

Psychology

What's on your mind? A sneak-peek of your wandering thoughts.

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ABSTRACT

Have you ever noticed that your thoughts are sometimes focused on the task-at-hand, while other times, your mind wanders from topic to topic? Our new study found that individuals' brain activity can provide a glimpse into how their train of thought unfolds over time. Specifically, it reveals whether their minds are focused on a task, wandering from topic to topic, or constrained to a topic.



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If you get a glimpse into all the thoughts you've had today, it will likely reveal pockets of time when they were focused on your ongoing task (for example when you rush through an assignment to meet a deadline); when they aimlessly wandered from one topic to another (such as when your thoughts jump from weekend plans to your last vacation in Greece to preparing meals for the week); and when they were stuck on a topic (as exemplified by when you

constantly worry about a medical test result). These different patterns of thought are prevalent throughout our day. Traditionally, scientists have studied whether our thoughts were focused on the current task or not; however, this line of work does not tell us the types of thoughts going on in our minds.

A recent theoretical framework proposed that our thoughts can unfold over time in different ways:

thoughts can freely move from one topic to another; thoughts can be constrained to a topic no matter how hard we try to steer our mind away from it; thoughts can also be constrained to a topic in a goal directed way. Importantly, this theory predicts that these three types of thoughts can occur independently of task-unrelated thoughts.

As a team of philosophers, psychologists and neuroscientists, we recently evaluated this theoretical framework by addressing the question: can brain activity differentiate these distinct thought patterns? In other words, are there different electrophysiological activity in the brain (referred to as brain markers hereafter) that are uniquely associated with the four types of thoughts? To that end, our study not only aimed to identify the brain markers of freely moving and two types of constrained thoughts, but it also sought to replicate past findings of well-established brain markers of task-unrelated thoughts.

To answer this question, we used electroencephalogram to measure the electrical activity in individuals' brain as they performed a boring task in the lab. To assess thought patterns, individuals were occasionally asked to report whether their thoughts were focused on the task or not, and whether their thoughts were freely moving or constrained. We then compared the brain activity associated with freely moving and constrained thoughts as well as task-unrelated thoughts.

Our study found unique brain signals associated with freely moving thoughts and task-unrelated thoughts. Specifically, we first measured alpha activity over the frontal cortex, which is a type of electrical activity in the brain linked to creative processes, and found that it increased during freely moving thoughts. This suggests that alpha activity over this frontal part of the brain may serve as an indicator of unconstrained thoughts that wander from one topic to another. In contrast, we found that P300 activity, another type of brain activity, was reduced during task-unrelated thoughts compared

to on-task thoughts in the parietal cortex (i.e. upper back part of the brain). In line with our findings, parietal P300 activity has been previously found to be an indicator of task-unrelated thoughts, suggesting that we successfully replicated past findings.

In conclusion, we identified brain markers that distinguish different thought patterns, indicating that your brain activity can reveal the dynamics of your thoughts. We found while that freely moving thoughts are linked to increased activity in the frontal cortex, task-unrelated thoughts are linked to decreased activity in the parietal cortex. These findings have theoretical importance as it is the first study to indicate that freely moving thoughts and task-unrelated thoughts have distinct brain markers, providing evidence they are distinct concepts that can occur independently of each other. For instance, individuals in the creative fields can attest to experiences in which they are concentrated on their task-at-hand such as composing music or painting on a canvas, and yet their minds are jumping all over the place as they brainstorm ideas for which musical note or paint stroke should come next. In contrast, we can all relate to the experience in which we stop paying attention to the ongoing task to focus on our future plans.

These findings also have practical value, such that these brain markers can potentially be used to predict individuals' different thought patterns. One plausible clinical application lies in the real-time prediction of thought patterns in attention-deficit/hyperactivity disorder (ADHD). Thoughts that freely move from topic to topic characterizes the types of thoughts that individuals with ADHD report. Therefore, these brain markers may eventually help detect when individuals are having these thoughts in real time. Bringing their awareness to this type of thought may be the first step in helping individuals with ADHD disengage from this pattern of thought to return to their ongoing activity should they wish to do so.