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A 5-Year Longitudinal Study on Mood Variability Across Adolescence Using Daily Diaries

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This study explored the development of mood variability in 474 Dutch adolescents (56.8% male, 90.1% medium to high socioeconomic status) from a community sample, followed from ages 13 to 18 years. Three times per year, adolescents reported on daily happiness, anger, sadness, and anxiety for 5 days using Internet diaries (15 assessment weeks; from 2006 to 2010). Mood variability scores were calculated as means of absolute differences between consecutive days. Results showed that happiness, anger, and sadness variability continuously declined across adolescence, while anxiety variability increased initially, then decreased, and then increased toward late adolescence. Despite females experiencing higher happiness and sadness variability, the rate of change across adolescence was similar for both sexes. Implications for normative emotional development and future studies are discussed.

Mood variability is characterized by frequent and intense changes in mood (Larsen, 1987) and represents an important outcome of emotion regulation (Cole & Hall, 2008; Hoeksma, Oosterlaan, & Schipper, 2004). Emotion regulation refers to processes that modify emotional reactions (i.e., their intensity and temporal features) with the intention to accomplish one's goals (Thompson, 1994). For instance, individuals may downregulate their anger in order to maintain a close relationship. Individuals that have problems with emotion regulation likely have more problems keeping their emotions between appropriate boundaries and therefore show higher levels of mood variability (Hoeksma et al., 2004). Heightened mood variability can disturb well-being, because it might create instability in one's ability to function (Gruber, Kogan, Quoidbach, & Mauss, 2013). Indeed, studies have shown that high levels of mood variability are associated with more internalizing and externalizing problems (Gruber et al., 2013; Maciejewski et al., 2014; Neumann, van Lier, Frijns, Meeus, & Koot, 2011; Silk, Steinberg, & Morris, 2003).

Adolescence is an important period for the development of emotion regulation, in general, and mood variability, in particular. This is because adolescents are confronted with multiple developmental changes when entering adolescence, which coincide with still developing emotion regulation capacities. Therefore, they are likely to react with higher levels of mood variability (i.e., more fluctuating moods) in the beginning of adolescence. However, after this period of temporary turmoil in which new equilibriums are reached in biological and social domains, and after which adolescents have developed more advanced emotion regulation strategies, mood variability should decrease again

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so that youths leave adolescence with more stable moods (Rosenblum & Lewis, 2003).

However, although there is no doubt about the changes that occur during adolescence, which may challenge the adolescents' capacity to keep their mood stable, there is surprisingly little empirical evidence on how mood variability actually develops during adolescence. Describing the normative development of adolescent mood variability is crucial, because it provides a baseline against which maladaptive trajectories can be identified. Therefore, the first aim of the present longitudinal study was to examine the normative development of mood variability across adolescence (i.e., in adolescents who were followed from ages 13 to 18 years). Moreover, our second aim was to explore sex differences in the developmental trajectories of mood variability.

Mood Variability Across Adolescence—Developmental Trends and Sex Differences

Adolescence is characterized by a number of important changes that are thought to influence the emotional experiences of many adolescents. For instance, it has been suggested that adjustment to hormonal and brain changes might lead to higher emotional reactivity and more unstable moods in early adolescence (for reviews, see Buchanan, Eccles, & Becker, 1992; Casey, Jones, & Hare, 2008; Somerville, Jones, & Casey, 2010; Steinberg, 2005). Similarly, early adolescence is characterized by important changes in the adolescent's social-relational environment and experiences of stressful events. For instance, adolescents face more potential negative life events (Ge, Lorenz, Conger, Elder, & Simons, 1994; Larson & Ham, 1993), have temporarily more conflicts with their parents (De Goede, Branje, & Meeus, 2009), or experience first romantic relationships (Carver, Joyner, & Udry, 2003). This might all tax the emotional lives of adolescents and lead to more frequent changes in positive and negative moods (Flook, 2011; Larson, Clore, & Wood, 1999). Moreover, these changes also coincide with still developing emotion regulation strategies, which may make adolescents even more vulnerable to experience increased mood variability (Rosenblum & Lewis, 2003). Indeed, a recent study that examined age differences in emotion regulation strategies from early adolescence to middle adulthood found that compared to the other ages, individuals had the smallest emotion regulation repertoire during middle adolescence, suggesting that especially during that time, adolescents restructure their emotion regulation strategy use (Zimmermann & Iwanski, 2014).

As adolescents grow older, mood variability likely decreases again. There are several reasons for this. First, new equilibriums are reached in biological and social domains. Empirical evidence suggests that toward late adolescence, the brain structures relevant for emotional control mature (Somerville et al., 2010), levels of experienced stressful life events may stabilize or decrease again (Ge et al., 1994), and relationships with parents may reach a new equilibrium (De Goede et al., 2009). Second, adolescents are also thought to increase in their emotion regulation capacities and therefore may have also learned to deal with the developmental changes and their associated moods (Rosenblum & Lewis, 2003). For instance, it has been shown that the use of adaptive emotion regulation strategies increases continuously from middle adolescence to young adulthood (Zimmermann & Iwanski, 2014). Together, these findings suggest that mood variability may follow a curvilinear course across adolescence; that is, increasing mood variability during early to middle adolescence and decreasing mood variability from middle to late adolescence.

Despite these theoretical explanations for an expected curvilinear development of adolescent mood variability, there is only one cross-sequential study that has examined age differences in mood variability (Larson, Moneta, Richards, & Wilson, 2002). In that study, 220 adolescents, who were 10 and 14 years old and who were reassessed 4 years later, provided reports on their moods for several times per day for 1 week on three bipolar scales (i.e., scales that balance two opposite qualities, e.g., ranging from friendly to angry). However, contrary to what would be expected based on the reviewed literature, results indicated that mood variability, as measured by the within-person standard deviation, was higher at the reassessment than at baseline, albeit only for females (Larson et al., 2002). The authors concluded that mood variability actually increased with age in adolescent females. However, although standard deviations are widely used as an index of mood variability or instability (e.g., Silk et al., 2003), they do not cover temporal dependency of changes (i.e., sequence of changes in time), which are one central feature of the definition of mood variability (see Method for further explanation; see Ebner-Priemer, Eid, Kleindienst, Stabenow, & Trull, 2009; Ebner-Priemer et al., 2007, for further discussion). Moreover, by using bipolar items, the authors did not examine developmental differences in specific moods. For that reason, it is not clear

whether the variabilities of different moods (e.g., happiness or sadness) might have different developmental courses in adolescence.

