

## Background

- Moral Foundations Theory*<sup>1</sup> postulates the existence of five universal, innate moral modules that motivate behaviors according to what is considered best for society as a whole.
- These modules produce sensibilities towards (observed) behaviors concerned with *Care/harm*, *Fairness/cheating*, *Loyalty/betrayal*, *Authority/subversion*, and *Purity/desecration*.
- Identifying and punishing moral transgressors serves an important function of maintaining group cohesion and hence is argued to elicit universal neural activation patterns.
- Here, we examine neural responses to ten experimental auditory narratives that describe actors which (a) violate one of the five moral foundations and (b) are either punished or rewarded for their actions. It is hypothesized that narratives with different moral transgressors elicit high intersubject correlations in separable networks, especially when transgressors are punished.**

## Method

### Procedure

- 64 subjects (48% female;  $M_{age} = 20.78$ ,  $SD_{Age} = 2.45$ ) listened to ten professionally narrated movie plots summaries<sup>2</sup> ( $\bar{x}_{Duration} = 45\text{sec}$ ) while undergoing functional magnetic resonance imaging (fMRI).
- In each plot summary (2 / foundation), the main character (a) violates one of the five moral foundations while adhering to all other foundations and (b) is either punished or rewarded for their moral transgressions. Character outcomes were counterbalanced across subjects. After listening to a story, subjects rated the degree to which they would like to see the movie.
- After undergoing fMRI, subjects listened to each plot summary again (randomized order) and rated the degree to which they perceived (a) the main character's actions to be moral-immoral, (b) the outcomes that befell the character to be good-bad, (b) the behavior of the character to uphold-violate each of five moral foundations.

### Data Preparation and Pre-processing

- Data was organized into *Brain Imaging Data Format* (BIDS) using *HeuDiConv*<sup>3</sup>.
- Minimal pre-processing was executed with *fMRIPrep*<sup>4</sup> followed by FWHM smoothing and nuisance regression including CSF, average white-matter, six motion parameters, and FD.
- Eight subjects were removed from all subsequent analyses due to (a) scanning issues or (b) excessive head motion as indexed by framewise displacement.

## Hypotheses

H1: For characters that violate a specified moral domain, the salience of that moral domain for viewers will negatively predict their perception of character morality.

H2: For characters that violate a specific moral foundation and are being punished for it, narrative engagement in the form of intersubject correlation across moral brain networks will be higher compared to characters that are rewarded.



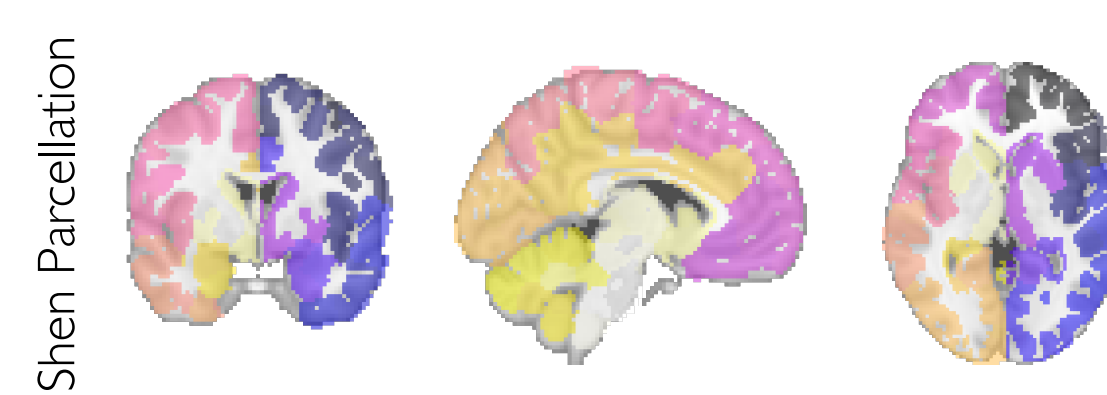
Moral Foundation Salience Predicting Perceived Character Morality (H1)

Trait	Positive Outcome		Negative Outcome	
	B	Adj. R2	B	Adj. R2
Care	-.10	.03	-.18*	.09*
Fairness	-.07	.01	-.01	.00
Loyalty	.02	.00	-.08	.03
Authority	-.16***	.21***	-.09	.05
Purity	-.15***	.26***	-.12**	.12**

\*  $p < .05$ , \*\*  $p < .01$ , \*\*\*  $p < .001$

## Intersubject Correlation Analysis

- First, regional fMRI data was extracted using the Shen-Parcellation<sup>5</sup> producing 268 ROIs.



