Emotional face processing biases and children's externalizing and internalizing behaviors in school

Cynthia J. Willner[1], Michelle K. Jetha[2], Sidney J. Segalowitz[3], & Lisa M. Gatzke-Kopp[1]

[1]Department of Human Development and Family Studies, The Pennsylvania State University; [2]Department of Psychology, Cape Breton University; [3]Department of Psychology, Brock University

Background

Anxious individuals often display early perceptual-attentional biases towards threatening faces, including enhanced amplitudes of early visual ERPs such as the P1.[1] These early perceptual-attentional biases are hypothesized to reflect a lower threshold for threat detection via "quick-and-dirty" information-processing routes.[2] Attention biases toward threat have also been suggested to play a role in reactive aggression,[3] but few studies have examined the precise nature or timing of such attention biases in aggression. Moreover, although substantial comorbidity is observed between anxious and aggressive symptoms, very little research has been conducted on attention biases to threatening faces among individuals exhibiting both anxiety and aggression. This study addresses these research gaps to explore the cognitive-affective mechanisms underlying both anxious and aggressive behaviors.

Research Questions

1) Do groups of children with externalizing symptoms, comorbid externalizing and internalizing symptoms, and low levels of both types of symptoms differ in their perceptual-attentional processing of emotional (angry, fearful, sad, and happy) vs. neutral faces, as indexed by early and mid-latency ERP amplitude differences?

2) Does the *timing* of perceptual-attentional processing biases to emotional faces differentiate between these symptom groups?

Methods

Participants

- Participants were 1st-grade children recruited in kindergarten from an urban, low-income school district to participate in a longitudinal study, selected according to high (n=207) or low (n=132) aggressive/oppositional screen scores at kindergarten entry.
- 120 children had sufficient data in 1st grade to be included in the analyses.
- Mean age = 7.2 yrs (*SD* = 0.4); 73% male; 70% Black, 22% Hispanic

Task

Children completed an emotional Go/No-Go task in which the stimuli were computer-generated faces expressing 4 primary emotions (anger, fear, sadness, and happiness), as well as emotionally neutral faces, all balanced across gender and race.

ERP Measures

P1, N170, and P2 peak amplitudes were scored across correct Go trials, separately for each of the 5 facial expressions. P1 peak amplitudes were assessed at O1, Oz, & O2; the N170 at P7 & P8; and the P2 at PO3 & PO4 (see Fig. 1 for the grand-average waveforms).

Internalizing & Externalizing Symptoms

Children were classified into 3 groups based on 1st-grade teacher ratings on the Strengths and Difficulties Questionnaire (SDQ):[4]

1) ***Externalizing* group (n = 45):** Total score ≥ 2 on the 5-item Conduct Problems subscale (i.e., two symptom indicators were rated as "somewhat true" or one was rated as "certainly true"), and total score < 2 on the 5-item Emotional Symptoms subscale.
2) ***Comorbid* group (n = 36):** Total score ≥ 2 on both subscales.
3) ***Comparison* group (n = 39):** Total score < 2 on both subscales (i.e., no more than one symptom indicator rated as "somewhat true" on either scale).

Children scoring high on the Emotional Symptoms subscale and low on the Conduct Problems subscale (n = 10) were excluded from the analyses due to the small group size.

References

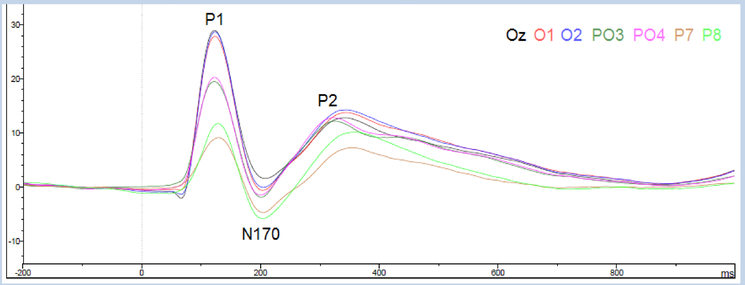
[1]Holmes, A., Nielsen, M. K., & Green, S. (2008). Effects of anxiety on the processing of fearful and happy faces: An event-related potential study. *Biological Psychology*, *77*(2), 159–173.
[2]Pourtois, G., Schettino, A., & Vuilleumier, P. (2013). Brain mechanisms for emotional influences on perception and attention: What is magic and what is not. *Biological Psychology*, *92*(3), 492–512.
[3]Wilkowski, B. M., & Robinson, M. D. (2010). The anatomy of anger: An integrative cognitive model of trait anger and reactive aggression. *Journal of Personality*, *78*(1), 9–38.
[4]Goodman, R. (1997). The Strengths and Difficulties Questionnaire: A Research Note. *Journal of Child Psychology and Psychiatry*, *38*, 581 – 586.

Analytic Strategy

Separate repeated-measures ANOVAs were conducted for each ERP peak amplitude measure, with emotion and electrode site entered as within-subjects factors and symptom group as a between-subjects factor. Planned contrasts between each emotional face (angry, fearful, sad, and happy) vs. the neutral face, among all three symptom groups, and for the interactions of symptom group with the emotional faces contrasts were examined. All within-subjects tests were evaluated using Greenhouse-Geisser adjusted *p*-values to correct for non-sphericity.

Results

Fig. 1. Grand-average waveforms across all target face stimuli in correct Go trials.