When studying the developmental trajectories of mood variability across adolescence, it is important to consider possible sex differences in their development (i.e., their initial level and their rate of change). This is because males and females seem to differ in general on emotional reactivity and regulation. For instance, studies indicate that early-adolescent females show a higher physiological reactivity to laboratory stressors (Gunnar, Wewerka, Frenn, Long, & Griggs, 2009), are more emotionally reactive to interpersonal events than males (Flook, 2011), and use more rumination compared to males (Broderick, 1998; Silk et al., 2003), which have been linked to more mood variability (Selby, Franklin, Carson-Wong, & Rizvi, 2013; Silk et al., 2003). Studies that have directly compared adolescent males and females on mood variability are sparse and moreover predominantly cross-sectional, thereby prohibiting testing for developmental differences. These studies did, however, show the expected higher levels of mood variability in females compared to males (Silk et al., 2003; Stringaris & Goodman, 2009; Weinstein, Mermelstein, Shiffman, & Flay, 2008). The only longitudinal study on mood variability development, as mentioned, found that only females increased in mood variability, whereas males stayed stable (Larson et al., 2002). Given the limited empirical evidence, the goals of the present study were to examine the developmental trajectories of variabilities of four basic moods, namely, happiness, anger, sadness, and anxiety, in adolescents from ages 13 to 18 years, while taking into account possible sex differences in the level and rate of change of these trajectories.

The Present Study

The present study addressed the development of the variability of happiness, anger, sadness, and anxiety in 474 adolescents followed from ages 13 to 18 years. On the basis of the reviewed literature, we hypothesized that the variability of all moods would show a curvilinear course across adolescence, with an increase in early to middle adolescence and a decrease in middle to late adolescence. We also hypothesized sex differences, in that females would experience generally higher levels of mood variability across the studied period. Given the limited empirical evidence, we did not form specific hypotheses on whether this would be different for different moods.

Method

Participants

The sample for the present study was drawn from the Research on Adolescent Development and Relationships–young cohort study (RADAR–y). The participants in this study were included by a two-step inclusion phase. In Grade 6, 230 schools in the Western and central parts of the Netherlands were approached, specifically in the province of Utrecht, and the cities of Amsterdam, Rotterdam, The Hague, and Almere. Given that the RADAR study has a focus on delinquency development, the first inclusion phase aimed at oversampling adolescents at risk for externalizing behavior. For that purpose, teachers rated the adolescents' externalizing behavior using the externalizing scale of the Teacher's Report Form (TRF; Achenbach, 1991; Verhulst, van der Ende, & Koot, 1997). Adolescents were labeled as being at risk for externalizing problems, if they received a *T*-score ≥ 60. Teachers' ratings were available on 5,150 children. Because the intensive data collection required a good command of the Dutch language, only adolescents of Dutch origin were selected ($N = 3{,}237$). In the second phase of the study, the families of the adolescents were approached. Additional requirements for being in the study were having both parents available and presence of a sibling ≥ 10 years. Of this sample, 497 families could be approached, met the mentioned inclusion criteria, agreed to participate, and provided written consent. This sample consisted of 291 target adolescents at average risk (165 males and 126 females) and 206 adolescents at high risk for externalizing behavior (118 males and 88 females).

For the present study, adolescents were only included if they had valid mood variability scores for at least 1 week (see Procedure and Measures) and valid data on the covariates (mood level, socioeconomic status [SES], and risk status; see Measures). The final sample of the present study consisted of 474 (56.8% male) adolescents with a mean age of 13.31 years ($SD = 0.45$) at the first assessment. The majority of the sample had a medium or high SES (90.1%) and 40.3% were at high risk for externalizing behavior. Male and female adolescents did not differ on age, $t(472) = 1.33$, $p = .19$; SES, $\chi^2(1) = 3.10$, $p = .08$; or risk status, $\chi^2(1) = 0.09$, $p = .76$.

Procedure

The medical ethical committee of the University Medical Center Utrecht (Netherlands) approved the

study. For the present study, the data were collected over a period of 5 years using Internet diaries. The data collection took place in the months of June, September, and December in the years 2006 until 2010. Each year, adolescents were approached for three Internet assessment weeks, which were separated by approximately 3 months, making a total of 15 Internet assessment weeks. On 5 consecutive days (i.e., Monday–Friday), adolescents were asked to rate the intensity of their emotions for that particular day for happiness, sadness, anger, and anxiety. Adolescents were sent e-mail invitations each day at 5:30 p.m. to remind them to participate. For the data collection, adolescents had to log on to the RADAR home page. In case adolescents had not filled out the questionnaire, reminder e-mails were sent 1.5 hr after the first e-mail invitation. After an additional 1.5 hr, text messages were sent and if adolescents did not respond, a member of the research team tried to reach them by phone. Adolescents received 10 euros (equivalent to US $11) for each Internet assessment week.

Measures

Adolescent Mood Variability

On each day of the Internet assessment weeks, adolescents were asked to complete the Daily Mood Device, an Internet version of the Electronic Mood Device (Hoeksma et al., 2000). Adolescents were asked to rate the intensity of happiness, anger, sadness, and anxiety for that particular Internet assessment day. Each of these four mood states was measured with three items. Happiness was measured using "glad," "happy," and "cheerful"; anger was measured using "angry," "cross," and "short-tempered"; sadness was measured using "sad," "down," and "dreary"; and anxiety was measured using "afraid," "anxious," and "worried." The intensity of these moods was rated on a 9-point Likert scale (1 = *not glad, sad, anxious* . . . to 9 = *glad, sad, anxious* . . .). For each mood, the three corresponding items were summed, resulting in a total mood score for the four emotions. Cronbach's αs ranged from .86 to .96 for happiness, from .92 to .98 for sadness, from .88 to .96 for anger, and from .73 to .94 for anxiety across the 5 years of assessment.

Given the extensive longitudinal data collection and to ensure that our analyses would not be biased by changes in response tendencies between males and females or across time, we checked whether our daily mood data were measurement invariant across sex, days within weeks, and the 5-year period. There are four stages of measurement invariance: configural invariance (equal factor structure), metric invariance (additional equal factor loadings; similarity in unit of measurement), scalar invariance (additional equal intercepts; common starting point), and strict invariance (additional equal residual variances). At least scalar invariance needs to be established to justify comparisons of scores across sex or time (Chen, Sousa, & West, 2005). The invariance testing was conducted separately across (a) sex for each day, (b) days within weeks (i.e., Monday–Friday), and (c) weeks across years. Results showed that configural, metric, and scalar invariance were established for sex across days, while strict invariance was additionally established for days within weeks and weeks across years. Therefore, mean comparisons between males and females are justified, daily scores within 1 week can be aggregated to calculate mood variability and level (see paragraph below), and differences between different years can be reliably tested (Maciejewski, Van Lier, Branje, Meeus, & Koot, 2015).

Using the daily mood measures, we calculated mood variability scores. This was done separately for each Internet assessment week and separately for each of the four moods. For mood variability, which represents the day-to-day fluctuation in adolescent mood, we calculated the mean absolute successive difference (Ebner-Priemer et al., 2007). This index covers the amplitude (how intense changes are), the frequency (how often changes occur), and the temporal dependency of changes (sequence of changes in time), which are central to the definition of mood variability and which are, for instance, not covered by other prominent measures (e.g., standard deviation; Ebner-Priemer et al., 2007). To illustrate, imagine participants had to rate their happiness on a scale from 1 to 9 for 5 days a week. One participant may rate his or her happiness 2, 3, 4, 6, 7 for the 5 days, whereas another person may rate his or her happiness 2, 6, 3, 7, 4. Based on the definition of mood variability (Larsen, 1987), the second participant would be rated as someone with higher mood variability, because the changes are more frequent and extreme. However, using standard deviations, both participants would receive the same score, whereas using mean absolute successive differences, the second participant would receive a higher score. Therefore, we calculated mean absolute successive differences as an index of mood variability.

