Functional Connectivity of the Insula-Amygdala Related to Parenting in Early Childhood

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Introduction

- The anterior insula integrates physical, emotional, and cognitive processes; linked to emotional regulation and reactivity.[4,11]
  - The insula is deeply integrated with the limbic system, tying sensory input with emotion experience.
  - Functional connectivity of the insula with the limbic system influences emotional reactivity and regulation in adults and clinical populations.[10,13]
- Emotion reactivity and regulation skills develop in childhood over time, children learn from their social context context to recognize, understand and regulate emotions. (Emotion Socialization)[7]
- Research gap: Few studies examine associations between insula-limbic functional connectivity and emotion socialization in early childhood.
- Current study: Investigates how emotion socialization predicts insula–limbic functional connectivity over a year in 4-8 year old children.

Methods

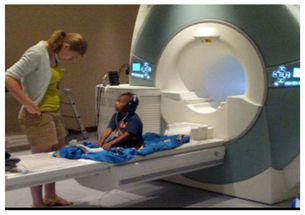
Participants

- Forty-two children ages 4–8 years completed an MRI visit and parent's completed a questionnaire as part of a longitudinal study
  - Baseline: M age = 6.59, SD = 1.08
  - 1-year Follow-Up: M age = 7.35, SD = 1.06.

Coping with Child's Negative Emotions Scale (CCNES)

- Parents responded to hypothetical situations in which a child is in emotional distress. Parent's reactions were coded into six subscales.

Supportive	Unsupportive
Problem Focused	Minimization
Emotion Focused	Punitive
Expressive Encouragement	Distress



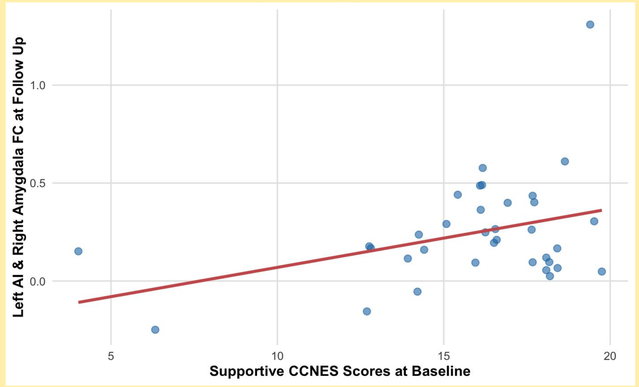
Resting-State fMRI (rsfMRI)

- T1w structural scans were obtained and processed via Freesurfer v5.1
- Seed regions: bilateral anterior insula
- Regions of interest (ROIs): bilateral amygdala, precuneus, mSFG, dlPFC,IPL
- Participants also completed a 7-minute resting state scan while watching Inscapes, a computer generated animation intended to maintain children's attention while scanning.
- Analyses were completed via Analysis of Functional NeuroImages (AFNI)
- Linear regression analyses were performed via R to investigate the relation between emotion socialization at Baseline and functional connectivity between the anterior insula and ROIs at Follow up, controlling for functional connectivity at baseline and age.

Results

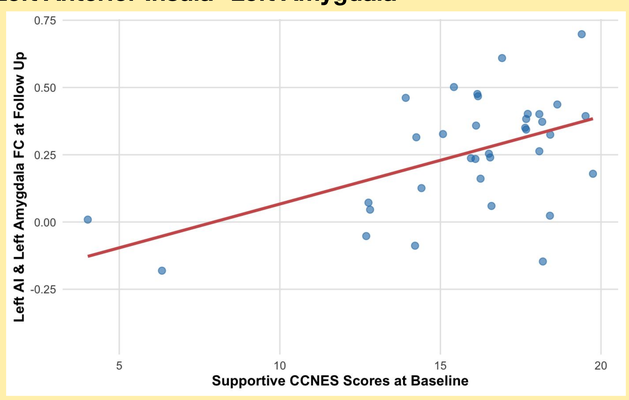
Supportive Emotion Socialization is Associated with Anterior Insula–Amygdala Connectivity One Year Later

Left Anterior Insula- Right Amygdala



Greater supportive emotion socialization at Baseline significantly predicted greater **left anterior insula–right amygdala** functional connectivity at 1 year follow up visit, controlling for baseline connectivity and age (β = .042, p = .019).

Left Anterior Insula- Left Amygdala



Greater supportive emotion socialization at Baseline also significantly predicted greater **left anterior insula–left amygdala** functional connectivity at 1-year follow up controlling for baseline connectivity and age. (β = 6.71,*p* = .003).

Results

- Insula-Frontoparietal connectivity was also explored in the current analysis.
  - No significant associations with emotional socialization.
  - Limbic system may play a more central role in early parent–child emotional dynamics.
- Insula-Precuneus connectivity was explored in the current analysis.
  - Marginal associations between unsupportive emotion socialization and greater functional connectivity between the right anterior insula and bilateral precuneus (part of the Default Mode Network).
  - A potential link between mind wandering responding to unsupportive emotion socialization.

Discussion

Left Anterior Insula - Bilateral Amygdala Connectivity

- Supportive parenting responses were associated with greater functional connectivity of the left anterior insula and amygdala.
  - Children whose parents had more problem-focused,emotion focused, expressive encouragement responses show stronger insula–amygdala coupling.
  - May indicate that more supportive reactions foster better emotional regulation and reactivity in children.
- Results do not survive multiple corrections.

Future work

- Additional bayesian analysis would be required to test the current model and further explore marginal effects.
- Additional measures of emotional socialization could be used to explore how parent child interactions contribute to neurodevelopment.
- Integrating work using emotional regulation measures and insula amygdala functional connectivity could further clarify emotional socialization mechanisms.
- Investigate whether functional connectivity and emotion socialization have a bidirectional relationship.

Acknowledgements

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References