Human multitasking

Human multitasking is the apparent performance by an individual of handling more than one task, or activity, at the same time. The term is derived from computer multitasking. An example of multitasking is taking phone calls while typing an email. Multitasking can result in time wasted due to human context switching and apparently causing more errors due to insufficient attention. However, studies have shown that some people can be trained to multitask where changes in brain activity have been measured as improving performance of multiple tasks (see below: The brain's role). Multitasking can also be assisted with coordination techniques, such as taking notes periodically, or logging current status during an interruption to help resume a prior task midway.

1 Etymology

The term "multitasking" originated in the computer engineering industry.[1] It refers to the ability of a computer to apparently process several tasks, or computer jobs, concurrently.[2] Computer multitasking in single-CPU microprocessors actually involves time-sharing of the processor; only one task can actually be active at a time, but partial work on each task is rotated through many times a second. With multi-core computers, each CPU can perform a separate task simultaneously.
The first published use of the word "multitask" appeared in an IBM paper describing the capabilities of the IBM System/360 in 1965.[3]

2 Research

Since the 1960s, experimental psychologists have conducted experiments on the nature and limits of human multitasking. The simplest experimental design used to investigate human multitasking is the so-called psychological refractory period effect. Here, people are asked to make separate responses to each of two stimuli presented close together in time. An extremely general finding is a slowing in responses to the second-appearing stimulus.

Researchers have long suggested that there appears to be a processing bottleneck preventing the brain from working on certain key aspects of both tasks at the same time (e.g., (Gladstones, Regan & Lee 1989) (Pashler 1994)). Many researchers believe that the cognitive function subject to the most severe form of bottlenecking is the planning of actions and retrieval of information from memory.[4] Psychiatrist Edward M. Hallowell[5] has gone so far as to describe multitasking as a "mythical activity in which people believe they can perform two or more tasks simultaneously as effectively as one." On the other hand, there is good evidence that people can monitor many perceptual streams at the same time, and carry out perceptual and motor functions at the same time.

Others have researched multitasking in specific domains, such as learning. Mayer and Moreno[6] studied the phenomenon of cognitive load in multimedia learning and concluded that it is difficult, and maybe impossible, to learn new information while engaging in multitasking. Junco and Cotten examined how multitasking affects academic success and found that students who engaged in high levels of multitasking reported significant issues with their academic work.[7] A more recent study on the effects of multitasking on academic performance found that using Facebook and text messaging while studying were negatively related to student grades, while online searching and emailing were not.[8]

Further information: Media multitasking

3 The brain's role

Because the brain cannot fully focus when multitasking, people take longer to complete tasks and are predisposed to error. When people attempt to complete many tasks at one time, "or [alternate] rapidly between them, errors go way up and it takes far longer—often double the time or more—to get the jobs done than if they were done sequentially," states Meyer.[9] This is largely because "the brain is compelled to restart and refocus".[10] A study by Meyer and David Kieras found that in the interim between each exchange, the brain makes no progress whatsoever. Therefore, multitasking people not only perform each task less suitably, but lose time in the process.

When presented with much information, the brain is forced to pause and refocus continuously as one switches between tasks.[10] Realistically, this is "a rapid toggling among tasks rather than simultaneous processing." According to a study done by Jordan Grafman, chief of the cognitive neuroscience section at the National Institute of Neurological Disorders and Stroke, "the most anterior part [of the brain] allows [a person] to leave something when it's incomplete and return to the same place

and continue from there," while Broadman's Area 10, a part of the brain's frontal lobes, is important for establishing and attaining long-term goals.[9] Focusing on multiple dissimilar tasks at once forces the brain to process all activity in its anterior. Though the brain is complex and can perform a myriad of tasks, it cannot multitask well.

Another study by René Marois, a psychologist of Vanderbilt University, discovered that the brain exhibits a "response selection bottleneck" when asked to perform several tasks at once. The brain must then decide which activity is most important, thereby taking more time. Psychologist David Meyer of the University of Michigan claims that, instead of a "bottleneck," the brain experiences "adaptive executive control" which places priorities on each activity. These viewpoints differ in that, while bottlenecking attempts to force many thoughts through the brain at once, adaptive executive control prioritizes tasks to maintain a semblance of order. The brain better understands this order and, as psychologists such as Dr. Meyer believe, can therefore be trained to multitask.[11] It is not known exactly how the brain processes input and reacts to overstimulation.