For that purpose, we took the absolute differences of daily mood assessments between consecutive days across the week. These differences were

summed and then divided by the valid number of difference scores per week (to control for missing data). Therefore, we had 15 weekly mood variability scores for each of the four moods with higher values indicating higher variability (range = 0–24). Mood variability scores were only calculated if there were at least 4 assessment days within a week or 3 assessment days in a row. For the analyses, we used the mean of the 3 Internet assessment weeks per year, so that there were five yearly mood variability scores, respectively, per adolescent mood (i.e., happiness, anger, sadness, and anxiety variability scores for each of the 5 years).

Control Variables

Adolescent Mood Level

On the basis of the daily mood ratings, we also calculated adolescent mood level (i.e., the average emotional tone) by taking the mean of the daily mood scores across the week. This is because mood level and variability are highly correlated (concurrent correlations ranging from −.39 to −.55 for happiness and from .41 to .64 for negative moods, all *p*s < .001) and we wanted to eliminate the possibility that sex differences in mood variability were confounded by differences in mood level. Therefore, we included mood level as a covariate for mood variability, which is a recommended practice when testing for individual differences in mood variability (Ebner-Priemer et al., 2009). Similar to mood variability, we used the mean of the three Internet assessment weeks per year for the analyses.

Risk Status

Given that the RADAR–y study oversampled adolescents that were at risk for early externalizing problems, we included risk status as a covariate in our analysis. Adolescents were labeled as being at risk for externalizing problems if they received a *T* score ≥ 60 scoring on the TRF (Achenbach, 1991; Verhulst et al., 1997) in Grade 6 (see Participants for more information). Risk status was coded as a binary variable (0 = *not at risk*, 1 = *at risk*).

Socioeconomic Status

Family SES was determined by the level of parental employment. Parents that were both unemployed or held a low-skilled job (e.g., construction worker, janitor, truck driver) were classified as having a low SES. Families in which at least one of the parents' occupations were classified as medium-skilled job (e.g., police officer, physician's assistant) or high-skilled job (e.g., doctor, scientist, high school teacher) were classified as having a medium to high SES. SES was coded as a binary variables (0 = *low SES*, 1 = *medium to high SES*).

Missing Data

Missing data in this study were inevitable because of the relatively strict criterion of a minimum of 4 days or 3 days in a row per week to be able to construct mood level and variability scores. In total, 5,398 valid mood variability scores were provided by 474 adolescents, meaning that 24.1% of mood variability scores were missing across all adolescents and assessment weeks. The mean of valid Internet assessment weeks (i.e., weeks that had sufficient data to calculate variability scores) was 11.39 (*SD* = 4.08, range = 1–15) per adolescent. The majority of adolescents (70.9%) had at least one valid weekly mood variability score for each of the 5 years. Adolescents that had valid data on 4 or fewer years available were significantly more likely to belong to the high-risk group, $\chi^2(1) = 12.85$, $p < .001$, and to have a low SES, $\chi^2(1) = 9.93$, $p < .01$, compared to adolescents that had valid data for all 5 years. However, both groups did not differ from each other regarding sex, $\chi^2(1) = 1.86$, $p = .17$, and mood variability and level scores in Year 1 for all of the four emotions (all *p*s > .40).

Statistical Analyses

In order to answer our research questions concerning the development of adolescent mood variability across ages 13–18, we fitted latent growth models (LGM) using Mplus version 6.0 (Muthén & Muthén, 1998–2012). In LGM, the developmental trajectories are captured by latent growth factors: the intercept, which refers to the mean initial level of mood variability, and by linear and possibly quadratic and cubic slope factors, which refer to the (curvilinear) change in mood variability over time. We used maximum likelihood estimation with robust standard errors to account for non-normal distributions and missing data. Fit of the models to the data was evaluated by multiple fit indices: the comparative fit index (CFI), the Tucker–Lewis fit index (TLI), the root mean square error of approximation (RMSEA), and the standardized root mean square residual (SRMR). Hu and Bentler (1999) recommend cutoff values of a value > .95 for CFI and

TLI, < 0.06 for RMSEA, and < 0.08 for SRMR to indicate a good fitting model. However, others have warned against overgeneralizing these rules (Cheung & Rensvold, 2002; Marsh, Hau, & Wen, 2004). Generally, values > 0.90 for CFI and TLI and values of < 0.10 for RMSEA and SRMR are deemed acceptable (e.g., Bollen & Curran, 2006).

Based on our research questions, analyses were performed according to the following plan. First, we determined the growth curve that best described the developmental trajectories for each of the four mood variability measures (i.e., variability of happiness, anger, sadness, and anxiety). Additional slope growth factors were included when their means and/or variances were significant (i.e., when there was evidence that including an additional slope factor would lead to a better description of the developmental trajectory), resulting in a better fitting model. Second, after having determined the growth models that best described the developmental trajectories, we regressed the growth factors (i.e., intercept and slopes) on adolescent sex to test for mean differences in growth parameters between males and females. In this model, we controlled for average affect by including the associated mood level as a time-varying covariate for mood variability (e.g., happiness level for happiness variability). Moreover, we controlled for SES and risk status by regressing the intercepts and slopes on them.

Results

Descriptive Statistics

Means and standard deviations of the mood variability outcome measures can be found in Table 1. Compared to males, females showed more happiness and anxiety variability on most occasions and more sadness variability on all occasions. In contrast, females and males did not differ in anger variability at any assessment. Correlations between the mood variability measures can be found in Table 2, indicating that all measures were significantly associated with each other. Moreover, the stability coefficients, which are the correlations of the same measure between two adjacent time points and which refer to the extent to which individuals keep their relative place across time compared to others, indicated moderate stability, ranging from .34 to .56, all *p*s < .001. When comparing the stability coefficients over time (Cohen & Cohen, 1983; Preacher, 2002), results indicated that the stability for happiness, anger, and sadness variability was significantly

Table 1
Means and Standard Deviations for Mood Variabilities Across the Study Period

