Neural Representation of Mental State Information in Schizophrenia: A Multivariate Pattern Analysis of fMRI Data from a Visual Theory of Mind Task

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Introduction

- **Theory of mind (ToM)–the ability to attribute and reason about the mental states of others–is disrupted in people with schizophrenia spectrum disorders (SSDs).**
- **Previous research using standard univariate analysis has shown neural abnormalities in the ToM-network (ToM-N) in people with SSDs.**
- **Only one prior study used multivariate pattern analysis (MVPA) to evaluate how belief information during the false-belief task is represented in the ToM-N in SSD–they found reduced classification accuracy in dorsal medial prefrontal cortex (DMPFC) and right temporo-parietal junction (RTPJ).**
- **Study Aim: To evaluate whether previously observed representational abnormalities of mental state information in SSD participants extend to other ToM tasks in which stimuli are presented visually rather than verbally.**

Methods

- **Participants completed the why/how task while undergoing fMRI in a single run, which requires participants to make judgements about what a target is doing (how condition), or the target's motivations (why condition) from a set of images (Fig. 1).**
- **After standard preprocessing procedures (realignment, normalization, smoothing), we conducted GLMs to estimate beta-maps for each of the 16 blocks in SPM.**
- **We used The Decoding Toolbox (TDT) to perform MVPA (leave-one-out design that left out every possible pair of why/how blocks; Fig. 2) to evaluate classification accuracy in 9 a priori ROIs defined from the original why/how study.**
- **Using R we performed one-sample t-tests to compare prediction accuracy to chance within group, and two-sample Welch's t-tests to compare prediction accuracy between-groups.**

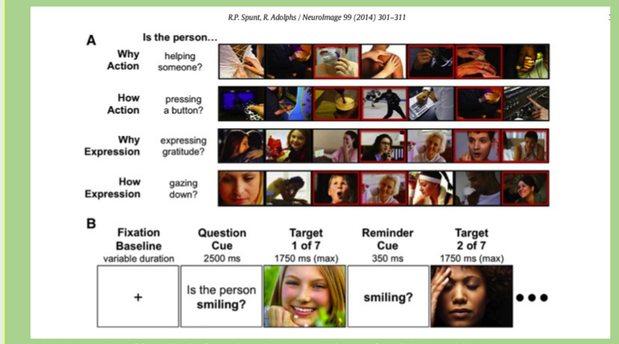


Fig. 1. Examples of four blocks from the why/how task (Spunt &, Adolphs 2014). Each participant completed one run with 8 blocks per condition, each containing 7 images.

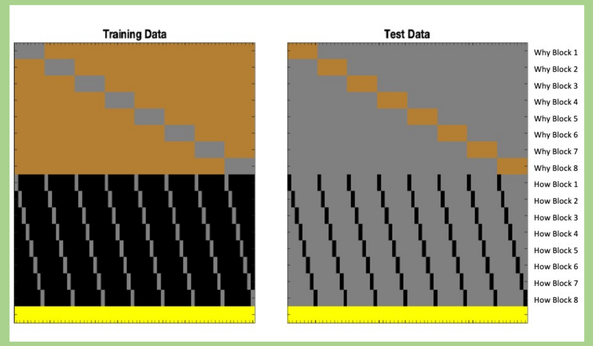


Fig. 2. Design Matrix created to contain all 64 possible unique combinations leaving one block of each condition out of the training set for evaluation in the decoding model.

