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Variability in Positive and Negative Affect Among Adolescents with and without ADHD: Differential Associations with Functional Outcomes

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Abstract

Introduction: This study examined whether adolescents with and without attention-deficit/hyperactivity disorder (ADHD) differed in affect variability and whether variability in positive and negative affect was associated with functional outcomes.

Method: Participants were 302 adolescents (12-14 years, *M*age=13.17, 55% male; 54% diagnosed with ADHD; 82% white) and their caregivers who each completed the 10-item Positive and Negative Affect Scale via daily diaries for approximately two weeks. Multi-informant ratings of emotional, behavioral, social, and academic outcomes were assessed.

Results: Adolescents with ADHD were found to experience greater variability in self- and parent-reported positive affect, fear, and distress. For adolescents with ADHD, greater variability in self- and parent-reported positive affect, fear, and distress were associated with more internalizing symptoms, greater variability in parent-reported positive affect was associated with worse social functioning, and greater variability in self- and parent-reported fear was associated with more externalizing symptoms. In contrast, greater variability in self- and parent-reported positive affect, fear, and distress were associated with better social functioning in adolescents without ADHD.

Limitations: Future work should examine affect variability in adolescents with ADHD within the same day rather than across days. The limited age range and demographic diversity of our sample may limit generalizability of findings.

Conclusions: Findings suggest the significant affect variability found among children with ADHD is also present in adolescents with ADHD and is associated with social and behavior impairment. Interventions for adolescents with ADHD should target emotion regulation abilities to help reduce the extremes of and shifts in affective experiences in this population.

Variability in Positive and Negative Affect Among Adolescents with and without ADHD: Differential Associations with Functional Outcomes

Attention-deficit/hyperactivity disorder (ADHD) is often characterized by extremes of and shifts in affect (also referred to as emotion lability or emotion impulsivity; see Barkley, 2010; Faraone et al., 2019). Additionally, youth with ADHD are more emotionally labile than youth without ADHD (e.g., Anastopolous et al., 2011). However, most research to date has examined affect variability at a single time point using retrospective ratings or affect-inducing lab tasks. There is emerging evidence that children with ADHD display greater affect variability (changes in affect within the day or across days, as measured by repeated assessment of negative and positive affect) than children without ADHD (Rosen, Walerius, Fogleman, & Factor, 2015; Slaughter, Leaberry, Fogleman, & Rosen, 2019). This is important because affect variability is associated with negative functional outcomes in children with ADHD (Rosen & Factor, 2015; Rosen et al., 2015). There is some evidence that affect variability may increase during adolescence (Sobanski et al., 2010). It is possible that increased affect variability plays an important role in the heightened risk for the development of psychopathology (Andersen & Teicher, 2008) and interpersonal conflict (Laursen & Collins, 1994) present during adolescence. Specifically, many, but not all, adolescents with ADHD experience severe negative long-term outcomes (e.g., school dropout, unemployment, substance abuse, delinquency; Fried et al., 2016; Küpper et al., 2012; Sibley et al., 2011). The ability to understand and modify affective experiences during this critical developmental period may serve as a protective factor against the development of these negative outcomes. As such, the present study sought to explore whether adolescents with ADHD displayed less positive and more negative affect on average, and more variability in positive and negative affect than adolescents without ADHD using parent- and

adolescent-reported daily diary ratings. Further, we examined whether affect variability was associated with a range of functional outcomes among adolescents with and without ADHD.

Differences in Affect Variability Across ADHD Presentations

Models of affective neuroscience support that youth with ADHD experience deficits in affective control as a result of a delay in the development of the prefrontal cortex (Nigg & Casey, 2005). Several theories also suggest that affect variability may differ across ADHD presentations (Barkley, 1997, 2010). Specifically, individuals with ADHD combined presentation and predominantly hyperactive-impulsive presentation are particularly likely to experience deficits in self-regulation of affect (see Bunford, Evans, & Wymbs, 2015 for a review). A handful of studies have explored whether affect variability differs across ADHD presentations. The findings of these studies have been mixed, with some studies finding support for theories suggesting greater affect variability among presentations characterized by high levels of hyperactivity/impulsivity (but not among individuals with ADHD predominantly inattentive presentation), and others failing to find such differential relations (see Bunford et al., 2015, for a review).

Benefits of Using Daily Ratings to Assess Affect Variability

Research examining affect variability has largely relied on either global retrospective measures (see Perwien et al., 2008; Sobanski et al., 2010, for examples) or on affective displays during lab tasks (see El-Sheikh, 2005; Walcott & Landau, 2004, for examples). However, global retrospective measures are subject to biases such as recency effects, memory deficiencies, and social desirability. Measuring affect during lab tasks also has potential bias as it may not be representative of affective displays in more naturalistic settings. In contrast, assessing affect variability using repeated assessments such as daily diary or ecological momentary assessment

(EMA) methodologies results in a more accurate assessment (Solhan, Trull, Jahng, & Wood, 2009). Additionally, these measures are more reflective of affect in daily life than affect eliciting lab tasks (Stone & Shiffman, 1994).

