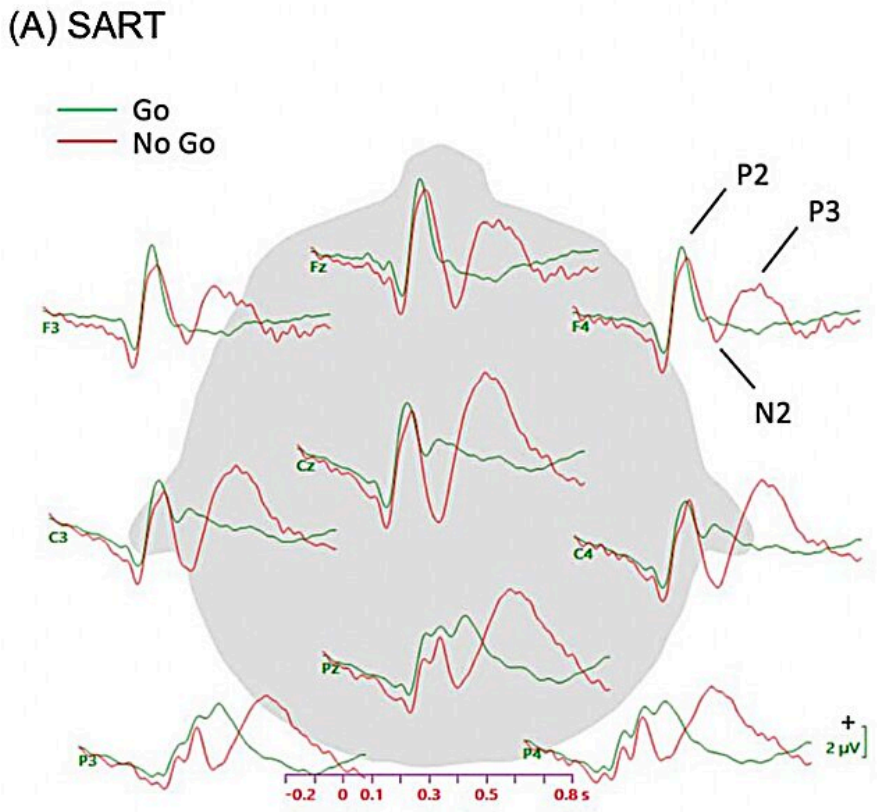
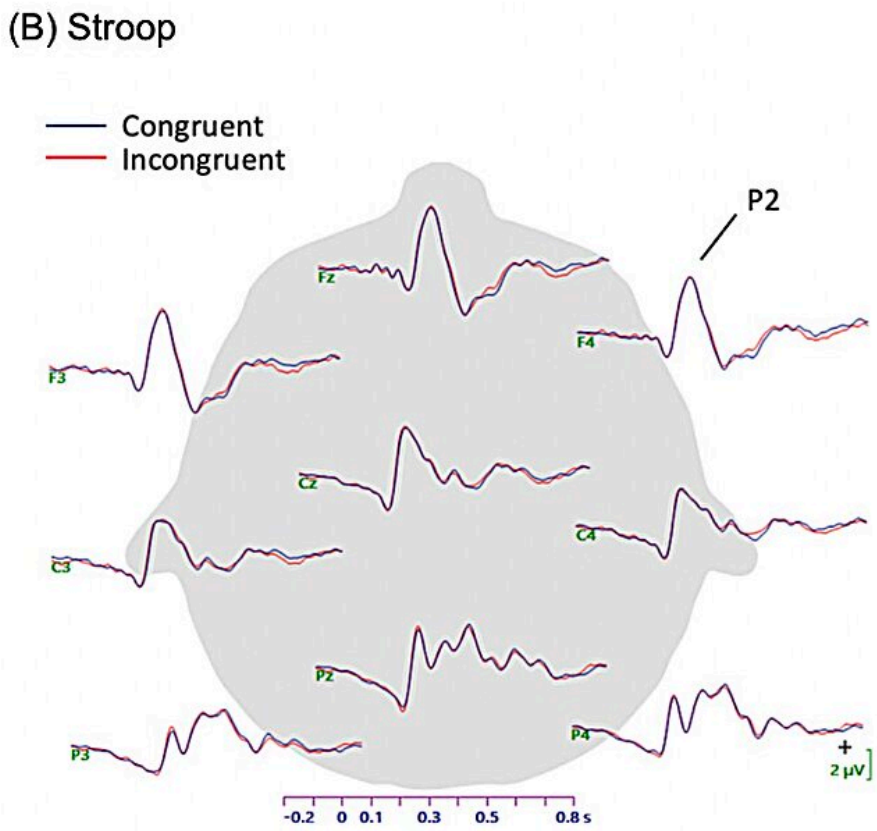
Study suggests that the neural correlates of mind-wandering can vary across different tasks