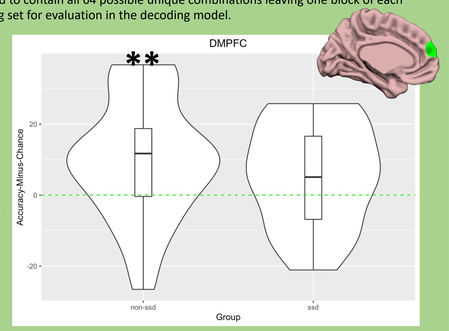
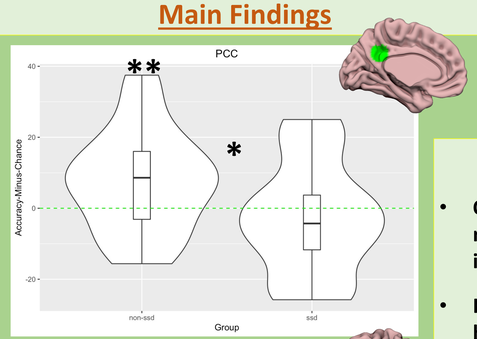


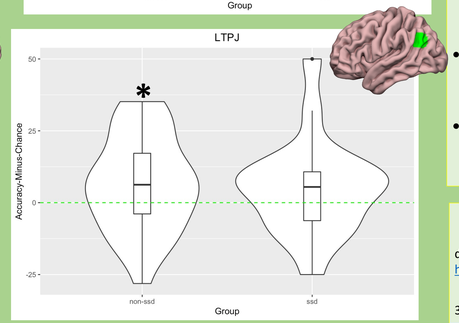
Fig. 3-5 Distribution of classification accuracy minus chance of the decoding models, *clockwise from top:* (1) model based on PCC activity, (2) model based on LTPJ activity, (3) model based on DMPFC activity. * = $p < .05$, ** = $p < .01$

	SSD Group	non-SSD Group
n	18	31
Age (years; *M*±*SD*)	42.7 ± 14.1	38.2 ± 14.9
Sex (*n*, %)		
Female	5 (28%)	18 (58%)
Male	13 (72%)	13 (42%)
Education (years; *M*±*SD*)	13.7 ± 2.1	15.7 ± 2.4
IQ (WASI; *M*±*SD*)	103.9 ± 12.4	109.4 ± 14.7

Table 1. Demographics of diagnostic groups

Main Findings





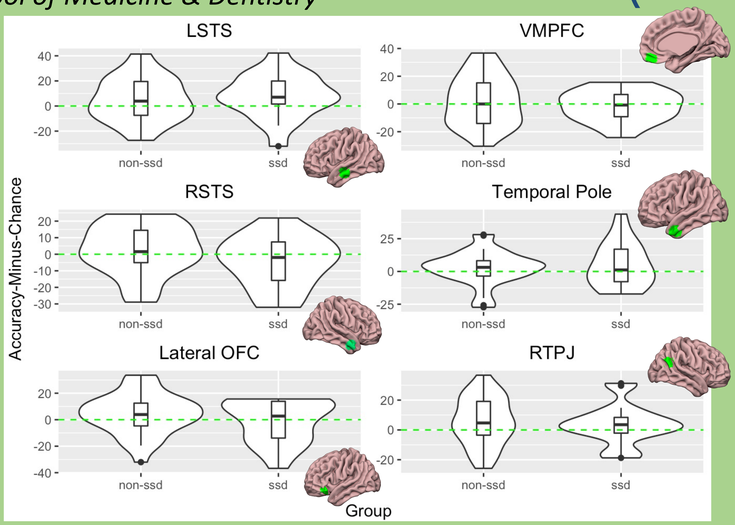


Fig. 6 Distribution of Accuracy-Minus-Chance for the decoding models based on activity in each ROI (from *left to right, top to bottom*): (1) LSTS, (2) VMPFC, (3) RSTS, (4) Temporal Pole, (5) Lateral OFC, (6) RTPJ. None of these models had accuracy significantly above chance. No significant group differences were observed.

Discussion/Conclusions

- **Only certain regions within the ToM-N discriminated between how & why reasoning in non-SSD individuals, and none of these regions did so in SSD individuals.**
- **However, except for PCC, group differences were not unexpected under the null hypothesis.**
- **Limitations include low power at the individual subject level (only 1 chunk with limited blocks of the task) and group level.**
- **These data suggest that representational deficits in the ToM-N in SSD may not generalize to tasks involving the visual depiction of mental states.**

References

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