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Temporal Dynamics of Positive and Negative Affect in Adolescents: Associations with Depressive Disorders and Risk

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Abstract

Alterations in dynamic affective processes are associated with dysregulated affect and depression. Although depression is often associated with heightened inertia (i.e., greater moment-to-moment correlation) and variability (i.e., larger departures from typical levels) of affect in adults, less is known about whether altered affect dynamics are present in youth at risk for depression. This study investigated the association of clinical depression and depression risk with the inertia and variability of positive and negative affect in a sample of youth at varying risk for depression. Our sample included 147 adolescents aged 14 to 17, categorized into three groups: never-depressed lower-risk, never-depressed higher-risk (based on maternal history of depression), and currently depressed adolescents. Adolescents completed ecological momentary assessments of positive and negative affect up to seven times per day for a week. Multilevel models and ANOVAs were used to examine associations of affective inertia and variability with adolescent depression and risk based on maternal history, controlling for average affect. Depressed adolescents showed more inert and diminished positive affect, and more variable and elevated negative affect compared to lower- and higher-risk youth, though associations attenuated after controlling for average affect. No differences were identified between never-depressed higher-risk and lower-risk youth. Additional longitudinal studies are needed to evaluate whether altered affect dynamics in daily life precede depression onset to understand their utility for developing preventive interventions.

Keywords

depression; affect dynamics; ecological momentary assessment; positive affect; negative affect

1. Introduction

Affective states are closely tied to depression. In foundational work by Watson et al. (1988), higher negative affect (NA) was associated with elevated depressive symptoms, whereas

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elevated positive affect (PA) was associated with diminished depressive symptoms. Prior studies of risk factors for depression in youth also found that children whose parents had a history of depression exhibited diminished positive affect relative to lower-risk children (Abitante et al., 2022; Dietz et al., 2008; Olino et al., 2011). These studies suggest dysregulated affect may reflect youths' vulnerability for developing depression, rather than simply being a marker of current depression, and consequently may be an important target for preventive interventions. Studies using intensive sampling procedures have shown that dynamic measures of affect also relate to depression in adults but account for little variance in depressive symptoms compared to average levels of affect (Dejonckheere et al., 2019; Houben et al., 2015; Nelson et al., 2020; Panaite et al., 2020). Few studies, however, have evaluated these relations during adolescence, a period of significant change in youths' emotional experiences. In the present study, we investigated differences in affect dynamics among lower-risk, higher-risk, and currently depressed adolescents.

Research methods that yield multiple observations per day of individuals' momentary affect enable questions about how short-term affective changes may characterize risk for depression and depressive states. We focus on two key constructs, inertia and variability, and display simulated examples of these constructs in Figure 1 (see Dejonckheere et al., 2019 for a comprehensive review). A third construct, instability, also has been often studied; however, research shows that instability is strongly collinear with inertia and variability (Jahng et al., 2008). Conceptually, *inertia* represents the tendency for affective states to predict themselves over time. Operationalized as the within-person autocorrelation between observations, higher inertia means one tends to maintain their current affective trend over time. In daily life, an individual with highly inert negative affect might stay in a bad mood after an upsetting event for much of the day, whereas an individual with minimally inert negative affect would not remain in that negative affective state. Such an effect is reported by Suls and colleagues (1998), who found that negative mood predicted poorer mood several hours later among adults completing diaries 6 times daily for 8 days. Colloquially, we think of inert constructs as being inactive or unmoving, but inert affect refers to how predictable one observation of affect is by the prior one. The important aspect of inert affect is the degree to which prior affect predicts subsequent affect, regardless of whether affect is increasing or decreasing. Studies of negative affective inertia have identified positive cross-sectional and longitudinal associations with depression diagnoses and depressive symptoms (e.g., Koval et al., 2013, Kuppens et al., 2012; Nelson et al., 2020; Panaite et al., 2020). When comparing depressed and lower-risk individuals, depressed adults showed elevated inertia for negative but not positive affect (Nelson et al., 2020; Panaite et al., 2020), or no significant differences in inertia for negative or positive affect between groups (e.g., Thompson et al., 2012). Studies using continuous measures of depression find that greater inertia for negative affect correlates with elevated depressive symptoms among undergraduate students (Koval et al., 2013). Despite disparate findings across some studies, depression appears to be associated with more inert affect; however, few studies have examined these relations for youth at varying risk for depression.

The *variability* of individuals' affective experiences over time also may relate to depression. Variability captures the extent to which an individual's affect departs from its usual level and is typically operationalized using an individual's within-person standard deviation (i.e., the

standard deviation of scores obtained across all observations for a given person). Two people could experience the same average level of negative affect, but one may have low variability (i.e., their scores stay relatively close to their average) and the other may exhibit high variability (i.e., their affect fluctuates above or below their typical level). On its face, we might expect variability and inertia to be inversely related. However, inertia does not imply lack of movement, but rather movement that is highly predictable from prior affective states. Consequently, inertia will be low for individuals who exhibit random changes in affect over time, and larger for individuals whose affect changes predictably over time. If these trends occur across a relatively narrow range of values, variability will be low, and if they span a wide range of values, variability will be high. People can theoretically experience high or low inertia in combination with either high or low variability.

