Attention

Attention is the behavioral and cognitive process of selectively concentrating on a discrete aspect of information, whether subjective or objective while ignoring other perceivable information. Attention has also been referred to as the allocation of limited processing resources.

Patients diagnosed with refractory epilepsy frequently experience attention impairments. Seizure activity in epilepsy may disturb brain networks and damage the brain function of attention.

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see Attention deficit hyperactive disorder.

The subthalamic nucleus (STN) of the basal ganglia is key to the inhibitory control of movement. Consequently, it is a primary target for the neurosurgical treatment of movement disorders like Parkinson's Disease, where modulating the STN via deep-brain stimulation (DBS) can release excess inhibition of thalamocortical motor circuits. However, the STN is also anatomically connected to other thalamo-cortical circuits, including those underlying cognitive processes like attention. Notably, STN-DBS can also affect these processes. This suggests that the STN may also contribute to the inhibition of non-motor activity, and that STN-DBS may cause changes to this inhibition. We here tested this hypothesis in humans. We used a novel, wireless outpatient method to record intracranial local field potentials (LFP) from STN DBS implants during a visual attention task (Experiment 1, N=12). These outpatient measurements allowed the simultaneous recording of high-density EEG, which we used to derive the steady-state visual evoked potential (SSVEP), a well-established neural index of visual attentional engagement. By relating STN activity to this neural marker of attention (instead of overt behavior), we avoided possible confounds resulting from STN's motor role. We aimed to test whether the STN contributes to the momentary inhibition of the SSVEP caused by unexpected, distracting sounds. Furthermore, we causally tested this association in a second experiment, where we modulated STN via DBS across two sessions of the task, spaced at least one week apart (N=21, no sample overlap with Experiment 1). The LFP recordings in Experiment 1 showed that reductions of the SSVEP after distracting sounds were preceded by sound-related γ-frequency (>60Hz) activity in the STN. Trial-to-trial modeling further showed that this STN activity statistically mediated the sounds' suppressive effect on the SSVEP. In Experiment 2, modulating STN activity via DBS significantly reduced these sound-related SSVEP reductions. This provides causal evidence for the role of the STN in the surprise-related inhibition of attention. These findings suggest that the human STN contributes to the inhibition of attention, a non-motor process. This supports a domain-general view of the inhibitory role of the STN. Furthermore, these findings also suggest a potential mechanism underlying some of the known cognitive side-effects of STN-DBS treatment, especially on attentional processes. Finally, our newly-established outpatient LFP recording technique facilitates the testing of the role of subcortical nuclei in complex cognitive tasks, alongside recordings from the rest of the brain, and in much shorter time than perisurgical recordings [1)].

Early and moderate Parkinson's disease patients seem to have attention dysfunctions manifested

differentially in separate attention streams: top-down and bottom-up. With a focus on the neurophysiological underpinnings of such differences, the study of Bin Yoo et al., evaluated source-localized regional activity and functional connectivity of regions in the top-down and bottom-up streams as well as any discordance between the two streams. Resting state electroencephalography was used for 36 Parkinson's disease patients and 36 healthy controls matched for age and gender. Parkinson's disease patients showed disproportionally higher bilateral gamma activity in the bottom-up stream and higher left alpha2 connectivity in the top-down stream when compared to age-matched controls. An additional cross-frequency coupling analysis showed that Parkinson's patients have higher alpha2-gamma coupling in the right posterior parietal cortex, which is part of the top-down stream. Higher coupling in this region was also associated with lower severity of motor symptoms in Parkinson's disease. This study provides evidence that in Parkinson's disease, the activity in gamma frequency band and connectivity in alpha2 frequency band is discordant between top-down and bottom-up attention streams [2].

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2)
Bin Yoo H, Concha EO, De Ridder D, Pickut BA, Vanneste S. The Functional Alterations in Top-Down Attention Streams of Parkinson's disease Measured by EEG. Sci Rep. 2018 Jul 13;8(1):10609. doi: 10.1038/s41598-018-29036-y. PubMed PMID: 30006636.