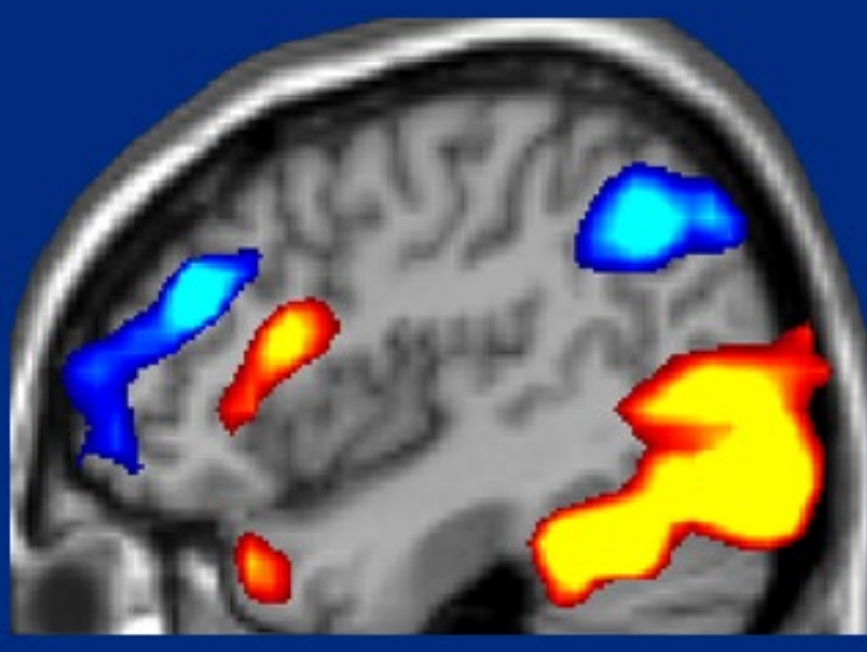


Regulating Emotional Experience in Middle-Childhood using Focused Attention: A Functional Magnetic Resonance Imaging Investigation

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I. Introduction

Background:

- The effectiveness of attentional deployment as an emotion regulation (ER) strategy in childhood remains unclear, as prior work has mainly focused on later-stage strategies of ER, such as reappraisal [1, 2]. Prior studies in adults using focused attention (FA) have shown that directing attention away from emotional content reduces subjective emotional responses, and this was associated with coordinated activity in fronto-parietal control regions [3, 4, 5].
- The present study investigated behavioral and neural effects of FA in children, during an emotion processing task, and their link to individual differences in affective experiences and temperament, within the STRONG Kids 2 (SK2) cohort [6].

Hypotheses:

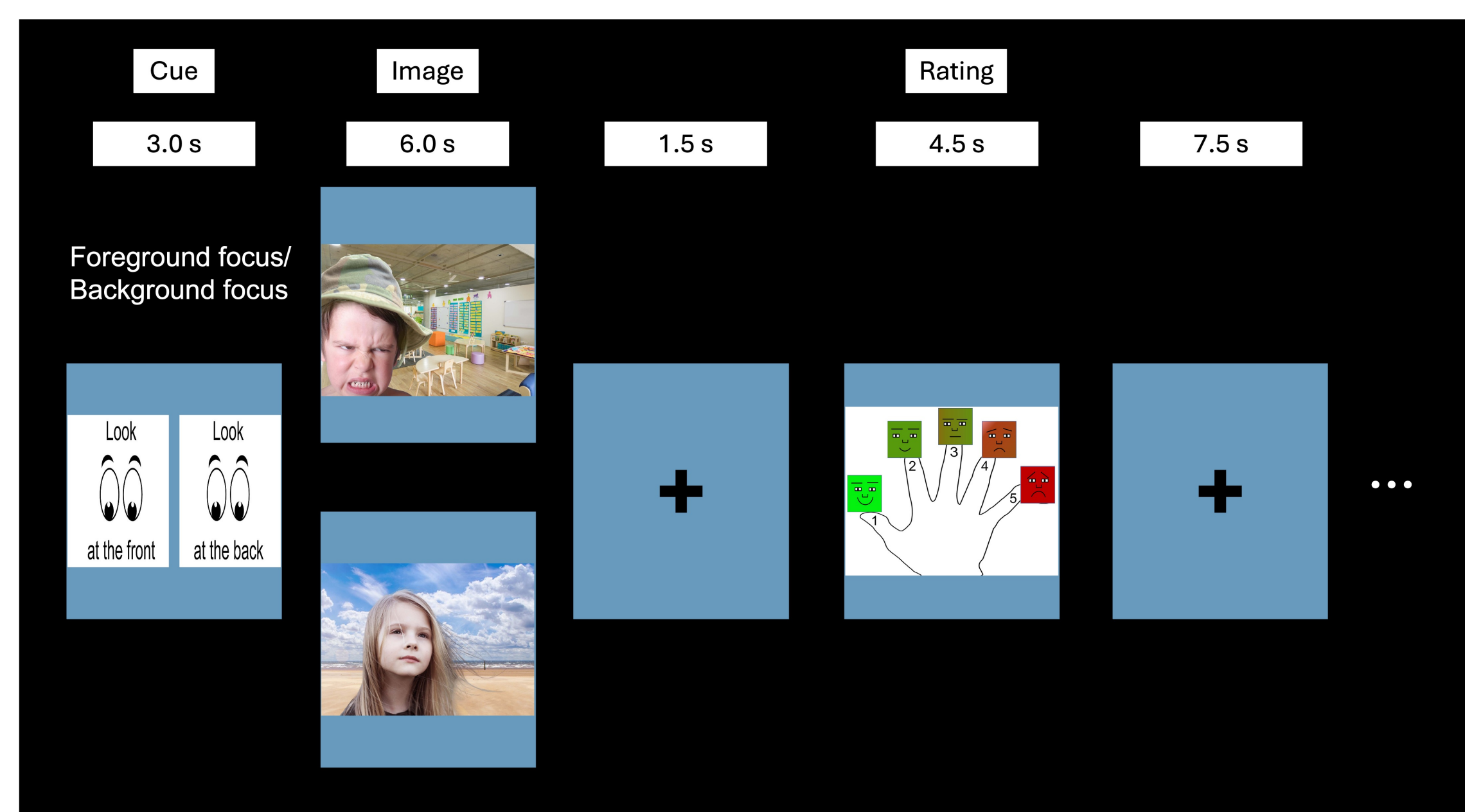
- Behaviorally, FA would reduce the emotional ratings when focusing on the background (BG) details of the negative images, compared to the foreground (FG): EmoBG < EmoFG.
- At the neural level, focusing on the BG contextual details of the negative images would increase activations in fronto-parietal and higher-order visual processing regions, while decreasing activation in the amygdala (AMY).
- [Exploratory] Individual differences in emotional ratings and temperament [7] would scale with activity in top-down executive control and bottom-up emotion processing regions.

II. Methods

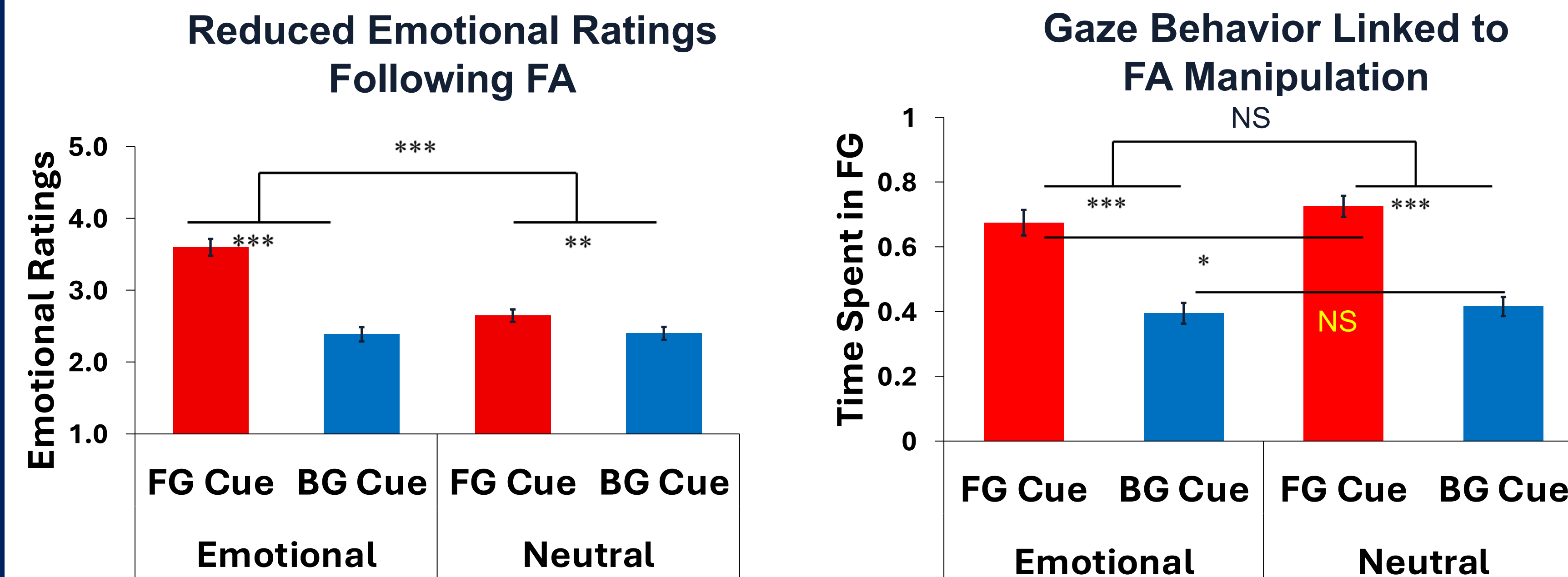
Participants: middle-childhood (7-11 years old) subjects were recruited from the longitudinal SK2 cohort [6] that was designed to examine biological and socioenvironmental factors that contribute to the development of cognitive and affective aspects (N=21).

