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BRIEF REPORT

Dysregulated Behavioral Responses to Hedonic Probes Among Youth With Depression Histories and Their High-Risk Siblings

Vanessa Panaite
James A. Haley Veterans' Hospital, Tampa, Florida, and University of South Florida

Lauren M. Bylsma and Maria Kovacs
University of Pittsburgh School of Medicine

Kimberly O'Leary
University of South Florida

Charles J. George
University of Pittsburgh Medical Center

Ildikó Baji, István Benák, Roberta Dochnal, Enikő Kiss, Ágnes Vetró, and Krisztina Kapornai
University of Szeged

Jonathan Rottenberg
University of South Florida

Affect dysregulation in response to rewarding stimuli has been proposed as a vulnerability factor for major depressive disorder (MDD). However, it remains unclear how affective behavioral dynamics may be altered among individuals who are at high risk for depression but not currently depressed. We examined the dynamics of affective facial behavior during hedonic probes among 3 groups of adolescents: remitted probands who had histories of childhood-onset MDD ($n = 187$), never-depressed siblings of probands (high familial risk; $n = 207$), and healthy controls ($n = 166$). Participants' happy and sad facial expressions were coded during 3 hedonic laboratory tasks: receiving a preferred prize, describing a positive autobiographical memory, and watching a humorous film. Happy and sad behavioral dynamics were indexed by mean level- and time-dependent reactivity, variability (mean of the squared successive differences), and inertia (autocorrelation). Relative to controls, probands and siblings exhibited a more rapid decrease in happy behaviors, and probands exhibited higher inertia of sad behaviors during hedonic probes. Both probands and siblings exhibited lower inertia of sad behaviors while receiving a desired prize, which highlights the importance of context variation in testing hypotheses. Overall, our study provides new evidence that hedonic behavioral dysregulation, as reflected in dynamic facial behavior, may highlight depression vulnerability.

Keywords: early onset depression, remitted depression, familial depression, emotion, behavioral dynamics

Supplemental materials: http://dx.doi.org/10.1037/emo0000409.supp

Affective disturbance is central to major depressive disorder (MDD) and is proposed as a vulnerability factor in children and adolescents (Clark, Watson, & Mineka, 1994; Compas, Connor-Smith, & Jaser, 2004). Indeed, both a history of depression (Forbes, Shaw, & Dahl, 2007) and familial risk for depression (Rawal, Collishaw, Thapar, & Rice, 2013) have been associated with disrupted hedonic and negative emotional responses (Kellough, Beevers, Ellis, & Wells, 2008) to both positive and negative

Vanessa Panaite, HSR&D Center of Innovation on Disability and Rehabilitation Research (CINDRR), James A. Haley Veterans' Hospital, Tampa, Florida, and Department of Psychology, University of South Florida; Lauren M. Bylsma and Maria Kovacs, Department of Psychiatry, University of Pittsburgh School of Medicine; Kimberly O'Leary, Department of Psychology, University of South Florida; Charles J. George, Western Psychiatric Institute and Clinic, University of Pittsburgh Medical Center; Ildikó Baji, István Benák, Roberta Dochnal, Enikő Kiss, Ágnes Vetró, and Krisztina Kapornai, Department of Psychiatry, University of Szeged; Jonathan Rottenberg, Department of Psychology, University of South Florida.

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Correspondence concerning this article should be addressed to Vanessa Panaite, HSR&D Center of Innovation on Disability and Rehabilitation Research (CINDRR), James A. Haley Veterans' Hospital, 8900 Grand Oak Circle, 132B, Tampa, FL 33637. E-mail: vanessap@mail.usf.edu

stimuli—albeit not consistently (e.g., Joormann, Talbot, & Gotlib, 2007).

Reduced positive affect (PA) reactivity and deficient mood repair (i.e., ability to decrease sad affect) following positive stimuli have also been documented in youth with current or remitted depression (Kovacs et al., 2015, 2016). Since emotions are dynamic, a focus on the magnitude of emotional responses cannot adequately capture their temporal aspects. Dynamic indices such as variability and inertia (see Houben, Van Den Noortgate, & Kuppens, 2015) can help elucidate potential abnormalities in affective dynamics in the context of depression or risk. While variability concerns the divergence of momentary affect from prior affect levels, inertia captures resistance to change in affective states and the moment-to-moment carryover of affect (Koval, Pe, Meers, & Kuppens, 2013).

