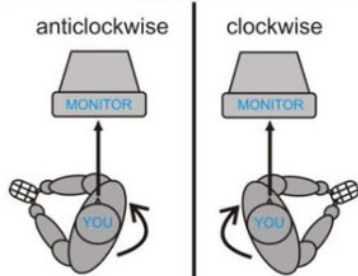


Rhythm makes the world go round: neuroimaging reveals the "embodied" roots of high-level social cognition

Significant aspects of information processing in humans are not shared with other species, such as the ability to imagine the mental states of others. However, to some extent this unique ability still seems to depend on “older” brain systems such as the body’s movement repertoire, which is functioning quite similarly in other species. The current research revealed that imagining another’s experience of the world (their perspective or viewpoint) is a significantly “embodied” mechanism, in the sense that humans mentally rotate their own internal body representation into the other’s orientation. This is surprising as the brain seems to engage the body control system in “simulation mode”, thus generating the simulated outcomes of a body rotation, yet, without actually moving.

1) Perspective taking task:

“Is the red target LEFT or RIGHT from the other’s perspective?”



Possible body postures of participant

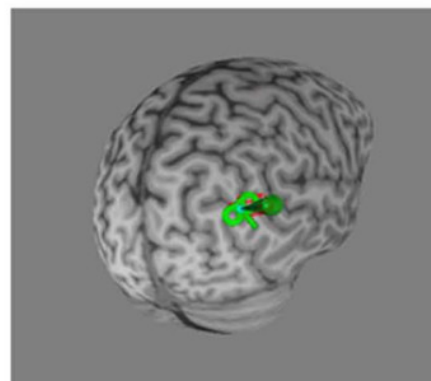
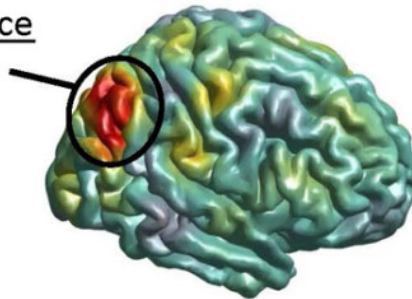
Turning your body towards the other person helps, makes your mental simulation faster.

2) MEG

(Magnetoencephalography)

theta source

Right pTPJ



⇒ **pTPJ** controls transformation of embodied self into another’s perspective.

3) dpTMS → Right pTPJ
(dual pulse Transcranial Magnetic Stimulation)

Fig. 1. Wang et al (2016) paradigm and findings. 1) Shows an example stimulus (originally used by Kessler & Rutherford, 2010) with an person (target perspective) and with a red target located to the left from the avatar’s perspective. Below the stimulus the two possible body postures of the participant are shown (body turned clockwise or anticlockwise, while the head remained gazing

straight ahead at the monitor). With respect to the stimulus the posture could either be congruent (body turned towards the avatar in the same direction as the assumed mental self-rotation) or incongruent (body turned away from the avatar in the opposite direction of the assumed mental self-rotation). A congruent posture speeded up responses, in other words, it helped the mental simulation of a body rotation. 2) Wang et al identified the right posterior temporo-parietal junction (pTPJ) as showing the maximum activity in the theta brain rhythm that was related to perspective taking. 3) In a subsequent experiment the authors targeted the pTPJ with dual pulse transcranial magnetic stimulation (dpTMS), which disrupted the embodied effect.

We used Magnetoencephalography (MEG) to measure the small magnetic fields generated by the electric neural activity of the brain. These magnetic fields allowed us to investigate which brain responses were most important for the process of perspective taking and we observed that specific low (theta 3-7 Hz) frequencies or rhythms reflected the process of mentally rotating oneself into another's perspective of the world (hence the title "Rhythm makes the world go round"). Using another brain research method, so-called transcranial magnetic stimulation (TMS), we showed that this process is indeed mediated by theta oscillations in a specific part of the right brain hemisphere, the so-called temporo-parietal-junction (TPJ). TMS applies focused magnetic pulses over the skull that are then turned into electric neural activity inside the brain, which then interacts with ongoing neural activity, modulating processes at that location of the cortex.

The TPJ part of the brain has often been related to keeping track of the body in space (in other words, of the body posture) in order to accomplish various conscious and deliberate cognitive operations - such as imaging oneself in another's viewpoint. Not surprisingly, however, the very same brain area (the TPJ) has also been related to so-called "out-of-body" experiences (OBEs), where individuals spontaneously and subjectively experience their self leaving their physical body location and occupying a different (out-of-body) viewpoint in space. The relationship between deliberate and controlled perspective taking in social interaction on the one hand, and spontaneous and uncontrolled OBEs on the other, is a focus of research in itself and has recently found substantial support. Our current research provides further support, emphasising that OBEs might just be other side of the coin of a crucial and uniquely human ability, namely, to use mental simulations of ourselves in social interaction to better understand others. At the same time our research also shows that humanities' high-level social thinking still depends in part on old brain systems, which are not uniquely human, like the body's action and posture repertoire.

Klaus Kessler
Aston University, Aston Brain Centre

Publication

[Rhythm makes the world go round: An MEG-TMS study on the role of right TPJ theta oscillations in embodied perspective taking.](#)

Wang H, Callaghan E, Gooding-Williams G, McAllister C, Kessler K
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