December 25 2023, by Ingrid Fadelli


(A) SART
Go
No Go
P2
P3
N2
Fz
F3
F4
Cz
C3
C4
Pz
P3
P4
+
2 μV
-0.2 0 0.1 0.3 0.5 0.8 s


(B) Stroop
Congruent
Incongruent
P2
Fz
F3
F4
Cz
C3
C4
Pz
P3
P4
+
2 μV
-0.2 0 0.1 0.3 0.5 0.8 s

Grand-average ERP waveforms for SART and Stroop tasks (all trials, n = 48). Credit: Compton et al. Springer, 2023.

When humans are completing a specific task, their minds can shift from what they are doing to their own internal thoughts. This shift of attention from a task to internal events, known as off-task thinking or mind-wandering, is well-documented and has been studied extensively in the past.

A research question that remains unanswered is whether mind-wandering should be considered an adaptive/beneficial or maladaptive/undesirable process. Depending on the circumstances in which it occurs, in fact, this process could distract a person from an important task they are trying to complete or shift their attention onto something equally or more important for them.

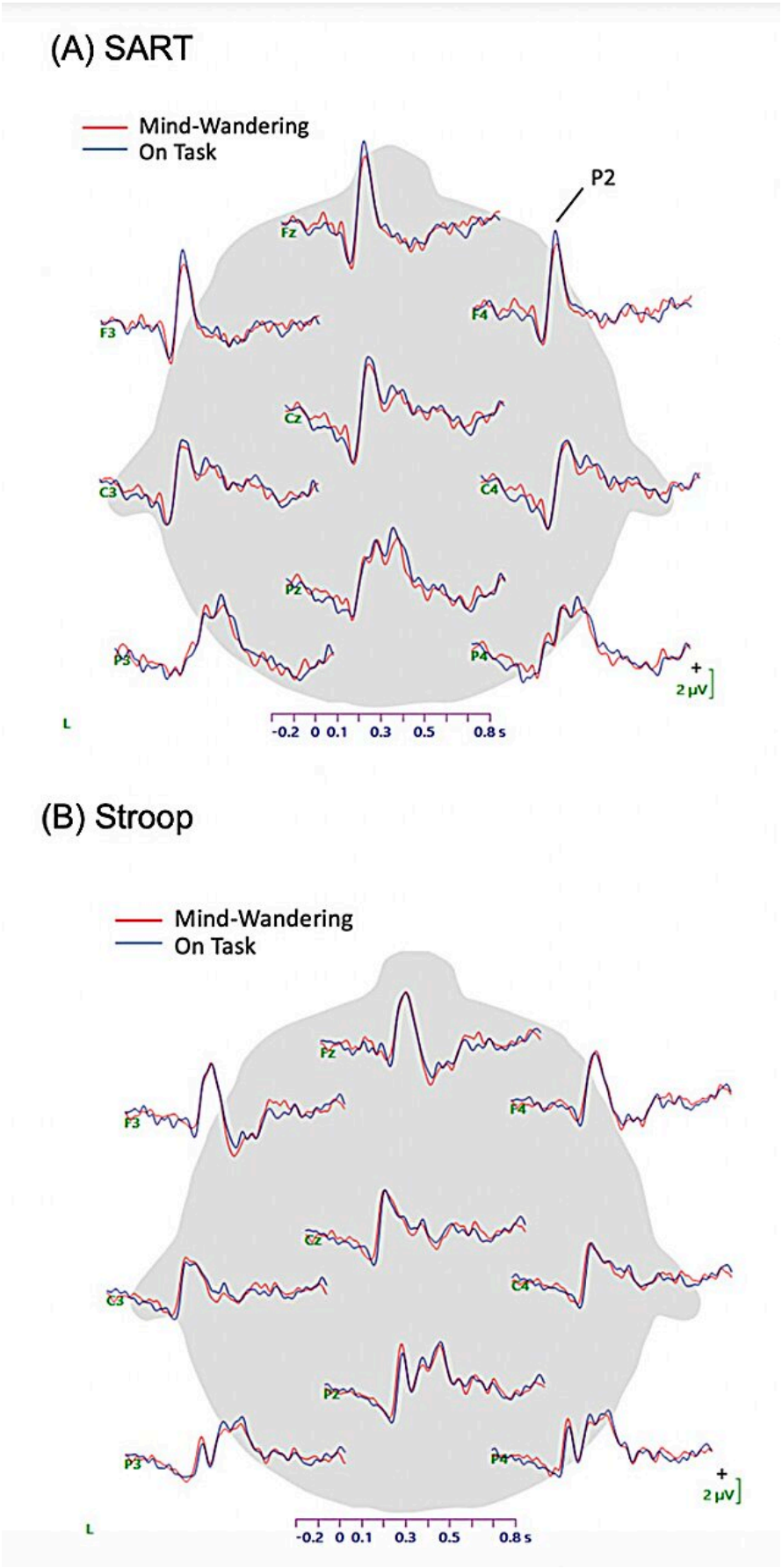
In other words, the thoughts onto which the attention shifts could be unimportant and distracting, or more applicable to the goals that are personally relevant to a specific person. Some psychology researchers have also proposed that intentional mind-wandering is more adaptive, as it entails the deliberate control of one's attention, while spontaneous mind-wandering is maladaptive, as it entails failing to control one's attention.