A common affect measure in daily diary/EMA methods is the Positive and Negative Affect Schedule (PANAS; Crawford & Henry, 2004), particularly in its shortened 10-item form (PANAS-10; Ebesutani et al., 2012). In prior work using the PANAS with this and other samples (e.g., Allan et al., 2015; Eadeh et al., 2019; Gaudreau, Sanchez, & Blondin, 2006; Seib-Pfeifer, Pugnaghi, Beauducel, & Leue, 2017), the PANAS and PANAS-10 have been found to consist of three factors: positive affect, fear, and distress. Examination of both positive and negative affect is important, given research suggesting that youth with ADHD experience more frequent and intense shifts between positive and negative affect than youth without ADHD (Norvilitis, Casey, Brooklier, & Bonello, 2000; Sobanski et al., 2010). To our knowledge, very few studies have examined affect variability in youth with ADHD, all of which found greater variability in children (Rosen & Factor, 2015; Rosen et al., 2015) or a combined child/adolescent sample (Sobanski et al., 2010) relative to children without ADHD.

Relation Between Affect Variability and Functional Outcomes

Prior work with lab tasks and global measures of affect has linked extreme expressions of and shifts in affect to social, educational, and occupational outcomes in individuals with ADHD (e.g., Anastopolous et al., 2011; Sobanski et al., 2010; Skirrow & Asherson, 2013). Only three studies have explored this relation using daily diary/EMA data. Rosen and colleagues (2015) found variability in parent-reported affect to be associated with greater internalizing and externalizing difficulties among children with ADHD but not among children without ADHD. Similarly, Rosen and Factor (2015) found variability in child- and parent-reported affect to be

associated with increased aggression and internalizing and externalizing symptoms. Finally, Slaughter and colleagues (2019) found variability in parent-reported negative affect to be associated with concurrent and later aggression and concurrent proactive aggression. It is important to expand this limited body of research, and to examine if these relations continue into adolescence, given that adolescence is a developmental period characterized by more frequent and intense affect (Larson et al., 1980; Larson & Lampman-Petraitis, 1989). As such, the present study will build on and expand the literature by examining the relation between affect variability and functional outcomes in a sample of adolescents, and by examining a broader range of functional outcomes such as social and academic functioning in addition to externalizing and internalizing symptoms. Examination of social and academic functioning during adolescence is particularly important since adolescence is characterized by an increased importance and interdependence of these two domains (Meijs, Cillessen, Scholte, Segers, & Spijkerman, 2010; Nelson & DeBacker, 2008). Additionally, global, retrospective measures of affect have been correlated with academic achievement (Gumora & Arsenio, 2002) and social functioning (Jacob et al., 2014). However, this relation has not been explored for affect variability using repeated measures.

The Present Study

The current study expands on existing work by using parent and adolescent daily diary data of positive and negative (fear and distress) affect in a large sample of adolescents with and without ADHD, and by examining a range of parent-, adolescent-, and teacher-reported functional outcomes. Given prior work suggesting that youth with ADHD may underreport behavioral and emotional problems (Fischer et al., 1993) and that youth with ADHD may not be aware of their own emotional states (Saarni, 2000), it is important to assess affect variability and

functional outcomes using multi-informant data. Prior EMA analyses with children with ADHD have used either parent EMA (two studies) or parent and child EMA data (one study) and parent and child ratings of externalizing and internalizing problems. The only study to include both parent and child EMA (Rosen & Factor, 2015) found these ratings to be moderately correlated, but found differential relations between parent- and child-rated affect variability with functional outcomes. Specifically, parent-rated affect variability, but not child-rated affect variability, were moderately to strongly correlated with all functional outcomes. In the present study, it was predicted that adolescents with ADHD would display greater variability in positive affect, fear, and distress based on both parent and adolescent report. Additionally, based on studies with lab tasks and global measures of affect variability (e.g., Anastopolous et al., 2011; Skirrow & Asherson, 2013) and EMA design with children with ADHD (Rosen & Factor, 2015; Rosen et al., 2015; Slaughter et al., 2019), it was predicted that variability in affect would be associated with negative social, academic, emotional, and behavioral outcomes. It was expected that differences in affect variability and the relations between affect variability and functional outcomes would be stronger for parent report, given limited prior research (Rosen & Factor, 2015) and that adolescent report may be impacted by social desirability and underreporting both of which may reduce variability in reported affect variability (Fischer et al., 1993; Saarni, 2000).

