Anticipation of Peer Evaluation in Anxious and Non-Anxious Adolescents: Divergent Patterns of Neural Maturation

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ANXIETY AND DEPRESSION ASSOCIATION OF AMERICA
CHICAGO – MARCH 28, 2014
Why Adolescence?

- Rapid development in neural circuits involved in motivation, emotion, & social interaction\(^1\)

- Peak onset time for many anxiety disorders\(^2\)

\(^1\)Dahl (2004); Steinberg & Morris (2001); \(^2\)Kessler et al. (2005)
Social Concerns in Adolescence

- Social concerns common during adolescence
  - Clinical anxiety can be debilitating\(^1\)

- Adolescent anxiety predictive of chronic long-term mental illness\(^2\)

- Understand how neuromaturational trajectories diverge in anxious adolescents

\(^1\)Rapee et al. (2009); \(^2\)Pine et al. (1998)
Exploring Neural Instantiation

- **Simulated social interactions paradigms**\(^1\)

- **Anxiety- and mood-related processing differences**\(^2\)
  - Amygdala
  - Striatum
  - Ventromedial prefrontal cortex (vmPFC)
  - Ascribe salience, generate predictions, & create flexible patterns of behavior within a motivated social context\(^3\)

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\(^1\) Jarcho et al. (2013)
\(^2\) Davey et al., (2011); Gunther Moor et al. (2010); Guyer et al. (2008, 2013); Jarcho et al. (in press); Lau et al. (2012); Masten et al. (2011); Silk et al. (in press)
\(^3\) Haber (2009); Pessoa & Adolphs (2010); Phelps et al. (2004); Schiller et al. (2008)
Social Paradigms

- Complex cognitive & motivational processes
  - Mentalizing, self-reflection
  - Differences related to development/anxiety often challenging to interpret

- Parse into smaller components
  - Evaluation/selection\(^1\)
  - Anticipation of interaction
  - Receipt of feedback\(^2\)
  - Learning from outcomes\(^3\)

\(^1\)Guyer et al. (2009); Somerville et al. (2013); \(^2\)Guyer et al. (2012); Somerville et al. (2013); \(^3\)Jarcho et al. (prep)
Anticipation

- Anticipation of an unknown, salient outcome is key component of anxiety
  - Grupe & Nitschke (2013): Many features of anxiety most likely to manifest during anticipation

- After a decision to socially engage but prior to knowing consequences
  - E.g., preparing to make a speech, waiting to ask someone for a date
Anticipation

- Regions implicated in anxiety & social tasks thought to play important role in experience of anxiety during anticipation\(^1\)

- Social anticipation particularly provocative for adolescents
  - Adolescent peak in reactivity to motivational stimuli\(^2\), particularly peer-related stimuli\(^3\)

\(^1\)Grupe & Nitschke (2013); \(^2\)Crone & Dahl (2012); Galvan (2010); \(^3\)Nelson et al. (2005); Morris et al. (2001)
Why Amplified in Adolescence?

- Subcortical structures particularly responsive to social stimuli during this time\(^1\)
- Connections with vmPFC underdeveloped\(^2\)
- Divergent patterns of maturation may predispose toward development of anxiety in adolescence

\(^1\)Guyer et al. (2008); Casey et al. (2008); Galvan (2010); \(^2\)Ernst et al. (2006)
Present Study

- Examined developmental trajectories
- Anxious & non-anxious youth
- Anticipated social feedback in established peer neuroimaging paradigm
Chatroom Task

- **Two visits:**
  - Visit 1: Selection of peers
  - Visit 2: Neuroimaging

- Participants told task designed to learn about internet-based social interaction

- Shown photographs of 60 age-matched individuals
  - Led to believe photos were other study participants
Chatroom Task: Visit 1
Chatroom Task: Visit 2
Chatroom Task: Visit 2

Anticipation
You were...

Peer Feedback
They were...