Some research suggests that the human brain can be trained to multitask. A study published in Child Development by Monica Luciana, associate professor of psychology at the University of Minnesota, discovered that the brain's capability of categorizing competing information continues to develop until ages sixteen and seventeen. A study by Vanderbilt University found that multitasking is largely limited by "the speed with which our prefrontal cortex processes information." Paul E. Dux, co-author of the study, believes that this process can become faster through proper training. The study trained seven people to perform two simple tasks, either separately or together, and conducted brain scans of the participants. The individuals multitasked poorly at first but, with training, were able to adeptly perform the tasks simultaneously. Brain scans of the participants indicate that the prefrontal cortex quickened its ability to process the information, enabling the individuals to multitask more efficiently. However, the study also suggests that the brain is incapable of performing multiple tasks at one time, even after extensive training.[12] This study further indicates that, while the brain can become adept at processing and responding to certain information, it cannot truly multitask.

People have a limited ability to retain information, which worsens when the amount of information increases. For this reason people alter information to make it more memorable, such as separating a ten-digit phone number into three smaller groups or dividing the alphabet into sets of three to five letters. George Miller, former psychologist at Harvard University, believes the limits to the human brain's capacity centers around "the number seven, plus or minus two." An illustrative example of this is a test in which a person must repeat numbers read aloud. While two or three numbers are easily repeated, fifteen numbers becomes more difficult. The person would, on average, repeat seven correctly.[13] Brains are only capable of storing a limited amount of information in their short-term memories.

This ineffectiveness of the human brain for multitasking has been demonstrated in different studies.[14][15][16]

Laboratory based studies of multi-tasking indicate that one motivation for switching between tasks is to increase the time spent on the task that produces the most reward (Payne, Duggan & Neth, 2007). This reward could be progress towards an overall task goal or it could simply be the opportunity to pursue a more interesting or fun activity. Payne, Duggan and Neth (2007) found that decisions to switch task reflected either the reward provided by the current task or the availability of a suitable opportunity to switch (i.e. the completion of a subgoal). A French fMRI study published in 2010 indicated preliminary support for the hypothesis that the brain can pursue at most two goals simultaneously, one for each frontal lobe (which has a goal-oriented area).[17]

4 Continuous partial attention

Main article: Continuous partial attention

Author Steven Berlin Johnson 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."[18] Multimedia pioneer Linda Stone coined the phrase "continuous partial attention" for this kind of processing.[19] Continuous partial attention is multitasking where things do not get studied in depth.

Rapidly increasing technology fosters multitasking because it promotes multiple sources of input at a given time. Instead of exchanging old equipment like TV, print, and music, for new equipment such as computers, the Internet, and video games, children and teens combine forms of media and continually increase sources of input.[20] According to studies by the Kaiser Family Foundation, in 1999 only 16 percent of time spent using media such as internet, television, video games, telephones, text-messaging, or e-mail was combined. In 2005, 26 percent of the time this media was used together.[11] This increase in simultaneous media usage decreases the amount of attention paid to each device. In 2005 it was found that 82 percent of American youth use the Internet by the seventh grade in school.[21] A 2005 survey by the Kaiser Family Foundation found that, while their usage of media continued at a constant 6.5 hours per day, Americans ages 8 to 18 were crowding roughly 8.5 hours' worth of media into their days due to multitasking. The survey showed that one quarter to one third of the participants have more than one input "most of

the time" while watching television, listening to music, or reading.[9] The 2007 Harvard Business Review featured Linda Stone's idea of "continuous partial attention," or, "constantly scanning for opportunities and staying on top of contacts, events, and activities in an effort to miss nothing".[11] As technology provides more distractions, attention is spread among tasks more thinly.