Like inertia, variability of negative affect is elevated among depressed compared to healthy adults (Nelson et al., 2020; Panaite et al., 2020). Higher variability of negative affect also is associated with elevated depressive symptoms among adults (Dejonckheere et al., 2019; Koval et al., 2013). Depressed individuals' elevated affective variability may reflect poorer emotion regulation, heightened reactivity to emotional stimuli, or more variable positive and negative events in one's life compared to healthy individuals. In sum, greater variability of negative affect is positively associated with depression diagnoses and depressive symptoms in adults and represents another facet of affective dysregulation that may arise in depressive disorders. Like inertia, however, few studies have assessed variability of affect among youth at varying risk for depression.

Prior studies suggest that affective inertia and variability may be associated with depression-related outcomes. Houben and colleagues (2015) conducted a meta-analysis of these dynamics and found that each was negatively correlated with psychological well-being. These findings suggested that poor psychological health is characterized by affect that is more inert (i.e., self-predictive) and variable (i.e., larger within-person variance), although these effects were stronger for negative than positive emotions. How important these dynamics are to understanding risk for depression is a subject of ongoing inquiry. Recent studies suggest that affect dynamics account for relatively little variance in well-being and depressive symptoms after controlling for average affect (e.g., Dejonckeere et al., 2019; Houben & Kuppens, 2020), and a study of adults from Koval and colleagues (2013) found that after controlling for average negative affect, only inertia, and not variability, was significantly associated with depressive symptoms. Other studies have not found differences in inertia of negative affect between currently depressed and healthy adults, or even between currently depressed and remitted adults (Thompson et al., 2012; 2021). Several recent studies suggest that for neuroticism-related variables like negative affect that exhibit strong positive skew, controlling for average affect when assessing variability of negative affect may overcorrect for their association (Ringwald & Wright, 2022). Instead, the authors suggest that the mode is a more appropriate variable to avoid underestimation of associations between negative affect variability and other variables. Indeed, findings from Hawes and colleagues (2023) suggest that the mode is a better representation of individuals' affective home base compared to the mean and exhibits less overlap with variability of negative affect. Regardless of how individuals' typical affect is operationalized, accounting for it is

necessary to accurately characterize associations between affect dynamics and depression risk.

Evaluating affect dynamics in youth may be particularly important for identifying developmental changes that precede clinical depression. Studies examining relations of inertia and variability to depressive symptoms obtain distinct findings when examining adult and adolescent samples (e.g., Kuppens et al., 2010; Thompson et al., 2012). Adolescence is a developmental period characterized by changes in emotional experiences. Adolescents experience more frequent, high-intensity positive and negative emotions compared to adults (Guyer et al., 2016; Larson et al., 1980). Adolescents' emotional responses are particularly strong in the context of social experiences (Bailen et al., 2019; Crone & Dahl, 2012), which may lead to greater variability in affect relative to adults and improve the ability to differentiate between depressed and healthy youth. Simultaneously, adolescence is a period in which emotion regulation and coping strategies are incipient and being learned, which may involve relatively ineffective regulation of emotional states. Youth who struggle to regulate their emotions may experience sustained negative states following stressors, which may be reflected in heightened inertia of negative affect. Indeed, prior research suggests suppression is associated with more inert positive behaviors (Koval et al., 2015). Adolescents also face frequent shifts in their social networks as they transition between schools and lose access to previous social networks (Brown & Larson, 2009; Meuwese et al., 2017; Rapee et al., 2019). This combination of heightened emotional responses and changing social networks may make adolescence a particularly salient developmental period to examine affect dynamics, which characterize fluctuations in affect over brief periods of time.

Altered affective processes may be most apparent in adolescent offspring of mothers with a history of depression who are at elevated risk for depression and exhibit heightened negative affect or diminished positive affect (Abitante et al., 2022; Connell et al., 2002; Davis et al., 2020; Dietz et al., 2008; Goodman et al., 2011; Olino et al., 2011). These mean-level differences in affect may reflect alterations in positive and negative valence systems such as deficits in reward learning and heightened frustrative non-reward (Sanislow et al., 2010). Higher-risk adolescents may exhibit altered affect dynamics in addition to mean-level changes in positive and negative affect. For instance, Kuppens and colleagues (2012) recruited a sample of adolescents without current or past depression and coded adolescents' positive and negative emotional behaviors during an interaction task with their parents. The authors found that heightened inertia of adolescents' emotional behaviors during these interactions predicted increased depression onset 2.5 years later. Results from Kuppens and colleagues suggest that altered inertia may indicate risk in youth prior to depression onset. However, whether similar findings would be identified using more ecologically valid measures of youth affect is unclear. To our knowledge, no study has evaluated differences in multiple indices of affect dynamics between currently depressed, higher-risk, and lower-risk youth using maternal history of depression as an index of risk. Evaluating differences across these groups could clarify whether altered affect dynamics represent early shifts in affective health that precede depressive disorder.

