**Introduction**

- Effortful Control is one of three temperament constructs
  - Characterized by attentional focusing, low inhibitory control, low intensity pleasure, and perceptual sensitivity
- Past research in children suggest that areas of executive functioning support Effortful Control (e.g., Posner and Rothbart, 2000)
- However, the links between Effortful Control and its executive networks with the limbic system are relatively under investigated
- This is important to study during early childhood
  - The amygdala and ACC undergo rapid growth early in life (e.g., Tottenham, Hare, & Casey, 2009)
- Research suggests age-related differences in Effortful Control during early childhood (e.g., Posner & Rothbart, 1998)

**Purpose:**
1. Explore developmental differences in Effortful Control
2. Investigate potential relations between amygdala and ACC with Effortful Control

**Methods**

**Participants**
- 111 children aged 3- to 7-years-old (M = 4.69, SD =1.47, 54 female)
- Of these, 94 provided usable MRI data for Amygdala volumes and 76 for ACC cortical thickness and surface area

**Child Behavior Questionnaire:**
- Parents of child participants completed the CBQ – very short form
- CBQ assesses temperament in children ages 3-8 providing individual scores for factors: Surgency (Extraversion), Negative Affectivity, and Effortful Control (Rothbart et al., 1994)
- A higher score reflects greater expression of factors

**Structural MRI Data**
- A T1-weighted structural MRI scan (0.9 mm³) was obtained using a Siemens 3T scanner with a 32-channel coil
- Amygdala volumes were extracted via Freesurfer v6.0 (Fischl, 2012) and adjusted using Automated Segmentation Adapter Tool (ASAT; Wang et al., 2011)
- ACC thickness and surface area were ???

**Results**

**Figure 1. Age differences related to Effortful Control score**

- One-way ANOVA was used to find a significant interaction between age and Effortful Control, p ≤ 0.01
- Gender was used as a covariate

**Figure 2. Negative correlation between Effortful Control score and Amygdala volume**

- Mild negative correlation was found between total volume of Amygdala and Effortful Control, correlation = -.323, p ≤ 0.05
  - Specifically, negative correlation was found between volume of left amygdala (but not right amygdala) and Effortful Control, p ≤ 0.05
  - Volumes were controlled for total intracranial volume, but volumes displayed in figure 2 are raw
- There were no significant findings associated with ACC

**Discussion**

- The results reinforce the idea that there are age-related differences in expression of Effortful Control
- Results suggest that regardless of age, the amygdala and Effortful Control have an inverse relationship
- Future analyses will incorporate longitudinal data to explore whether early temperamental functioning is a predictor for brain development
- Future directions can examine functional connectivity between executive and limbic systems in relation to Effortful Control

**Take-Home Message**

Effortful Control fluctuates in early childhood. The amygdala and executive functioning of Effortful Control seem inversely related.

**Acknowledgements**

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**References**

- Tottenham, N., Hare, T., & Casey, B. (2009).