Neural Correlates of Emotion Regulation and Adolescent Suicidal Ideation

Supplemental Information

Supplementary Methods and Materials

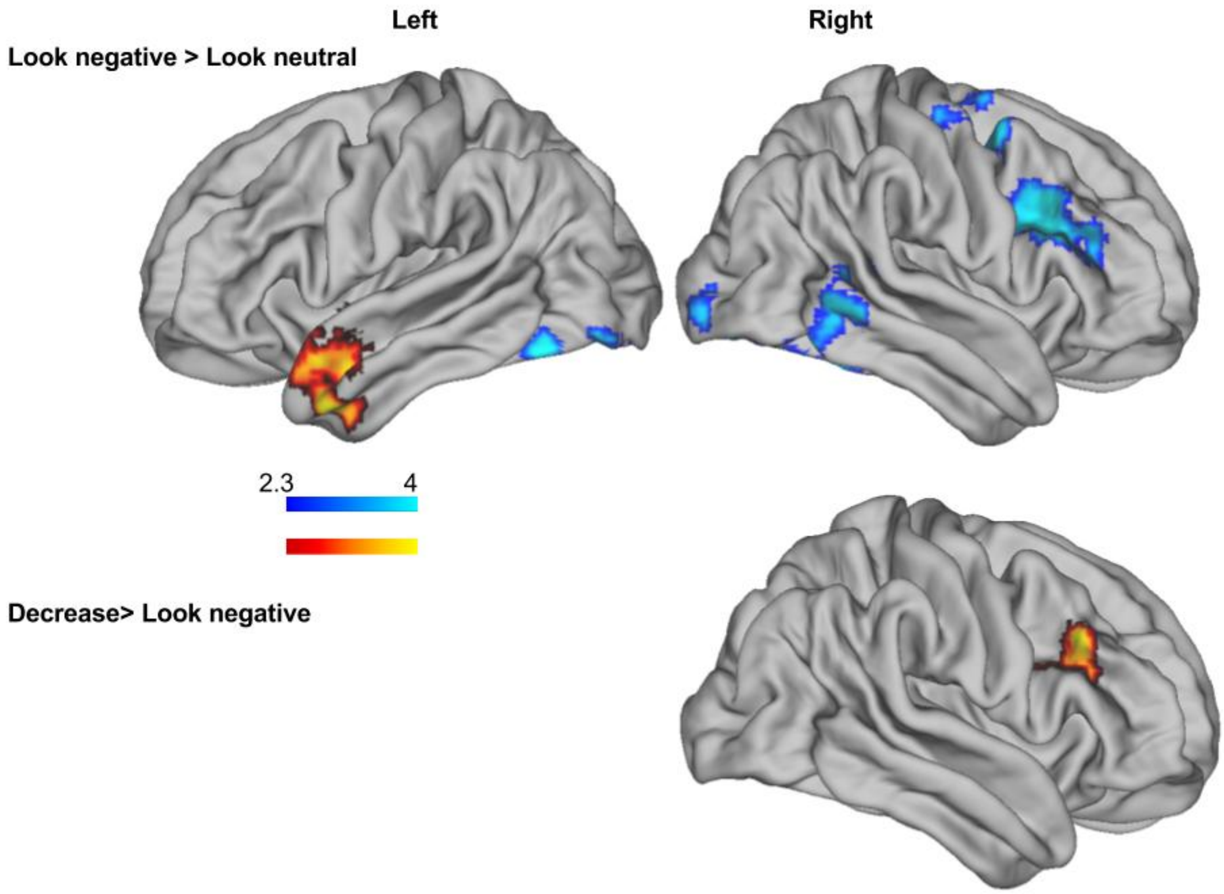
Acquisition Parameters. T1-weighted multiecho MPRAGE volumes (anatomical scans) were acquired for coregistration with fMRI (TR = 2,520 ms, TE = 1640-7,040 ms, flip angle = 7°, FOV = 220×220 mm, 176 slices, in plane voxel size = 1 mm.). A navigator echo prior to scan acquisition was used to reduce artifacts caused by motion. This compares slices to the echo online and permits up to 20% of slices to be reacquired.

Blood oxygen level dependent (BOLD) signal during functional runs was acquired using a gradient-echo T2*-weighted EPI sequence. Thirty-nine 3-mm-thick slices were acquired parallel to the AC-PC line (TR = 2,500 ms, TE = 30 ms, flip angle = 90°, bandwidth 2,240 Hz/Px, echo spacing = 0.51 ms, FOV = 216×216 mm, matrix size = 72×72 mm). Prior to each scan, four images were acquired and discarded to allow for longitudinal magnetization to reach equilibrium. An online prospective motion correction algorithm (PACE) was used to reduce motion artifacts.

