**Time Course of Brain Reactivity in Anxious Youth Performing an Attentional Bias Task: A Pupilometry Study**

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**Attentional Bias**
- Altered attention to threat is a transdiagnostic feature of clinical and non-clinical forms of anxiety
- Findings might implicate a role for biased attention in perpetuating anxiety:
  - Excessive focus on danger cues in the environment -> more anxiety -> more excessive focus …
- Understanding these processes in youth could inform early intervention and alter life-long trajectories of mental health

**Three Forms of Bias**
- Time course is a critical factor in attention bias, with alternate forms of bias emerging at different points in time following threat presentation

- **Early bias**: Excessive vigilance to threat
  - 0-500ms

- **Intermediate bias**: Avoidance of threat
  - 1.5-4s

- **Sustained bias**: Perseverative attention to threat (worry, rumination)
  - several seconds, minutes, or hours

*Present in anxious adults and youth (Bar-haim et al, 2007)*
*Younger samples may show vigilance irrespective of anxiety (Vasey & MacLeod, 2001)*
*May be causally related to anxiety symptoms (MacLeod et al, 2002; Amir et al, 2009, Eimer et al, in press)*

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**Sustained neural bias/ perseverative cognition**

- fMRI studies of adult depression:
  - Depressed adults show increased sustained activity in the amygdala (an emotional processing region) following negative stimuli—correlates with self-reported rumination.
  - Depressed adults show sustained deficits in a prefrontal regulatory region.
- Pupilometry study of adults with GAD

**Sustained neural bias/ perseverative cognition (cont.)**

- Pupilometry studies:
  - Adults with high levels of worry show decreased sustained pupil dilation to negative stimuli, possibly consistent with decreased regulatory control.
  - Depressed youth show decreased sustained pupil responses to negative stimuli.
- Sustained neural alterations may:
  - Promote perseverative thinking patterns (worry, rumination)
  - In youth, confer neurocognitive risk for adult psychopathology (e.g., depression).

**Current sample**

- 74 youth (age 9-13; mean=10.5) with generalized anxiety disorder (GAD; 68%), separation anxiety disorder (SAD; 26%), and/or social phobia (SP; 25%)
- 20 youth with no lifetime DSM-IV diagnoses

**Current study goals**

- Investigate sustained forms of bias in anxious youth using pupillary reactivity
- Concurrently collect behavioral measures of early and intermediate bias
- Gain insight into potential neurocognitive targets for early intervention

**Methods**

- Dot-probe task
Method
- Dot-probe task
  - Sustained bias measure:
    - Pupil dilation collected during the extended post-stimulus dot period
    - Hypothesis: Sustained alterations (increases or decreases) in anxious youth
  - Early and intermediate bias measures:
    - Reaction times for short and long face presentations—comparison of dot-on-fear to dot-on-neutral trials

Results--Sustained bias: Pupil dilation
- Short duration, dot-on-fear
  - Increased pupil diameter
  - Increased cognitive-affective load
- Short duration, dot-on-neutral
  - Increased pupil diameter
  - Increased cognitive-affective load
Results--Sustained bias: Pupil dilation
Average pupil diameter during sustained processing

Non-anxious youth show flexible pattern of responding during sustained post-threat processing (cognitive-affective load increases following dot-on-neutral trials)
Anxious youth are inflexible and show greater reactivity only on dot-on-fear trials

Group by dot-location interaction: p=.007

Results--Sustained bias: Pupil dilation
Average pupil diameter during sustained processing

Non-anxious youth may bring cognitive control online in response to dot-on-neutral trials, which required reversal of the general pattern of vigilance to threat observed in RT data
Anxious youth are inflexible and fail to relax cognitive-affective load following dot-on-fear trials

Group by dot-location interaction: p=.007

Summary of findings
- An inflexible pattern of sustained post-threat processing was found in anxious youth
- A vigilant pattern in RTs was found in all participants
- Non-anxious youth may have flexibly brought cognitive control on-line only when the dot appeared in the unattended/unexpected location
- This resulted in increased cognitive-affective load in anxious youth observed specifically following dot-on-fear trials

Conclusions: sustained bias
- Altered neural reactivity to threat in anxious youth persists well beyond the timeframe of stimulus presentation and responses
- Sustained bias is dissociable from the peri-stimulus biases more commonly studied in anxiety
- Approaches to directly modify attentional bias in order to reduce anxiety vulnerability are being developed
  - Will these approaches effect sustained bias?
  - Or do sustained patterns require a targeted intervention of their own?

Conclusions: early and intermediate bias
- No evidence of excessive vigilance or avoidance in anxious youth
  - Consistent with a subset of previous findings, RT vigilance to threat was seen in this age group irrespective of anxiety
- The ability to inhibit attention to threat may develop in non-anxious individuals at a later age
- Only one previous study has shown a vigilant-avoidant pattern in anxious youth
- Many more studies in youth are needed to counteract a potential “file drawer problem”
Future Directions

- Use observed pupil pattern to guide future neuroimaging analysis—identify the neural substrate of sustained patterns
- Determine the developmental trajectory—e.g., do sustained pupil alterations in anxious youth confer risk for later development of depression?
- Develop new interventions, or tailor selection of existing options (e.g., CBT, early bias modification) to the individual patient

Questions?