Cerebral Topography of Emotional Perception and Experience

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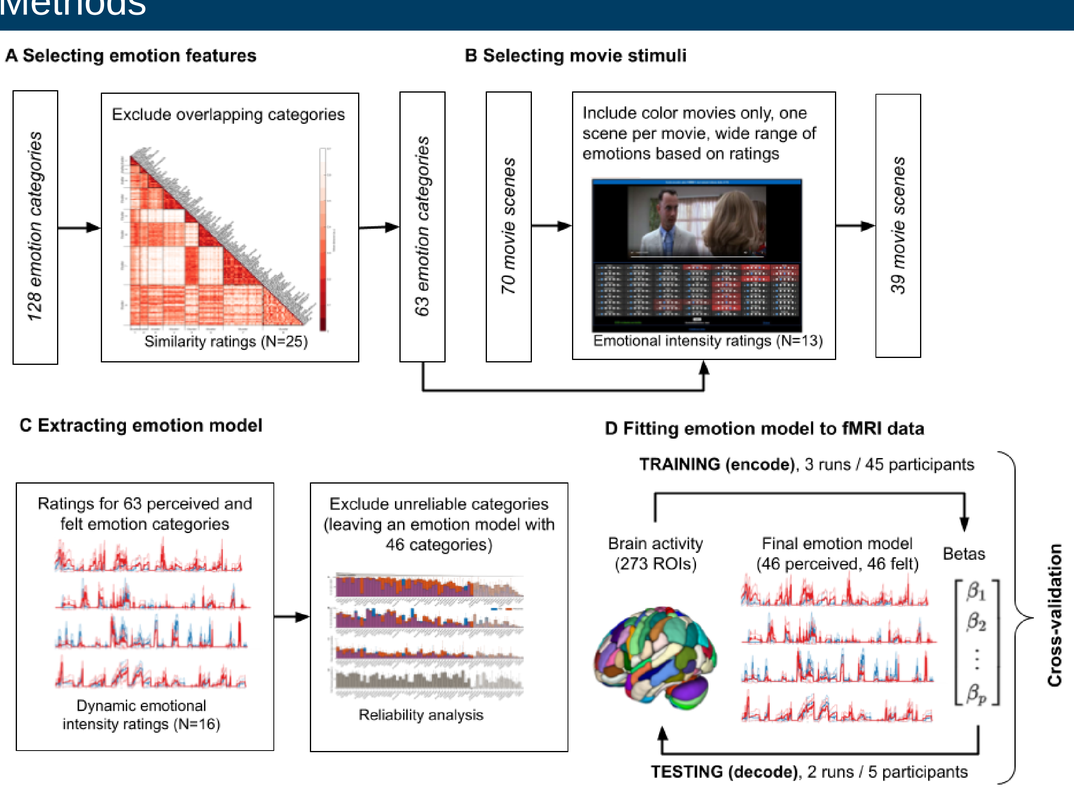
Introduction

