Multitasking

Forms of Multitasking

There are (at least) two modes of behavior that are commonly called multitasking:

- working on two or more different tasks, giving one's partial attention to each simultaneously
- working on two or more different tasks, rapidly switching one's full attention from one task to the other

The first mode is best called *pure multitasking*, and corresponds to the way a multicore processor may execute a collection of processes (literally) simultaneously, with one or more distinct cores dedicated to each particular process.

The second mode may produce the illusion of pure multitasking, but at any given instant only one process is actually being executed; this corresponds to the way a unicore processor may be managed. Let's call this *context switching*.

Human Multitasking

Can the human brain achieve pure multitasking?

Since some tasks (at least) can be carried out using only portions of the brain that are capable of carrying out specific kinds of actions autonomously, it would seem that pure multitasking is possible as long as no two tasks require using the same brain "unit" at the same time for two different purposes.

Analogy:

- I can twirl a pencil with my left hand while I write a letter with my right hand because neither hand is asked to do two things at once.
- I cannot twirl a pencil and write a letter with my right hand, at the same time.

Human Multitasking

This brings us to a basic question: how capable are the independent "processing centers" in the brain"?

First, how many "processing centers" does the brain have?

Second, how complex a task can a "processing center" carry out by itself?

Third, how much redundancy is there?

Studies of Human Multitasking

There have been many experimental studies that attempt to qualify and quantify our ability to multitask.

We know that pure multitasking is possible as long as no more than one task requires our direct concentration.

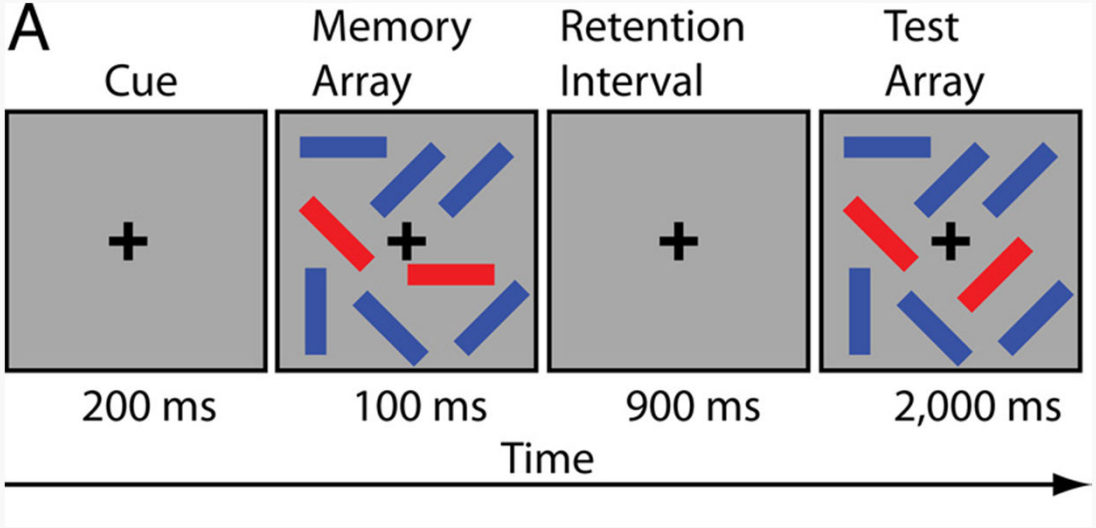
We know that context-switching is possible as long as the number of individual tasks is not too great.

A Little Test

Task: indicate whether or not a target (red) rectangle has changed orientation from the first exposure to the second, while ignoring distractor (blue) rectangles.