	Happiness variability					Anger variability					Sadness variability					Anxiety variability				
	Males		Females			Males		Females			Males		Females			Males		Females		
Ages	*M*	*SD*	*M*	*SD*	*t*	*M*	*SD*	*M*	*SD*	*t*	*M*	*SD*	*M*	*SD*	*t*	*M*	*SD*	*M*	*SD*	*t*
13–14	2.72	1.80	3.21	2.23	−2.56*	2.57	2.19	2.59	2.13	−0.14	1.72	1.95	2.62	2.66	−4.07***	1.65	1.57	2.18	1.97	−3.12**
14–15	2.50	2.00	3.05	2.14	−2.77**	2.45	2.35	2.68	2.21	−1.07	1.75	2.37	2.53	2.40	−3.40***	1.88	2.06	2.39	2.04	−2.57*
15–16	2.25	1.90	2.78	2.14	−2.62**	2.25	2.11	2.30	1.90	−0.25	1.46	1.65	2.16	2.08	−3.69***	1.60	1.68	2.05	1.76	−2.64**
16–17	2.33	2.03	2.72	2.06	−1.91	2.13	2.23	1.95	1.90	0.85	1.42	1.92	2.19	2.41	−3.45***	1.58	1.65	1.95	1.79	−2.14*
17–18	2.06	1.65	2.40	1.71	−1.89	1.77	1.90	1.87	1.94	−0.49	1.50	1.94	2.03	2.10	−2.51*	1.61	1.76	1.97	1.85	−1.88

Note. *T* values as obtained from independent *t* tests.
*$p < .05$. **$p < .01$. ***$p < .001$.

Table 2
Correlations Among Mood Variability Measures for Happiness, Anger, Sadness, and Anxiety

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
1. Happiness variability Y1																			
2. Happiness variability Y2	.39																		
3. Happiness variability Y3	.35	.53																	
4. Happiness variability Y4	.28	.48	.55																
5. Happiness variability Y5	.22	.34	.39	.56															
6. Anger variability Y1	.54	.30	.31	.25	.17**														
7. Anger variability Y2	.27	.58	.28	.29	.19	.34													
8. Anger variability Y3	.19	.38	.56	.34	.28	.35	.45												
9. Anger variability Y4	.18	.33	.40	.56	.26	.31	.38	.49											
10. Anger variability Y5	.16**	.29	.24	.31	.46	.30	.28	.43	.48										
11. Sadness variability Y1	.67	.26	.26	.25	.22	.59	.29	.22	.24	.28									
12. Sadness variability Y2	.38	.62	.42	.42	.29	.36	.66	.39	.48	.35	.46								
13. Sadness variability Y3	.18	.34	.49	.28	.28	.24	.32	.60	.39	.32	.28	.45							
14. Sadness variability Y4	.24	.35	.34	.52	.33	.28	.33	.36	.63	.41	.36	.53	.43						
15. Sadness variability Y5	.18	.34	.27	.38	.54	.25	.28	.34	.40	.69	.26	.39	.40	.55					
16. Anxiety variability Y1	.56	.22	.17	.14**	.13*	.55	.31	.19	.20	.25	.75	.39	.25	.29	.25				
17. Anxiety variability Y2	.38	.54	.35	.37	.29	.38	.68	.43	.45	.35	.48	.80	.47	.50	.38	.50			
18. Anxiety variability Y3	.27	.37	.46	.29	.27	.26	.34	.57	.41	.29	.32	.42	.72	.46	.34	.28	.55		
19. Anxiety variability Y4	.26	.35	.35	.43	.31	.28	.36	.40	.61	.33	.38	.51	.47	.75	.39	.35	.54	.53	
20. Anxiety variability Y5	.23	.35	.24	.25	.48	.19	.26	.31	.35	.62	.26	.39	.35	.44	.74	.26	.41	.42	.43

Note. Y = year. All correlations are significant at $p \leq .001$, except the ones marked with an asterisk.
$^{*}p < .05$. $^{**}p < .01$.

greater in later than in earlier adolescence, whereas it was significantly lower for anxiety variability in later than earlier adolescence (see Table 3).

Developmental Trajectories of Adolescent Mood Variability

The model selection process revealed that anger and sadness variability were best described by a linear curve, happiness variability by a quadratic curve, and anxiety variability by a cubic curve. Table 4 shows the model fit indices as well as the means and variances of the growth parameters of the final unconditional models (i.e., the models without covariates). We had to constrain the highly insignificant variance of the cubic slope to zero ($p = .98$) in the final anxiety variability model to allow the model to run due to problems with the latent variable covariance (PSI) matrix. Although the value of the TLI is just below acceptable limits (i.e., TLI = 0.89), all other fit indices point toward an acceptable fit.

The developmental courses of mood variability for happiness, anger, sadness, and anxiety are depicted in Figure 1. As can be seen from the figure, happiness, anger, and sadness variability declined linearly across adolescence. Although a quadratic model fitted best for the happiness variability data, the mean of the quadratic slope was not significant in the happiness variability model; only the variance was. This indicates that 'overall' adolescents showed a linear decline in happiness variability. However, the significant variance estimate of the quadratic growth term suggests individual differences in the deceleration or acceleration of the decline of happiness variability. Anxiety variability showed an initial increase in early adolescence, then a decrease in middle adolescence, followed by a slight increase toward the end of adolescence, almost returning to the score adolescents had when entering adolescence.

Table 3
Rank-Order Stability for Happiness, Anger, Sadness, and Anxiety

	Y1–Y2	Y2–Y3	Y3–Y4	T4–Y5
Happiness variability	0.39_a	0.53_b	0.55_b	0.56_b
Anger variability	0.34_a	0.45	0.49_b	0.48_b
Sadness variability	0.46	0.45	0.43_a	0.55_b
Anxiety variability	0.50	0.55_a	0.53	0.43_b

Note. All correlations are significant at $p < .001$. Correlations with different subscripts within rows indicate that rank-order stabilities are significantly different from each other at $p < .05$. Comparisons are based on the difference test for independent correlation coefficients (Cohen & Cohen, 1983; Preacher, 2002). Y = year.

Table 4
Results of Unconditional Latent Growth Curve Analyses of Study Variables

	Model fit indices						Intercept		Linear slope		Quadratic slope		Cubic slope	
	χ^2	*df*	CFI	TLI	RMSEA	SRMR	*M*	Variance	*M*	Variance	*M*	Variance	*M*	Variance
Happiness variability	2.98	6	1.00	1.00	0.00	0.02	2.93***	1.67***	−0.20*	1.02	0.01	0.07*		
Anger variability	10.96	10	1.00	1.00	0.01	0.04	2.66***	1.95***	−0.19***	0.09*				
Sadness variability	25.49	10	0.93	0.93	0.06	0.07	2.11***	2.64***	−0.10**	0.15**				
Anxiety variability	20.89	5	0.94	0.89	0.08	0.05	1.90***	2.32***	0.37*	1.18*	−0.28**	0.04	0.05**	0[a]

Note. Table displays unstandardized coefficients. CFI = comparative fit index; TLI = Tucker–Lewis fit index; RMSEA = root mean square error of approximation; SRMR = standardized root mean square residual.
[a]The highly insignificant variance of the cubic slope (p = .98) was constrained to zero, because of problems with the latent variable covariance (PSI) matrix.
*p < .05. **p < .01. ***p < .001.