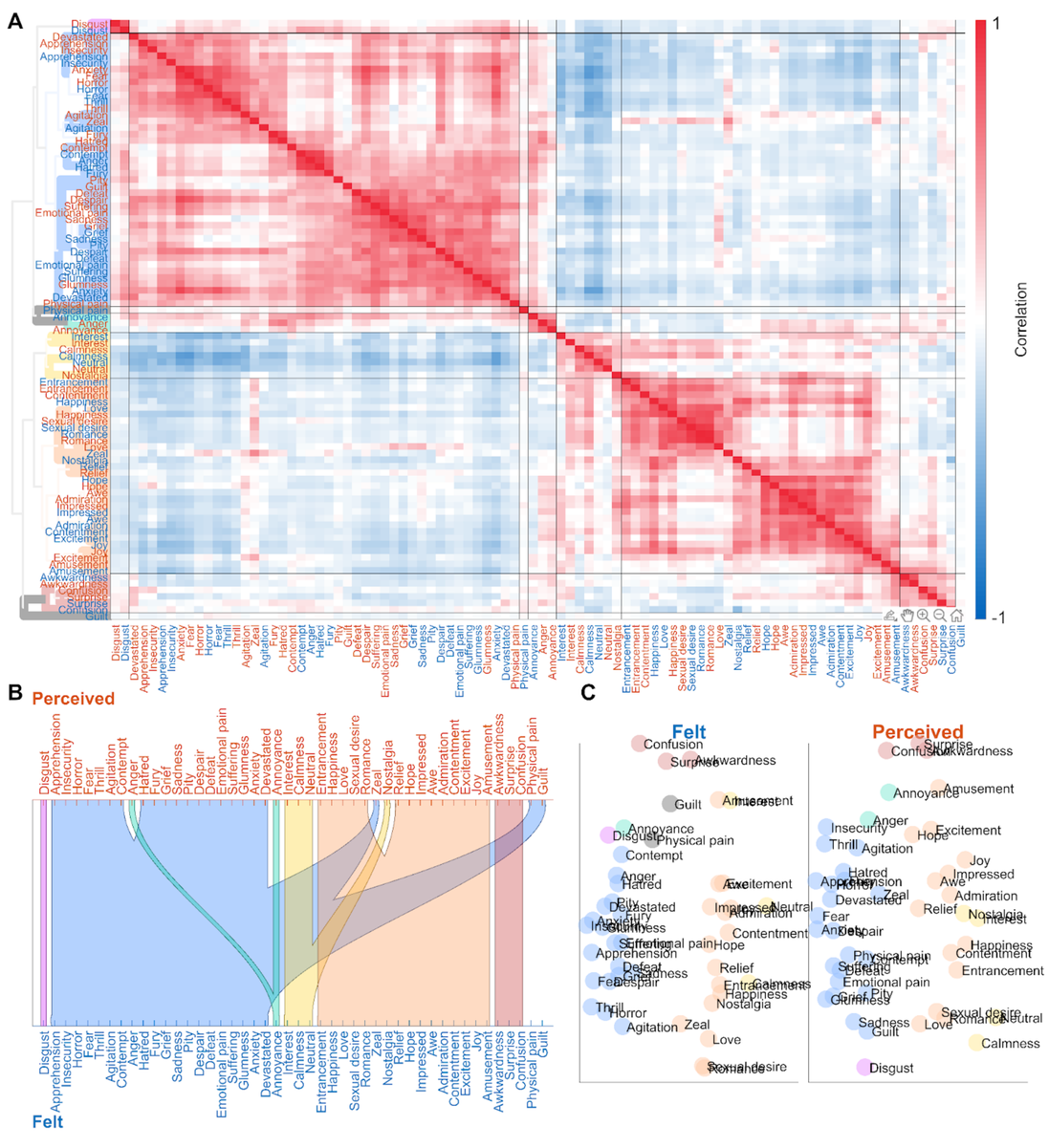
Emotions promote survival by monitoring external and internal challenges and coordinating automatic changes in peripheral physiology, behavior, motivation, and conscious experiences ("feelings") accordingly[1]. Emotion circuits span the whole brain and are focused in the limbic and paralimbic structures[2]. Despite significant advances in mapping the brain basis of emotions, two critical questions remain unanswered. First, how distinct emotional states - such as anger, fear, or disgust - are coordinated in the brain, and second, what is the relationship between the brain circuits that extract and recognize emotional information from the external input and those that subsequently generate the subjective experience of emotions.

Methods



A. Candidate emotions were selected based on previous studies. **B** A total of 70 movie scenes with total duration > 2 hours were selected from a prior study by Schaefer et al.[3] to elicit a wide range of emotions. **C** Dynamic ratings for perceived and felt emotion features were collected during movie viewing. The reliability of the ratings of the emotion features was evaluated and only the 46 most reliable features were included in the stimulus models. **D** The emotion models were fit to the BOLD data using cross-validation.