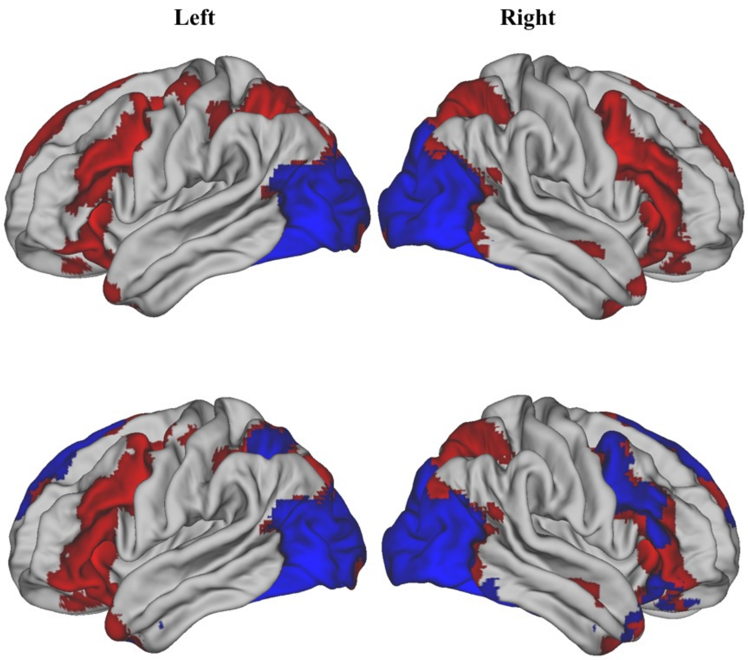
Image Processing. T1-weighted scans were processed using FreeSurfer (1–5). Subcortical gray matter structures were identified with automatic image segmentation. Gray/white matter and gray matter/cerebrospinal fluid (CSF) boundaries were constructed using spatial intensity gradients across tissue types. The cortex was parcellated based on structure of gyri and sulci following reconstruction (3, 6). Results were inspected and manually edited to optimize correct placement of gray/white and gray/CSF boundaries based on shifts in the image intensity gradient (1, 5). FreeSurfer morphometric procedures have demonstrated good test-retest reliability across scanner manufacturers and field strengths (7, 8), been validated against manual measurement (9, 10) and histological analysis (11). Further, this process has been used with children (12–14).

Preprocessing and statistical analysis of fMRI data was performed in Nipype (15). Preprocessing included spatial realignment, slice-time correction, and spatial smoothing (6-mm full width at half maximum [FWHM]), implemented in FSL. Data were inspected for artifacts using the RapidART library in Nipype; single point outlier regressors were generated for any volume in which scan to scan motion of any center point of a cuboid drawn around the brain exceeded 1.5 mm or in which over-all image intensity was more than 3 standard deviations from the mean. Results from an independent samples t-test revealed that the groups did not significantly differ based on number of motion outliers, $t(14.22) = -1.55$, $p = .14$. 6 Rigid-body motion regressors were included in person-level models. Person and group-level models were run in FSL. Noise associated with physiological fluctuations was reduced using a component-based anatomical noise correction method (16). Following person-level model estimation, the resulting contrast images were normalized in standard space, and anatomical co-registration of the functional data with each participant's T1-weighted images was conducted in FreeSurfer using surface-based registration. This process provides better alignment compared to other methods with children (17). Normalization was implemented in Advanced Normalization Tools (ANTs) software.

Supplemental Figure 1. Neural responses to passive viewing and effortful regulation of negative emotional stimuli in individuals with suicidal ideation histories versus those without suicidal ideation histories. Regions with significant blood-oxygen level-dependent (BOLD) activation depicted. Control variables included age and maltreatment status.



Supplemental Figure 2. Within-group activation patterns with the Suicidal Ideation Group (Blue) overlaid onto the No Suicidal Ideation Group (Red). Lateral view of blood-oxygen-level dependent (BOLD) activation depicted.



Look Negative vs. Base: Within-group activation during look negative (reactivity) compared to baseline (fixation cross). No Suicidal Ideation Group recruits prefrontal cortex areas.

Decrease vs. Base: Within-group activation during decrease (regulation) compared to base (fixation cross). Both groups activate prefrontal cortex areas.

N **= 35 No Suicidal Ideation Group (Red)**
N **= 14 Suicidal Ideation Group (Blue)**

Conclusion: Together, the pattern of results support the idea that during reactivity (look negative) trials, youth without suicidal ideation histories are actively recruiting prefrontal areas possibly in the service of emotion regulation. During decrease trials, both groups recruit prefrontal areas indicating that youth with suicidal ideation histories are capable of engaging in emotion regulation when explicitly instructed. An alternative explanation for our findings is that youth with suicidal ideation histories are inefficient at recruiting prefrontal cortex areas during decrease trials, and therefore, they exhibit more activation in prefrontal cortex areas compared to youth without suicidal ideation histories.

Supplemental References

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