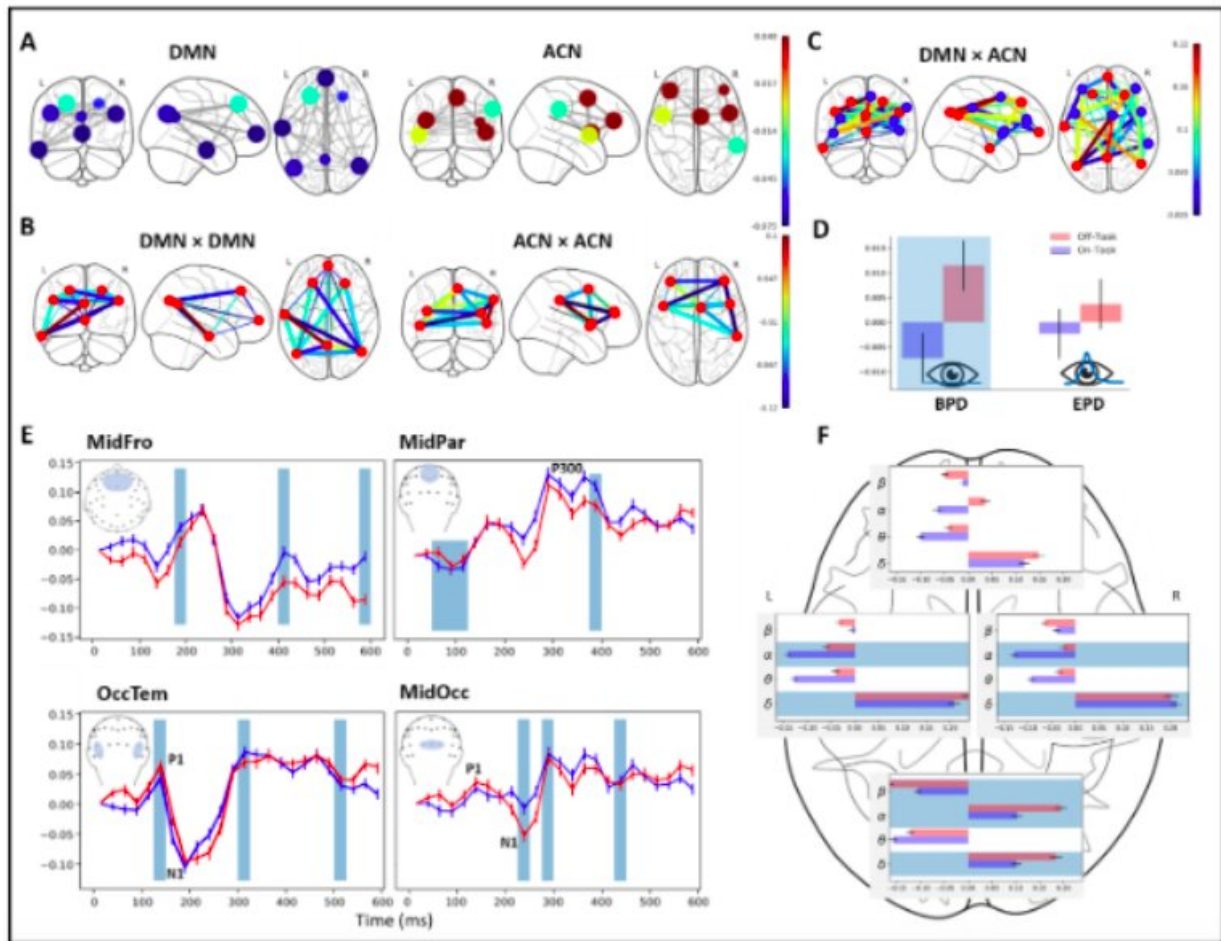


# Exploring the neural underpinnings of mind wandering

July 8 2020, by Ingrid Fadelli



Standardized feature activation across all trials after supervised classification learning. (a) Average difference (off-task minus on-task) in default mode network (DMN) (left) and anticorrelated network (ACN) node activity. Positive values indicate stronger activity while a participants' attention was not on the task, while negative ones stronger activity while it was on the task. (b) Average

difference in intra-DMN and intra-ACN node-pair connectivity, where positive values indicate a stronger positive correlation (less anticorrelation) while the attention was off-task and negative values a stronger positive correlation while it was on-task. (C) Average difference in inter-network node-pair connectivity. (D) Average baseline and evoked pupil diameter separately for off-task (red) and on-task (blue) conditions. (E) Average amplitudes in bins of 25ms (0-600 ms post-stimulus per ERP channel cluster separately for off-task and on-task conditions. (F) Average pre-stimulus beta, alpha, theta and delta frequency power per channel cluster separately for off-task and on-task conditions. More positive values indicate more power. Features that survived elimination are indicated by larger nodes, thicker edges, or light blue colored backgrounds. Credit: Groot et al.

