Multitasking—what goes in our brain when we try to do two or more things at once

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"One of my goals is to try to find that tipping point, when the cost of multitasking outweighs the benefit," said Nathan Ward. Credit: Alonso Nichols

Multitasking has been blamed for everything from lowering your IQ and damaging your brain to creating distracted drivers who cause fatalities.

But it's not that simple, says Tufts applied cognitive psychologist Nathan Ward. He believes the consequences of juggling multiple streams of information are more subtle, and that they sometimes even lead to an occasional positive effect on performance.

Ward, who was hired as an assistant professor of psychology last fall after doing research as a Beckman Postdoctoral Fellow at the University of Illinois at Urbana-Champaign, relishes the chance to decode the complex neural underpinnings of multitasking as the principal investigator in the Tufts Applied Cognition Lab. He talked with Tufts Now about his research—and why it's best not to multitask while playing darts.

Tufts Now: How do you and other cognitive psychologists characterize multitasking?

Nathan Ward: Multitasking is somewhat of a bucket term that cognitive psychologists use to describe the act of managing more than one piece of information. Some researchers use the term multitasking to describe switching between tasks in rapid succession, while others describe it as simultaneously doing two or more tasks. If you are placing an order at a coffee shop while having a phone conversation, one way to accomplish both tasks is to pause the phone conversation so you can turn all of your attention to the barista taking your order. Another way is to ration your attention across both tasks by partially processing the conversation and the drink order.

In my work, I have tried to consider the union of these two approaches by comparing them and identifying cases in the lab and in applied settings when we're challenged to switch and divide attention. A large part of my research program aims to tease apart these mechanisms by focusing on the neural signatures that support them.

How do you track what the brain is doing when we multitask?

We can get a glimpse of how the brain handles instances of switching and dividing attention by recording brain activity using neuroimaging techniques, like functional MRI, called fMRI. These tools allow us to determine the neural generators of tasks in isolation and in combination. Identifying the generators then allows us to differentiate theories of multitasking in ways that may not be apparent by just looking at behavior.

A classic example of multitasking in the lab is number classification. For example, we might present you with a series of numbers in blue or red on a computer screen, and ask you if a particular number is colored blue, if it's larger than a certain other number, and at the same time, if it's odd or even. The task switch here involves flipping between thinking about whether a number is greater than, say, five versus thinking about whether it's odd or even, or red or blue.

On top of this, we might introduce a challenge that calls for dual or divided attention; you also have to keep a running count about some information, like the number of times you encounter a color. This tally is then scored for accuracy at some point later in the task. Using this kind of design, we can begin to see if there is a neural or behavioral difference between situations when you only need to switch among rules vs. those when you need to switch among rules and divide your attention by doing a counting task.

Preliminary results from an fMRI project I did as a postdoc suggested that areas of the brain for task switching are not the same as those for dual tasking. These two kinds of multitasking recruit distinct neural resources. Moreover, individuals' responses vary quite a bit; some people

are just better at multitasking than others, and some people really struggle with multitasking. More research is needed to find out what accounts for that variability.

Will that be part of your research here?

Future work in the lab will focus on understanding individual differences in multitasking in healthy young adults, as well as differences across populations, including older adults. I am also exploring how multitasking plays out in applied situations, such as simulated driving exercises and in helping people recover motor skills after surgery or illness. For someone who has had a traumatic brain injury or stroke, for instance, it is particularly hard to multitask, and I want to understand how this difficulty arises and what we can do to mitigate it.

What else will you be working on?

Another area of my research program investigates whether we can influence the neural generators associated with task switching and dual tasking by administering short bouts of non-invasive brain stimulation. One such technique is transcranial direct current stimulation, called tDCS, which involves applying a low electrical current to the scalp through small electrodes to temporarily excite populations of brain cells residing in the current's path.

As tDCS is applied to the areas we discovered in the MRI study, we introduce various multitasking scenarios and monitor participants' performance. The idea is that exciting neural generators supporting a subcomponent of multitasking, like task switching, should selectively make participants faster and more accurate in cases when they need to switch between rules or information. What we learn could be a step toward gaining a better understanding of how to optimize performance

on different multitasking functions.

I'm also excited to explore how tests are given to track multitasking. Classically, cognitive psychologists ask participants to respond to a stimulus—visual or auditory—via button press. It turns out that certain stimulus-response combinations are more compatible than others. Hearing something and making a verbal response is easier than hearing something and pushing a button.

Gaining a better understanding of these cross-sensory pairings could have huge implications for technology that is being put into cars to enable multitasking while driving, for instance. Vehicle features should communicate information via tactile, verbal or visual cues, depending on the kind of response wanted from the driver. I suspect there might be better ways to combine these different methods of communicating in multitasking environments that could lessen the burden on attention.

You're interested in empirical research, but could you talk about what multitasking means culturally?

We need to constantly make decisions to multitask or not—whether to answer your cell phone while you're about to cross the street, for example, or how to handle the kinds of demands you find at work by having several devices to receive information. That said, I think technologies evolve drastically faster than the speed we humans evolve to deal with those technologies—for better and for worse. We're going to have to figure out a way to live with the situation and balance it out, so we don't feel frayed, stressed and at risk of making poor judgments.

For me, multitasking is about finding a delicate balance, knowing my limits. Unfortunately, people tend to think that they are above average at multitasking and that everyone else can't multitask as well. It's a false

sense of confidence that can come with some very high risks. One of my goals is to try to find that tipping point, when the cost of multitasking outweighs the benefit.

Some research suggests there are super-multitaskers, people who are really good at being able manage multiple streams of information. Where do you fall on the multitasker scale?

I'm definitely bad at multitasking—psychologists joke that we study phenomena we fail at. In any event, I admire people who can multitask well. I am fascinated by air traffic controllers and top chefs who work in high-stress environments where they are constantly managing multiple streams of information. One idea I'm interested in is whether individuals who multitask often are better at multitasking in new situations—that is, does occupational multitasking generalize to improved performance elsewhere?

So what's it's like to be a single-tasker?

I have to constantly remind myself to work on one task and not allow myself to be interrupted. I am more productive when that happens. When I have engaged in things like mindfulness meditation even for 10 minutes at a time, those times of quiet reflection have been incredibly enjoyable.

I'm also learning how to play darts. It's a really fun activity that definitely requires single tasking—distraction can be bad for performance. I hope to be able to incorporate darts into future work—I just need to target the right approach.

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