Self-other emotional congruency and visual perspective taking in immersive VR: a TMS and eye-tracking study

B Ford, A Qureshi, D Litchfield
Department of Psychology, Edge Hill University, Ormskirk, L39 4QP

Background

Visual perspective taking is a fundamental social ability concerned with how the world appears from another's viewpoint[1].

Is the dog visible?

Where is the flower in relation to the rock?

Emotions and Visual Perspective Taking

Anxiety, anger and guilt affect how well we represent another person's perspective[2] [3]. and how we orient attention on these tasks [4]. However, **no work has considered both participant and other/avatar as emotional agents or induced affect and tracked participants eye-gaze.**

Conflict Processing

Overcoming egocentricity in the emotional domain relies on separate networks to overcoming egocentricity in the cognitive domain[5]. Yet, **no study has implemented emotional and non-emotional conflicts in the same task to examine whether separate conflict management processes interact**. For example, emotion-congruence may facilitate our 'step' into the other person's viewpoint, whilst emotion-incongruence may hamper this process[6].

TMS and Perspective Taking

Using TMS to disrupt processing has shown that posterior regions of the right temporoparietal junction (rTPJ) are associated with overcoming visual perspective conflict[7]. Whilst anterior regions of the TPJ (rSMG) are associated with overcoming egocentric emotional conflict[8]. **No study has reported evidence of a double-dissociation in the same participants.**

References

1 Kessler, K., & Rutherford, H. (2010). The two forms of visuo-spatial perspective taking are differently embodied and subserve different spatial prepositions. *Frontiers in Psychology*, *1*(DEC), 1–12. https://doi.org/10.3389/fpsyg.2010.00213

2 Todd, A. R., Forstmann, M., Burgmer, P., Brooks, A. W., & Galinsky, A. D. (2015). Anxious and egocentric: How specific emotions influence perspective taking. *Journal of Experimental Psychology: General*, *144*(2), 374–391. https://doi.org/10.1037/xge0000048

3 Todd, A. R., & Simpson, A. J. (2016). Anxiety impairs spontaneous perspective calculation: Evidence from a level-1 visual perspective-taking task. *Cognition*, *156*, 88–94. https://doi.org/10.1016/j.cognition.2016.08.004

4 Bukowski, H., & Samson, D. (2016). Can emotions influence level-1 visual perspective taking? *Cognitive Neuroscience*, *7*(1–4), 182–191. https://doi.org/10.1080/17588928.2015.1043879

5 Hoffmann, F., Singer, T., & Steinbeis, N. (2015). Children's Increased Emotional Egocentricity Compared to Adults Is Mediated by Age-Related Differences in Conflict Processing. *Child Development*, *86*(3), 765–780. https://doi.org/10.1111/cdev.12338

6 Niedenthal, P. M. (2007). Embodying emotion. *Science*, *316*(5827), 1002–1005. https://doi.org/10.1126/science.1136930

7 Wang, H., Callaghan, E., Gooding-Williams, G., McAllister, C., & Kessler, K. (2016). Rhythm makes the world go round: An MEG-TMS study on the role of right TPJ theta oscillations in embodied perspective taking. *Cortex*, *75*, 68–81. https://doi.org/10.1016/j.cortex.2015.11.011

8 Silani, G., Lamm, C., Ruff, C. C., & Singer, T. (2013). Right supramarginal gyrus is crucial to overcome emotional egocentricity bias in social judgments. *Journal of Neuroscience*, *33*(39), 15466–15476. https://doi.org/10.1523/JNEUROSCI.1488-13.201

9 Siedlecka, E., & Denson, T. F. (2019). Experimental Methods for Inducing Basic Emotions: A Qualitative Review. *Emotion Review*, *11*(1), 87–97. https://doi.org/10.1177/1754073917749016

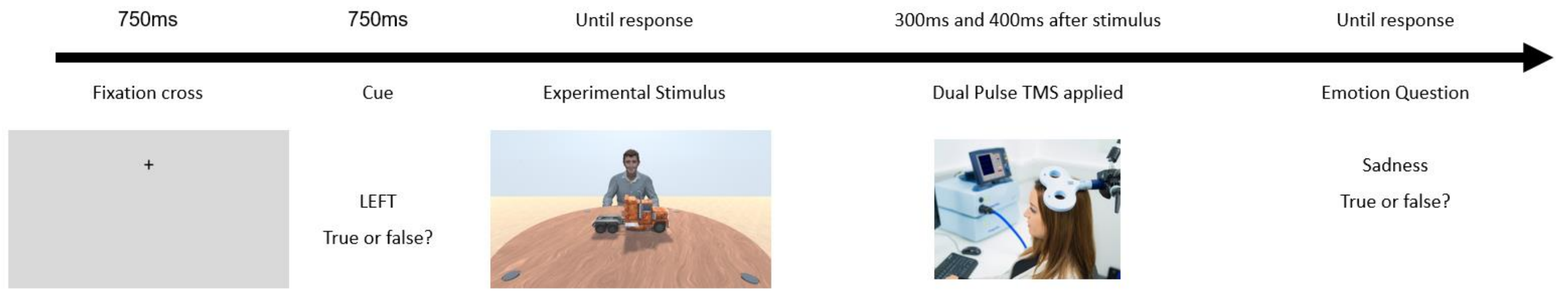
fordb@edgehill.ac.uk

@Ben_ford_psych

The Current Study, Task Sequence and Design

The proposed study combines immersive virtual-reality with dual-pulse TMS and eye-tracking. Participants will be induced with positive or negative affect using video, music and autobiographical recall[9]. An immersive virtual paradigm will require participants to represent the visual perspectives of an avatar sat on the opposite side of a table.

Trial Sequence Example



2x2x3 within participants design with emotion induction (happy/sad) and avatar emotion (happy/sad) and TMS application (rpTPJ, rSMG, sham) as factors.
4 blocks of 48 trials – each block will take around 4 minutes. The task is split into 4 blocks because of the two mood inductions and two TMS coil positions.
Between each block, participants will complete mood induction procedures and fill-out visual-analogue mood scales.

Research Methods and Aims

Research Method → Research Aim

Virtual Reality with built-in Eye Tracking

Participants will sit on a chair with their arms rested on a table, mirroring the virtual set up.

VR allows stimuli to be presented and gaze to be tracked in a spatially realistic environment.

Built-in Tobii eye-tracking will measure attentional allocation.

Behavioural Data (response times)

Whether emotional conflict processing (incongruent emotions) impacts on cognitive conflict processing (incongruent visual perspectives) and whether emotional congruency facilitates overcoming perspective incongruency.

Eye Tracking Data (fixation duration, number of fixations)

To understand how our attention is allocated across a scene under different emotion congruency conditions and how this impacts perspective taking.

TMS

Anterior and posterior TPJ located using Neuronavigator.

Dual-pulse TMS administered at 110% resting motor threshold 300ms and 400ms after the experimental stimuli is presented, causing interference for around 300-500ms [7] to either the rSMG or rpTPJ to disrupt egocentric-emotional-bias processing or visual-perspective representation, respectively.

TMS data (response times)

Investigate a possible double dissociation between posterior and anterior regions of the TPJ.

TMS Hypotheses

Disrupting the rpTPJ is expected to affect RT on all perspective taking conditions equally. If neural networks associated with the rSMG and rpTPJ interact with each other, disrupting the rSMG should only affect visual perspective taking performance on incongruent emotion trials. If these networks do not influence each other, disrupting rSMG will have no effect on visual perspective taking, irrespective of emotional congruency.