The present study examined affect dynamics in currently depressed, never-depressed but higher-risk (based on maternal history of depression), and never-depressed but lower-risk adolescents (no current depression or maternal history). Specifically, we modeled associations between risk status and average affect, inertia, and variability of positive and negative affect to evaluate whether groups at varying risk for depression exhibit distinct affect dynamics after controlling for their average affect. We also examined whether results differed when using the mean and mode to assess inertia and variability of negative affect. We hypothesized that currently depressed and higher-risk youth would show higher average affect, inertia, and variability of negative affect relative to lower-risk youth. We also expected to observe lower average affect and variability of positive affect for currently depressed and higher-risk adolescents compared to lower-risk adolescents.

2. Methods

2.1 Participants

Participants who completed EMA surveys included 147 adolescents aged 14 to 17 years at the time of consent (mean age = 15.17 years, *SD* = 1.07) and their biological mothers. All participants were English speaking and had access to a mobile phone. The sample was 72.1 % White, 12.9% Black or African American, 6.8% Asian, 6.1% Other, 1.4% Native Hawaiian or Pacific Islander, and 0.7% American Indian or Alaska Native; 6.1% of participants identified as Hispanic or Latino. Participants' biological sex was 63.9% female and 36.1% male, and participants' gender was 59.9% female, 34.0% male, 4.8% did not respond (two reported their biological sex as male, four as female), and 1.4% identified as gender fluid or that they use they/them pronouns. We excluded adolescents with autism spectrum, developmental disorders, intellectual disabilities, or auditory or visual impairments, and adolescents or mothers with history of mania or psychosis. Adolescents with past but not current depressive episodes were also excluded. Participants entered the study at varying risk for depression, with 34.0% currently depressed, 32.0% at higher-risk based on maternal history of depression but no personal history of a clinically significant depressive episode, and 34.0% at lower-risk of depression based on no personal or maternal history of depression.

2.2 Depression Diagnoses

Adolescents and their mothers completed diagnostic interviews at baseline to characterize past and current depressive disorders. Mothers' current and lifetime diagnoses were assessed using the clinician version of the Structured Clinical Interview for DSM-5 Disorders (First et al., 2015). Adolescents of mothers with a lifetime episode of persistent depressive disorder (PDD), major depressive disorder (MDD), and/or otherwise specified or unspecified depressive disorder were classified as higher risk. Unspecified depression was defined as four symptoms of depression for two or more weeks plus distress or impairment or as meeting full criteria for MDD or PDD with distress or impairment but not meeting the full duration requirement. Mothers of adolescents in the higher-risk group had lifetime depressive disorder diagnoses of MDD only (n = 30), PDD only (n = 3), MDD and PDD only (i.e., either concurrent MDD and PDD or both occurred at separate points in lifetime;

n = 8), only unspecified depression (*n* = 3), or a combination of MDD, PDD, or unspecified depression (n = 3).

Adolescents and mothers were administered the DSM-5 version of the Schedule for Affective Disorders and Schizophrenia for School Aged Children 6–18 years (K-SADS; Kaufman et al., 2013) to assess current and lifetime diagnoses in adolescents. Adolescents with current MDD only (*n* = 16), PDD only (*n* = 22), MDD and PDD (i.e., persistent major depressive episode for at least 1 year within the duration of PDD or for the full PDD duration; *n* = 11), or unspecified depression (*n* = 1) were classified as currently depressed. Adolescents with a history of a clinically significant depressive episode but no current depression were excluded.

Interviews were conducted by supervised clinical psychology doctoral students and trained research staff. Diagnoses were verified by a licensed clinical psychologist (AK). An independent rater reviewed and coded a subset of audio-recorded interviews to assess inter-rater reliability, and reliability of lifetime depressive disorders in both mothers (kappa = .88, *n* = 17) and adolescents (kappa = 1.00, *n* = 15) was excellent.

2.3 Procedure

Measures of positive and negative affect were obtained through multiple daily survey responses. Surveys were built using Survey Monkey and Qualtrics and were distributed using SurveySignal. Participants received text messages through SurveySignal seven times per day for one week (SurveySignal; Hofmann & Patel, 2015). Text messages were sent at random times between 6:25 am and 10:00 pm Central time and provided a link to a survey. Due to a change in software, 95 participants in the total sample were set on a different time zone and received texts between 8:25am and 12:00am. We estimated inertia controlling for this shift and found no effect of time zone. Participants had 30 minutes to respond to the survey link before it expired. Participants received $15 for completing 15 or more surveys and a bonus of $20 if they completed 35 or more. Participants were prompted to report their current positive and negative affect in each survey. Two participants did not have valid positive or negative affect responses and were excluded from the analytic sample. Participants responding to fewer than 20% of survey prompts were excluded from the analytic sample. Thresholds ranging from 20% to 50% are relatively common in ecological momentary assessment studies on affect and depression (e.g., Bean & Ciesla, 2023; Liu et al., 2021; Thompson et al., 2021; Vanderlind et al., 2022), and we adopted this lower threshold to maximize the amount of observed data analyzed and reduce the likelihood of introducing bias by only including highly compliant participants (Jacobson, 2020). This resulted in removal of 24 participants (9 currently depressed, 7 higher-risk, 8 lower-risk; 12 female, 12 male). The rate of exclusion for survey non-compliance did not differ by risk group χ^2 (2, N = 145) = 0.27, p = .87. The average number of completed surveys did not differ significantly by teen race (F(5, 139) = 0.61, p = .69), risk group (F(2, 142) = 2.21, p = .11), or biological sex (t(98) = −1.87, p = .06). We identified non-significant correlations of .02, p = .80, and −.03, p = .75, between positive and negative affect, respectively, and number of completed surveys. In our previous work with this sample, we did not find significant differences in survey completion on weekend days (i.e., Saturday and Sunday; *M*

