Movie-fMRI as an acquisition state for functional connectivity-based precision psychiatry

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INTRODUCTION

- Functional connectivity (FC) is the Pearson's correlation between the BOLD signal time-courses from pairwise brain regions
- For FC to be clinically useful, it must be reliable across repeated measurements and sensitive to individual differences[1]
- fMRI scans must also be of high quality and sufficient length[1]
- Movie-fMRI improves reliability,[2] the ability to detect individual differences,[3] and data quality and quantity of FC[4,5]

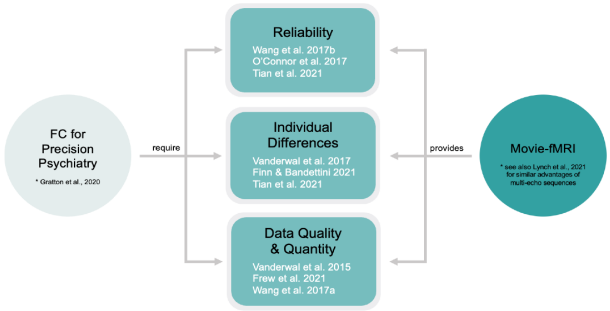

Figure 1. Overlap between the requirements of FC for precision psychiatry and the benefits of movie-fMRI.

METHODS

Data

- Minimally preprocessed Human Connectome Project (HCP) 7T release[6]
- Subjects with mean FD < 0.2mm in all functional runs
- Healthy subjects: N = 109, 64 F, mean age of 29.4 ± 3.4 years
- Gradient-echo EPI run parameters: TR = 1s, TE = 22.2ms, flip angle = 45°, FOV = 208 x 208 mm^2, matrix size = 130 x 130, 85 slices, slice thickness = 1.6 mm, voxel size = 1.3 x 1.3 x 1.3 mm^3, multiband factor = 5, image acceleration = 2

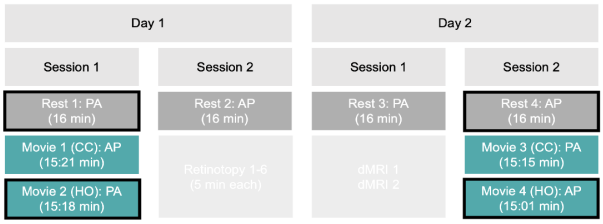

Figure 2. Scan sessions collected by the HCP. Runs in black were used for this study. Movie scans include clips from Hollywood movies with 20 second rest epochs between clips.

FC Matrices

- We created 3 ROI masks: the left Dorsolateral Prefrontal Cortex (DLPFC), left Temporoparietal Junction (TPJ), and the right pre-Supplementary Motor Area (pre-SMA)
- Parcellated the rest of the brain with the Schaefer 1000 parcellation
- For each subject, ROI, and run (Rest1, Movie2, Rest4, Movie4), created an FC matrix of the Pearson's correlation between every grayordinate in the ROI and every parcel of the rest of the brain

Analysis

- Reliability: we estimated test-retest reliability at the univariate level with the intraclass correlation coefficient (ICC), and at the multivariate level with the image intraclass correlation coefficient (I2C2) and discriminability (Discr)
- Individual Differences: we measured the ability to detect individual differences with the test-retest identification algorithm (i.e. fingerprinting)
- All analyses were conducted within condition for each ROI
- Analyses were repeated with increasing data amounts

RESULTS

- Movie and rest are equally as reliable in the DLPFC and pre-SMA, and multivariate reliability measures are superior for movie compared to rest in the TPJ
- Movie and rest are equally as sensitive to individual differences in the DLPFC, representing a ceiling effect, and movie outperforms rest in the pre-SMA and TPJ

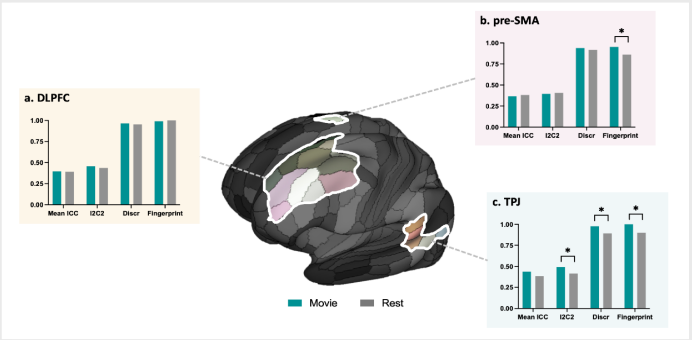

Figure 3. Reliability and fingerprinting results across all ROIs between conditions. * = p < 0.05, determined via bootstrapping or permutation testing.

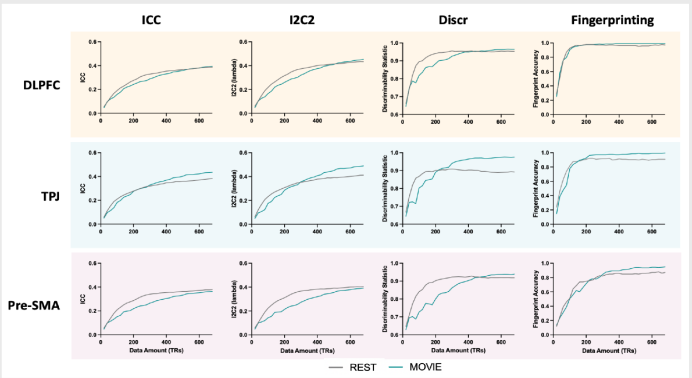

Figure 4. The effect of data amount on reliability and fingerprinting across all ROIs and conditions.

- All measures improve with increasing data amount across rest and movie
- Rest and movie mostly improve at the same rate, however movie continues to improve when rest reaches a ceiling, particularly in the TPJ

CONCLUSION

- Movies are either equal or superior to rest across various measures of reliability and sensitivity to individual differences in the three ROIs
- This was true despite the fact that the test-retest movie runs used different movies
- The TPJ appears to show the most benefit from movies, possibly because of social and language processing involved in movies
- In conclusion, movie-fMRI appears to be a good candidate acquisition state to optimize FC quality and quantity for precision psychiatry. Future study designs could likely improve on the promising results seen here.

LIMITATIONS

- Healthy participants
- Difference in scanner strength
- These findings pertain only to the quality of FC in these regions overall and not to specific interventional targets

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