- Next, ISC analyses were conducted with the *Brain Imaging Analysis Kit*<sup>6</sup> (BrainIAK).

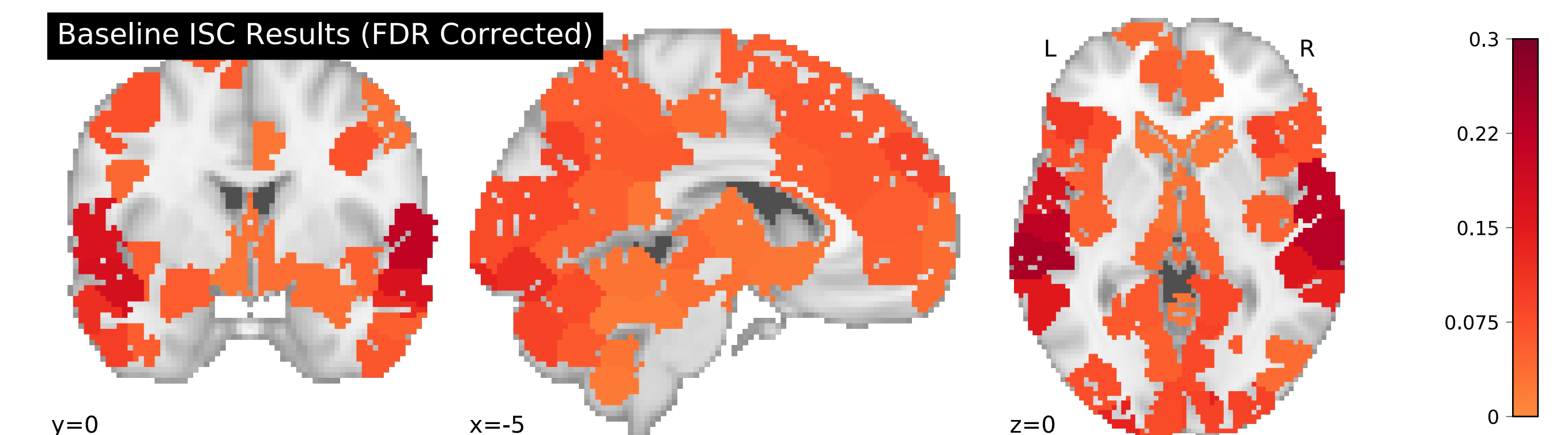
- For each ROI, ISC is calculated as average correlation where the individual  $r_j$  represents the Pearson correlation between a region's BOLD time series in one individual and the average of that region's BOLD time series in all other individuals.
- A null distribution of ISCs is then constructed through phase randomization to compute the  $p$ -values for each ISC<sup>7</sup>.
- False discovery rate (FDR) was controlled with a criterion of .05<sup>8</sup>.

### Acknowledgements

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## Preliminary ISC Results



### Highest ISC per ROI

- Superior Temporal Gyrus (ISC = 0.25)
- Middle Temporal Gyrus (ISC = 0.23)
- Temporal Pole (ISC = 0.18)

## Discussion & Outlook

- Moral foundation salience linked to character perception and evaluation.
- Short stimulus times likely limit the detection of significant ISC results.

### Future Analyses

- Improved alignment of auditory stimuli and BOLD responses via sound envelopes.
- Aggressive preprocessing with ICA-AROMA and additional confounds.
- Moral foundation salience as predictor for ISC and story evaluation.
- Decoding of moral information processing via Multivoxel Pattern Analysis, Hidden Markov Models, and Representational Similarity Analysis.

## References

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