= 54% of surveys completed) versus weekdays (M = 56% of surveys completed), $t(144) = -1.55$, $p = .12$, Cohen's $d = -.09$ (Politte-Corn et al., 2024).

Additionally, six participants endorsed only the minimum rating of negative affect and one had errors in survey timing who were excluded as well. Consequently, we obtained a final analytic sample consisting of 114 participants. Demographic information for the total and analytic samples is provided in Table 1. The mean number of assessments completed by our analytic sample was 31.16 (SD = 9.32), with a total of 3,552 surveys across 114 participants.

2.4 Measures

2.4.1 Positive and Negative Affect—

Adolescents completed the short version of the Positive and Negative Affect Schedule for Children in the daily surveys (PANAS-C; Ebesutani et al., 2012). The PANAS-C is a 10-item measure comprised of adjectives describing different moods. Adolescents rated how much they were experiencing each affective state in that moment. Each item was rated on a 5-point Likert scale from 1 (not at all) to 5 (very much). Consistent with the short PANAS-C, we included joyful, cheerful, happy, lively, and proud as positive affective items, and miserable, mad, afraid, scared, and sad as negative affective items. At each time point, we obtained measures of positive and negative affect by summing scores across the 5 items representing each construct. We used the multilevelTools package in R to calculate within- and between-person reliability of the positive and negative affect scales. We obtained within-person reliability of .87 and .62, and between-person reliability of .96 and .87, for positive and negative affect, respectively, in the analytic sample.

2.5 Data Analytic Plan

We conducted analyses using R (R Core Team, 2021). To assess associations between risk status and average affect, within-person variance, and inertia, we first obtained estimates for each of these parameters. Person-means of positive and negative affect were calculated by averaging across all surveys within each person. We calculated variability of positive and negative affect around these person means using the within-person variance. Prior work suggests that with 31 surveys per participant, we have .85 power to detect a relation between average affect and risk group, and .83 power to detect a relation between affect variance and risk group, given our sample size (Pirla et al., 2023). We also calculated within-day inertia using consecutive surveys, operationalized as the autocorrelation between consecutive within-person observations, for each participant using a multilevel modeling approach with the R package lme4 (Bates et al., 2015). We calculated intraclass correlation coefficients with three-level random intercept-only models for positive affect and negative affect to determine whether models should account for nesting of observations within day and within person but found relatively little variance due to between-day effects (12% or less). Consequently, we implemented two-level models with observations nested within person.

Next, we fitted models predicting positive and negative affect with person-mean centered prior affect to obtain average estimates of inertia for each person (Hamaker & Grasman, 2015). Inertia and participant ID were modeled as random effects. We display this model

below for negative affect and used the same model for positive affect. Each participant is represented by *i*, and each risk group is represented by *j*. In this model, γ_{00} represents the intercept of affect, γ_{10} represents the intercept of inertia, and r_{ij}, u_{0j}, and u_{1j} represent error. Estimates of γ_{10} for each participant were used as estimates of inertia in ANOVA analyses.

$$\text{Level 1(Observations):}\quad NA(t)_{ij} = \beta_{0j} + \beta_{1j}(NA(t-1)_{ij}) + r_{ij}$$

$$\text{Level 2(Observations):}\quad \beta_{0j} = \gamma_{00} + u_{0j}$$

$$\beta_{1j} = \gamma_{10} + u_{1j}$$

Next, we used ANOVAs to test main effects of risk status (lower-risk, higher-risk, and currently depressed) on inertia and variability of positive and negative affect. Risk group was included as a predictor and within-person variability of positive and negative affect were incorporated as outcomes in two separate ANOVA analyses. We then conducted ANCOVAs including risk status and average positive or negative affect as predictors of inertia and variance. We also conducted exploratory analyses adding main effects of youth biological sex and lifetime anxiety diagnosis with risk group. We compared between-group differences using pairwise comparisons that controlled for multiple comparison. Code for analyses is available through the Open Science Framework (OSF) at this link: https://osf.io/e9zy3/. De-identified data for this study are available by emailing the corresponding author. This study was not preregistered.