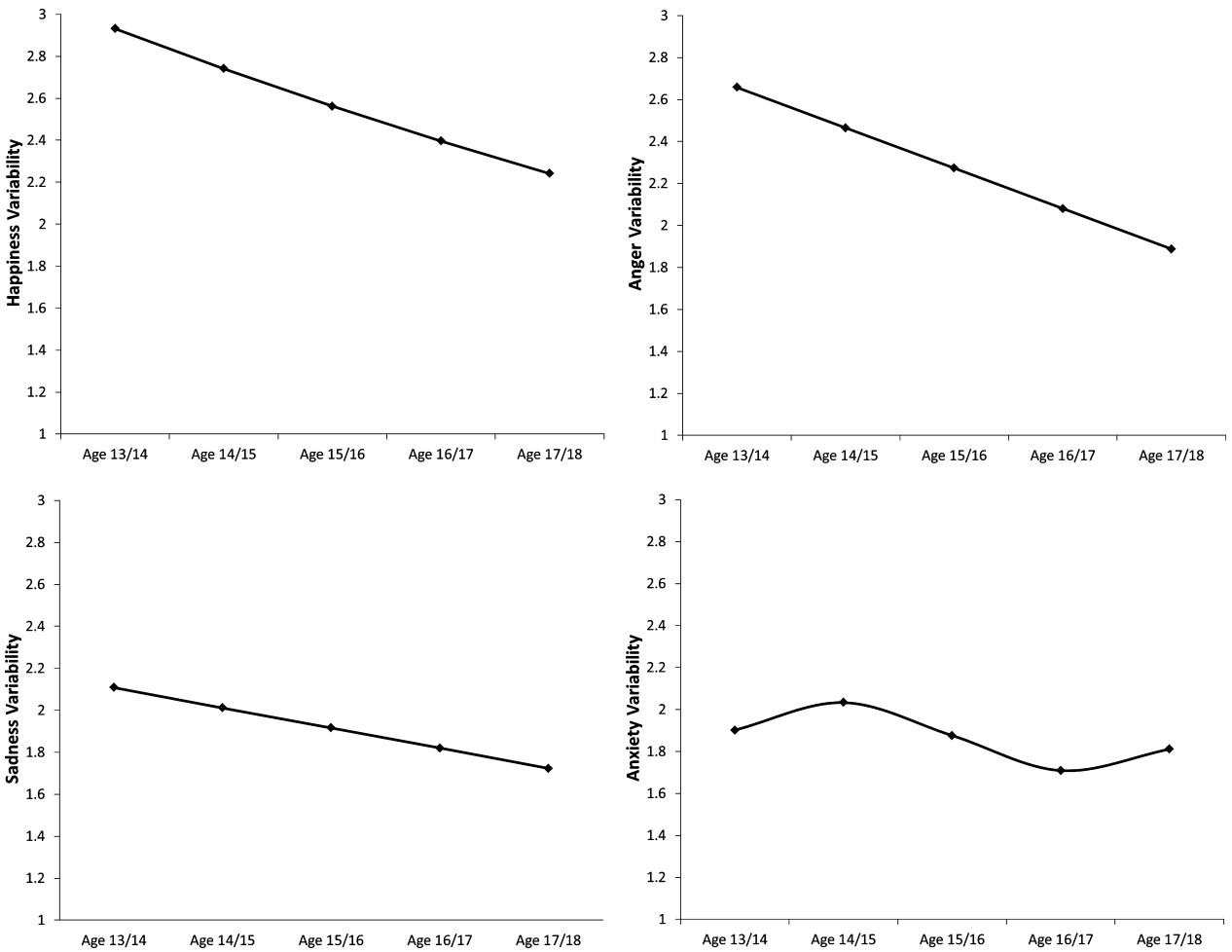

Figure 1. Developmental trajectories of mood variability across adolescence (possible range of mood variability scores = 0–24).

Table 5
Model Fit Indices of Conditional Growth Models As Well As Effects of Time-Varying Covariates (i.e., Mood Level) on Mood Variability and Time-Invariant Covariates (i.e., SES and Risk Status) and Adolescent Sex on Growth Parameters

	Model fit indices					
	χ^2	*df*	CFI	TLI	RMSEA	SRMR
Happiness variability	40.69	32	0.99	0.98	0.02	0.03
Anger variability	62.71	39	0.96	0.94	0.04	0.03
Sadness variability	49.48	39	0.98	0.98	0.02	0.03
Anxiety variability	37.51	28	0.98	0.97	0.03	0.03

	Happiness variability		Anger variability		Sadness variability		Anxiety variability	
Time-varying covariates	*B*	*SE*	*B*	*SE*	*B*	*SE*	*B*	*SE*
Mood level								
ML1 → MV1	−0.29***	0.02	0.36***	0.04	0.43***	0.05	0.33***	0.03
ML2 → MV2	−0.26***	0.02	0.33***	0.03	0.36***	0.03	0.28***	0.03
ML3 → MV3	−0.23***	0.02	0.28***	0.03	0.29***	0.03	0.22***	0.02
ML4 → MV4	−0.20***	0.02	0.27***	0.03	0.27***	0.03	0.20***	0.02
ML5 → MV5	−0.18***	0.02	0.23***	0.03	0.24***	0.03	0.18***	0.03

	Intercept		Linear slope		Quadratic slope		Cubic slope	
Time-invariant covariates	*B*	*SE*	*B*	*SE*	*B*	*SE*	*B*	*SE*
SES								
Happiness variability	0.18	0.28	−0.01	0.29	−0.00	0.07		
Anger variability	0.26	0.27	0.03	0.09				
Sadness variability	0.40	0.26	−0.07	0.12				
Anxiety variability	0.53	0.28	−0.17	0.58	−0.02	0.38	0.01	0.06
Risk status								
Happiness variability	0.16	0.16	0.20	0.19	−0.05	0.04		
Anger variability	0.30	0.16	−0.06	0.06				
Sadness variability	0.08	0.15	0.04	0.06				
Anxiety variability	0.19	0.13	0.16	0.30	−0.17	0.19	0.03	0.03
Sex								
Happiness variability	0.42**	0.16	−0.05	0.17	0.00	0.04		
Anger variability	0.08	0.14	−0.02	0.05				
Sadness variability	0.45**	0.15	−0.02	0.06				
Anxiety variability	0.21	0.13	0.12	0.29	−0.08	0.18	0.01	0.03

Note. Table displays unstandardized coefficients. Mood variability was always regressed on its associated mood level score (e.g., happiness variability Year 1 was regressed on happiness level Year 1). SES was coded 0 = *medium to high*, 1 = *low*; risk was coded 0 = *average*, 1 = *high*; and sex was coded 0 = *male*, 1 = *female*. CFI = comparative fit index; TLI = Tucker–Lewis fit index; RMSEA = root mean square error of approximation; SRMR = standardized root mean square residual; ML = mood level; MV = mood variability; SES = socioeconomic status.
**$p < .01$. ***$p < .001$.