Measures: Behavioral, eye-tracking, and fMRI data were collected at a 3T scanner. Longitudinal measures of child temperament (Infant Behavior Questionnaire Revised, and the Child Behavior Questionnaire) [8] were also collected.

Emotion Rating Task: Participants were cued to focus either on the FG or the BG of 78 composite images, containing negative or neutral peer-age faces in FGs and neutral places in BGs. Next, they rated their emotional feeling on a scale from 1 to 5.



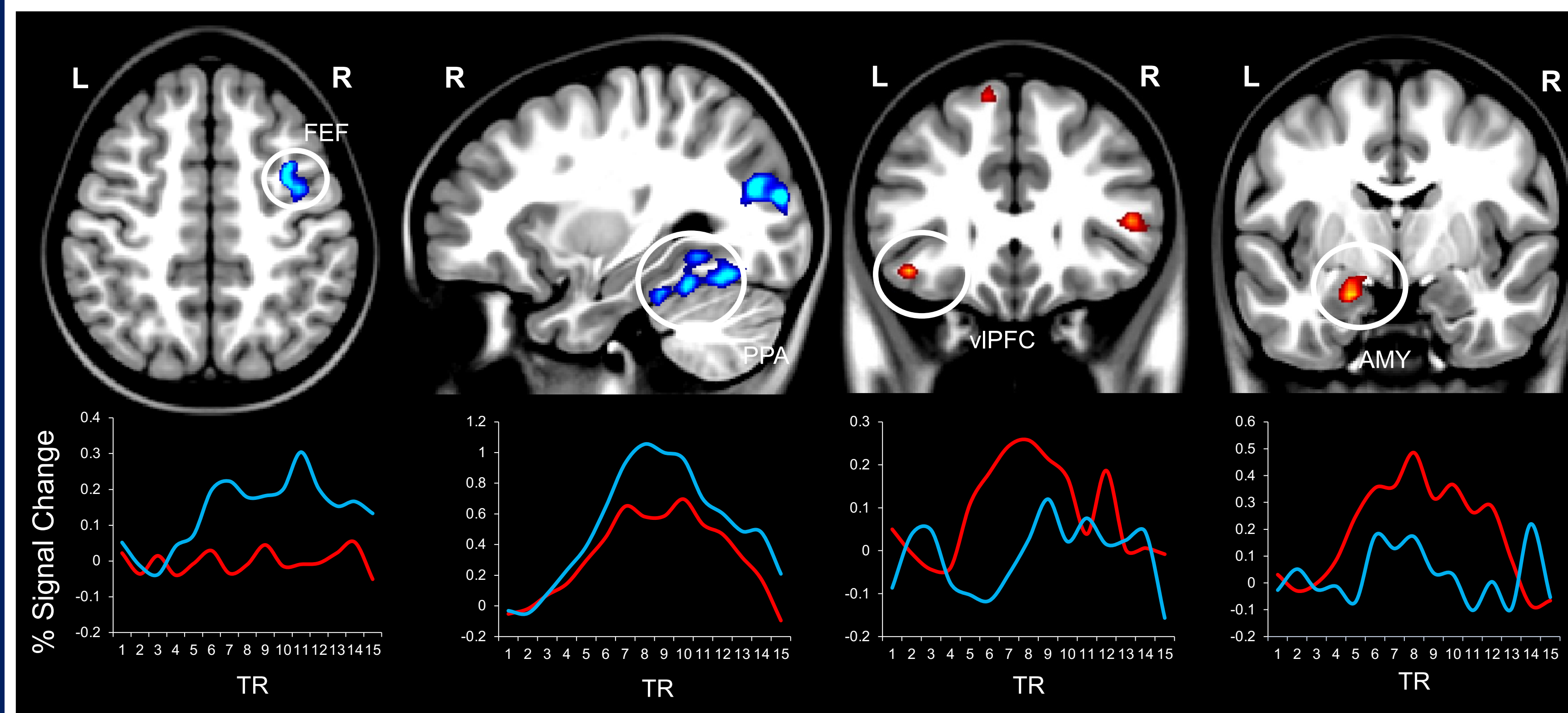
III. Results



Focusing away from negative stimuli reduced the subjective feeling to the level of that for neutral stimuli. **p < .01; ***p < .001

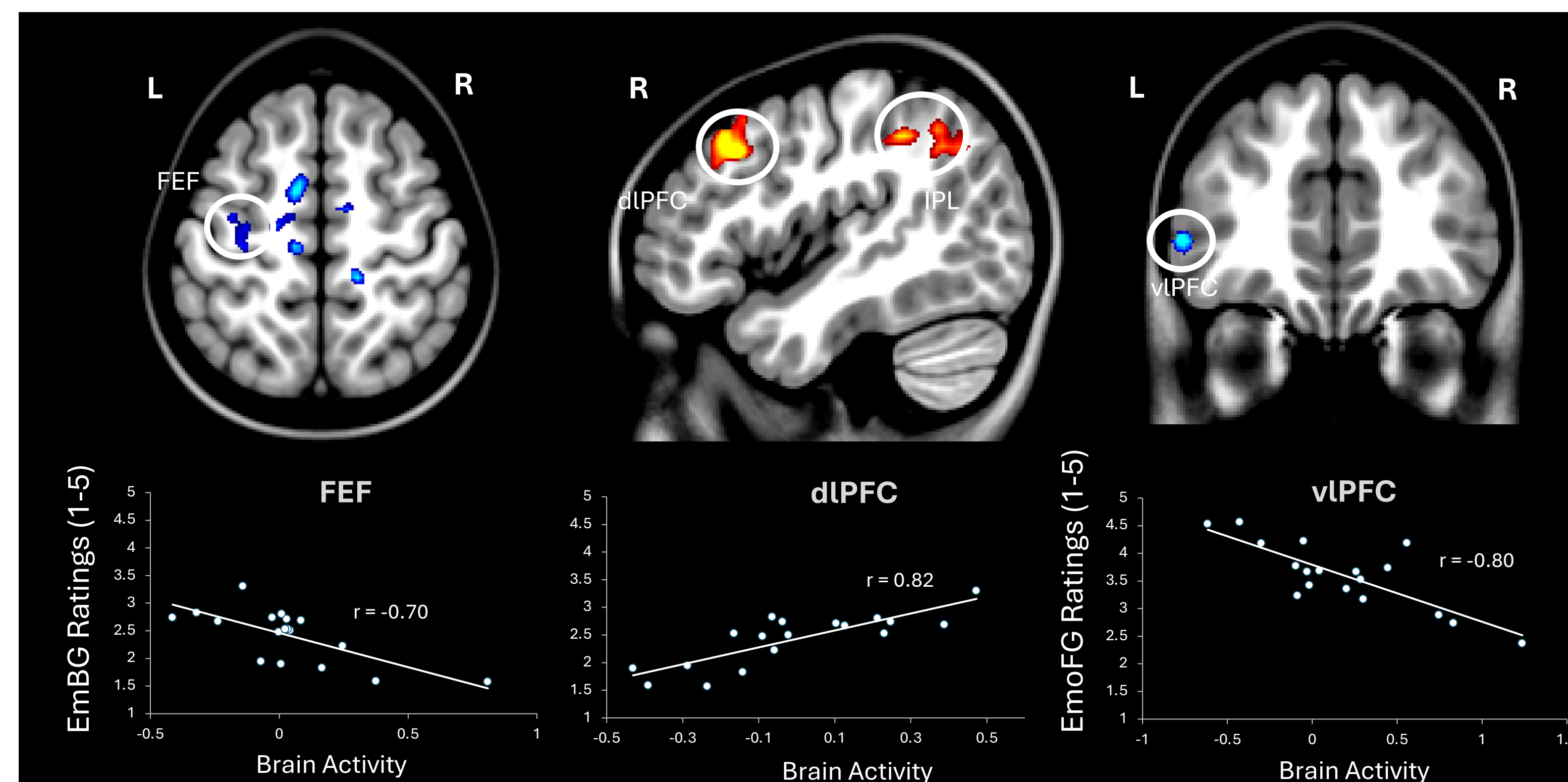
Eye-tracking results showed that participants followed the task instructions. *p < .05; ***p < .001; NS, non-significant.

