that heavy media multitaskers performed worse on a test of task-switching ability, likely due to reduced ability to filter out interference from the irrelevant task set.

MEDIA MULTITASKING IN INFORMAL & FORMAL LEARNING ENVIRONMENTS

Studies that examine the relationship between electronic media use and learning generally indicate that "the content delivered by electronic media is far more influential than the media themselves" (Schmidt & Vandewater, 2008). However, few studies to date have examined media multitasking and learning in youth. Research on multitasking in the adult population generally indicates that multitasking impairs the speed and quality of task performance when compared to performing tasks serially (Rubinstein, Meyer, & Evans, 2001; Iqbal & Horvitz, 2007; Posner & Boies, 1971).

In one study that examined the effects of media multitasking in the classroom, college students in one group were allowed to use their laptops during lectures while those in the other group were not. Students with laptops were obviously distracted by having access to the Web, e-mail, IM, and other digital tools, and suffered decrements on traditional measures of memory for lecture content (Hembrooke & Gay, 2003).

In general, dividing attention has been shown to disrupt memory encoding and reduce subsequent recall (Naveh-Benjamin, Craik, Guez, & Krueger 2000). Especially when two channels of information convey semantically different information, viewers can recall less information, and often only focus on one channel (Bergen, Grimes, & Potter, 2005; Drew & Grimes, 1987; Grimes, 1991; Lang, 1995; Reese, 1984; cited in Foehr, 2006). Cable news shows frequently feature divided screens with tickers and running headlines of semantically unrelated information, and the presence of news tickers has been shown to reduce memory for news content among college students (Bergen, Grimes, & Potter, 2005). However, when different information channels require non-conflicting processing resources, multitasking may not necessarily impair task performance. Youths' performance on a homework task was reduced when multitasking with soap operas on television, but their performance was not affected when multitasking with music or music videos (Pool, Koolstra, & van der Voort, 2003). Finally, learning under multitasking versus focused attention conditions may result in different types of memory, with different implications for knowledge transfer. In a recent study of adults, learning while maintaining focused attention resulted in declarative memory, which is associated with hippocampal activity and considered to produce richer, more flexibly applied memories. Learning while multitasking resulted in procedural memory, a form of memory associated with activation of the striatum and used to support habitual task performance, which tends to generalize poorly to new situations (Foerde, Knowlton, & Poldrack, 2006). Thus, if information is learned under multitasking conditions, the flexible application of knowledge associated with creativity and adaptive problem solving may be less likely to occur.

Media multitasking during lectures and homework may indicate that these tasks are failing to engage children's interests. Several children in the Kaiser Family Foundation's time-diary studies (Roberts, Foehr, & Rideout, 2005) expressed that media multitasking warranted the "slight" reduction in productivity because it helped them avoid boredom. Dewey (1915) theorized that "the divided mind" represents a division between interest and effort, "External mechanical attention to a task as a task is inevitably accompanied by random mind-wandering along the lines of the pleasurable," (p. 9). Meanwhile, children learn "the exact amount of attention that has to be given to the external material to satisfy the requirements of the teacher, while saving up the rest of his powers for following lines of suggestion that appeal to him," (p. 10). In Outliers, Gladwell (2008) notes frequently that extraordinarily successful people have dedicated at least 10,000 hours worth of practice in their area of expertise. The relationship between media multitasking and the ability and desire to focus, or to unify interest and effort, is an important topic for future inquiry in the domain of learning.

Barron's (2006) work on learning ecologies for youth development of technological fluency, as well as Hidi and Renniger's (2006) model of interest development, provide theoretical frameworks for understanding conditions that promote interest and learning across informal and formal settings. In particular, intimate social relationships play an important role in developing interests that lead to learning across informal and formal boundaries (Barron, 2006). There is evidence to suggest that media use is displacing family interactions in the home (Wallis, 2006) and cultivating impersonal social relationships (Turkle, 2007). However, the content of media and the context of use are important considerations. When media displace educational activities, they have been shown to adversely impact scholastic achievement, but when media provide educational opportunities, they have been shown to promote scholastic achievement (Schmidt & Vandewater, 2008).

