

Breadth-biased versus focused cognitive control in media multitasking behaviors

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Ophir, Nass, and Wagner report in this issue of PNAS (1) that heavy media multitaskers (HMMs) performed worse on task switching than light media multitaskers (LMMs), likely because of HMMs' reduced ability to filter out interference from irrelevant stimuli and representations in memory. Their findings are surprising in that, intuitively, HMMs should be better at task switching (i.e., multitasking) because they frequently switch between tasks, a habit or expertise (if so) that should have helped them to be better multitaskers (task switchers). However, the findings are also not surprising in that, as pointed out by Ophir, Nass, and Wagner, HMMs tend to be breadth-biased in their behaviors and are inclined to pay attention to a larger scope of information instead of focusing on a particular piece of information. Such a behavior or habit has conditioned them to be less selective when it comes to filtering information and tasks in front of them. In other words, HMMs may have developed a habit of treating all of the information in front of them with equal (or almost equal) amounts of attention instead of focusing their attention steadily on a particular task. As a result, they performed worse than LMMs did when they were asked to focus attention on selective pieces.

Ophir, Nass, and Wagner's study (1) is significant in many respects. Research in media multitasking is in its early stages, although in recent years, media multitasking has become an increasingly popular phenomenon because of the development and convergence of many forms of new media and technologies (2). Media multitasking and its inherent mental habits of dividing attention, switching attention, and keeping multiple trains of thought in working memory have significant implications for the way people think, communicate, socialize, learn, and understand the world. Ophir, Nass, and Wagner's study (1), with its solid theoretical framework, well-thought-out experimental designs, and in-depth analyses, sets a good foundation for future investigations into information processing behaviors and learning associated with new media and technologies. Here, I have intended to

extend inquiries based on insights from their study.

Casting a Wide Net or Studying the Fish

HMMs approach fundamental information-processing activities differently from LMMs; their breadth-biased media consumption behavior is mirrored by breadth-biased cognitive control (1). In traditional lab experiments, however, we tend to assess the focused cognitive control or attention rather than the breadth-biased cognitive control. We define the primary task and

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the distractions so that we can assess the participants' ability to differentiate the main task from the distractions and to measure their attention focus on the primary task.

What happens in lab experiments, however, 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. They may have more control over what they see as their primary task and what they see as distractions. Such an internal control or direction may affect their cognitive control and task-switching performances (3). In addition, the distractions in experiments are not necessarily distractions in real life. The distractions may be useful or potentially important for the multitaskers, although they tend to be disregarded in experiments. Johnson (4) describes this intentionally reduced form of cognitive processing as follows: "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."

Based on these differences, is it possible that the HMMs were absorbing or obtaining pieces of information that would be potentially useful, although they were "distractions" in these experiments? By the same token, is it possible that the LMMs were ignoring information that might be useful in the long run in real life? Often the "weak signals" could be signs of new discoveries or innovation (5). If so, how do we design experiments to detect the potentially useful information and assess the ability to catch potentially important weak signals? We need to understand to what extent the hidden or potential benefits may occur in real-life media multitasking situations.

The differences between HMMs and LMMs also lead to a question about the required skills and expertise to function in society. Society with its ever-increasing complexity seems to move people toward juggling among multiple tasks rather than focusing on one task for a long period. Ophir, Nass, and Wagner (1) point out that HMMs are distracted by multiple streams of media that could be a difference in orientation rather than a deficit and that future tests of higher-order cognition could reveal benefits. It may not be a stretch to expect that HMMs' inclination toward bottom-up attentional control and exploratory information processing (1) could help them develop creative and innovative approaches to problems. Yet, if so, how do we assess and capture the new skill sets and expertise possibly developed by HMMs?

Media as Extensions or Amputations to Cognition

Ophir, Nass, and Wagner (1) further point out that "if the growth of multitasking across individuals leads to or encourages the emergence of a qualitatively different, breadth-biased profile of cognitive control, then the norm of multiple input streams will have significant consequences for learning, persuasion, and other media effects."

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Technology has long been identified as the catalyst that allows us to do more with less time or effort. McLuhan (6), whose work is viewed as one of the cornerstones of media theory studies, reminded us that media and technologies are extensions of humankind. According to McLuhan, each medium adds itself on to what we already are, creating both “amputations and extensions” to our senses and bodies, shaping them into a new technical form (6). It is our dependency and linkage to technology that makes it an integral part of our lives.

The internet, with its increasing use of nonlinear nonsequential hypermedia, multimedia, and sophisticated graphic and visual features, has changed our habits of searching, locating, retrieving, accessing, using, and producing information. Users of hypertexts constantly conduct dual tasks or switch tasks by switching screens or web pages. The computer is a highly media-multitasked medium because it offers many opportunities for media multitasking, both within itself and across other platforms (7). The nonlinear and decentralized structure of information on the web, which is potentially contributing to media-multitasking behaviors, may have the potential to promote learning and creativity. Weinberger (8) argues that individuals exposed to a concept in multiple decentralized sources may gain deeper and more complex understandings of this concept.

The new technologies are gearing people, especially young people who grow up with digital technologies and

wired networks, toward breadth-biased information processing behavior rather than linear in-depth study behavior. A long-term exposure to media multitasking is expected to produce both positive and negative outcomes on cognitive, emotional, and social development. Understanding the outcomes presents both theoretical and methodological challenges. We will need to assess both focused and breadth-biased cognitive control abilities to understand people’s real cognitive control abilities.

Learning Versus Performance in Media Multitasking Environments

The relationship between media multitasking and the ability and desire to focus is an important topic in the domain of learning. Gladwell (9) notes that extraordinarily successful people dedicate at least 10,000 h worth of practice in their area of expertise. Poldrack and Foerde (10) found that people had a harder time learning new things when their brains were distracted by another activity. The fMRI used by Poldrack and Foerde showed that when people learned without distraction, the hippocampus was involved. This part of the brain is critical to the processing and storing of information. But when people learned the task while multitasking, the hippocampus was not engaged; instead, the striatum was activated. The striatum is generally thought to support habitual task performance. Results showed that learning while distracted or multitasking altered the brain’s learning processes (10). When information is obtained un-

der multitasking conditions, the flexible application of knowledge associated with creativity and adaptive problem solving may be less likely to occur (10).

Cognitive load plays an important role in both enhancing experience and hindering performance (11). Some tasks such as learning new skills have higher cognitive loads, whereas other familiar and automatic tasks require lower cognitive loads. Tasks, however, can be transferred from high cognitive loads to low cognitive loads by repetition (11). One explanation could be that repetitive practice stimulates activity in the striatum, resulting in habit learning and lower cognitive loads. The level of required focus changes with experience. According to Just et al. (12), the brain rewires itself to do the routine tasks involved in driving over time, for instance, when our eyes see a red light, our foot hits the brake, with no conscious thought involved. The “automaticity” enables us to do one thing while focusing on something else (12). In other words, learning to do a task well automatically helps us to multitask. Other studies have also suggested that practice and training may increase brain processing speed, improve working memory, and improve our ability to multitask (13–15). Through continuous immersion in multitasking settings, HMMs are likely to develop different mental models and situational awareness abilities than LMMs do. Therefore, it is important to define the context, measurement, and valued outcomes of learning when considering the effects of media multitasking on learning.

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