Neural Correlates of FA Use with Emotional Images



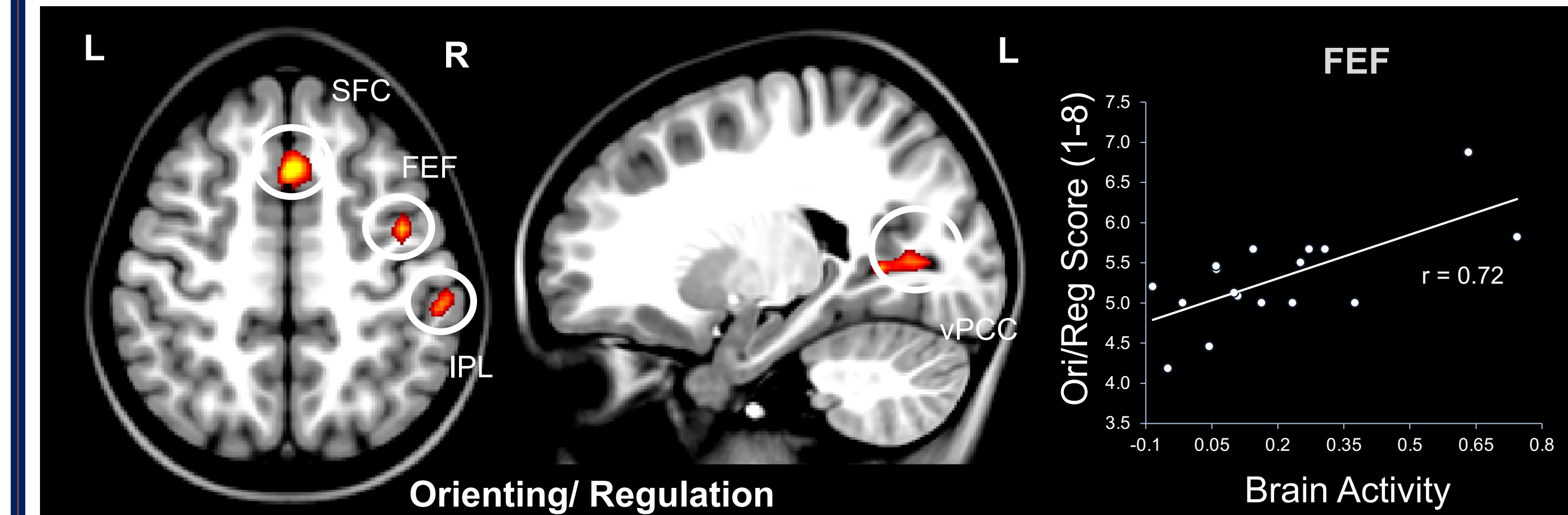
BG Focus of negative images was associated with increased activity in gaze control and visual regions and decreased activity in emotion-processing/regulation regions. FEF, Frontal Eye Field; PPA, Parahippocampal Place Area; vIPFC, Ventrolateral PFC.

Brain-Behavioral Correlations between Activity in Cognitive Control Regions and Emotional Ratings of Images



Opposing patterns of associations between activity in gaze (FEF) and executive (dIPFC) control regions and individual differences in emotional ratings. The negative association between activations in vIPFC and emotional ratings suggests a role in ER. dIPFC, dorsolateral PFC; IPL, Inferior Parietal Lobule.

Positive Associations between Activity in Cognitive Control Regions and Temperament Score



Activity in control regions during the BG Focus of negative images was positively associated with temperament (Orienting/Regulation, collected at 3 months old). SFC, Superior Frontal Cortex, vPCC, ventral Posterior Cingulate Cortex.

IV. Conclusion

- Children effectively used FA to down-regulate emotional responses: focusing on contextual aspects reduced the experienced emotion.
- Neural results showed greater activation in executive control regions and reduced activity in emotion-related areas, reflecting top-down regulation when applying FA.
- The negative correlation between FEF activity and emotional ratings during the BG Focus, paired with the negative association of vIPFC activity affective rating, highlight the role of individual differences in using self-guided attentional control.
- The positive link between activity in control regions (e.g., FEF, IPL) and temperament (Orienting/Regulation) during the BG Focus highlights individual variability in self-regulatory capacity.
- The group-level fMRI and individual differences results point to hemispheric differences in the role of FEF in attention control.

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