Method

Participants

Participants were 302 adolescents (55% male), ages 12-14 years old (M = 13.17, SD = 0.40), and their caregivers who took part in a multisite longitudinal study (see Becker et al., 2019 for more details). Approximately half (n = 162; 120 predominantly inattentive presentation, 42 combined presentation) of the sample was diagnosed with ADHD during the in-person intake

assessment. The majority of participants (81.8%) identified as White; 5.3% identified as Black, 4.6% identified as Asian, and 8.1% identified as multiracial or another race. The mean family income was $93,073 (*SD* = $34,856). The majority of participants with ADHD were taking medication for ADHD (58%) and 9.9% of all participants were on medication for emotional and behavioral disorders (e.g., antidepressant, antianxiety). Based on combined parent and adolescent report on the Children's Interview for Psychiatric Syndromes (ChIPS; Weller, Weller, Fristad, Rooney, & Schecter, 2000), 14% of adolescents exhibited an externalizing disorder (i.e., oppositional defiant disorder or conduct disorder; 22% in ADHD sample, 4% in comparison sample) and 27% exhibited an internalizing disorder (i.e., any anxiety or depressive disorder; 32% in ADHD sample, 21% in comparison sample).

Procedure

Participants were recruited across two consecutive years (2016 and 2017) for a prospective longitudinal study examining the role of sleep in the social-emotional and academic functioning of adolescents with and without ADHD. Longitudinal data collection is ongoing; all data from the present study are from the initial study visits. Potential participants were recruited via flyers, referral, word-of-mouth, and through schools during their eighth-grade year. Interested caregivers completed a phone screen. The presence of autism spectrum disorder, bipolar disorder, an organic sleep disorder, or a psychotic disorder were considered exclusionary criteria. Participants needed an estimated IQ of ≥80 on the Wechsler Abbreviated Scale of Intelligence, Second Edition. Participants could not be homeschooled or in a full-time special education classroom.

Interested and eligible families per the phone screen were scheduled for an in-person visit to determine final study eligibility and group. During this visit, the ChIPS (Weller et al., 2000)

parent and self-report versions, online rating scales, and intelligence and achievement testing were administered. To be eligible for the ADHD group, the adolescents had to meet criteria for ADHD predominantly inattentive or combined presentation based on ChIPS parent report. To be eligible for the comparison group, the adolescent had to display three or fewer ADHD inattentive and hyperactive/impulsive symptoms. To increase generalizability, comorbidities were allowed in both the ADHD and comparison groups. At the visit, participants were provided with diaries to complete daily for at least a two week period; participants were instructed to complete the diaries each day until their follow-up visit. Follow-up visits were scheduled at least two weeks from the intake visit (max number of days = 24).

All procedures were approved by both the Virginia Commonwealth University and Cincinnati Children's Hospital Medical Center Institutional Review Boards. Written informed consent and adolescent assent were obtained from all participants. Power analyses for the larger study were conducted in Mplus using Monte Carlo simulations with 1,000 replications of each model. Models accounted for the nesting of adolescents within cohorts and schools. Analyses yielded effective sample sizes of 152, 122, and 102 based on intracluster correlations of .10 (power = .94), .15 (power = .90), and .20 (power = .85). As such, the present study is sufficiently powered with a sample of 302 participants.

Measures

Positive and Negative Affect. Adolescents and parents each completed diary data about the adolescent's affect throughout the entire day using the PANAS-10 (Ebesutani et al., 2012). Each item was rated on a 5-point Likert scale from 1 (*very slightly or not at all*) to 5 (*extremely*), with respondents indicating how often the adolescent felt that way during that day, adolescents based on their experienced affect and parents based on their observations of adolescents' affect

expression. Adolescents were instructed to complete the PANAS at night, about that day; parents were instructed to complete the PANAS in the morning about their child's behavior during the prior day. The PANAS-10 was developed via item-response theory from the 27-item PANAS (Laurent et al., 1999), with both parent and self-report versions demonstrating a greater than chance discrimination between different psychopathology domains (Ebesutani et al., 2012). Prior research (Allan et al., 2015; Gaudreau et al., 2006; Eadeh et al., 2019; Seib-Pfeifer et al., 2017) suggests that the PANAS-10 can be best represented by three factors (*positive affect*: joyful, cheerful, happy, lively, proud; *distress*: miserable, mad, sad; *fear*: afraid, scared). Additionally, high collinearity (.74-.95 for positive, .94 for fear, .66-.73 for distress for adolescent-report; .70-.94 for positive, .91 for fear, .67-.75 for distress for parent-report) between affect in the current dataset further supports the use of factors rather than individual items. Moderate correlation between adolescent and parent report was found for each factor for the ADHD (*r*s=.344 - .394) and comparison (*r*s=.385-.425) groups. In the present sample, the PANAS demonstrated good internal consistencies for adolescent report (.87 - .97) and parent report (.87 - .96). The mean number of days with completed PANAS data was 16.53 (*SD*=2.67); adolescents with (*M*=16.70, *SD*=2.59) and without (*M*=16.40, *SD*=2.74) ADHD did not differ on the number of days with completed PANAS data (*t*=-0.94, *p*=.35).