A prevalent example of this inattention to detail due to multitasking is apparent when people talk on cell phones while driving. One study found that having an accident is four times more likely when using a cell phone while driving.[22] Another study compared reaction times for experienced drivers during a number of tasks, and found that the subjects reacted more slowly to brake lights and stop signs during phone conversations than during other simultaneous tasks.[22] A 2006 study showed that drivers talking on cell phones were more involved in rear-end collisions and sped up slower than drivers intoxicated over the .08% legal limit.[23] When talking, people must withdraw their attention from the road in order to formulate responses. Because the brain cannot focus on two sources of input at one time, driving and listening or talking, constantly changing input provided by cell phones distracts the brain and increases the likelihood of accidents.

5 Gender differences

Although the idea that women are better multitaskers than men has been popular in the media as well in conventional thought, there is very little data available to support claims of a real gender difference. Most studies that do show any gender differences tend to find that the differences are small and inconsistent.[24]

A study by psychologist Keith Laws was widely reported in the press to have provided the first evidence of female multitasking superiority.[25][26]

In another study, females were found to perform slightly better at coordinating a primary test with a secondary test, supporting the notion that females are better at multitasking. However, the authors concluded their tests may not reflect real-life multitasking and that further research was required.[27]

Conversely, a Swedish study found that men actually outperformed women at handling multiple tasks simultaneously, with the performance gap being correlated to the female menstrual cycle.[28]

More recently, a new brain connectivity study from Penn Medicine, funded by in part by the National Institutes of Mental Health, published in the Proceedings of the National Academy of Sciences found "striking differences in the neural wiring of men and women that's lending credence to some commonly-held beliefs about their behavior." "...on average, men are more likely better at learning and performing a single task at hand, like cycling or navigating directions, whereas women have superior memory and social cognition skills, making them more equipped for multitasking and creating solutions that work for a group."[29] The full text of the study can be found on the PNAS website.[30] However, this study has been widely criticized because the differences that are seen, could easily have been caused by increased head movement . Moreover, the link between the DTI data and behavioral performance is speculative . Importantly, this study contains no such evidence of any superiority in multitasking in women.

6 Popular commentary on practical multitasking

Multitasking has been criticized as a hindrance to completing tasks or feeling happiness. This is a traditional thought, as in the saying "to have too many irons in the fire", or in Vulgar Latin *Duos qui sequitur lepores neutrum capit* "Who follows two hares catches neither", or other 19th century phrasing such as "To do two things at once is to do neither."[lower-alpha 1]

In more modern times, Barry Schwartz has noted that, given the media-rich landscape of the Internet era, it is tempting to get into a habit of dwelling in a constant sea of information with too many choices, which has been noted to have a negative effect on human happiness.[31]

Observers of youth in modern society often comment upon the apparently advanced multitasking capabilities of the youngest generations of humans (Generation Y and Generation Z). While it is true that contemporary researchers find that youths in today's world exhibit high levels of multitasking, most experts believe that members of the Net Generation are not any better at multitasking than members of older generations.[32] However, recent studies by Bardhi, Rohm, and Sultan argue that Generation Y is becoming better at media multitasking. This is evidenced by the fact that they are gaining control over deciding which messages they pay attention to or not.[33] Nonetheless, while there is a great deal of evidence showing the negative effects of multitasking on cognitive tasks,[34][35][36][37][38] there is no evidence showing that multitasking has a positive or neutral effect on these tasks.

Many studies,[39][40][41][42][43] literature,[44] articles[45][46][47] and worldwide consulting firms,[48] including recent ones from Louisiana State University psychology Professor Emily Elliott[39] stresses the fact that multitasking of any kind reduces the productivity and/or increases rate of errors, thus generates unnecessary frustrations.

It has been estimated that $650 billion[49] a year is wasted in US businesses due to multitasking.

7 See also

- Polychronicity
- Absent-mindedness
- Attention management
- Crossmodal attention
- Human reliability
- Media multitasking
- Multi-boxing
- Pareto principle
- Parkinson's Law
- Time management

8 Notes

[1] Misattributed to Publilius Syrus; see Publilius Syrus for origin.

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