3. Results

3.1 Comparisons of Average Affect Between Groups

We first conducted one-way ANOVAs to compare mean levels of positive and negative affect between groups. For positive affect, we found a significant medium to large effect of Group on average affect, $F(2, 111) = 7.38$, $p < .001$, $\eta^2 = .12$. We used the Tukey-HSD test to assess pairwise differences between groups. We found that currently depressed youth exhibited lower positive affect compared to lower-risk (mean difference = −2.56, *p*-adjusted = .007) and higher-risk (mean difference = −2.88, *p*-adjusted = .002) youth. Contrary to our hypotheses, we did not identify a significant difference between higher- and lower-risk youth (mean difference = .32, *p*-adjusted = .92). For negative affect, we identified a significant large effect of Group predicting average affect $F(2, 111) = 10.70$, $p < .001$, $\eta^2 = .16$. Currently depressed youth exhibited higher negative affect compared to lower-risk (mean difference = 1.75, *p*-adjusted < .001) and higher-risk (mean difference = 1.23, *p*-adjusted = .005) youth. Contrary to our hypotheses, we did not identify a significant difference between higher- and lower-risk youth (mean difference = .52, *p*-adjusted = .36). Together, these results indicate that currently depressed youth exhibited lower average positive affect and higher average negative affect compared to higher- and lower-risk youth.

3.2 Testing Group Differences in Inertia and Variability of Affect

We obtained person-specific estimates of inertia using two-level models of positive affect and negative affect. In our two-level model for positive affect, we obtained an average estimate of .23 for inertia. The standard deviation of inertia was .07. One participant exhibited inertia less than 0, and inertia estimates ranged from −.01 to .47. In our two-level model for negative affect, we obtained an average estimate of .17 for inertia. The standard deviation of inertia was .13. Nine participants had estimates less than 0, and inertia estimates ranged from −.09 to .65.

We then conducted ANOVAs to examine main effects of Group on inertia and variance of positive affect and negative affect. These results are presented in Table 2. For inertia of positive affect, we obtained a significant effect of Group on inertia $F(2,111) = 6.04$, $p = .003$, $\eta^2 = .10$. We found significant differences in inertia of positive affect between currently depressed and lower-risk (mean difference = .04, p-adjusted = .048) and higher-risk (mean difference = .05, p-adjusted = .003) youth. Contrary to our hypotheses, we did not find a significant difference between higher- and lower-risk youth (mean difference = −.02, p-adjusted = .59). Exploratory analyses of biological sex and anxiety history were not significant. For inertia of negative affect, the effect of Group on inertia was not significant $F(2,111) = 1.63$, $p = .20$, $\eta^2 = .03$. Exploratory analyses including biological sex or lifetime anxiety diagnoses were not significant for inertia of negative affect.

For variance of positive affect, we did not obtain a significant effect of Group predicting variance $F(2,111) = 1.51$, $p = .23$, $\eta^2 = .03$. Exploratory analyses with biological sex and history of anxiety were not significant for positive affect. For variance of negative affect, we found a significant main effect of Group on variance $F(2,111) = 10.75$, $p < .001$, $\eta^2 = .16$. We found significant differences in variance of negative affect between currently depressed and lower-risk (mean difference = 3.94, p-adjusted < .001) and higher-risk (mean difference = 3.21, p-adjusted = .001). We also found that youth with a history of anxiety experienced greater variability of negative affect beyond the effect of risk group ($F(1, 109) = 9.09$, $p = .003$, Cohen's $d = .82$). The effect of biological sex was not significant.

We then examined whether associations were maintained after controlling for average levels of affect. We also assessed the extent to which average affect accounted for variability in affective inertia and variance. These results are displayed in Table 3. For inertia of positive affect, the effect of Group on inertia was still significant, $F(2,110) = 4.74$, $p = .01$, $\eta^2 = .02$. Average positive affect was not significantly related to positive affective inertia and accounted for less than 1% of its variability. We obtained significant differences in inertia of positive affect between currently depressed and higher-risk youth (mean difference = .05, p-adjusted = .009). We did not find significant differences between currently depressed and lower-risk, or between higher- and lower-risk youth. For inertia of negative affect, we did not obtain a significant effect of Group on inertia $F(2,110) = 1.72$, $p = .18$, $\eta^2 = .01$ or significant differences between groups in inertia of negative affect. Additionally, average negative affect accounted for 15% of variability in negative affective inertia.

We did not find a significant effect of Group on positive affect variance when controlling for average positive affect $F(2,110) = 2.06$, p = .13, $\eta^2 = .02$. Average positive affect

accounted for less than 1% of variability in positive affect variance. For variance of negative affect, we did not obtain a significant main effect of Group after controlling for average negative affect $F(2,110) = 1.55$ $p = .22$, $\eta^2 = .01$. Average negative affect accounted for 46% of variability in variance of negative affect. We also conducted analyses for inertia and variance of negative affect based on recent studies suggesting the use of the mode instead of the mean when studying neuroticism-related variables (Hawes & Klein, 2023; Ringwald & Wright, 2022). Taking this approach, we found that group was not a significant predictor of negative affective inertia $F(2,110) = 1.01$, $p = .37$, $\eta^2 = .01$. In contrast, the mode accounted for 18% of variance in negative affective inertia. We identified a significant effect of group on variance of negative affect $F(2,110) = 6.48$, $p = .002$, $\eta^2 = .08$. The mode was still a significant predictor of negative affect variance $F(1,110) = 24.25$, $p < .001$, $\eta^2 = .16$. We obtained significant differences between currently depressed and lower-risk youth (difference = 2.84, p-adjusted = .004) and higher-risk youth (difference = 2.44, p-adjusted = .01). We did not find significant differences between higher- and lower-risk youth.