Externalizing Symptoms. Parent and teacher ratings of externalizing symptoms were collected using the Vanderbilt ADHD Rating Scale (VARS; Wolraich et al., 2003). VARS items map onto the symptoms of ADHD, oppositional defiant disorder, and conduct disorder, and are assessed on a 4-point scale ranging from 1 (*Never*) to 4 (*Very Often)*. In order for a symptom to count as present, the rater needed to endorse that symptom as occurring *Often* or *Very Often.* A total symptom count across the three disorders was used to assess parent and teacher report of

externalizing symptoms. Internal consistency in the present study was high for parents and teachers (αs=.91 and .95, respectively).

Internalizing Symptoms. Parent and adolescent ratings of internalizing symptoms were collected using the Revised Child Anxiety and Depression Scale (RCADS; Ebesutani et al., 2012). The RCADS consists of 47 items assessing anxiety and depression symptoms on a 4-point scale ranging from 1 (*Never*) to 4 (*Always).* Grade and gender normed *T*-scores were calculated for Total Internalizing Symptoms. Internal consistency in the present study was high for parents and adolescents (αs=.94 and .96, respectively).

Aggression. Parent, adolescent, and teacher ratings of adolescent aggression were collected using the Proactive and Reactive Aggression Measure (PRAM; Dodge & Coie, 1987). The PRAM is a 6-item youth measure consisting of three reactive aggression (e.g., "When I have been teased or threatened I get angry easily and strike back") and three proactive aggression (e.g., "I threaten or bully others in order to get my way") items. Items are anchored on a 5-point scale (1 = *Never*, 5 = *Almost Always*). In the present study, the total aggression subscale was used, which is an average across the six items. Good construct and criterion validity have been demonstrated for this measure (Waschbusch & Willoughby, 1998). Internal consistency in the present study was acceptable to good for parents and teachers (αs=.77 and .89, respectively); since internal consistency was questionable for adolescent report, α=.68, it was not used in the present study.

Social Functioning. Parent and adolescent ratings of adolescent social acceptance on the Self-Perception Profile for Adolescents (SPPA; Harter, 1988) were used to assess social functioning. The SPPA is a well-validated measure of self- and other-perceived competence (Harter, 1988). The adolescent social acceptance scale consists of six items; the parent social

acceptance scale consists of two items. Items were scored on a scale from 1 to 4, with higher values indicating greater perceived social acceptance. The six adolescent social acceptance items and two parent social acceptance items were averaged to compute a subscale score (Cronbach's αs=.79 and .74 for parents and adolescents, respectively).

Academic Functioning. Parent and teacher ratings of adolescent homework problems on the Homework Performance Questionnaire (HPQ; Power, Dombrowski, Watkins, Mautone, & Eagle, 2007) were used to assess academic functioning. The HPQ scores correlate with measures of homework behavior and academic skills, as well as academic achievement (Mautone et al., 2012). The HPQ items use a 7-point scale ranging from 0 (*Never/Rarely - 0% to 10% of the time*) to 6 (*Always/Almost Always - 91% to 100% of the time*), with corresponding percentages to indicate the amount of time a behavior occurs. Items were worded in the positive so that 90–100% of the time indicates that the child does that behavior consistently well. All items were averaged to create a total score. Internal consistency in the present study was high for parents and teachers (αs=.93 and .96, respectively).

Data Analytic Plan

First, group differences in affect on average were examined. Next, to see if adolescents with and without ADHD differed in affect variability, multilevel modeling (MLM; Goldstein, 2012; Hox et al., 2017) analyses were run in SPSS 25 for each factor (positive affect, fear, distress) and Level 1 residuals (i.e., how much each participant's affect on a given day differed from their average affect) were saved for each adolescent to reflect daily affect variability. This indicator of variability is a squared metric of the average variability in each affect factor for each adolescent. Two-level (i.e., days nested within individuals) MLM with random intercepts to accommodate correlated errors were then conducted, with the residual terms for each affect

factor as an outcome variable to examine whether group status predicted affect variability, accounting for the effects of adolescent sex, medication status (ADHD or emotional and behavioral disorders), race, and family income. Parent-reported adolescent biological sex, race, and family income were included as Level 1 time-invariant covariates in analyses given sex and cultural differences in affect (e.g., Kring & Gordon, 1998; Matsumoto, 1993). Additionally, medication status was entered as a Level 1 time-varying covariate (i.e., analyses account for medication status each day) using adolescent reports on the daily diary data; coefficients for these covariates can be interpreted as the effect of medication status on average (1 = on medication, 0 = not on medication) on affect variability. Missing data were handled in MLM analyses using restricted maximum likelihood estimation.

Next, functional outcome measures were included in a MLM to examine their associations with variability in each PANAS factor, with analyses run separately for the ADHD and comparison groups. To reduce the number of variables, multi-informant reports of the same measure were averaged. In the event that one of the informants did not complete a rating, all existing data was used (e.g., if there was only data for one informant, the value used would be that of the one informant). This multi-step analytic process allowed a link to be first established between ADHD group status and affect variability, prior to determining if there were unique effects between functional outcomes and affect variability in the ADHD and comparison groups.