Sex Differences in Developmental Trajectories

To test for sex differences in the developmental trajectories of mood variability, the growth parameters were regressed on adolescent sex while controlling for effects of mood level, SES, and risk status. The results of these conditional models can be found in Table 5. Specifically, the table shows the influence of the time-varying covariate mood level on mood variability at each time point as well as the effects of the time-invariant covariates (i.e., SES and risk status) and sex on the growth parameters (i.e., intercepts and slopes). Analyses showed that mood level was significantly associated with mood variability for all moods and all time points, whereas risk and SES did not have a significant influence on any growth parameter (all *p*s > .05). Analyses of the influence of sex on the growth

parameters indicated no differences between males and females concerning anger and anxiety variability. However, females had a higher intercept in happiness and sadness variability. Males and females did not differ on slopes of any of the variability parameters, implying that the sex differences in mood variability stayed stable across adolescence.

Discussion

The present study examined the developmental trajectories of variabilities of happiness, anger, sadness, and anxiety in 474 adolescents that rated their daily moods using Internet diaries from ages 13 to 18 years. Overall, happiness, anger, and anxiety variability decreased linearly across adolescence, whereas anxiety variability showed a waxing and waning course. Moreover, results showed that males and females experienced similar changes with regard to mood variability across adolescence, while females generally showed higher happiness and sadness variability.

Developmental Trajectories of Mood Variability

The results on the developmental trajectories of mood variability were in part contrasting our hypotheses, in which we predicted initial increases toward middle adolescence, followed by decreases toward late adolescence. In particular, we found a linear decline for happiness, sadness, and anger variability—the fluctuations in these moods were most pronounced in early adolescence, but became gradually less intense toward late adolescence—suggesting that mood became more stable overall. It might be that an increase in mood variability took place before age 13 for these moods (i.e., before our study started), for instance, when adolescents entered puberty. The results on anxiety variability are more consistent with our hypothesis. Specifically, anxiety variability was best characterized by a waxing and waning—an initial increase, then decrease, and then increase again by the end of adolescence. Although the slight increase toward late adolescence is in contrast to our hypothesis, it might be explained by the transition toward adulthood. This includes that individuals have to become financially independent, make their own decisions, and accept responsibility for themselves (Arnett, 2000). This might involve stress or uncertainty, therefore leading to increases in anxiety variability.

The results on mood variability contrast with the —to the best of our knowledge—only study that has examined the development of mood variability (Larson et al., 2002) and that found that females experienced more mood variability with increasing age, whereas males did not change. However, there are several differences between the present study and the study by Larson et al. (2002) that might account for the different results. First, Larson et al. merged positive and negative affect by using bipolar items (e.g., using items with response options friendly—angry), whereas we examined different emotions separately. Second, the operationalization of mood variability was different. Specifically, while Larson et al. used standard deviations to calculate mood variability, we used mean absolute successive differences. Third, Larson et al. examined within-day mood variability, whereas our study examined within-week variability. All these factors might contribute to the different results.

The present study adds to the current literature, because it was the first study that examined the longitudinal development of mood variability of different moods across a prolonged developmental span. Importantly, measurement invariance across time was established for the daily mood data, corroborating that the results are true developmental changes and not, for instance, changes in response tendencies. It is important to note that there was considerable interindividual variability in the intraindividual variability (i.e., the changes in mood variability across time), which can be seen by both the significant variances of the growth parameters and the only moderate rank-order stability. This indicates that the development is not necessarily universal for all adolescents. The significant variances of the intercepts and slopes in the growth curves (i.e., the deviations of the individual curves from the overall curve) suggest that not all adolescents start at the same mood variability initial level and some adolescents decline more steeply, whereas others decline less steeply compared to other adolescents. Similarly, the rank-order stability (i.e., the correlations between two adjacent time points) was only moderate and only increased slightly for happiness, anger, and sadness. This indicates that the relative position of an adolescent compared to others can still change over time (e.g., an adolescent with high mood variability at one time point does not necessarily also experience high mood variability at another time point compared to others). It might be that interindividual differences become more stable in adulthood, as is, for instance, the case with personality variables (Roberts & DelVecchio, 2000).

The development of mood variability, as indicated by the growth of the trajectories, seemed to be fairly similar for both sexes. Although the rate of change did not differ between males and females, there were sex differences in initial levels of mood variability. Specifically, females showed higher happiness and sadness variability, which persisted across the whole period of adolescence. These results are, for instance, consistent with a study that examined the relation between interpersonal family and friend events and mood in adolescents. It was found that adolescent females did not only show higher negative and lower positive moods in response to negative events, but also higher positive and lower negative moods in response to positive events than males (Flook, 2011). Importantly, we controlled for adolescent mood level in our analyses (Ebner-Priemer et al., 2009), implying that the sex differences in happiness and sadness variability were not explained by differences in individual mean scores.

Interestingly, we did not find that risk for externalizing behavior was related to mood variability, despite the fact that emotional dysregulation is a central factor in externalizing problems (Beauchaine, Gatzke-Kopp, & Mead, 2007; Mullin & Hinshaw, 2007) and studies have found that higher mood variability is associated with more externalizing problems (Silk et al., 2003; Stringaris & Goodman, 2009). However, in the present study we controlled for individual differences in mood level and a study using the present sample has shown that when simultaneously testing for mood level and variability, only mood level, but not variability was associated with aggressive behavior (Neumann et al., 2011). Therefore, externalizing problems seem to be related to consistently high levels of negative moods rather than highly unstable moods.

Limitations

The results of this study need to be seen in light of several limitations, some of which were already mentioned (e.g., that data collection might have started too late). Moreover, our sample consisted of mostly middle- to high-class, Dutch adolescents and adolescents that were at risk for externalizing behavior problems at age 12 were oversampled. Therefore, caution should be exerted when generalizing the results. However, it should be noted that we controlled for SES and risk status in our analyses and that they did not have a significant influence on the growth parameters of mood variability. Moreover, please note that although we tested for sex differences in intercepts and slopes, due to power issues we did not run the models for males and females separately in order to investigate whether the shape itself differed (e.g., whether males followed a quadratic shape, whereas females followed a linear trajectory).

Finally, adolescent mood was only sampled once per day and not multiple times per day. It has been argued that recall biases may even occur at a very short time frame and that it may be difficult for study participants to summarize their moods for 1 day, especially because moods are very dynamic (Shiffman, Stone, & Hufford, 2008). However, a recent study compared the relation between happiness variability and well-being for variability scores measured at different time scales (Gruber et al., 2013). The authors compared reports that were made multiple times per day using a day reconstruction method (microlevel variability) with reports that were made once per day across 2 weeks (macrolevel variability). Results showed that for both micro- and macrolevel variability, heightened happiness variability was related to worse well-being, suggesting that associations were consistent across the two different time frames. Nevertheless, present results should be replicated with more fine-grained measures of mood variability.

