Neuromodulation of the Theory of Mind Network with Real-Time fMRI Neurofeedback

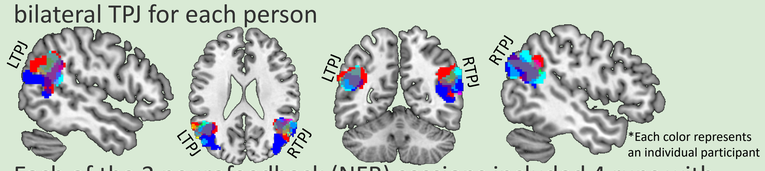
Abhishek Saxena[1], Emily M. Dudek[1], Arun Venkataraman[2], J. Steven Lamberti[3], & David Dodell-Feder[1,2]
Departments of Psychology[1], Neuroscience[2], and Psychiatry[3] |University of Rochester

Background:

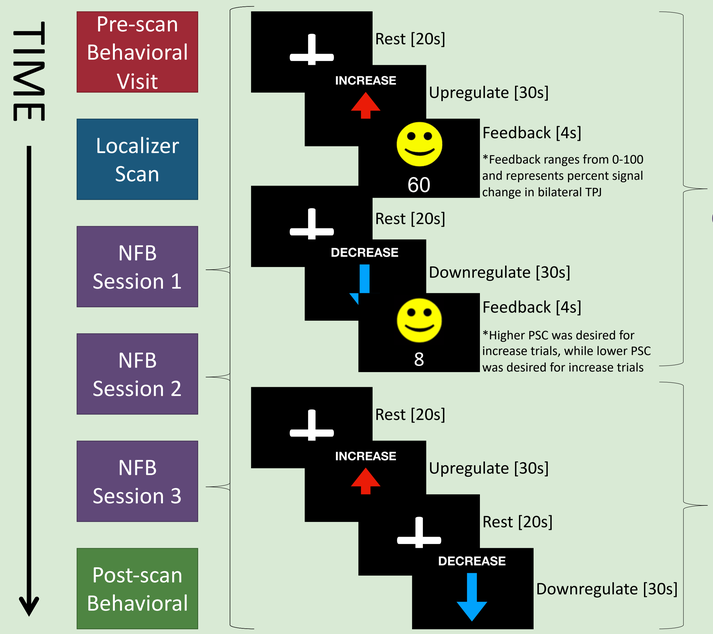
- Theory of mind (ToM)—the ability to attribute and reason about the beliefs, intents, and emotions of others—is a vital component to successful social interaction
- Deficits in ToM are a hallmark of some of the most debilitating mental disorders, including autism and schizophrenia
- For individuals with impairments in ToM, the ability to volitionally modulate these brain regions, and bring them online during social interaction, may alleviate deficits in ToM and concomitant social difficulties
- We present a proof-of-concept study to evaluate the efficacy of using real-time fMRI towards training volitional control of the ToM network

Methods:

- 5 neurotypical adults (NA) and 1 adult with schizophrenia (SZ)
- The False-Belief Task (Dodell-Feder et al., 2011) was used to localize bilateral TPJ for each person



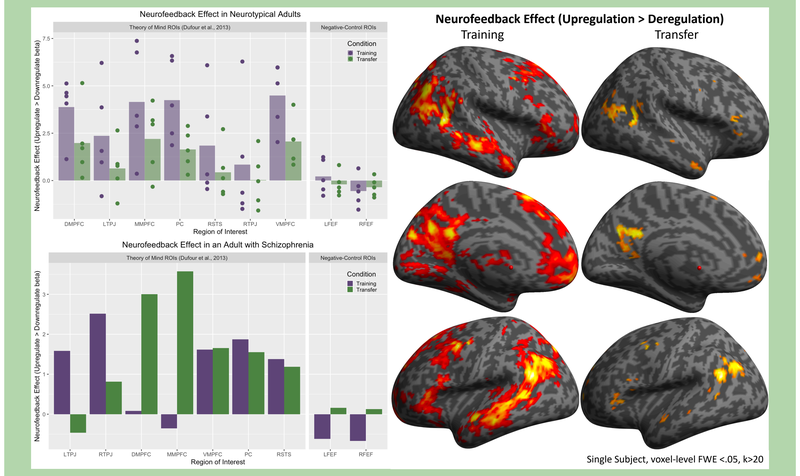
- Each of the 3 neurofeedback (NFB) sessions included 4 runs with feedback (**training**) and 1 run without feedback (**transfer**)
  - OpenNFT (Koush et al., 2019) was used to provide real-time feedback in the form of percent signal change (PSC) in bilateral TPJ



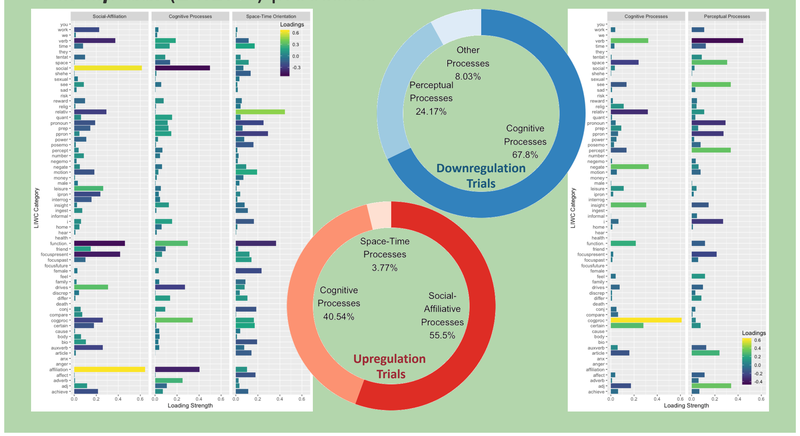
- Participants reported the strategies they used to **up-** and **downregulate** their TPJs during the most successful trial
  - Responses were analyzed using Linguistic Inquiry and Word Count (LIWC 2015; Pennebaker et al., 2015)
  - Partial least squares regression were run to determine which mental processes predicted brain activity across the bilateral TPJ in either the **up-** or **downregulation** trials

Results:

- **Neurofeedback Effect (NFBe)**: beta difference between **upregulation** and **downregulation** sessions
  - ROI analyses show NA and SZ demonstrate positive NFBes in ToM ROIs but not control ROIs (e.g., Frontal Eye Fields)



- **99.81% of variance in TPJ** activity during **upregulating** trials was accounted for by strategies involving ***Social-Affiliative*** (55.50%), ***Cognitive*** (40.54%), and ***Space-Time*** (3.77%) processes
- **91.97% of variance in TPJ** activity during **downregulating** trials was accounted for by strategies involving ***Cognitive*** (67.80%) and ***Perceptual*** (24.17%) processes



Conclusions & Future Directions:

- This study finds preliminary evidence for the volitional control of the ToM network, specifically using social-affiliative processes
- These data highlight the potential utility of real-time fMRI for improving social deficits in psychiatric illness
- Future directions include the collection of a larger sample and comparison to a sham neurofeedback condition

Preliminary evidence for volitional control over aspects of the Theory of Mind network can be gained through real-time fMRI neurofeedback.

#theoryofmind
#neuromodulation
#neurofeedback
@PsychSaxena

labsites.rochester.edu/scplab
researchgate.com/AbhishekSaxena15
abhishek.saxena@rochester.edu
bit.ly/cns2020_poster

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SCP Lab

MELIORA
UNIVERSITY of ROCHESTER