MLM in SPSS provides unstandardized regression weights, as such all presented coefficients are unstandardized. Given the number of analyses being run, a false discovery rate-controlling analysis (Benjamini & Hochberg, 1995, 2000) was conducted; false discovery rate controlling analysis is designed to control the expected proportion of false discoveries (i.e., Type I Error). To conduct a false-discovery rate analysis, all observed *p*-values were ordered

sequentially from low (p_1) to high (p_m), where m represents the total number of *p*-values. We then identified the largest *k* such that $p_k < .05 * k/m$. The adjusted alpha of .05**k*/*m* was .021.

Results

[Insert Table 1 Around Here]

Group Differences in Affect

Results for preliminary analyses exploring group differences in affect on average can be found in Table 1. Adolescents with ADHD were rated by their parents as experiencing less positive affect than adolescents without ADHD. Additionally, both parents and adolescents rated adolescents with ADHD as experiencing more distress (miserable, mad, sad) than adolescents without ADHD.

[Insert Table 2 Around Here]

Group Differences in Affect Variability

Results for group differences in affect variability can be found in Table 2. ADHD group status was a significant or marginally significant predictor of positive affect, fear, and distress based on both adolescent- and parent-report, controlling for adolescent sex, daily medication status, race, and family income (*p*s<.042). Specifically, adolescents with ADHD displayed greater adolescent- and parent-reported variability than adolescents without ADHD from day to day in positive affect, fear, and distress.

Although all coefficients indicated that adolescents with ADHD inattentive presentation had less variability than adolescents with ADHD combined presentation (*b*s=-0.189 to -0.211), only one of these relations was significant. Specifically, adolescents with ADHD inattentive presentation had significantly less variability in adolescent-reported positive affect than adolescents with ADHD combined presentation (*b*=-0.211, *SE*=0.067, *p*=.002). As such, results

suggest that the group differences found between adolescents with and without ADHD were not driven by either the combined or predominantly inattentive presentation of ADHD.

Almost all of the covariates were unrelated to affect variability. The one covariate that displayed inconsistent relations with affect variability was race. Specifically, White adolescents with ADHD were reported to experience significantly less variability in fear and distress than non-White adolescents with ADHD based on parent-report.

[Insert Table 2 Around Here]

Associations Between Affect Variability and Functional Outcomes

Results suggest differential relations between affect variability and functional outcomes for adolescents with and without ADHD (see Table 3). Specifically, for adolescents with ADHD, greater variability in adolescent- and parent-reported positive affect, fear, and distress were significantly or marginally associated with more internalizing symptoms (with the exception of parent-reported fear). Additionally, greater variability in parent-reported positive affect was associated with poorer social functioning, and greater variability in adolescent- and parent-reported fear was associated with more externalizing symptoms. In contrast, for adolescent in the comparison sample, greater variability in adolescent- and parent-reported positive affect, fear, and distress were significantly or marginally associated with better social functioning (with the exception of adolescent-reported distress).

Again, almost all of the covariates were unrelated to affect variability for both adolescents with and without ADHD. The one covariate that continued to display inconsistent relations with affect variability was race. Specifically, White adolescents with ADHD were found to experience marginally less variability in fear than non-White adolescents with ADHD based on parent-report, and White adolescents without ADHD were found to experience

marginally less variability in positive affect than non-White adolescents without ADHD based on adolescent-report.

Discussion

This is the first study to examine variability in affect among adolescents with and without ADHD using daily diary data. Additionally, this study expanded on prior EMA studies with children with ADHD, which examined the link between affect variability and internalizing and externalizing symptoms, by examining a broad range of functional outcomes, including social and academic functioning using multi-informant report. Results suggest that adolescents with ADHD experience more negative affect (mad, miserable, sad) and less positive affect on average based on parent report, and more negative affect (mad, miserable, sad) on average based on self-report. Additionally, they suggest that adolescents with ADHD have greater variability in both positive and negative affect based on both self- and parent-report, and that this variability is not unique to adolescents with ADHD who display hyperactive/impulsive symptoms (i.e., was found in both the predominantly inattentive and combined presentations). Additionally, results suggest that variability tends to be associated with negative outcomes for adolescents with ADHD, but not for adolescents without ADHD. Parents of White adolescents rated their children as experiencing less variability in fear and distress; however, when affect variability was examined separately among adolescents with and without ADHD these differences became marginally significant or non-significant. These findings and their implications are discussed next.

Our preliminary findings of group differences in affect on average stand in contrast to prior research using the PANAS, which found that adolescents with ADHD reported more positive and less negative affect than other clinic-referred adolescents (Okado, Mueller, & Nakamura, 2016). It is possible that the difference is due to the Okado et al. comparison group being comprised of other non-ADHD clinical populations, whereas our comparison sample

largely did not have clinical diagnoses. Further, the Okado et al. (2016) study only collected the PANAS once, at the time of an intake visit; thus, differences in findings may also be the result of our sample completing ratings about each day rather than globally about the past few weeks.