Repeated-measures ANOVAs: emotion, site, & symptom-group effects

P1 amplitude at O1, Oz, & O2

- Smaller to all four emotional vs. neutral faces, *p*s < .05 (see Fig. 2)
- **No main effect of symptom group,** *F* (2, 117) = 0.04, *p* = 0.96, or symptom-group contrasts.
- **No symptom group differences in the emotional vs. neutral face contrasts,** *p*s > .26.
- Effect of symptom group did not vary across electrode sites, *F* (4, 234) = 0.52, *p* = .50, and did not interact with the emotion x site effect, *F* (16, 936) = 0.93, *p* = 0.51.

Fig. 2. P1 Mean Amplitude to Target Face Stimuli by Emotion

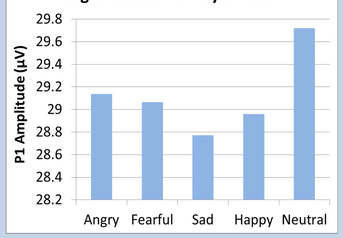


Fig. 3. N170 Mean Amplitude to Target Face Stimuli by Emotion

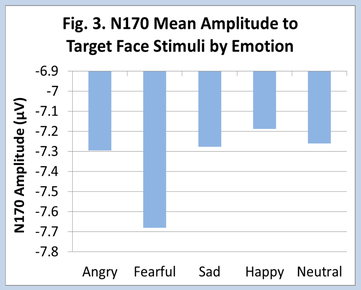
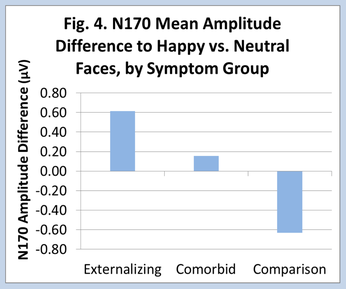


Fig. 4. N170 Mean Amplitude Difference to Happy vs. Neutral Faces, by Symptom Group



Note. More negative values indicate a *larger* negative peak to happy vs. neutral.

N170 amplitude at P7 & P8

- Larger to fearful vs. neutral faces, *F* (1, 117) = 4.10, *p* = 0.05 (see Fig. 3).
- **No main effect of symptom group,** *F* (2, 117) = 1.23, *p* = 0.29, or symptom-group contrasts.
- **One symptom group difference in the happy vs. neutral face contrast only:**
  - Externalizing vs. comparison, *F* (1, 117) = 5.47, *p* = .02 (See Fig. 4)
- Effect of symptom group did not vary across electrode sites, *F* (2, 117) = 0.50, *p* = .61, and did not interact with the emotion x site effect, *F* (8, 468) = 0.43, *p* = 0.90.

P2 amplitude at PO3 & PO4

- Larger to angry vs. neutral, *F* (1, 117) = 7.22, *p* = .008, and sad vs. neutral, *F* (1, 117) = 6.44, *p* = .01, faces (see Fig. 5).
- **No main effect of symptom group,** *F* (2, 117) = 0.02, *p* = .98.
- **Two symptom group differences in the angry vs. neutral face contrast** (see Fig. 6, black bars)**:**
  - Externalizing vs. comparison, *F* (1, 117) = 10.1, *p* = .002
  - Comorbid vs. comparison, *F* (1, 117) = 5.71, *p* = .02
- **Two symptom group differences in the *laterality* of the angry vs. neutral face contrast** (see Fig. 6, colored bars):
  - Comorbid vs. comparison, *F* (1, 117) = 5.27, *p* = 0.02
  - Comorbid vs. externalizing, *F* (1, 117) = 3.85, *p* = 0.05

Fig. 5. P2 Mean Amplitude to Target Face Stimuli by Emotion

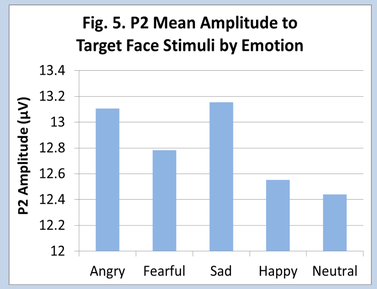
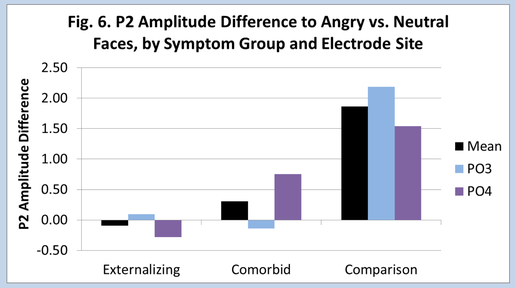


Fig. 6. P2 Amplitude Difference to Angry vs. Neutral Faces, by Symptom Group and Electrode Site



Conclusions

1) Children with externalizing symptoms, with or without comorbid internalizing symptoms, exhibited an attenuation of the normal P2 amplitude enhancement to angry vs. neutral faces.

- This could reflect deficient perceptual-attentional processing of negative social cues, which may contribute to the continuation of externalizing behaviors.

2) Children with comorbid internalizing and externalizing symptoms exhibited greater right laterality of the P2 angry vs. neutral face contrast compared to both pure-externalizing and comparison children.

- Since the right hemisphere is more closely associated with emotional information-processing and withdrawal motivations, this finding could reflect greater emotional reactivity and withdrawal motivation to a threatening social cue.

3) No symptom group differences were observed in P1 amplitudes to emotional faces, whereas differences were observed for later components.

- This suggests that, at least in this sample of at-risk 1st-grade children, externalizing and comorbid problems are associated with differences in conscious processing of social threats rather than pre-attentive threat detection biases. Thus, this does not support the hypothesis that children with comorbid internalizing symptoms would exhibit pre-attentive threat biases.

Co-PIs: Drs. Mark Greenberg & Karen Bierman, The Pennsylvania State University.
Funding Sources: Pennsylvania Department of Health; U. S. Dept. of Education, Institute of Education Sciences.