Maastricht University

The balance of power

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SUMMARY

The goal of this thesis was to obtain a deeper understanding of the neurobiological mechanisms underlying visuospatial attention. Using a multimodal approach including functional magnetic resonance imaging (fMRI), transcranial magnetic stimulation (TMS) and electroencephalography EEG, we assessed how those changes affected both oscillatory brain activity measured with EEG, and behavior (cognitive performance).

In **chapter 2** we firstly introduced the concept of brain oscillations, explaining why they are crucial for understanding the workings of the brain. This review focused on illustrating the possible mechanisms involved in visual conscious experiences, and how a visual information can become conscious by moving along feedforward projections and reaching higher-order areas. The work presented in the following chapters has (mostly) focused on gaining theoretical insights into the basic dynamics of visuospatial attention by studying the healthy human brain. A comprehensive understanding of how precisely the brain is able to deploy attention in visual space, which areas are involved in this process, and how they interact, is still unknown but extremely relevant for both basic research and clinical contexts. In **chapter 3** we provided evidence for the link between brain oscillations in the alpha range (7-13 Hz) and top-down control of visuospatial attention, and further elucidated what functional role each hemisphere has in this context. We revealed that the right hemisphere has a dual role when attending to visual stimuli, suppressing unattended and enhancing attended visual information, whilst the left hemisphere is only able to enhance attended visual information. The obtained results were then related to the *hemispatial* and the *interhemispheric competition* theories of attention. Moreover, they refined current functional-anatomical attention models.

We then aimed to move beyond the mere observation of brain activation patterns related to shifts of attention. We disrupted the attention system with brain stimulation to reveal the causal role of its core nodes and unravel the fine-grained processes happening within the fronto-parietal dorsal attention network. Specifically, in **chapter 4** we employed fMRI to individually localize left and right FEFs. Brain activity in those frontal nodes was then inhibited by means of TMS. Effects of this inhibition were evaluated by assessing changes in posterior alpha power magnitude measured with EEG, and cognitive performance. We were able to demonstrate compensatory effects put in place by the brain to counteract the inhibition induced by the TMS insult, and to show how these develop over time. These mechanisms most likely reflected the attempt of the brain to maintain the brain function under investigation still efficient. Using this multimodal approach allowed us to better understand the relation between these oscillatory signatures of attention deployment and the brain regions responsible for this process.

In **chapter 5** multiple (interactive) nodes of the DAN network were concurrently inhibited by using a novel network-based TMS approach. Cognitive performance was then compared to the more commonly used single-node stimulation, and sham. This new approach showed more robust effects, and might be able to prevent compensatory mechanisms within a given brain network. Given the importance of reproducibility and reliability in both basic research and clinical contexts, the development of an approach that is able to improve the efficacy of brain stimulation applications is increasingly crucial, having the potential to be concretely beneficial.