Our finding of increased affect variability among adolescents with ADHD supports and extends prior research among children with ADHD into adolescence. This is concerning given that adolescence is a key developmental period when youth learn to self-regulate their emotions in adaptive ways (see Bakracevic Vukman & Licardo, 2010). Notably, the moderate correlations between parent- and adolescent-report, and the consistency in findings across parent- and adolescent-report, suggest that adolescents with ADHD may be more aware of and accurate in reporting affective states, relative to children with ADHD[1]. This supports prior research suggesting that adolescents are more reliable than children in their reports of differentiating emotions, not hiding their emotions, and body awareness of emotional experiences (Rieffe et al., 2008). This is particularly noteworthy as adolescents are reporting on their experienced affect, whereas parents are reporting on adolescent affect expression. Despite these consistencies, observed associations were stronger based on parent-report. Longitudinal research is needed to determine whether youth with ADHD do in fact develop greater awareness of their affective states as they transition from childhood to adolescence, and how this awareness relates to outcomes.

Taken together, the possibility that children with ADHD display better awareness of their affective states as they transition into adolescence, but also still display more emotional impulsivity (as indicated by greater affect variability) than their typically developing peers, may explain the high rates of internalizing symptoms experienced by this population (Becker &

[1] Prior research with children with ADHD displayed smaller or similar correlations and found different patterns of findings across parent- and child-report for relations with outcomes.

Fogleman, 2020; Yoshimasu et al., 2012). That is, adolescents with ADHD may realize that they are having a harder time regulating their affective states and are more reactive than their peers, which may result in feelings of anxiety or self-consciousness. This may be particularly salient during adolescence, a developmental period characterized by heightened comparison to peers and feelings of others observing and judging one's behavior (e.g., Frankenberger, 2000; Rankin, Lane, Gibbons, & Gerrard, 2004). Supporting this possibility, among adolescents with ADHD, variability in adolescent- and parent-reported positive affect, fear, and distress were associated with more internalizing symptoms. This finding is consistent with prior work suggesting that emotion dysregulation underlies the association between ADHD and depressive symptoms in young adolescents (Seymour et al., 2012) and prior work with children with ADHD using EMA data which found PANAS total affect variability to be associated with more internalizing symptoms (Rosen & Factor, 2015). Additionally, among adolescents with ADHD, variability in parent-reported positive affect was associated with less social acceptance. It may be that variability in positive affect is indicative of more global/severe difficulties with regulating expressed affect. Our findings are consistent with the youth with ADHD who we treat clinically, who often seem emotionally immature and experience extremes in positive affect (e.g., overly exuberant, rambunctious) that interfere with interpersonal interactions. For instance, youth with ADHD may become so excited and fixed on whatever prompted the positive affect (e.g., earning a privilege, learning that they are going to do something positive) that they no longer attend to what the other person is saying. It is likely that during adolescence, when social relationships are of increased importance (La Greca & Prinstein, 1999), these overly strong positive reactions and poor attending to interpersonal demands may result in a more detrimental impact on social acceptance. The fact that greater positive affect variability is associated with more internalizing

symptoms and less social acceptance is consistent with prior work finding associations between global emotion dysregulation and both of these constructs (e.g., Bunford, Evans, & Langberg, 2018; Graziano, McNamara, Geffken, & Reid, 2013). Additionally, it is consistent with research finding associations between internalizing symptoms and lower social acceptance/social skills among adolescents with ADHD (Becker, Langberg, Evans, Giro-Herrera, & Vaughn, 2015).

Interestingly, among adolescents with ADHD, greater variability in adolescent- and parent-reported fear was associated with more externalizing symptoms. This finding extends work with children with ADHD suggesting that youth with ADHD and comorbid disorders display greater affect variability than children with ADHD only (Factor et al., 2014). It is noteworthy that we found this relation between fear variability and externalizing symptoms for adolescents with ADHD, but not for the comparison sample. This suggests that perhaps parents of adolescents with ADHD often view anxious/fearful behavior as oppositional or irritable, resulting in them also endorsing higher rates of externalizing symptoms. In contrast, parents of youth without ADHD may be less likely to provide this externalizing interpretation for their adolescents. Alternatively, adolescents with ADHD who experience greater variability in fear may be more prone to also display chronic irritability and oppositionality. Together, results suggest that interventions targeting emotion dysregulation among adolescents with ADHD hold significant promise for reducing the negative social-emotional outcomes experienced among this population (Bunford et al., 2015).

