The Relationship Between Anxiety and Brain Activity During an Emotional Inhibitory Control Task in Adolescents and Young Adults

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Introduction

Adolescence is a period characterized by limited inhibitory control and hypersensitivity to emotion, with increases in the prevalence of mood disorders and other forms of psychopathology. During this period, adolescents are required to make complex cognitive decisions in the face of emotional distraction. To complicate matters, adolescents become increasingly vulnerable to anxiety. In spite of the increasing relevance of this topic, our understanding of the relationship between anxiety symptoms and the neural correlates of cognitive control remains incomplete. The current study utilizes fMRI to investigate age-related differences in cognitive control and the influence of anxiety. We hypothesized there would be developmental changes in the relationship between anxiety symptoms and brain activity during an emotional go-nogo task.

Questions:

Does trait anxiety relate to brain activity in an emotionally challenging cognitive task?
Are there developmental differences in this relationship?

Participants

17 Adolescents (12-14 years old)
13 Adults (20-22 years old)

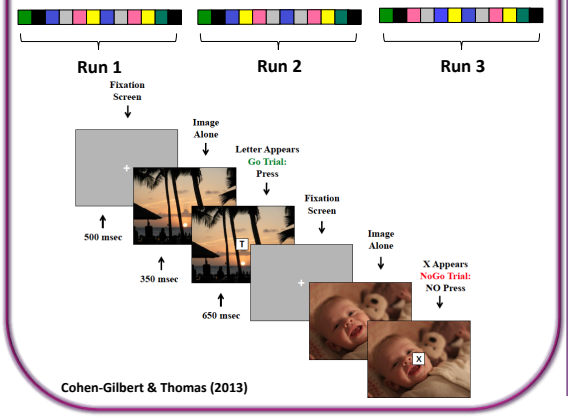
Anxiety Measures

State-Trait Anxiety Inventory (STAI)
State-Trait Anxiety Inventory for Children (STAI-C)

Task

Go-nogo task with emotional background (IAPS images)
Picture blocks (20 trials each) included:

- All-go trials (scrambled)
- Rest block
- Scrambled images
- Negative images
- Neutral images
- Positive images

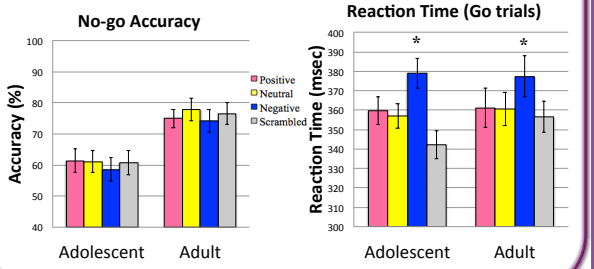


Cohen-Gilbert & Thomas (2013)

Imaging Procedures

Scanner: Siemens 3T Trio scanner
Structural: T1 MPRAGE (TR=2530, TE=3.65, Flip=7°, 240 slices, 1x1x1 voxel)
Functional: EPI BOLD, T2 weighted whole brain images (TR=2000, TE=28, Flip=90°, 3.125x3.125x4mm voxel, 34 slices, 186 repetitions)
Data processing (FSL)
Motion correction
High-pass filtering and spatial smoothing (7mm)
Co-registered with structural volume and transformed into 2mm MNI space
Whole-brain voxel-wise analysis at p <.005 with cluster threshold of 10 raw voxels (Lieberman & Cunningham, 2009).

Behavioral Results

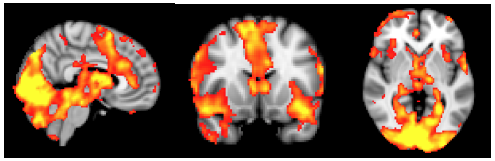


fMRI Results

Task Effects

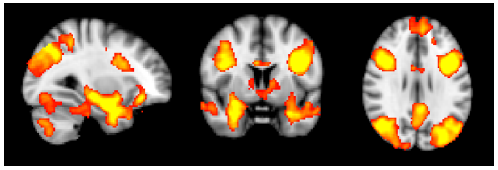
All

Inhibitory Control: Scrambled Nogo > All go



Anterior cingulate, middle frontal, caudate, thalamus, insula, superior parietal, occipital

Emotion Modulation: Negative > Neutral

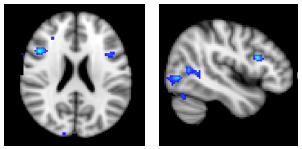


Bilateral ventromedial PFC, bilateral amygdala, bilateral dorsomedial PFC, bilateral dorsolateral PFC, precuneus, posterior cingulate, bilateral angular gyrus/lateral occipital, bilateral fusiform.

Anxiety **Negative > Neutral**

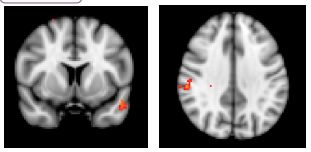
All

Red = Positive correlation with trait anxiety
Blue = Negative correlation with trait anxiety



Negative Correlations:
Bilateral inferior frontal gyrus
Bilateral lateral occipital
Left frontal pole
Right middle temporal
Right orbital frontal

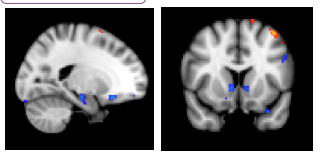
Adults



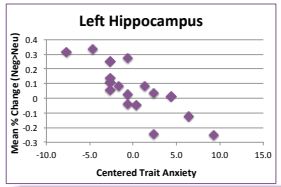
When separated into groups, the above regions remained true of adults but not adolescents. Additionally, adults showed the following positive correlations:

Positive Correlations:
Right supramarginal gyrus
Left temporal pole

Adolescents



Negative Correlations:
Bilateral hippocampus/ parahippocampal gyrus
Bilateral caudate
Bilateral orbital frontal
Left superior frontal
Left temporal pole
Left lateral occipital
Right middle temporal/ lateral occipital



Positive Correlations:
Left dorsolateral PFC

Discussion

This emotional go-nogo task activated brain regions important for cognitive control and emotion regulation. Behavioral results indicated that inhibitory control with emotional backgrounds was challenging (especially for teens) and that negative images in particular resulted in slower reaction times. In typically developing participants with normal levels of anxiety, there were regions that showed significant correlations with trait anxiety. Adolescents showed unique regions of activation that varied with anxiety. These results suggest that there are developmental changes in how anxiety relates to cognitive control, such that low anxiety teens and adults use distinct brain regions to cope with negative distractors while recruiting cognitive control circuits. Future directions include investigating different kinds of anxiety and exploring how life stress impacts developmental changes in the relationship between cognitive control and anxiety.

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