Ophir, Nass & Wagner

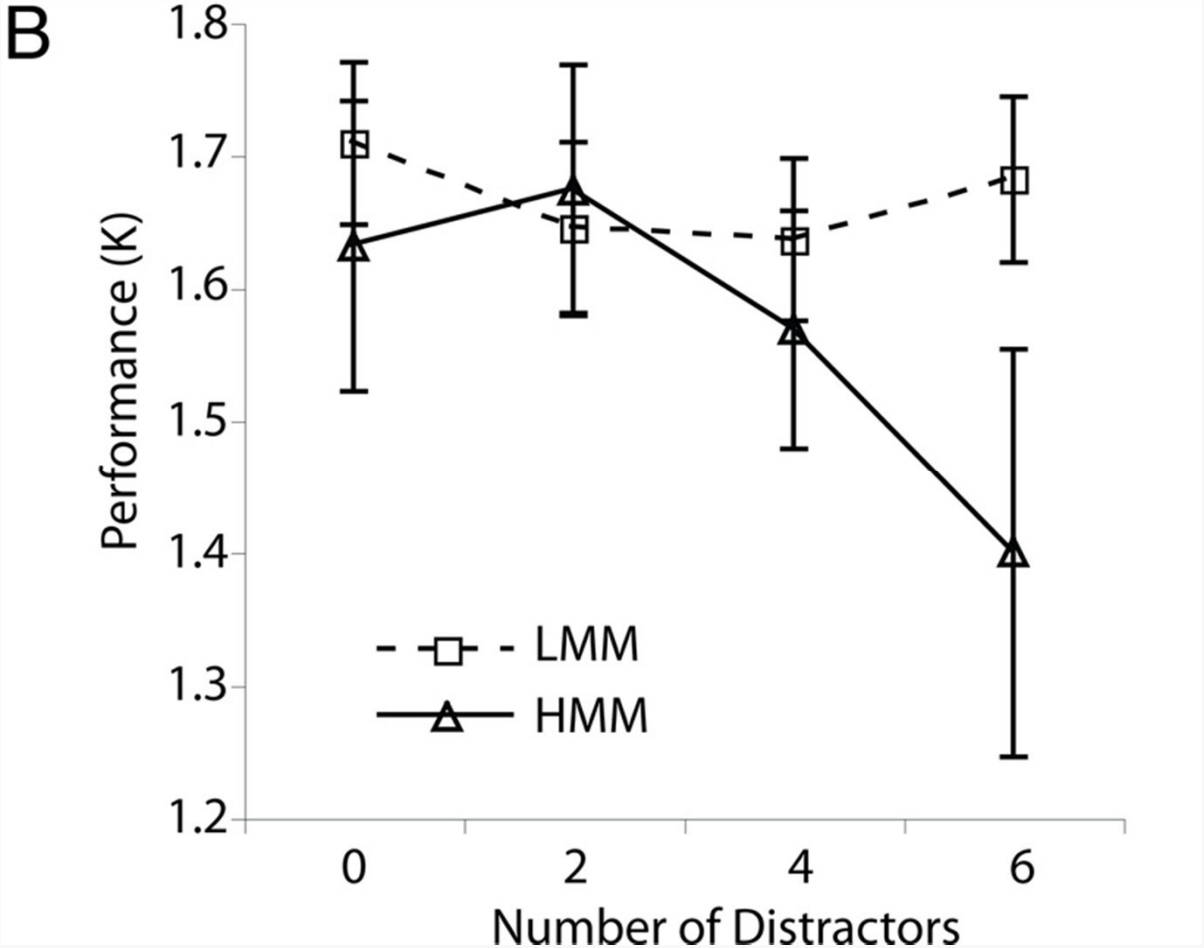
"Are chronic media multitaskers more attentive to irrelevant stimuli in the external environment and irrelevant representations in memory?"



Task: indicate whether or not a target (red) rectangle has changed orientation from the first exposure to the second, while ignoring distractor (blue) rectangles.

Ophir, Nass & Wagner

"HMMs' performance was linearly negatively affected by distractors… whereas LMMs were unaffected by distractors, demonstrating that LMMs have the ability to successfully filter out irrelevant stimuli…"



Ophir, Nass & Wagner

"Participants were presented a number and a letter, and performed either a letter (vowel or consonant) or a number (even or odd) classification task depending on a cue presented before the stimulus. Switch cost was calculated as the difference in mean response time between trials preceded by a trial of the other type (switch trials) vs. trials preceded by a trial of the same type (nonswitch trials)."

- HMMs were 426 ms slower to respond (than LMMs) on switch trials
- HMMs were 259 ms slower to respond (than LMMs) on nonswitch trials

"Because switch costs have been attributed to competition from activation of the irrelevant task-set …, these results suggest that HMMs are less capable of filtering out the irrelevant task-set representation in memory on a given trial."

Ophir, Nass & Wagner

"The present data suggest that LMMs have a greater tendency for top-down attentional control, and thus they may find it easier to attentionally focus on a single task in the face of distractions. By contrast, HMMs are more likely to respond to stimuli outside the realm of their immediate task, and thus may have a greater tendency for bottom-up attentional control and a bias toward exploratory, rather than exploitative, information processing (26, 27). If so, they may be sacrificing performance on the primary task to let in other sources of information."

"Gladwell … notes that extraordinarily successful people dedicate at least 10,000 h[ours] worth of practice in their area of expertise."

"Poldrack and Foerde … 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 …. When information is obtained under multitasking conditions, the flexible application of knowledge associated with creativity and adaptive problem solving may be less likely to occur …."

"Cognitive load plays an important role in both enhancing experience and hindering performance ….

Some tasks such as learning new skills have higher cognitive loads, whereas other familiar and automatic tasks require lower cognitive loads.