Rating
Did you expect this?

- Interested
- Not Interested

Interested
Not Interested

0 - 100
Not at all - Totally

3 sec | 0-8 sec | 2 sec | 3-5 sec
Chatroom Task: Anticipation

- Emotional engagement with social stimuli greatly affected by participant-specific attributions

- Compared activation:
  - Peers deemed socially desirable (selected) vs. peers deemed not desirable (rejected)
Present Study: Anticipation

- Is neural response to peers differ in youth with an anxiety disorder?
- Does neural response to peers change with development?
- Do neuromaturational trajectories differ in youth with anxiety disorder?
Hypotheses

- **Amygdala**
  - Identify salient stimuli, enhance processing of salient features\(^1\)

- **Ventral striatum**
  - Predicting motivational relevance of stimuli\(^2\)

- **Ventromedial prefrontal cortex**
  - Top-down biasing of amygdala\(^3\)

\(^1\) Pessoa & Adolphs, 2010; \(^2\) Haber, 2009; \(^3\) Phelps et al., 2004
Hypotheses: Activation

- **Non-anxious adolescents:**
  - Feedback from selected peers likely more salient than rejected
    - Greater activation in amygdala & ventral striatum to selected

- **Anxious adolescents**
  - Feedback from rejected peers likely more salient than selected
    - Greater activation in amygdala & ventral striatum to rejected

- **Maturation**
  - Greater control over motivational reactivity
    - Greater activation with age in vmPFC
Method: Participants

- 42 participants aged 8-17
  - 52% female
  - Mean age = 13.3 (2.8)

- Anxiety group
  - n = 16 participants (63% female, mean age mean = 12.7 yrs)
  - Met criteria for Social Phobia (n = 13) or GAD (n = 9)

- Healthy group
  - n = 26 participants (46% female, mean age mean = 13.7 yrs)
  - Did not meet criteria for any psychiatric disorder
Method: fMRI Processing

- Implemented via FSL\textsuperscript{1} tools
- Motion-corrected, .0125 Hz. high-pass filter, spatially smoothed (FWHM = 5mm), slice-timing corrected, & intensity-normalized
- 2-level hierarchical model

\textsuperscript{1}Jenkinson et al. (2012)
Method: fMRI Processing

- **Level 1 predictors:**
  - Two predictors modeling anticipation (selected & rejected)
  - Four predictors modeled the feedback period
  - Nuisance predictors modelling outlying volumes

- **Contrast of interest:**
  - Selected vs. rejected
Method: fMRI Processing

- **Level 2 predictors:**
  - Anxiety group
  - Age
  - Anxiety group X Age interaction

- GRF correction for multiple comparisons
Result: Anxiety Group

- Left Amygdala
Result: Anxiety Group

- Bilateral nucleus accumbens (NAcc)
Result: Anxiety X Age

- Rostral anterior cingulate cortex (rACC)
  - Important for fear extinction\(^1\)

\(^1\)Phelps et al., 2004
Discussion

- Greater amygdala for rejected in anxiety
  - Anxious youth ascribe more salience to interactions with potentially distressed peers (i.e., rejected peers)
  - Healthy youth ascribe more salience to potentially rewarding interactions
Discussion

- Decreased NAcc to selected in anxiety
  - Anxious youth do not anticipate interacting with selected will be rewarding
  - Healthy youth anticipate potential reward
rACC

- In healthy, age associated with greater control over fear of ‘liked’ peers, potentially facilitating approach behavior
- Opposite true for anxious youth
Implications & Future Directions

- Differences in neural instantiation of anticipation by adolescence
- Divergent patterns of neural maturation in key areas involved in top-down control
- Examine patterns of connectivity between regions
- Parse development more finely
  - Specific processes (e.g., puberty)
  - Longitudinal measurement
Disclosures

- No disclosures to report

- Views do not reflect the official policy or position of the Department of Veterans Affairs