Perceived and felt emotions cluster together following valence



A Correlation matrix and dendrogram of ratings over emotion models across all runs and both felt and perceived emotions. **B** Alluvial diagram shows corresponding cluster structures between felt and perceived emotions. **C** Multidimensional scaling visualizes the similarity of emotions based on only the ratings of felt emotion (left) and perceived emotions (right). Emotions not belonging to any cluster are shown in gray and are left unconnected in the alluvial diagram.

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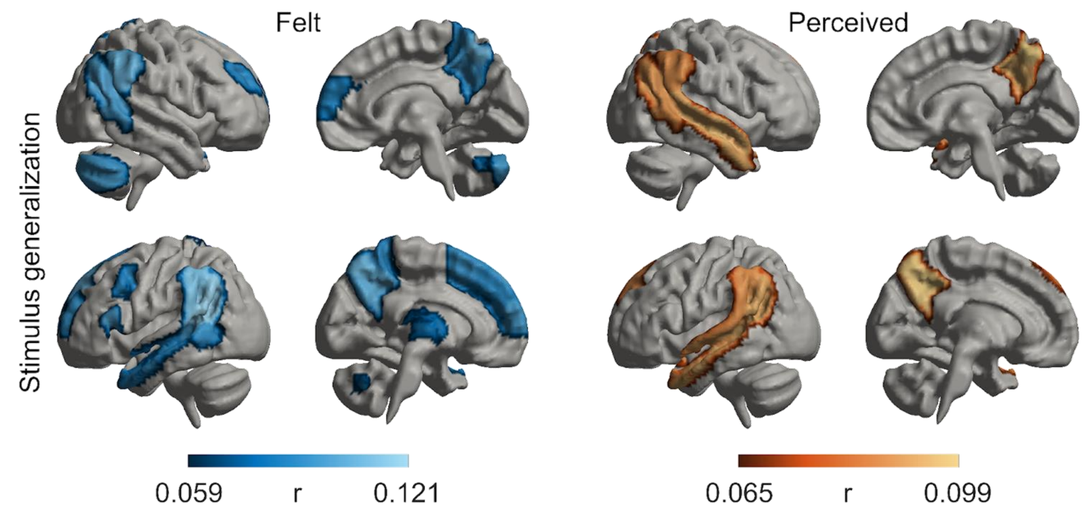
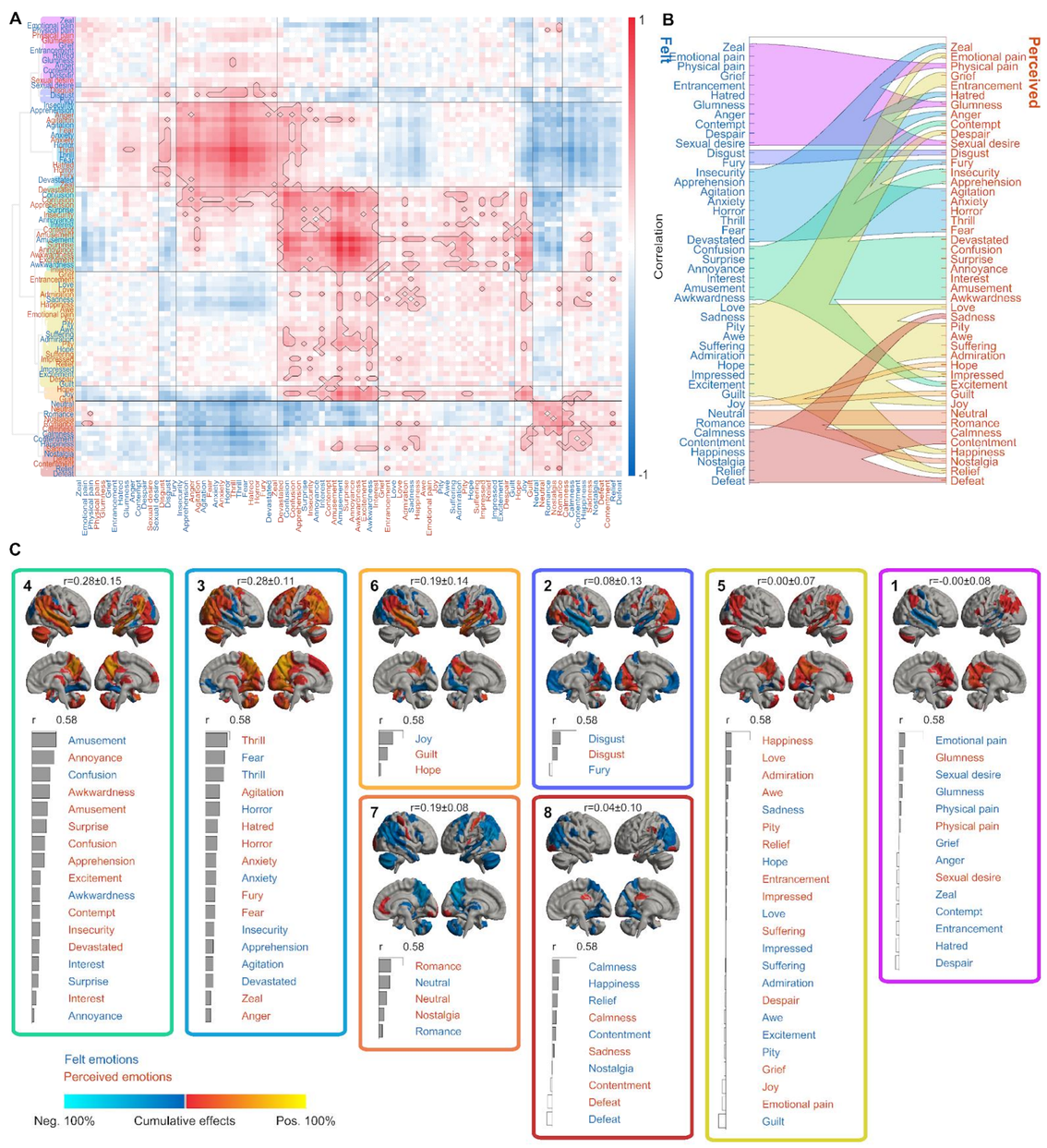
Brain responses to perceived and felt emotions generalize



