

Background

- The right temporoparietal junction (rTPJ) is thought to be closely related to theory of mind (ToM) and cognitive empathy, two processes linked to the ability to attribute other's mental states, such as beliefs and intentions.
- Successful social interaction with others depends on inference of mental states (ToM) and the ability to perceive nonliteral language.
- Transcranial direct current stimulation (tDCS) has been used to explore the role of the rTPJ in social cognition. Although high-level evidence exist with regards to the rTPJ and theory of mind, there is minimal research determining the scope of evidence of transcranial stimulation of the rTPJ and social cognition.

Purpose

- To systematically map and explore literature available on the effects of non-invasive brain stimulation of the right temporoparietal junction on social cognition.
- Examine the scope of evidence currently available to provide insight and direction for future research.

Methods

IDENTIFYING RELEVANT STUDIES

- Databases:**
- Scopus
 - PubMed
 - Web of Science
 - Embase
 - PsycINFO
 - The Cochrane Library
- Inclusion Criteria:**
- Quantitative research
 - Studies must have explored non-invasive stimulation of the temporo-parietal junction.

STUDY SELECTION

Titles and abstracts were first reviewed to eliminate articles irrelevant to the research questions, followed by review of the full paper. Screening was conducted by two independent reviewers with discrepancies resolved by a third reviewer.

CHARTING THE DATA

Information from each study such as the age range of the study sample, side of TPJ studied, sample size, mean age, gender, ethnicity, stimulation conditions, stimulation type, duration of stimulation, intensity of stimulation, method of electrode placement, measures of social cognition tested, assessment points, key findings, and limitations were extracted from each article under review.

COLLATING, SUMMARIZING, AND REPORTING RESULTS

Data will be synthesized quantitatively and qualitatively with strengths and gaps in the current literature outlined. Recommendations for the direction of future research will also be made.

Table 1: Role of Temporoparietal Junction

Study	Role of (l/r/bilateral) TPJ based on results of study
Martin, 2019	Causal role for the rTPJ in embodied mental rotation .
Martin, 2020	Support the theory that the rTPJ is causally involved in embodied processes relevant for social cognition .
Nobusako, 2017	rTPJ helps to control different representations of self and others , i.e., inhibiting imitation of and taking the perspective of another;
Noguchi, 2018	The neural enhancement of rTPJ increased the psychological resistance to lying , resulting in poorer deceptive performances.
Obeso, 2018	rTPJ is involved in the representation of the conflict between moral and material values associated with a donation .
Payne, 2017	Targeting the rTPJ affects self–other face discrimination by inhibiting recognition of the self while facilitating the recognition of a familiar other.
Santiesteban, 2012	rTPJ stimulated in this study is recruited in situations where online control of coactivated self and other representations is crucial for successful social interaction.

Table 2: Data Extracted on Study Design

Study	TMS' or 'tES'	if tES: Anodal/cathodal?	Duration of stim [minutes]	Intensity of stimulation
Martin, 2019	HD-tDCS	Anodal	20 min	1 mA
Martin, 2020	HD-tDCS	Anodal	20 min	1 mA
Nobusako, 2017	tDCS	Anodal	20 min	1 mA
Noguchi, 2018	tDCS	Anodal	20 min	1 mA
Obeso, 2018	TMS, TBS	N/A	50 Hz in 30 minutes	rTPJ mean cTBS intensity: 38%;
Payne, 2017	tDCS	Anodal and cathodal	20 min	1 mA
Santiesteban, 2012	tDCS	Anodal and cathodal	20 min	1 mA
Santiesteban, 2015	tDCS	Anodal	20 min offline (before task)	1 mA
Santiesteban, 2017	TMS (disruptive)	N/A	N/A	6 pulses at 10 Hz per trial
Sellaro, 2005	tDCS	Anodal and cathodal	20 min	1 mA
Slaby 2015	tDCS	Anodal and cathodal	20 min	2 mA
Soutschek, 2016	TMS	N/A	N/A	40-s cTBS
Sowden, 2015	rTMS	N/A	Delivered during task	6 pulses at 10 Hz per trial
Tang, 2017	tDCS	Anodal and cathodal	20 min	1.5 mA
Vandenbroucke, 2016	TDCS	Anodal and cathodal	20 min	1.5 mA
van Elk, 2017	tDCS	Anodal and cathodal	20 min	1-mA
Ye, 2015	tDCS	Anodal and cathodal	15 min	2 mA

Results

Full articles have been reviewed and we have extracted the detailed data from the relevant articles and have began making data figures.

We have evaluated 32 articles in greater detail. The following data were obtained:

- Articles focusing on the rTPJ specifically (n=29)
- Articles utilizing tDCS (n=20)
- Articles utilizing anodal stimulation (n=13)
- Articles utilizing anodal and cathodal stimulation (n=17)
- Measures of social cognition examined include: Moral judgements, deception/lying, empathy, sociocognitive abilities, verbal associative thought, egocentric perspective

Findings of select studies can be found in *Table 1*. Data extracted on study design including type of stimulation, anodal/cathodal, duration of stimulation and intensity can be found in *Table 2*.

Conclusions

In multiple, there was an increase or decrease of task performance depending on the type of stimulation used (anodal/cathodal) and duration of stimulation. However, many of these studies used tasks that were not peer-reviewed with small sample sizes. Future studies should attempt to replicate these findings in larger sample sizes with different stimulation approaches to the rTPJ.

Based on the results of this scoping review, the right tempo-parietal junction does have a major role in various aspects of social communication including deception, face-discrimination, and perception of self and others.

The data extracted will assist us on maximizing our study design on our current experimental study investigating how nonliteral language perception and the ability to make social-pragmatic inferences changes with modulating brain activity.

References

- Frith, U., & Frith, C. (2001). The Biological Basis of Social Interaction. *Current Directions in Psychological Science*, 10(5), 151–155. <http://doi.org/10.1111/1467-8721.00137>
- Mai, X., Zhang, W., Hu, X., Zhen, Z., Xu, Z., & Zhang, J. (2016). Using tDCS to Explore the Role of the Right Temporo-Parietal Junction in Theory of Mind and Cognitive Empathy, 7(March), 1–7. <http://doi.org/10.3389/fpsyg.2016.00380>
- Rothermich, K., & Pell, M. (2015). Introducing RISC: A new video inventory for testing social perception. *PLoS ONE*, 10(7)
- Martin, A. K.; Su, P.; Meinzer, M. *Neuropsychologia* 2019;133(1):107170 2019
- Gan, Tian; Shi, Rui; Liu, Chao; Luo, Yuejia *Acta Psychologica Sinica* 2018;50(1):36-46
- Mai, X.; Zhang, W.; Hu, X.; Zhen, Z.; Xu, Z.; Zhang, J.; Liu, C. *Frontiers in psychology* 2016;7(1):380
- Ye, H.; Chen, S.; Huang, D.; Zheng, H.; Jia, Y.; Luo, J. *Frontiers in human neuroscience* 2015;9(1):659
- Hughes, G. *Neuropsychologia* 2018;113(1):1-5
- Jeurissen, D.; Sack, A. T.; Roebroek, A.; Russ, B. E.; Pascual-Leone, A. *Frontiers in neuroscience* 2014;8(1):18
- Zhang, Y.; Chen, S.; Hu, X.; Mai, X. *Frontiers in psychology* 2019;10(1):185