4. Discussion

In this study, we sought to assess how risk for, and presence of, adolescent depressive disorders relate to within-day momentary affect dynamics. First, we identified significant differences in mean-levels of positive and negative affect for currently depressed compared to never-depressed lower- and higher-risk youth, such that currently depressed youth exhibited diminished positive affect and heightened negative affect. Contrary to our hypotheses, we did not obtain significant differences between higher- and lower-risk youth for either positive or negative affect. Second, we found that currently depressed youth exhibited more inert positive affect and more variable negative affect compared to higher- and lower-risk youth, but we did not find significant differences between higher- and lower-risk youth. Third, we examined whether effects remained significant after controlling for average affect. We found that currently depressed youth exhibited elevated positive affective inertia compared to higher-risk, but not lower-risk, youth, and elevated variance of negative affect for currently depressed compared to higher-risk, but not lower-risk, youth. However, the variability accounted for by affect dynamics decreased substantially after controlling for average affect. We also examined whether using the mode rather than average affect led to different results for negative affect. We found that the mode accounted for significant variability in negative affect inertia and variance, but the effect of group was still significant for the model examining affect variance. In summary, our results suggest that altered affect dynamics may represent epiphenomena of depression in youth rather than serving as risk factors.

First, although we found that currently depressed youth experienced elevated negative affect and diminished positive affect compared to lower-risk youth, we were surprised by the lack of differences between higher-risk and lower-risk youth. Prior studies have found that higher-risk adolescents exhibit diminished positive affect and elevated negative affect compared to lower-risk adolescents, but these studies primarily relied on trait, rather than momentary, affect (e.g., Abitante et al., 2022; Dietz et al., 2008; Olino et al., 2011). Our results suggest that higher-risk adolescents may experience similar momentary affect as lower-risk youth day-to-day, whereas depressed youth experience dysregulated momentary

affect. Differentiating between measurement approaches that assess momentary and general affect is important for studies of affective health, as they reflect distinct constructs that may differentially relate to depression and depression risk.

Second, we obtained only partial support for our hypotheses relating greater depression risk to more inert and variable affect. Prior studies have primarily identified associations between depression and elevated inertia and variability of negative affect (Dejonckheere et al., 2019; Houben et al., 2015; Koval et al., 2013; Nelson et al., 2020; Panaite et al., 2020). Houben and colleagues (2015) identified associations between inertia and variability of positive affect with depression, but these associations were weaker than the relation between negative affect and depression. In our sample, depressed youth experienced lower average levels of positive affect and heightened inertia compared to higher- and lower-risk youth, which suggests that they experienced more persistent low positive affect. These youth may experience fewer positive events and show weaker improvements in positive affect when exposed to positive stimuli in daily life, consistent with the positive attenuation hypothesis of depression (e.g., Bylsma et al., 2008; Panaite et al., 2021). We also found that depressed youth experienced higher average levels of negative affect and greater variability compared to higher- and lower-risk youth, which may reflect greater emotional reactivity to negative stimuli and more frequent stressful events, supporting a negative potentiation hypothesis (e.g., Bylsma et al., 2008; Sheets & Armey, 2020).

Our results broadly suggest that altered affect dynamics in youth may be epiphenomena of depression rather than vulnerabilities that precede depression onset. This interpretation is consistent with recent work from Houben and colleagues (2020), who found that among adults with varying levels of depression, affect dynamics were inconsistently associated with depressive symptoms, and depressive symptoms prospectively predicted stronger affect dynamics after a year, but not vice versa. Their longitudinal results suggest affect dynamics represent consequences, rather than antecedents, of depression in adults. It is worth noting, however, that never-depressed, higher-risk youth may represent a unique subset of higher-risk youth. We examined this population to assess youth who have not yet experienced a depressive episode, but these individuals may be resilient in myriad ways compared to higher-risk youth who already developed depression. Longitudinal studies comparing higher-risk youth who do and do not become depressed are needed to clarify whether altered affect dynamics are consequences or antecedents of depression among higher-risk youth.

