EXPLORING DIFFERENCES IN ARM MOVEMENT DURING AN ANXIETY-INDUCTION TASK IN CHILDREN WITH MENTAL HEALTH DISORDERS

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Introduction: Externalizing (e.g., ADHD) and internalizing (e.g., anxiety, depression) disorders are common in children [1]. Current screening relies on parent-report surveys as children cannot reliably report on their emotions [2]. However, even the most attentive caregivers may underreport since many symptoms are unobservable [1]. When presented with emotional stimuli, children with ADHD and internalizing disorders exhibit distinct bio-behavioral responses as compared to children without these disorders [3], [4]. Furthermore, children with ADHD and anxiety exhibit differential stimuli reactivity than children with ADHD alone [5]. In this analysis, we consider children's arm movement as a bio-behavioral measure of reactivity during an anxiety-inducing task with two buzzers, serving as stimuli. We hypothesized that children's reactivity to emotionally-laden stimuli would indicate the presence of a disorder, and would differentiate amongst children by disorder type. Overall, this study aims to enhance our ability to detect mental health disorders in young children by identifying objective biomarkers.

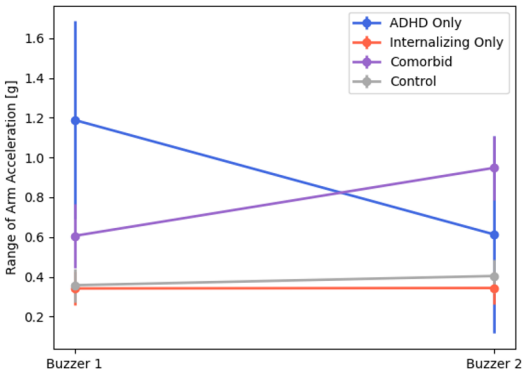

Figure 1: Mean and standard error of range in arm acceleration during the 15 second period after buzzers 1 and 2 by diagnostic group.

Methods: We present arm movement data from children ages 4-8 (N=73, 44% female, 7 ADHD only, 22 internalizing disorders only, 8 comorbid ADHD and internalizing disorders, 36 controls) during the three phases of the Trier Social Stress Task adapted for kids. In this three-minute task, children are told they will be judged while telling an impromptu story. Two startling buzzers sounded halfway through the task and with 30 seconds remaining, at which point children were told the amount of time remaining, increasing contextual fear. Child mental health diagnoses were determined via a gold-standard semi-structured interview (KSADS-PL) with clinical consensus. Range in arm acceleration was considered in 15 second periods after each buzzer. Change in arm movement from 15 seconds before and 15 seconds after each buzzer was also studied. Participants with more than a 20% increase in range were considered "reactors" to the stimuli. Cross tabulations were performed to compare the percentage of reactors in the control and any disorder (ADHD and/or internalizing) groups. One-way and repeated measures ANOVAs were performed to examine movement after the buzzers by diagnostic groups.

Results & Discussion: Cross tabulations of "reacting" to buzzers was significantly more common for children with a mental health diagnosis than without. For controls, 33.3% reacted to buzzer 1 and 36.1% to buzzer 2. For children with a diagnosis, 59.5% reacted to buzzer 1 and 40.5% to buzzer 2. We then analyzed post-buzzer movement further by diagnostic group. Children with ADHD exhibited significantly greater arm movement at buzzer 1 compared to those with internalizing disorders ($p=.009$) and controls ($p=.007$). There were significant interactions between arm movement across the two buzzers and diagnostic group. Children with ADHD exhibited relatively *smaller* movement following the second buzzer than the first, whereas children with internalizing disorders ($p=.030$) and controls ($p=.038$) exhibited a similarly small movement to both buzzers (Fig 1). While children with mental health disorders demonstrated greater likelihood of reactivity to the buzzers overall, the effect appeared to be driven by children with ADHD. Inconsistent with previous literature, children with internalizing disorders only did not appear different than controls. This could be due to types of anxiety and depression being collapsed in our group, which have been shown to have some opposing startle effects [6], or in the reactivity measurement being gross motor and not physiological. Children with ADHD had greater movement to buzzers overall, and this pattern differed depending on whether the child had comorbid anxiety, consistent with previous works. The differential patterns over time could be indicative of differential fear learning, wherein adults with internalizing disorders learn to anticipate aversive stimuli and become more sensitive over time [7] whereas adults with ADHD only do not [8]. Future work should examine physiological reactivity, such as heart rate and galvanic skin response, and further explore changes in reactivity over time by diagnostic group.

Significance: Arm movements surrounding surprising stimuli during a short anxiety-induction task provide potential biomarkers of mental health conditions in young children, supported by theory-driven hypotheses related to hyperarousal and fear learning.

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References: [1] K. B. Madsen et al. (2018), *Eur Child Adolesc Psychiatry*; [2] B. C. Loftness et al. (2023), *IEEE JBHI*; [3] M.G. Melegari et al. (2020), *J Atten Disord.*; [4] L. S. Wakschlag et al. (2005), *Clin Child Fam Psychol Rev* 8(3); [5] S. J. Lane et al. (2019), *Frontiers in integrative neuroscience* 13(40); [6] L. M. McTeague et al. (2012), *Depression and anxiety* 29(4); [7] A.R. Naudé et al. (2022), *Cogn Affect Behav Neurosci* 22; [8] D. Feifel et al. (2009), *Journal of psychiatric research* 43(4).