Finally, the non-linear and decentralized structure of information on the web, which is potentially contributing to media multitasking behaviors, has potential to promote learning and creativity. In Everything is Miscellaneous: the Power of the New Digital Disorder (2007), Weinberger argues that by breaking down established orders of ordering information, individuals exposed to a concept in multiple decentralized contexts may gain deeper and more complex understandings of that concept (also see "cognitive flexibility theory" from Spiro & Jengh, 1990 for related prior work). Perhaps through revealing multiple and simultaneously true meanings of a concept, media multitasking might cultivate "dialectical" reasoning (e.g. Nisbett, Peng, Choi, & Norenzayan, 2001). In sum, preliminary research in informal and formal learning environments suggests media multitasking may well detract from learning, but it also has potential for enhancing learning. In considering the effects of media multitasking on learning, it will be important to define the context of learning, how learning is measured, and the outcomes of learning that are valued.

DESIGNS TO ENHANCE LEARNING

Many of today's digital tools were inspired by the highly influential 1945 Atlantic Monthly essay "As We May Think" by President Roosevelt's Science Advisor, Vannevar Bush. In this vision of the future of computing, Bush proposed that using technology to automate the routine aspects of thought would help to free up more time for scholars to devote to the creative aspects of thought (Bush, 1991; cited in Levy, 2007), solving what was referred to then as the "library problem," but which has more recently been reincarnated as "information overload" and the "data deluge" (NSF, 2008). Bush distinguished between the "routine" processes of thought, which he believed could be automated, and the creative work of deep and original thinking, which could not be automated. While modern society has better tech-

nology than ever before to automate and reduce the burden of routine processes of thought, it is failing to exploit its newfound time for creative thought and acts of leisure that nurture creative thought (Levy, 2007). When considering the role of media multitasking in our lives, considering the ratio of creative to automated thought processes may serves as a useful heuristic or design principle.

A recent longitudinal study revealed that, although young people demonstrate an apparent ease and familiarity with computers, they rely heavily on search engines, view rather than read, and do not uniformly possess the critical and analytical skills to assess the information they find on the web (CIBER, 2008). The youth of today need effective strategies, tools, and techniques with which to navigate the sea of information surrounding them. Teaching young people how to organize and manage information could help them improve their productivity and develop more intentional media use. Parents, teachers, and youth need to know how to leverage media multitasking habits to enhance learning. Guidelines for effective media multitasking could be derived from multiple resource theories, which specify when multitasking might result in information processing-resource conflicts, thus reducing learning and productivity. Furthermore, tasks involving routine thought processes might be completed effectively while multitasking, but tasks involving higher level cognitive skills, creative, or original thought require total focus. Salvucci & Taatgen (2008) propose a model for effective multitasking, which entails planning out an entire multitasking situation, suggesting individuals can move between tasks relatively automatically, and specifies principles for interruptions and keeping goals in working memory. Educational curriculum will need to incorporate different media activities to address the development of a variety of cognitive skills (Greenfield, 2009). Reading has been shown to develop imagination, induction, reflection, critical thinking, and vocabulary, while visual media

affords the development of visual-processing skills. Jenkins, Clinton, & Purushotma, et al. (2006) argue that the participatory media culture, enabled by the web and wikis, blogs, and media-sharing sites such as Flickr and YouTube, cultivates skills which are critical to participation in a global society permeated by Information and Communication Technology (ICT). Among the cultural competencies he describes are "transmedia navigation: the ability to follow the flow of stories and information across multiple modalities" and "multitasking: the ability to scan one's environment and shift focus as needed to salient details."

Finally, a media multitasking literacy curriculum should address how media distractions can strain social relations, particularly in the home (Wallis, 2006). Parents and teachers need to model effective multitasking and communicate the value of face-to-face interactions. Developing media multitasking literacy has the potential to improve family interactions in the home as well as the quality of learning in informal and formal environments. As researchers elucidate how learning and cognitive development are supported in media multitasking contexts, designers of educational tools and strategies can incorporate this knowledge to promote effective uses of media multitasking. Media multitasking can be like walking without looking where you're going, but if used consciously, it can perhaps help us get to where we're going and realize our creative visions more efficiently.

2. Goals of the Seminar

By focusing on the increasingly prevalent and evolving behavior of media multitasking, the seminar intends to create a forum for interdisciplinary dialogue about the frontiers of research. Leaders from fields related to media multitasking, child development, and learning will convene at the conference, encouraging a new academic community that will engage in interdisciplinary knowledge sharing, agenda-setting, and collaborative research. The seminar will provide a venue as well as online tools to share preliminary findings on media multitasking from our research labs. Furthermore, the seminar will catalyze research on this topic, promoting it among key decision-makers who may be able to advance investment in a new frontier of inter-disciplinary research.