Implications and Conclusions

The present study suggests that adolescents experience significant normative changes in mood variability across adolescence. Specifically, temporary unstable moods seem to be part of early adolescence. However, over the course of adolescence, intense and frequent mood swings decline. Only anxiety seems to become more unstable again toward late adolescence, possibly due to responsibilities that are associated with young adulthood (Arnett, 2000). Importantly, the development of mood variability seems to be more or less similar for males and females.

Our results have directions for future research. Specifically, there was a lot of variation in the developmental trajectories. Therefore, studying factors that explain these individual differences or distinguish subpopulations with specific mood variability trajectories seems warranted. For instance, it might be that some adolescents do not show a decline in mood variability, a pattern that is likely linked to more psychopathology (Gruber et al., 2013; Larson, Raffaelli, Richards, Ham, & Jewell, 1990; Maciejewski et al., 2014; Neumann et al., 2011; Silk et al., 2003, 2011; Stringaris &

Goodman, 2009). Moreover, data from the present study cannot explain *why* adolescent mood variability changed. Specifically, it is unclear whether mood variability declined because new equilibriums were reached in biological and environmental domains or because adolescents learned to adapt to the biological and environmental changes by increasing their emotion regulation capacities or both. Future research might therefore study which factors affect the development of mood variability.

The present study was only the beginning in the study of adolescent mood variability development. Although there are many stereotypes about how adolescents' subjective emotional experiences develop during adolescence (Arnett, 1999; Hall, 1904), this was the first longitudinal study that has actually examined the development of adolescent mood variability for different moods. Hopefully this study will stimulate more research, because although the current study was based on strong data, our results need replication. Moreover, subjective experiences of mood are only one facet of emotional development. Therefore, future research should study adolescent mood variability in concert with environmental, biological, and psychophysiological measures in order to receive a clear and integrated picture on how adolescents develop and manage to deal with the transition from childhood to adulthood.

References

Achenbach, T. M. (1991). *Manual for the Youth Self Report and 1991 profiles*. Burlington: Department of Psychiatry, University of Vermont.

Arnett, J. J. (1999). Adolescent storm and stress, reconsidered. *American Psychologist*, *54*, 317–326. doi:10.1037/0003-066X.54.5.317

Arnett, J. J. (2000). Emerging adulthood: A theory of development from the late teens through the twenties. *American Psychologist*, *55*, 469. doi:10.1037/0003-066X.55.5.469

Beauchaine, T. P., Gatzke-Kopp, L., & Mead, H. K. (2007). Polyvagal theory and developmental psychopathology: Emotion dysregulation and conduct problems from preschool to adolescence. *Biological Psychology*, *74*, 174–184. doi:10.1016/j.biopsycho.2005.08.008

Bollen, K. A., & Curran, P. J. (2006). *Latent curve models: A structural equation perspective*. New York, NY: Wiley.

Broderick, P. C. (1998). Early adolescent gender differences in the use of ruminative and distracting coping strategies. *Journal of Early Adolescence*, *18*, 173–191. doi:10.1177/0272431698018002003

Buchanan, C. M., Eccles, J. S., & Becker, J. B. (1992). Are adolescents the victims of raging hormones? Evidence for activational effects of hormones on moods and behavior at adolescence. *Psychological Bulletin*, *111*, 62–107. doi:10.1037/0033-2909.111.1.62

Carver, K., Joyner, K., & Udry, J. R. (2003). National estimates of adolescent romantic relationships. In P. Florsheim (Ed.), *Adolescent romantic relations and sexual behavior: Theory, research, and practical implications* (pp. 23–56). Mahwah, NJ: Erlbaum.

Casey, B., Jones, R. M., & Hare, T. A. (2008). The adolescent brain. *Annals of the New York Academy of Sciences*, *1124*, 111–126. doi:10.1196/annals.1440.010

Chen, F. F., Sousa, K. H., & West, S. G. (2005). Teacher's corner: Testing measurement invariance of second-order factor models. *Structural Equation Modeling*, *12*, 471–492. doi:10.1207/s15328007sem1203_7

Cheung, G. W., & Rensvold, R. B. (2002). Evaluating goodness-of-fit indexes for testing measurement invariance. *Structural Equation Modeling*, *9*, 233–255. doi:10.1207/s15328007sem0902_5

Cohen, J., & Cohen, P. (1983). *Applied multiple regression/correlation analysis for the behavioral sciences*. Hillsdale, NJ: Erlbaum.

Cole, P. M., & Hall, S. E. (2008). Emotion dysregulation as a risk factor for psychopathology. In T. P. Beauchaine & S. P. Hinshaw (Eds.), *Child and adolescent psychopathology* (pp. 265–298). New York, NY: Wiley.

De Goede, I., Branje, S. J. T., & Meeus, W. H. J. (2009). Developmental changes in adolescents' perceptions of relationships with their parents. *Journal of Youth and Adolescence*, *38*, 75–88. doi:10.1007/s10964-008-9286-7

Ebner-Priemer, U. W., Eid, M., Kleindienst, N., Stabenow, S., & Trull, T. J. (2009). Analytic strategies for understanding affective (in)stability and other dynamic processes in psychopathology. *Journal of Abnormal Psychology*, *118*, 195–202. doi:10.1037/a0014868

Ebner-Priemer, U. W., Kuo, J., Kleindienst, N., Welch, S. S., Reisch, T., Reinhard, I., Lieb, K., . . . Bohus, M. (2007). State affective instability in borderline personality disorder assessed by ambulatory monitoring. *Psychological Medicine*, *37*, 961–970. doi:10.1017/S0033291706009706

Flook, L. (2011). Gender differences in adolescents' daily interpersonal events and well-being. *Child Development*, *82*, 454–461. doi:10.1111/j.1467-8624.2010.01521.x

Ge, X., Lorenz, F. O., Conger, R. D., Elder, G. H., & Simons, R. L. (1994). Trajectories of stressful life events and depressive symptoms during adolescence. *Developmental Psychology*, *30*, 467–483. doi:10.1037/0012-1649.30.4.467

Gruber, J., Kogan, A., Quoidbach, J., & Mauss, I. B. (2013). Happiness is best kept stable: Positive emotion variability is associated with poorer psychological health. *Emotion*, *13*, 1–6. doi:10.1037/a0030262

Gunnar, M. R., Wewerka, S., Frenn, K., Long, J. D., & Griggs, C. (2009). Developmental changes in hypothalamus–pituitary–adrenal activity over the transition to adolescence: Normative changes and associations with puberty. *Development and Psychopathology*, *21*, 69–85. doi:10.1017/S0954579409000054

Hall, G. S. (1904). *Adolescence: Its psychology and its relation to physiology, anthropology, sociology, sex, crime, religion, and*

education (Vols. I & II). Englewood Cliffs, NJ: Prentice Hall.