Mind wandering occurs when a person's attention shifts from things that are happening in her present environment to internal thought processes. For instance, while cooking or attending a lesson, one might start thinking about something that happened the day before or fantasizing about something that could happen in the future.

Past neuroscience studies suggest that the [task](#)-unrelated thoughts (TUTs) associated with [mind wandering](#) can impair people's performance on a number of tasks. While there is now a considerable amount of literature exploring the effects of mind wandering on task performance, the [neural mechanisms](#) underlying this mental process have only been partly uncovered.

Researchers at the Arctic University of Norway (UiT), Leiden University and University of Oslo have recently carried out a study aimed at better understanding what happens in the brain while humans are having thoughts that are unrelated to what they are doing in the present moment. Their paper, [pre-published on PsyArXiv](#), highlights a series of activation patterns in multiple [brain regions](#) that specifically take place during

mind wandering.

To study the neural underpinnings of TUTs, the researchers recorded the [brain activity](#) of approximately 30 healthy people aged over 21 who were completing a task that required sustained attention. The task entailed responding to digits that appeared on a computer screen by pressing a button until a particular number appeared.

Occasionally, the sequence of digits was interrupted by a message asking participants where they were focusing their attention during previous trials (i.e., whether on the task or on something unrelated to the task, such as memories or other thoughts). To record the participants' brain activity, the researchers used three techniques: functional magnetic resonance imaging (fMRI), electroencephalography (EEG) and pupillometry.

Subsequently, features that were particularly salient to mind wandering were extracted and fed to a support vector machine (SVM), a computational model trained via supervised learning methods. The analyses carried out by the [computational model](#) yielded a number of interesting results, unveiling neural activity patterns that could be associated with mind wandering in humans.

Most notably, the researchers found that the participants' performance on the attentional task they were completing declined when their attention was focused on internal, task-unrelated trains of thoughts. Moreover, the SVM model they trained was able to predict when a participant was having task-unrelated thoughts with an average accuracy of 65%, which is above chance level. The model thus helped to unveil neural activity patterns that could be a 'signature' of mind wandering in humans.

"Compared to task-focused attention, the neural signature of TUTs was

characterized by weaker activity in the [default mode network](#) (DMN) but elevated activity in its anticorrelated network (ACN), stronger functional coupling between these networks, widespread increase in alpha, theta, delta, but not beta, frequency power, predominantly reduced amplitudes of late, but not early, event-related potentials, and larger baseline pupil size," the researchers wrote in their paper.

The study provides valuable insight that could improve the present understanding of what brain regions and networks are involved in mind wandering. Overall, the findings presented in their paper suggest that several neural markers characterize the shift from thoughts relevant to a task one is completing in the present to automatically generated, irrelevant thoughts.

Most notably, they highlight the involvement of ACN nodes, which have often been found to be associated with spontaneous [thought](#) processes. In addition, activity in the DMN appeared to decrease during mind wandering, which might suggest the role of this network in enhanced states of concentration. In the future, the findings gathered in this recent study could pave the way for new investigations into the neural underpinnings of [mind](#) wandering.

"We hope that our findings will motivate future studies to consider an agnostic, whole-brain approach, to better entangle the respective contributions of dynamic interactions," the researchers conclude in their paper. "Furthermore, employing paradigms that allow continuous tracking of attentional intensity combined with neuroimaging could be better suited to investigate the evolution of task-unrelated trains of thought with higher temporal precision."

**More information:** Josephine Maria Groot et al. Probing the neural signature of mind wandering with simultaneous fMRI-EEG and pupillometry, (2020). [DOI: 10.31234/osf.io/24v3r](https://doi.org/10.31234/osf.io/24v3r)

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