One of the key outcomes for the seminar is to develop a coherent agenda for future research on the effects of media multitasking on learning and cognitive development in informal and formal learning environments, as well as the effects on social interaction and social relations. Through transparency and knowledge sharing facilitated by the conference sessions, and extensive public dissemination activities, the seminar aims to create a more informed community that will ultimately shape the future conduct of research on media multitasking and children's learning and development. These conversations will have the potential to introduce new ways to invest government and philanthropic funds, influence state and national policy, and change practices in K-12 classrooms. The LIFE Center, MediaX, and the Joan Ganz Cooney Center, with generous support from the National Science Foundation and Spencer Foundation will ensure that the results of the workshop will reach a wide community of researchers, as well as policy and education stakeholders.

Overall, we hope to create a solid theoretical and experimental base from which to launch both basic and cutting-edge applied research on media multitasking.

Appendix C: Research Questions Generated at the Seminar

Methodological/Epistemological

How do we define multitasking and media multitasking? Do we define it by the number of media used? The number of tasks? If one is using a variety of media in the service of a single task, should this be considered media multitasking (e.g., calling for directions while driving)? If one is using a single medium—e.g., the computer—for multiple tasks, is this media multitasking? Is the computer really one "medium" when audio, video, photos, interactive games, text, animations can all be integrated on it – or ought we to consider each of those media and not the "computer" as a medium?

Alternately, should the word "media" be dropped in favor of "digital" now that multiple media have converged on the computer and smart phones?

How should researchers distinguish between social/communicative multitasking and solo multitasking? How do they differ in terms of task interference, engagement, and other aspects of cognitive processing?

How can we design studies that better match real-world experience? Forced multitasking in lab settings may not approximate the more volitional nature of everyday multitasking.

How can we design and fund large-scale ethnographic and longitudinal studies (e.g., following infants raised in TV-constant homes vs. low-media homes)?

Are there valid animal models for multitasking?

How can we study the long-term effects of multitasking on brain development?

Developmental/Cognitive

How does our multitasking environment affect the primary learning tasks of childhood (i.e., empathy, language learning, motor development, executive function)? What are the potential costs and benefits (e.g., increased cognitive flexibility, creativity)?

Are there developmental windows for introducing media and media multitasking? And are there optimal levels of exposure at certain points in development?

How does the development of executive control competencies relate to multitasking?

In what ways do the specific media matter in terms of task interference, memory, learning, and other processing (e.g., games vs. text vs. video vs. audio-only, etc.)?

Are we inherently capable of moving easily from focused attention to dispersed attention? Does it need to be learned? (Stephanie Carlson notes that young children often overestimate their abilities to remember to do things, to manage multiple goals, and to resist temptation.)

What are the roles of motivation and reward systems in multitasking?

How and when does task switching activate circuits involved in addiction? For example, do people feel a compulsion to check email? Do different media activate reward systems differently?

How do we design imaging studies to look at brain activity during different types of MM and in different individuals?

Individual Differences

We need to understand individual differences in abilities and preferences for multitasking. How much of this is acquired, how much a character trait?

What moderates these differences: gender, age, culture, ethnicity, exposure?

How are individual differences in executive function related to media multitasking performance?

How does trait multitasking develop? What are the differences between people who actively prefer multitasking and those who prefer to avoid it?

Do efficient multitaskers seek out multimedia environments or is it the other way around, in that they have difficulty resisting them?

Do we get better at multitasking? Do only some get better? Or only with some types of multitasking?

What is the role of capacity to delay gratification in optimizing multitasking?

How do self-awareness, monitoring, and strategic organization influence media multitasking and its costs/benefits?

What can we learn from non-multitaskers? (KFF report shows 15-20 percent of kids do not MM.)

What can we learn about MM from special populations like those with attention deficit hyperactivity disorder (ADHD) or pervasive developmental disorder (PDD)?

Learning & Education

How do we guide students now and in the future to develop healthy, productive, collaborative, and creative media lifestyles?

What are the key developmental needs of students that relate to media use? How do we best match the media tools to the learning goals and a student's unique learning profile?

How are priorities set during MM? How conscious is the process? Are there optimal ways to prioritize that can and should be taught to children and adults?

Media multitasking is often used to fill interstices and waiting time during tasks. This may seem cost-free, but is it? What about the loss of downtime or recovery time?

What are the effects of background media on learning (e.g., television and music during homework, for example)?

As reading print is displaced, the pause-to-reflect moments, the pause-to-reread moments, may be lost. Continuously streaming media do not allow for it—though pause buttons on video and audio do. What are the effects on comprehension, retention, meta-cognition, and other aspects of learning?

