

Mapping the influence of social threat in the brain

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This thesis set out to gain a further understanding in a range of topics spanning from the link between emotions and actions, to bodily self-consciousness, and into methodological challenges when studying these questions.

Overview of the findings

Part 1 of the thesis addressed the question whether areas related to the observation of actions are crucial in emotion body processing. In **Chapter 2** we focused on one well established area involving the observation of actions, namely Inferior Parietal Lobule (IPL), and tested its causal relevance in emotion body perception. Participants received online TMS stimulation over either IPL, extrastriate body area, early visual cortex or sham stimulation, while completing a delayed match-to-sample task. This task involved briefly presented static images of body postures depicting either a fearful or a neutral stance, and minimal postural changes between the sample and the probe had to be detected. Critically, behavioural performance improved selectively for the fearful postures after stimulation of IPL, but not any of the other stimulation sites. The next step was to see with which remote areas IPL interacts under circumstances of emotion body perception. In **Chapter 3** we used an offline combination of cTBS and fMRI to answer this question. Additionally, we wanted to investigate another action related area with regard to emotion body processing, namely ventral premotor cortex (PMv). Participants completed three separate sessions, in which they either received cTBS over IPL, cTBS over PMv or no stimulation, before entering the scanner. We then investigated condition and stimulation specific influences on the BOLD signal by presenting the participants with blocks of dynamic stimuli depicting either neutral or angry whole body actions. Interestingly, results showed an interaction between stimulus condition and stimulation site in the amygdala, a well-known site for emotion processing. This interaction revealed that whereas at baseline no distinction was being made between angry and neutral actions in the amygdala, this difference became highly significant after stimulation of either IPL or PMv. Besides this finding, interactions between stimulation site and stimulus condition were found in a host of other regions related to both action observation and action preparation.

Part 2 of the thesis focused on the motor system. Firstly, in **Chapter 4** we were interested in the relation between the state of the motor system and emotion body perception. Specifically, we were interested to see whether changes in corticospinal excitability could be observed in both conscious and unconscious perception of threatening body postures. To this end we used a combination of assessment of the amplitude of Motor Evoked Potentials (MEPs) with a Continuous Flash Suppression (CFS) task. In this CFS task participants were presented with static images of threatening (angry or fearful) or neutral bodies, or objects, either inside or outside of their conscious awareness. While these stimuli were being presented, single pulses of TMS were applied at different time points after stimulus onset to evoke MEPs. The only significant finding was an early effect of increased MEP amplitude in response to angry bodies compared to objects in a conscious viewing condition. This led us to the question about high variability in MEPs and possible ways to reduce this. Therefore, in **Chapter 5** we specifically targeted one possible underlying cause of MEP variability, namely oscillatory power and phase. By using an online combination of transcranial alternating current stimulation (tACS) and single pulse TMS, we looked into the influence of individual alpha or individual beta peak frequency of the tACS signal on MEP amplitude. We found no offline changes as a result of the tACS entrainment in either the alpha or beta condition. When looking at the influence of the ongoing phase of the entraining tACS signal however, we were able to significantly fit a one cycle sinusoid over the normalized MEP amplitude across

eight different phase bins in the beta, but not the alpha or sham, condition. We further extended these findings by showing this phase dependence was specific to participants showing a low intrinsic beta frequency.

Lastly, *part 3* of the thesis related to questions surrounding bodily self-consciousness. In **Chapter 6** we addressed the question whether perception of emotions in the environment can alter the experience of body ownership. We tested this question by using a well-established paradigm for measuring and manipulating body ownership, namely the Rubber Hand Illusion (RHI). We combined this illusion with the presentation of emotional vocalizations or control stimuli (no sound or non-vocal sounds) and measured the influence on the subjective experience of ownership over the rubber hand and proprioceptive drift towards the rubber hand. We found a significant increase in the proprioceptive drift towards the rubber hand, but not the subjective experience of ownership, when participants were presented with affective vocalizations compared to the control conditions. In a second experiment, we ruled out that this was simply the result of being presented with vocalizations per se by adding a neutral vocalizations condition. We replicated the increase in proprioceptive drift in response to affective vocalizations. Furthermore, we ruled out that the effect was caused by being presented with voices in general, as there was no difference between a no sound and neutral vocalizations condition. In **Chapter 6** we were interested in another perceptual illusion, namely positive afterimages. Specifically, we were interested to see whether the fading of afterimages of the hands, which stems from a conflict between vision and proprioception, is the result of active inhibition of early visual cortex (EVC). To test this hypothesis, we assessed whether the amount of perceptual fading of the hand could be altered by online TMS stimulation of EVC overlapping with the phosphene location of the hand afterimage. The results showed that triple pulse stimulation lead to gestalt-like reappearance of the faded afterimage of the hand, which did not occur in the single pulse or sham TMS conditions. However, this effect was evident for both the left and the right hand, despite that stimulation only was applied to the right hemisphere (corresponding to the left hemifield).