1. Introduction and Aims

- Emotion dysregulation is present in 40-50% of children and 70% of adults diagnosed with ADHD (Farace et al., 2019). ADHD is linked with difficulties recognising vocal emotions (Sells et al., 2023).
- It is debated whether these difficulties in ADHD reflect executive function (EF) deficits only (Barbey, 1997) or atypicalities in motivational processes (Sonuga-Barke, 2005).
- Behavioural studies report individuals with ADHD display generic attention difficulties in support of EF theories (Sells et al., 2023), whereas an Event-Related Potential (ERP) study has reported emotion-specific atypicalities in support of motivational accounts of ADHD (Chronaki et al., 2015).
- For example, children with ADHD showed an enhanced N1 to vocal anger, suggesting that the N1 may be a marker for an automatic hyper-orientation to vocal threat in ADHD (Chronaki et al., 2015).
- However, as existing research relied on explicit recognition tasks, it is not known if there are atypicalities in the initial ‘preattentive’ perception of vocal emotions when vocal cues are irrelevant to task demands, or how relevant vocal emotions may influence attentional mechanisms in ADHD.
- In healthy adults, studies have reported enhanced P2 amplitudes to irrelevant happy and angry versus neutral voices (Gadeke et al., 2013), suggesting the P2 is a marker of preattentive vocal emotion processing. Also, irrelevant auditory cues can affect attentional mechanisms, as shown by faster reaction times and enhanced P1 amplitudes to visual targets presented in a spatial location congruent to the prior auditory cue in spatial cueing paradigms (Stormer, Hilliard & MacDonald, 2009).

Aims

The present ERP study aimed to employ a novel emotional spatial cueing paradigm to explore:
1. If adolescents with traits of ADHD present with a preattentive hypersensitivity to vocal emotions, by measuring the P2 component to an irrelevant vocal cue.
2. If the preattentive processing of vocal emotions affects the allocation of attention in adolescents with traits of ADHD, by measuring reaction times and the P1 component to a visual target.

2. Methods

Participants. A community sample of 61 adolescents (aged 12-16 years) with high and low levels of inattentive and hyperactive traits, measured using the self and parent version of the Strengths and Difficulties Questionnaire (Goodman, 1997).

Vocal Stimuli. Angry, happy and neutral voices (‘/A/’ taken from the Maurage et al. (2007) battery standardised in duration (700ms) and mean intensity (77db).

Paradigm. A novel Emotional Spatial Cuing (ESC) paradigm was designed and optimised for use with EEG. Each trial consisted of an irrelevant vocal cue presented in the left or right ear which was spatially congruent or incongruent to a subsequent task-irrelevant vocal stimulus (See Figure 1).

Experimental Design. A mixed 2(congruency) x 3(emotion) x 2(group) design.*
* Due to unexpected findings regarding the group factor, only the categorical analyses is presented.

ERP Task

Participants were fitted with a 66-electrode cap and completed the task with the instructions: Catch the stars which will appear in the left or right side of the screen by pressing the left or right arrow key. You will also hear some voices – try to ignore these.

3. Results: RTs to the Visual Target

The effect of congruency, emotion and group on reaction times (n=61). A 2(congruency) x 3(emotion) x 2(group) ANOVA was conducted. There was a main effect of congruency [F(1,59)=10.71, p<.001] and a main effect of emotion [F(1,59)=13.11, p=.004] on RTs to the visual target. There was no main effect of group [F(1,59)=.45, p=.51] on RTs to the visual target. There was no significant emotion x congruency interaction effect on RTs [F(1,59)=1.21, p=.25].

Adolescents were faster to respond to congruent compared to incongruent trials, suggesting that the irrelevant vocal cue influenced attentional mechanisms.

4. Results: ERPs to the Vocal Cue

The effect of emotion on the P2 amplitude to the vocal cue (n=61). There was a significant main effect of emotion on the P2 amplitude [F(1,59)=58.91, p<.001]. The P2 was larger to happy and angry compared to neutral voices (MD=0.45, p=.0016, MD=0.11, p=.011), suggesting the P2 is a neural marker of preattentive vocal emotion processing in adolescents. The effect of emotion and group on the P2 amplitude to the vocal cue (n=25). A 2(AHD group) x 3(emotion) ANOVA was conducted. There was a significant emotion x group interaction [F(1,44)=3.71, p=.05]. Adolescents with high levels of ADHD traits presented with larger P2 amplitudes to happy and angry, but not neutral voices, compared to adolescents with low levels of ADHD traits (MD=2.56, p=.001; MD=1.98, p=.006; See Figure 3).

5. Results: ERPs to the Visual Target

Finally, the P1 component to the visual target was taken as a measure of visual spatial attention, as in previous spatial cuing paradigm (Stormer et al., 2009). Results from a 2(congruency) x 3(emotion) ANOVA revealed there was no main effect of congruency on the P1 [F(1,59)=5.3, p=.02]. There was a main effect of emotion on the P1 [F(1,59)=7.83, p=.001]. The P1 to trials preceded by vocal anger was larger than the P1 to trials preceded by neutral [MD=0.61, p=.012] and happy voices [MD=0.64, p=.010]. There was no significant emotion x congruency interaction effect on the P1 [F(1,59)=0.30, p=.58]. Analyses of the P1 to the visual target in relation to ADHD traits are in progress.

6. Discussion and Conclusion

- First, participants responded faster to trials preceded by irrelevant spatially congruent compared to incongruent cues. This congruency effect is consistent with classic cuing paradigms in the literature (Spence & Driver, 1997), and therefore validates our novel paradigm.
- Second, irrelevant angry voices appeared to have a hindering effect of RTs in adolescents. This is consistent with studies which find children and adolescents are distracted by irrelevant vocal anger (Chronaki & Marsh, 2024).
- Third, we isolated the P2 as a marker of preattentive vocal emotion processing in adolescents, consistent with previous research in adults (Gadeke et al., 2013; Schirmer & Kott, 2006).
- Fourth, the P2 to emotional (happy and angry) voices was larger in adolescents with high versus low levels of ADHD traits, suggesting those with high ADHD traits perceive emotional voices as more salient.
- Fifth, it is surprising there was no congruency effect on the P1 to the visual target, in line with previous ERP studies in adults (Stormer et al., 2009). However, emotion effects on the P1 support the hypothesis that vocal emotions (specifically anger) influence the allocation of attention in the emotional spatial cueing paradigm.
- Overall, this is the first study to provide support for a preattentive hypersensitivity to emotionally salient vocal stimuli in ADHD, in favour of motivational accounts of ADHD (Sonuga-Barke, 2005).

References