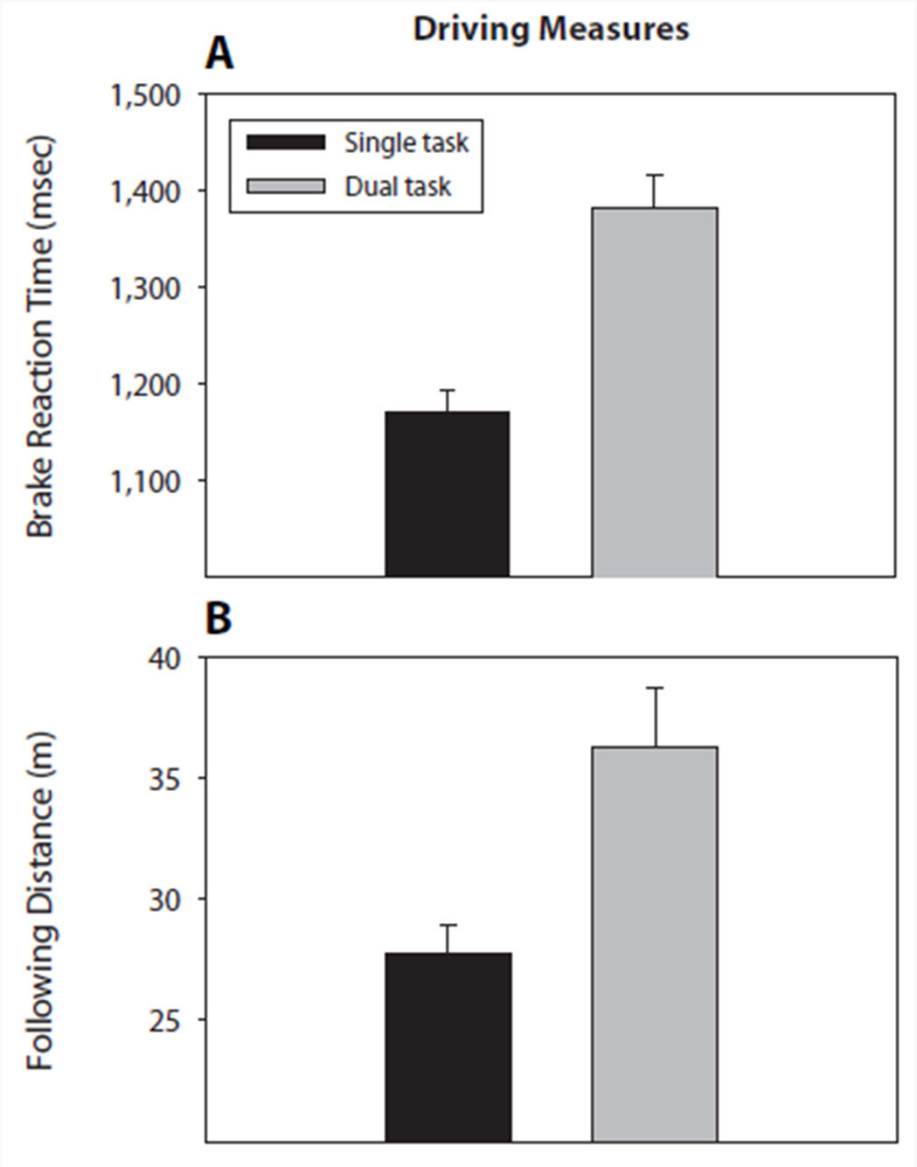
Tasks, however, can be transferred from high cognitive loads to low cognitive loads by repetition ….

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. …, 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 …. 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 …."



"Supertaskers have a strikingly remarkable ability to successfully perform two attention-demanding tasks that over 97% of the population cannot perform without incurring substantial costs in performance."

"Indeed, our studies over the last decade have found that a great many people have the belief that the laws of attention do not apply to them (e.g., they have seen other drivers who are impaired while multitasking, but they themselves are the exception to the rule)."

Watson & Strayer

"Why are we all not supertaskers?"

"First, there may be some cost associated with being a supertasker. Elsewhere, Grossberg (1987) suggested that organisms are faced with a stability/plasticity dilemma in which they must strike a delicate balance between being overly rigid and overly flexible in their processing style.

Indeed, many clinical disorders are associated with an imbalance, being either overly rigid or overly flexible (American Psychiatric Association, 1994). It may be that supertaskers excel at multitasking at the expense of other processing abilities."

"Second, there may be few costs (and possibly some benefits) associated with being a supertasker, but the environmental and technological demands that favor this ability are relatively new, and any selective advantage for being a supertasker has yet to propagate throughout the population.

Indeed, it has been only in the last few generations that technology has placed high value on multitasking ability. This time scale is too short for any selective advantage to spread through the population."

Read More About It

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Cognitive control in media multitaskers, Ophir, Nass and Wagner, Proceedings of the National Academy of Sciences, September 15, 2009

Breadth-based versus focused cognitive control in media multitasking behaviors, Lin, Proceedings of the National Academy of Sciences, September 15, 2009

These are available via pbr.psychonomic-journals.org; go to Past Issues and select the one for August 2010:

Supertaskers: Profiles in extraordinary multitasking ability, Watson and Strayer, Psychonomic Bulletin & Review, 17(4) 479-485, 2010