Researchers at Haverford College recently set out to shed further light on the deliberate modulation of mind-wandering. Their findings, published in *Cognitive, Affective, & Behavioral Neuroscience*, confirm the hypothesis that mind-wandering is sensitive to the context underpinning different tasks.

"This study was designed to examine how mind-wandering and its neural correlates vary across tasks with different attentional demands, motivated by the context regulation hypothesis of mind-wandering," Rebecca J. Compton, Danylo Shudrenko, and their colleagues wrote in their paper.

To explore the modulation of mind-wandering, the researchers carried out a series of experiments involving 59 undergraduate students at Haverford College. These participants were asked to complete two distinct cognitive tasks, known as the sustained attention to response task (SART) and the Stroop selective attention task.

SART requires participants to perform movements every time they see some stimuli but remain still when they see one specific stimulus that occurs rarely. The Stroop test, on the other hand, entails correctly saying out loud the color in which written words are presented on a screen, even when these words are names of colors that do not match the text's color.


(A) SART
Mind-Wandering
On Task
P2
Fz
F3
F4
Cz
C3
C4
Pz
P3
P4
+
2 µV
L
-0.2 0 0.1 0.3 0.5 0.8 s
(B) Stroop
Mind-Wandering
On Task
Fz
F3
F4
Cz
C3
C4
Pz
P3
P4
+
2 µV
L
-0.2 0 0.1 0.3 0.5 0.8 s

ERP waveforms for the SART and Stroop tasks for trials that occurred during mind-wandering or on-task episodes (n = 37). Credit: Compton et al. Springer, 2023.

While SART is often used to test participants' ability to stay focused on the instructions of a task for a long time, the Stroop test assesses selective attention, or in other words the ability to only focus on one aspect of presented stimuli (i.e., the color as opposed to the meaning of words). While participants completed these two tasks, Compton and her collaborators measured the electrical activity in the brain using an electroencephalogram (EEG).

"The tasks included experience-sampling probes to identify self-reported episodes of mind-wandering, along with retrospective reports," Compton, Shudrenko and their colleagues wrote. "Participants reported more mind-wandering during the SART than the Stroop and during whichever task was presented second during the session, compared with first."

Out of the 59 students who took part in the study, only 37 ultimately produced usable EEG data. The researchers analyzed the recordings collected from these 37 study participants in conjunction with their actions during the two cognitive tasks they completed.

"Replicating previous findings, EEG data indicated increased alpha oscillations during episodes of mind-wandering, compared with on-task episodes, for both the SART and Stroop tasks," Compton, Shudrenko and their colleagues said. "ERP data, focused on the P2 component reflecting perceptual processing, found that mind-wandering was

associated with increased P2 amplitudes during the Stroop task, counter to predictions from the perceptual decoupling theory."

The data collected by this research team confirms that mind-wandering is associated with an increase in alpha oscillations, which was also reported in previous works. In contrast with theoretical predictions, however, it found that mind-wandering was also linked to an increase in so-called P2 amplitudes while completing the Stroop task, which suggests that executive function was heightened.

Collectively, these results suggest that the neural underpinnings of mind-wandering can vary depending on the task that a person is completing. This could be further explored and validated in future studies with larger experimental samples and employing different imaging tools.

"Overall, the study found that self-report and neural correlates of mind-wandering are sensitive to task context," the researchers added. "This line of research can further the understanding of how mechanisms of mind-wandering are adapted to varied tasks and situations."

More information: Rebecca J. Compton et al, Effects of task context on EEG correlates of mind-wandering, *Cognitive, Affective, & Behavioral Neuroscience* (2023). DOI: 10.3758/s13415-023-01138-9