In contrast, among adolescents without ADHD, variability in adolescent- and parent-reported positive affect, fear, and distress was associated with better social functioning. In typically developing samples, affect variability is often discussed as a reflection of the ability to flexibly switch between affective states (Hollenstein, Lichtwarck-Aschoff, & Potworowski,

2013). Additionally, in typically developing samples, affect variability has been associated with better handling of conflictual situations, and less externalizing and internalizing symptoms (Hollenstein, Granic, Stoolmiller, & Snyder, 2004; Van der Giessen, Branje, Frijns, & Meeus, 2013; Van der Giessen et al., 2015). Taken together with findings from the present study, results suggest that some amount of variability is adaptive with regard to social-emotional and behavioral outcomes, but that too much variability in affect may be indicative of emotion dysregulation and lability (i.e., extreme shifts in affect that are not appropriate for the given situation), resulting in impaired social-emotional and behavioral outcomes.

Limitations and Areas for Future Research

Findings of the present study should be interpreted in the context of several limitations. First, although PANAS daily diary data holds considerable strengths over global, retrospective measures of affect variability, there is some evidence that EMA collected throughout the day is more accurate than data collected at the end of the day (Stone & Shiffman, 1994). As such, it will be important for future work to examine affect variability in adolescents with ADHD within the same day rather than across days to better capture affect variability. Examining affect multiple times within the day may also help shed light on how adolescents respond to similar stressful/negative experiences. Additionally, our daily diary data were collected at different times for adolescents (evening) and parents (morning). The delay in parental reporting of adolescent affect could have resulted in biases in reporting, such as a possible dampening of variability. Further, with regard to parent ratings, although the majority of families (76.6%) had the same parent complete ratings throughout the study, a substantial minority of families had shared custody resulting in two parents completing ratings. This limits our ability to examine whether parent sex impacted PANAS ratings. Second, despite the use of multi-informant data for all

functional outcomes, two of these outcomes (internalizing symptoms and social functioning) still relied on a combined parent and adolescent report, which could result in issues of shared method variance since the same informants provided affect ratings. Third, the present study only examined whether differences in affect variability between adolescents with and without ADHD were driven by ADHD presentation. It will be important for future research to also examine whether differential relations between affect variability and functional outcomes are present based on ADHD presentation. Finally, given that this is the first study to examine affect variability in adolescents with ADHD using daily diary data, the limited age range of our sample (ages 12-14) may limit generalizability of findings to older adolescents. It will be important for future work, particularly longitudinal studies, to follow adolescents with ADHD into later adolescence to see how affect variability may improve in this population with time (e.g., perhaps group differences would disappear by late adolescence, suggesting that adolescents with ADHD may display delayed emotion regulation abilities). Similarly, our sample was predominately White and largely middle-class. Given that parents of White adolescents reported less variability in negative affect than parents of non-White adolescents in the combined sample, it will be important for future research to examine affect variability in a more diverse adolescent sample with respect to age, race/ethnicity, and socioeconomic status, to determine the impact these demographic variables may have on the experience and expression of affect.

Conclusions and Clinical Implications

Using daily diary data, the present study was the first to examine affect variability among adolescents with and without ADHD, and to examine the differential relation between this variability and a range of functional outcomes. The significant affect variability found among adolescents with ADHD and the association of this variability with negative social-emotional

and behavioral outcomes suggests that interventions are needed for adolescents with ADHD that target emotion regulation abilities. Specifically, helping this population learn how to better regulate and cope with positive and negative affect, may help reduce the extremes of and shifts in affective experiences, ultimately resulting in better functional outcomes.

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Table 1.

Group Differences in Adolescent Affect

Variable	ADHD *M (SD)*	Comparison *M (SD)*	*t*	*p*
Adolescent-Reported Positive Affect	3.15 (0.97)	3.22 (0.88)	0.67	.504
Adolescent-Reported Fear	2.37 (0.75)	2.24 (0.50)	1.80	.073
Adolescent-Reported Distress	**2.76 (0.95)**	**2.53 (0.65)**	**2.44**	**.013**
Parent-Reported Positive Affect	**2.75 (0.76)**	**2.99 (0.75)**	**-2.74**	**.006**
Parent-Reported Fear	2.17 (0.46)	2.11 (0.26)	1.43	.155
Parent-Reported Distress	**3.99 (1.18)**	**3.51 (0.63)**	**4.50**	**<.001**

Note. Bold lines indicate significant results.

Table 2.

ADHD Diagnosis as a Predictor of Variability in Adolescent Affect

	Positive Affect Variability *b (SE)*	Fear Variability *b (SE)*	Distress Variability *b (SE)*
Adolescent-Report			
Sex	0.010 (0.039)	0.124 (0.135)	0.215 (0.274)
Medication Status	-0.011 (0.020)	-0.081 (0.068)	-0.149 (0.139)
Race	-0.065 (0.047)	-0.060 (0.163)	0.005 (0.331)
Family Income	-0.001 (0.001)	0.002 (0.003)	0.005 (0.005)
ADHD Group Status	**0.008 (0.004)**†	**0.037 (0.014)***	**0.073 (0.029)***
Parent-Report			
Sex	-0.009 (0.034)	0.151 (0.114)	-0.222 (0.312)
Medication Status	0.004 (0.017)	-0.096 (0.058)	0.023 (0.158)
Race	-0.029 (0.041)	**-0.344 (0.137)***	**-0.903 (0.376)***
Family Income	-0.001 (0.001)	-0.002 (0.003)	-0.002 (0.008)
ADHD Group Status	**0.010 (0.004)**†	**0.047 (0.012)*****	**0.160 (0.033)*****