Should media literacy programs be developed to teach best practices, priority setting, efficient self-management of time and attention?

What is the relationship between engagement/motivation and the allocation of attention? Students say they multitask through boring assignments. Do we need a higher proportion of assignments that demand focused attention so that students learn how? Do we need more assignments that leverage their ability to multitask and use media creatively?

How does the role of teachers change as schools incorporate more project-based learning in which students use media for research, communication, and creative production?

Social-cultural

How does the rise of MM impact family dynamics?

Is MM deepening generational segregation by promoting more intensive communication with peers and less between generations? This should be quantifiable.

What are the pluses and minuses of more socializing at a distance through media and perhaps less face-to-face socializing?

What are the social and cultural pressures to engage in media multitasking? It seems clear that there are social pressures among youth (from peers especially) and in the workforce (from management, customers, and peers), but we understand too little about such influences.

What are the health implications of media multitasking? More ADHD, obesity, sensory processing and self-regulatory problems, and/or Internet addiction?

Commercial & Product Development

How can new products/technologies leverage cognitive and development research to make MM more efficient, less disruptive, and train focused attention?

Do scaffolded reading technologies like LeapFrog help emergent readers? What are the best ways to design them?

Explore the impact of media channels that allow distance sharing of reading, video, and game experiences.

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Appendix E: About Us

Organizers of the Seminar

COMMUNICATION BETWEEN HUMANS AND INTERACTIVE MEDIA (CHIME) LAB

Stanford University's CHIMe Lab focuses on uncovering fundamental relationships between humans and interactive media. The Lab is interested both in advancing the overall understanding of human psychology and in exploring the practical implications of its discoveries. CHIMe findings have informed software application design in a variety of contexts, including personal computing, mobile technologies, collaborative work environments, education, e-commerce, and driving. Currently CHIMe has four areas of concentration: interfaces for automobiles, embodied agents, mobile systems, and technologies for developing-world contexts. http://chime.stanford.edu

THE LEARNING IN INFORMAL AND FORMAL ENVIRONMENTS (LIFE) CENTER

Researchers at the LIFE Center are exploring how people learn in a variety of different settings. LIFE, founded in the fall of 2004, is devoted to uncovering how humans learn in and out of school, from birth to adulthood, with an emphasis on the social foundations of learning. The Center's goal is to integrate and transform the science of learning in ways that change and improve education, training and self-directed learning. LIFE, a National Science Foundation-supported Science of Learning Center, represents a collaboration between the University of Washington, Stanford University, SRI International, Inc. http://www.life-slc.org

THE JOAN GANZ COONEY CENTER AT SESAME WORKSHOP

The Joan Ganz Cooney Center at Sesame Workshop is a nonprofit research and production institute named after the creator of *Sesame Street*. Housed at Sesame Workshop in New York City, the Cooney Center's mission is to foster innovation in children's learning through digital media. The Center supports action research; encourages partnerships to connect child development experts and educators with interactive media and technology leaders; and mobilizes public and private investment in promising and proven new media technologies for children. An important focus of the Center is to leverage the potential of interactive media to promote 21st century literacies so that students can compete and cooperate in our connected world. http://www.joanganzcooneycenter.org

Authors of the Seminar Report

CLAUDIA WALLIS
Claudia Wallis has been a regular contributor to *TIME* Magazine for 25 years, both as an editor and writer specializing in stories about health and science, education, women's and children's issues and social trends. She was the founding editor of *TIME for Kids*, a newsmagazine that debuted in 1995 and reaches nearly 4 million elementary school students. Ms. Wallis has written dozens of cover stories for *TIME*, including recent covers on the teaching profession, the multitasking generation and autism. She has also written for *Fortune*, *Rolling Stone*, and *Parade*. Her writing has won citations from the American Psychiatric Association and the American Society of Magazine Editors, among other organizations. She recently completed a fellowship at Columbia University, where her research and reporting focused on autism.

VANESSA VEGA
Vanessa Vega is a doctoral candidate in the Communication Department at Stanford University. She received her B.A. in Communication from UCLA, where she conducted survey research on the role of pornography in sexual aggression. Vega recently designed and implemented an experiment on the effects of multitasking on visual-spatial processing, working memory and cognitive control using an undergraduate sample, which she presented at the International Communication Association Conference 2008, in Montreal. Vega is the lead author of the project's background paper, and is providing logistical support for the seminar as well as the seminar website.

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