Third, a somewhat distinct pattern of results emerged when accounting for average affect. Although the main effect of group on positive affective inertia was retained when controlling for average positive affect, we only found differences between depressed and higher-risk youth. Additionally, average positive affect was not a significant predictor of positive affective inertia in this analysis and accounted for less than 1% of variance in positive affective inertia. For negative affect, we obtained similar patterns of findings for variance of negative affect, though risk group was not a significant predictor of negative affect variance after controlling for average negative affect. In both cases, the variability accounted for declined after controlling for average affect. When accounting for the mode, rather than the mean, of negative affect, we obtained similar results for negative affect inertia, but found that risk group was a significant predictor of negative affect variance. Our findings are

overall consistent with prior work (e.g., Hawes & Klein, 2023; Ringwald & Wright, 2022) suggesting distinct overlap of negative affect variance with the mean and mode of affect. Overall, these results support the recommendations from Dejonckheere and colleagues (2019) to account for measures of individuals' typical affect when assessing affect dynamics to obtain a robust understanding of how they relate to depression. Our findings suggest that controlling for average affect or the mode is important for understanding the relative contributions of affect dynamics.

Two important study characteristics may contribute to the pattern of results we obtained. First, classification of risk based on any maternal history of depression can produce relatively heterogeneous risk categories. In this sample, higher-risk youth were offspring of mothers with a history of depression, and the severity, timing, and duration of mothers' depression varied within this group. Mothers in our sample also experienced a variety of depressive disorders (e.g., MDD, PDD). Although findings are mixed, some studies have shown that youth whose mothers suffer from more chronic or severe depression, or prenatal depression, exhibit worse internalizing symptoms (Goodman, 2020). Additionally, maternal depression is associated with less secure infant attachment and poorer mother-infant interactions, so youth whose mother's depression occurred early in life may be particularly at risk (Carter et al., 2001; Śliwerski et al., 2020). Similarly, some mothers only experienced depressive episodes prior to their child's birth. These are important factors to consider in the context of child depression risk because they suggest that higher-risk participants in our study may have experienced disparate risk for depression due to variability in their mothers' depression severity, timing, and duration. Our findings of some significant differences between currently depressed and higher-risk, but not lower-risk youth, may reflect a variety of factors. Higher-risk youth may show effects of parental psychopathology earlier in development, and teens' symptoms in our sample may obscure those early effects. Additionally, if effects of risk group are more modest, we may have been underpowered to detect them. In summary, future studies are needed to clarify the replicability of our findings and to understand the processes underlying these results.

Second, we assessed affect dynamics for each participant across all survey responses rather than focusing on responses to stressful or positive events. Prior studies suggest that depressed adults experience fewer positive events and similar rates of stressful events in daily life compared to healthy adults (Panaite et al., 2021; Sheets & Armey, 2020). Assessing interpersonal interactions may be particularly relevant, as depressed children and adolescents spend less time with family and friends compared to healthy youth, and positive social interactions are generally associated with elevated positive affect, whereas negative social interactions relate to more negative affect (Hawkley et al., 2007; Silk et al., 2011). The benefits of social interactions also may be attenuated for depressed individuals, such that young adults with higher depressive symptoms exhibited smaller decreases in negative affect following a positive social context (Kesselring et al., 2021). Alterations in affective functioning may be more apparent when comparing groups during exposures to negative or positive events, at which times higher-risk and depressed youth may exhibit altered reactivity and emotion regulation compared to lower-risk adolescents (e.g., Bylsma et al., 2008; Bylsma et al., 2011; Joormann & Stanton, 2016). For instance, a study of inertia of positive affect and negative affect among adolescents during a parent-child interaction task

involving planning a pleasant activity and discussing a conflict predicted elevated odds of depression onset 2.5 years later in a sample of youth at varying risk for depression (Kuppens et al., 2012). Analyses of momentary affect dynamics that focus on specific types of events (e.g., interpersonal conflict) may yield results consistent with findings from Kuppens and colleagues.

Although this study had many strengths including assessing a sample at varying risk for depression and using a time-sampling approach to obtain multiple observations per participant, we note several important limitations. First, our sample was predominantly White and showed relatively little gender diversity, so our results may have limited generalizability to important populations. Second, our analyses focused on maternal history of depression due to its relevance for offspring depression (e.g., Goodman et al., 2011; Connell et al., 2002), but prior work suggests the additional importance of paternal depression history for altered negative affectivity in offspring, which may relate to heightened risk across development (Spry et al., 2020). Third, we focused on understanding daily affect dynamics across all observations rather than moments involving specific types of experiences, which may underestimate differences in the mean, variability, and inertia of affect for these groups and represents an important area for future research. Fourth, we assessed associations between affect dynamics and depression risk categories cross sectionally, so we cannot draw causal claims about temporal precedence of dysregulated affect dynamics and depression across adolescence. Fifth, we examined summary scores of positive and negative affect rather than conducting item-level analyses. Studies using network analytic approaches (e.g., Funkhouser et al., 2021) enable assessment of relations between affective items and may provide additional information about associations between affect and depression risk. Additional prospective longitudinal studies are needed to clarify the timing of change in affective functioning relative to depression onset.

5. Conclusions

In summary, this study examined daily affect dynamics in a sample of lower-risk, higher-risk, and depressed adolescents to examine differences in affective health across levels of risk for depression. We found that depressed adolescents showed higher mean-levels and variability of negative affect, and diminished mean-levels and more inert positive affect. These effects for positive affective inertia were partially robust to controlling for average positive affect, and effects for variability of negative affect were partially robust when controlling for the mode but not average negative affect. Additional research is needed to clarify and extend our understanding of how affect dynamics relate to adolescents' risk for depression.