Note. ADHD = attention/deficit-hyperactivity disorder. Sex coded: 0 = male, 1 = female; medication status coded: 0 = did not take any medication for ADHD or emotional-behavioral disorders, 1 = took medication for ADHD and/or emotional-behavioral disorders that day; race coded: 0 = non-White, 1 = White. †$p<.05$, *$p<.021$, ***$p<.001$. Bold lines indicate significant results.

Table 3.

Associations Between Variability in Adolescent Affect and Functional Outcomes

	ADHD Sample			Comparison Sample		
	Positive Variability *b (SE)*	Fear Variability *b (SE)*	Distress Variability *b (SE)*	Positive Variability *b (SE)*	Fear Variability *b (SE)*	Distress Variability *b (SE)*
Adolescent-Report						
Sex	0.113 (0.079)	0.198 (0.275)	0.840 (0.503)	0.020 (0.050)	0.315 (0.174)	0.379 (0.330)
Medication Status	0.044 (0.062)	0.193 (0.216)	0.597 (0.395)	-0.012 (0.024)	-0.156 (0.085)	-0.194 (0.162)
Race	0.120 (0.088)	-0.022 (0.306)	0.612 (0.563)	**-0.130 (0.060)**†	-0.052 (0.202)	-0.289 (0.384)
Family Income	0.000 (0.001)	0.002 (0.003)	0.007 (0.006)	0.000 (0.001)	0.002 (0.003)	-0.004 (0.005)
Externalizing	0.001 (0.004)	**0.040 (0.015)***	-0.011 (0.027)	0.003 (0.005)	0.016 (0.016)	0.016 (0.031)
Internalizing	**0.003 (0.001)**†	**0.011 (0.005)**†	**0.028 (0.009)**†	0.001 (0.001)	0.011 (0.013)	0.016 (0.009)
Aggression	0.021 (0.029)	0.116 (0.099)	0.063 (0.182)	0.016 (0.019)	0.006 (0.136)	0.110 (0.257)
Social Functioning	0.025 (0.022)	-0.064 (0.076)	-0.022 (0.140)	**0.092 (0.039)***	**0.122 (0.037)***	0.031 (0.124)
Academic Functioning	0.007 (0.016)	-0.056 (0.056)	-0.017 (0.102)	0.003 (0.010)	0.004 (0.035)	-0.022 (0.066)
Parent-Report						
Sex	0.011 (0.072)	0.159 (0.284)	-0.452 (0.719)	0.000 (0.040)	0.219 (0.111)	-0.010 (0.310)
Medication Status	0.024 (0.057)	0.091 (0.224)	-0.121 (0.568)	0.002 (0.020)	-0.108 (0.054)	-0.002 (0.152)
Race	0.077 (0.080)	**-0.629 (0.313)**†	-1.341 (0.793)	-0.023 (0.004)	-0.095 (0.129)	-0.233 (0.359)
Family Income	0.000 (0.001)	-0.001 (.003)	-0.000 (0.008)	0.001 (0.001)	0.002 (0.002)	0.003 (0.005)
Externalizing	0.001 (0.004)	**0.034 (0.016)***	0.066 (0.041)	-0.002 (0.004)	0.000 (0.010)	0.026 (0.029)
Internalizing	**0.004 (0.001)***	0.004 (0.006)	**0.034 (0.012)***	0.002 (0.001)	0.005 (0.003)	0.018 (0.090)
Aggression	0.014 (0.026)	-0.014 (0.103)	0.442 (0.260)	0.038 (0.032)	0.093 (0.087)	0.048 (0.242)
Social Functioning	**-0.059 (0.020)****	-0.024 (0.078)	-0.152 (0.198)	**0.043 (0.015)***	**0.109 (0.042)***	**0.261 (0.118)**†
Academic Functioning	0.008 (0.015)	0.325 (0.689)	0.200 (0.153)	-0.002 (0.008)	-0.038 (0.022)	-0.105 (0.062)

Note. ADHD = attention/deficit-hyperactivity disorder. Sex coded: 0 = male, 1 = female; medication status coded: 0 = did not take any medication for ADHD or emotional-behavioral disorders; 1 = took medication for ADHD and/or emotional-behavioral disorders that day; race coded: 0 = non-White, 1 = White. Higher scores on externalizing, internalizing, and aggression indicate more externalizing/aggressive and internalizing behaviors; higher scores on social and academic functioning indicate better functioning. Bolded results indicate significant findings.

†$p<.05$, *$p<.021$, **$p<.01$.