Hoeksma, J. B., Oosterlaan, J., & Schipper, E. M. (2004). Emotion regulation and the dynamics of feelings: A conceptual and methodological framework. *Child Development*, *75*, 354–360. doi:10.1111/j.1467-8624.2004.00677.x

Hoeksma, J. B., Sep, S., Vester, F., Groot, P., Sijmons, R., & De Vries, J. (2000). The electronic mood device: Design, construction, and application. *Behavior Research Methods*, *32*, 322–326. doi:10.3758/BF03207801

Hu, L., & Bentler, P. M. (1999). Cutoff criteria for fit indexes in covariance structure analysis: Conventional criteria versus new alternatives. *Structural Equation Modeling*, *6*, 1–55. doi:10.1080/10705519909540118

Larsen, R. J. (1987). The stability of mood variability: A spectral analytic approach to daily mood assessments. *Journal of Personality and Social Psychology*, *52*, 1195–1204. doi:10.1037/0022-3514.52.6.1195

Larson, R. W., Clore, G. L., & Wood, G. A. (1999). The emotions of romantic relationships: Do they wreak havoc on adolescents? In W. Furman, B. B. Brown, & C. Feiring (Eds.), *The development of romantic relationships in adolescence* (pp. 19–49). New York, NY: Cambridge University Press.

Larson, R. W., & Ham, M. (1993). Stress and "storm and stress" in early adolescence: The relationship of negative events with dysphoric affect. *Developmental Psychology*, *29*, 130–140. doi:10.1037/0012-1649.29.1.130

Larson, R. W., Moneta, G., Richards, M. H., & Wilson, S. (2002). Continuity, stability, and change in daily emotional experience across adolescence. *Child Development*, *73*, 1151–1165. doi:10.1111/1467-8624.00464

Larson, R. W., Raffaelli, M., Richards, M. H., Ham, M., & Jewell, L. (1990). Ecology of depression in late childhood and early adolescence: A profile of daily states and activities. *Journal of Abnormal Psychology*, *99*, 92–102. doi:10.1037/0021-843X.99.1.92

Maciejewski, D. F., Van Lier, P. A. C., Branje, S. J. T., Meeus, W. J. H., & Koot, H. M. (2015). *Using daily diary methods to study adolescents' emotions—Measurement invariance across sex, short-term and long-term periods*. Manuscript submitted for publication.

Maciejewski, D. F., Van Lier, P. A. C., Neumann, A., Giessen, D., Branje, S. J. T., Meeus, W. H. J., & Koot, H. M. (2014). The development of adolescent generalized anxiety and depressive symptoms in the context of adolescent mood variability and parent-adolescent negative interactions. *Journal of Abnormal Child Psychology*, *42*, 515–526. doi:10.1007/s10802-013-9797-x

Marsh, H. W., Hau, K.-T., & Wen, Z. (2004). In search of golden rules: Comment on hypothesis-testing approaches to setting cutoff values for fit indexes and dangers in overgeneralizing Hu and Bentler's (1999) findings. *Structural Equation Modeling*, *11*, 320–341. doi:10.1207/s15328007sem1103_2

Mullin, B. C., & Hinshaw, S. P. (2007). Emotion regulation and externalizing disorders in children and adolescents. In J. J. Gross (Ed.), *Handbook of emotion regulation* (pp. 523–541). New York, NY: Guilford.

Muthén, L. K., & Muthén, B. O. (1998–2012). *Mplus user's guide* (7th ed). Los Angeles, CA: Author.

Neumann, A., van Lier, P. A. C., Frijns, T., Meeus, W. H. J., & Koot, H. M. (2011). Emotional dynamics in the development of early adolescent psychopathology: A one-year longitudinal study. *Journal of Abnormal Child Psychology*, *39*, 657–669. doi:10.1007/s10802-011-9509-3

Preacher, K. J. (2002). Calculation for the test of the difference between two independent correlation coefficients [Computer software]. Retrieved from http://quantpsy.org/corrtest/corrtest.htm.

Roberts, B. W., & DelVecchio, W. F. (2000). The rank-order consistency of personality traits from childhood to old age: A quantitative review of longitudinal studies. *Psychological Bulletin*, *126*, 3. doi:10.1037/0033-2909.126.1.3

Rosenblum, G. D., & Lewis, M. (2003). Emotional development in adolescence. In G. R. Adams & M. Berzonsky (Eds.), *Blackwell handbook of adolescence* (pp. 269–289). Oxford, UK: Blackwell.

Selby, E. A., Franklin, J., Carson-Wong, A., & Rizvi, S. L. (2013). Emotional cascades and self-injury: Investigating instability of rumination and negative emotion. *Journal of Clinical Psychology*, *69*, 1213–1227. doi:10.1002/jclp.21966

Shiffman, S., Stone, A. A., & Hufford, M. R. (2008). Ecological momentary assessment. *Annual Review of Clinical Psychology*, *4*, 1–32. doi:10.1146/annurev.clinpsy.3.022806.091415

Silk, J. S., Forbes, E. E., Whalen, D. J., Jakubcak, J. L., Thompson, W. K., Ryan, N. D., . . . Dahl, R. E. (2011). Daily emotional dynamics in depressed youth: A cell phone ecological momentary assessment study. *Journal of Experimental Child Psychology*, *110*, 241–257. doi:10.1016/j.jecp.2010.10.007

Silk, J. S., Steinberg, L., & Morris, A. S. (2003). Adolescents' emotion regulation in daily life: Links to depressive symptoms and problem behavior. *Child Development*, *74*, 1869–1880. doi:10.1046/j.1467-8624.2003.00643.x

Somerville, L. H., Jones, R. M., & Casey, B. (2010). A time of change: Behavioral and neural correlates of adolescent sensitivity to appetitive and aversive environmental cues. *Brain and Cognition*, *72*, 124–133. doi:10.1016/j.bandc.2009.07.003

Steinberg, L. (2005). Cognitive and affective development in adolescence. *Trends in Cognitive Sciences*, *9*, 69–74. doi:10.1016/j.tics.2004.12.005

Stringaris, A., & Goodman, R. (2009). Mood lability and psychopathology in youth. *Psychological Medicine*, *39*, 1237–1245. doi:10.1017/S0033291708004662

Thompson, R. A. (1994). Emotion regulation: A theme in search of definition. *Monographs of the Society for Research in Child Development*, *59*, 25–52. doi:10.2307/1166137

Verhulst, F. C., van der Ende, J., & Koot, H. M. (1997). *Handleiding voor de Youth-Self-Report* [Manual for the Youth Self-Report]. Rotterdam, Netherlands: Afdeling

jeugdpsychiatrie, Sophia Kinderziekenhuis/Academisch Ziekenhuis Rotterdam/Erasmus Universiteit Rotterdam.

Weinstein, S. M., Mermelstein, R., Shiffman, S., & Flay, B. (2008). Mood variability and cigarette smoking escalation among adolescents. *Psychology of Addictive Behaviors*, *22*, 504. doi:10.1037/0893-164X.22.4.504

Zimmermann, P., & Iwanski, A. (2014). Emotion regulation from early adolescence to emerging adulthood and middle adulthood: Age differences, gender differences, and emotion-specific developmental variations. *International Journal of Behavioral Development*, *38*, 182–194. doi:10.1177/0165025413515405