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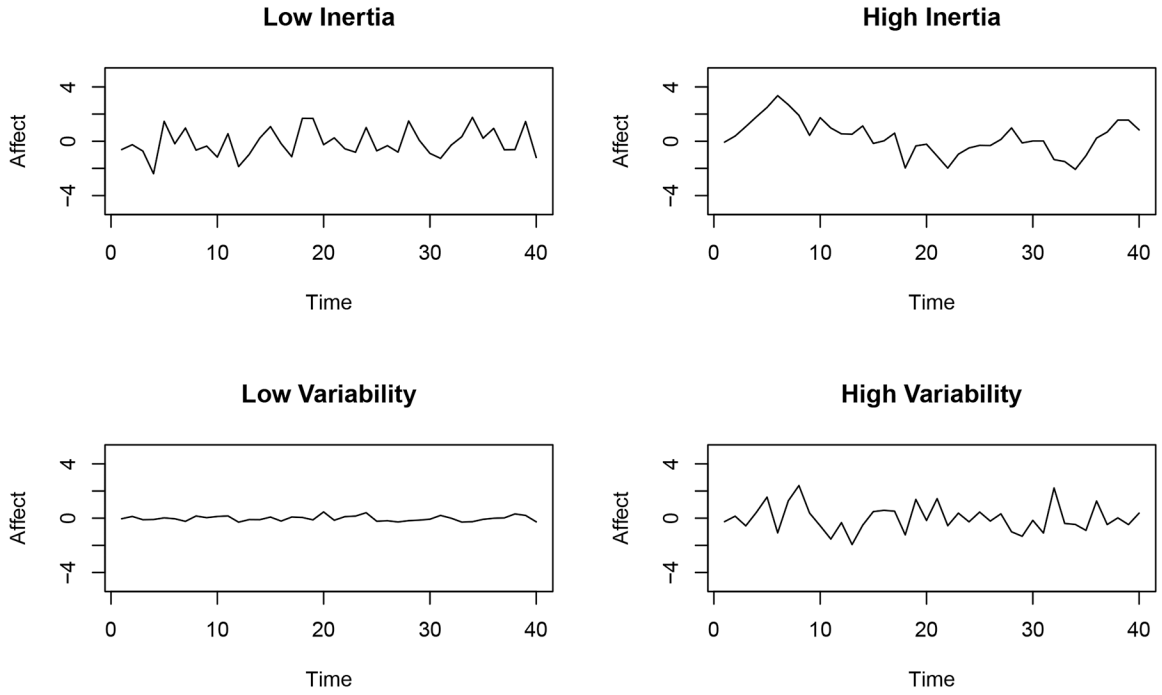

Figure 1:
Simulated Examples of Affective Inertia and Variability

Table 1

Demographic Information for Total and Analytic Samples

	Total EMA Sample (n = 147)	Analytic Sample (n = 114)
Age	15.17 (1.07)	15.25 (1.10)
Biological Sex		
Female	63.9%	65.8%
Male	36.1%	34.2%
Race and Ethnicity		
Black or African American	12.9%	13.2%
American Indian or Alaska Native	0.7%	0.9%
Asian	6.8%	7.0%
White	72.1%	72.8%
Native Hawaiian or Pacific Islander	1.4%	1.8%
Other	6.1%	4.4%
Hispanic or Latino	6.1%	4.4%
Risk Group		
Currently Depressed	34.0%	32.5%
Higher Risk	32.0%	34.2%
Lower Risk	34.0%	33.3%

Table 2:

Main Effects of Group on Affective Inertia and Variance

Measure	Currently Depressed		Higher-Risk		Lower-Risk		*F*(2, 111)	η^2
	M	***SD***	***M***	***SD***	***M***	***SD***		
Positive Affect								
Inertia	.26	.07	.20	.06	.22	.08	**6.04** *	**.10**
Variance	12.70	7.53	10.10	6.79	10.30	7.03	1.51	.03
Negative affect								
Inertia	.20	.16	.14	.13	.17	.10	1.63	.03
Variance	5.84	4.85	2.63	3.97	1.90	2.62	**10.75** **	**.16**

* $p < .05$

** $p < .001$

Table 3:

Effects of Group on Affective Inertia and Variance Controlling for Average Affect

Measure	Currently Depressed		Higher-Risk		Lower-Risk		*F*(2, 110)	η^2
	M	***SE***	***M***	***SE***	***M***	***SE***		
Positive Affect								
Inertia	.26	.01	.20	.01	.22	.01	**4.74** *	**.02**
Variance	13.10	1.22	9.92	1.16	10.20	1.16	2.06	.02
Negative affect								
Inertia	.16	.02	.15	.02	.20	.02	1.72	.01
Variance	4.07	0.45	3.02	0.41	3.21	0.43	1.55	.01

* $p < .05$

** $p < .001$