Cross-validated generalizability of linear combinations of emotion responses for different stimuli for felt (left) and perceived (right) emotions (p<.05, FWER).

Spatial consistency and clustering of the neural responses across stimuli differs from behavioral clusters



A Between-runs correlation matrix and dendrogram clustering of brain responses. **B** Alluvial diagram of cluster correspondence between felt and perceived emotions. **C** Cumulative activity patterns for the brain clusters of felt and perceived emotions. The clusters are ordered based on the mean reliability of the activity patterns (between-runs spatial correlation) of the emotions contained within the cluster. The emotions in the clusters are ordered by reliability (bar plots). Brain maps show the cumulative significant (p<.05 Bonferroni) activations over runs and emotions belonging to each cluster, from negative 100% (all negative correlations) to positive 100%. Felt and perceived emotions are shown in blue and red text, respectively.

Conclusions

- Modulation of brain activity by felt and perceived emotions generalize both between individuals and between different stimuli, but only a subset of reliably rated emotions evoke similar brain activity patterns across stimuli.
- Emotions elicited during natural movie scene perception evoke distributed activity patterns in the brain across spatial scales from general emotion sensitivity in higher-order temporoparietal and default mode areas to more selective activity, especially in subcortical regions.
- Experiencing emotions appears evoke more reliable activity in frontal, thalamic, and cerebellar regions than mere perception of emotions
- Our data highlights both commonalities and decoupling of perception and experience of emotions on the level of brain activity.

References
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