

EXPLORATORY FACTOR ANALYSIS OF POSTURAL SWAY MEASURES REVEAL POTENTIAL BIOMARKERS OF CHILDHOOD MENTAL HEALTH

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Introduction: Externalizing (e.g., ADHD) and internalizing (e.g., anxiety, depression) disorders are common in children [1], [2]. Current screening relies on parent-report surveys as children are unreliable reporters of their emotions [3], yet even the most attentive caregivers may underreport as many symptoms are unobservable [2], [3]. When presented with emotional stimuli, children with ADHD and internalizing disorders exhibit distinct bio-behavioral responses as compared to children without these disorders [4], [5]. In this analysis, we consider children's postural sway during an anxiety-inducing task. Overall, this study aims to enhance our ability to detect mental health disorders in children with ADHD, internalizing disorders, and controls by identifying objective biomarkers.

Methods: We present chest movement data from children ages 4-8 (N=94, 43% female, 19 with ADHD, 34 with internalizing disorders) during the three phases of the Speech Task, adapted from the Trier Social Stress Task. 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 (end of phase 1, start of phase 2) and with 30 seconds remaining (end of phase 2, start of phase 3). Child mental health diagnoses were established via a gold-standard semi-structured interview (KSADS-PL) with clinical consensus. Exploratory factor analysis (via principal component analysis) was used to reduce sixteen postural sway features derived from chest accelerometer data [6] into three factors, together explaining 78.2% of the variance. Repeated measures ANOVA were performed to compare children with ADHD, internalizing disorders, and controls across task phases.

Results & Discussion: The sixteen chest-based postural sway features reduced to the following three factors: Amount (F1), accounting for 42.5% of variance; Jerkiness (F2), accounting for 24.7%; and Complexity of Movement (F3), accounting for 11.0%. Amount of Movement describes intensity and size of movement as it was mainly determined by power, path, root mean square, and mean velocity. Jerkiness describes dynamic frequency characteristics of movement as it was mainly determined by frequency dispersion, range, centroidal frequency, and jerk. Complexity describes irregularity and unpredictability of the acceleration signal as it was primarily determined by sample entropy. Children with ADHD and/or an internalizing disorder had a significantly greater Amount of Movement than the control group ($p=0.02$, Fig. 1). Children with only ADHD (no comorbid internalizing disorder) had a significantly greater Jerkiness ($p=0.004$) and lower Complexity ($p=0.01$) than those with only an internalizing disorder. While children with only ADHD had a significantly greater Jerkiness than the control group ($p=0.01$), there were no other significant differences between ADHD or internalizing groups as compared to the control group for Jerkiness or Complexity of Movement. These results suggest that children with ADHD have more intense and dynamic movements as compared to children without disorders and those with only internalizing disorders. Children with only internalizing disorders have more varied, unpredictable movements as compared to those with only ADHD. There were no significant interactions between disorder groups and phases. Future work should leverage machine learning to develop models to predict the presence of ADHD and internalizing disorders from these factors, to support development of a more objective method for screening young children for mental health disorders. Future work could also consider movement features from other body segments to further explore how children respond to this anxiety-inducing task across diagnostic groups.

Significance: Applying exploratory factor analysis to chest-derived postural sway features created three factors that are significantly different by mental health disorder groups in a large sample of young children. The Amount factor identifies children with mental health impairment, and the Jerkiness and Complexity factors differentiate between types of mental health disorders.

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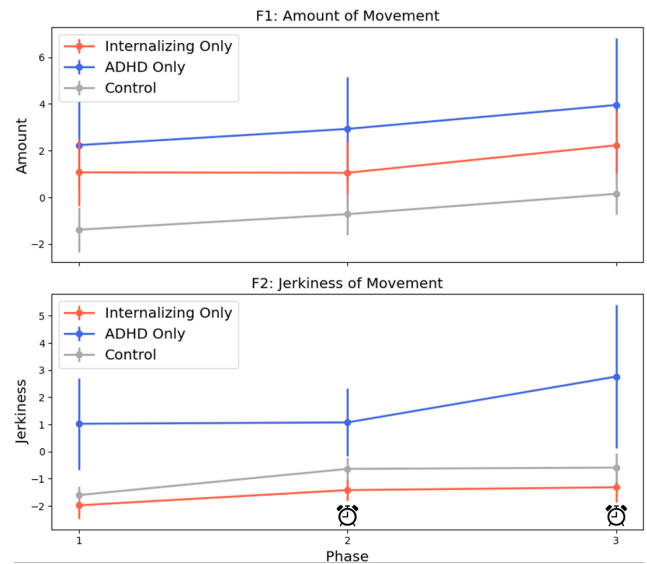


Figure 1: Mean and standard error of Amount (top) and Jerkiness (bottom) of Movement at each of the three Speech Task phases for children with only internalizing disorders, only ADHD, and controls.