Facial expressive behavior provides an unobtrusive window into affective dynamics (Gruber & Keltner, 2007). There are indications that behavioral stereotypy (i.e., expressive rigidity) is linked to both a history of depression (Hankin, Wetter, & Flory, 2012) and risk for future depression (Kuppens et al., 2012). Along these lines, offspring of depressed parents (a familial high-risk group) tend to exhibit fewer positive and more negative expressions than offspring of healthy parents (Jones, Field, Hart, Lundy, & Davalos, 2001). Depression in siblings is known to be a robust risk factor for the later development of depression in their (as yet) unaffected siblings (Kovacs et al., 2016). Therefore, it is important to understand whether high-risk siblings might also exhibit deficits in their affective behavioral dynamics that might predate the onset of depression, but no prior studies have investigated affective behavioral dynamics among high-risk siblings. Importantly, facial expressive dynamics do not rely on self-reported emotion, which may be less reliable among youth (Achenbach, McConaughy, & Howell, 1987). Unfortunately, the limited number of studies of facial behavior dynamics has predominantly focused on negative affect (e.g., Koval, Kuppens, Allen, & Sheeber, 2012; Sheeber et al., 2012). The only study to examine PA behavioral dynamics in depressed youth found that depressed adolescents exhibited no differences in inertia of PA behaviors during rewarding social interaction tasks (Kuppens, Allen, & Sheeber, 2010).

The Current Study

We examined both happy and sad facial expressive behaviors during three hedonic stimuli (receiving a desired prize, generation of positive autobiographical memories, watching a humorous film) among three groups of youth: probands with a history of childhood-onset MDD, never-depressed siblings of probands (high familial risk), and controls with no history of any major psychiatric disorder. Given theoretical and empirical support for lasting effects of early onset depression, we hypothesized that depression risk status would impact happy expressive behavior to positive stimuli, such that probands would exhibit the least happy reactivity (and faster decreases of happy behavior), lowest happy variability, and lowest inertia of happy expressive behaviors. In contrast, we predicted that controls would exhibit the most reactivity, variability, and inertia of happy expressive behaviors, while high-risk siblings would exhibit a pattern of dynamic behaviors midway between the two groups, consistent with our prior pattern of findings for self-reported PA in response to hedonic stimuli in this same sample (Kovacs et al., 2016). We examined sadness behavioral dynamics as a point of comparison, but given the relative novelty of examining sadness behavior in hedonic contexts, we did not make specific predictions regarding sadness behavior.

Method

Participant Characteristics and Recruitment

This study was approved by the institutional review boards of the University of Pittsburgh and the Hungarian clinical research sites. The current sample included three groups of Hungarian youth, recruited from 23 outpatient mental health facilities: 186 remitted probands, 198 unaffected siblings of probands, and 164 healthy controls. Probands satisfied the following inclusion criteria: a history of a depression disorder, based on *DSM–IV* criteria (American Psychiatric Association, 2000); aged 7–14 years; absence of mental retardation or major medical disorder; have one full biological sibling aged 7–18 years; and have one biological parent available to participate. Control youth recruited from public schools were free of any current or past major psychiatric disorder and were selected to match the probands on age and gender (see Kovacs, Bylsma, et al., 2016). Level of depressive symptoms was quantified with the Children's Depression Inventory–2 (CDI-2; Kovacs & MHS Staff, 2011) and level of anxiety symptoms with the Multidimensional Anxiety Scale for Children (MASC; March, Parker, Sullivan, Stallings, & Conners, 1997).

Experimental Procedures

The current study reports on facial behavior responses to three hedonic probes in randomized order, briefly described below (see Kovacs et al., 2016, for more detail). Unobtrusive webcams were used to capture participant behavior. The hedonic probes included the following: (1) positive autobiographical memory (PAM, 120 sec), consisting of the recall of two positive events (60 sec each) from the past year; (2) humorous film (186 sec), which was a segment from *Mr. Bean,* a slapstick-style comedy; and (3) desired prize (60 sec), where youth unexpectedly received a small prize they had previously ranked as preferred from a list of seven prizes.

Behavioral Coding

Happy and sad expressive behavior was coded using an adaptation of the Emotional Behavior Coding System (Gross & Levenson, 1993). All behavior was coded for valence, duration, and intensity in 10-sec epochs throughout the tasks. Composite scores were computed to account for both behavior intensity and duration across the 10 sec. Happy and sad behavior was coded as a composite of intensity rated on a 4-point scale (from 0 = *no behavior* to 3 = *strong behavior*) and duration (1–10 sec). Composite scores ranged from 0–30, and each composite of intensity and duration was computed as follows for happy and sad separately: for example, slight_happyXduration + moderate_happyXduration + strong_happyXduration.

Statistical Analyses

Given the nested structure of the data, we implemented hierarchical linear modeling to examine group differences for each of our behavioral dynamics indices (reactivity, trajectory, variability, and inertia) using the SPSS MIXED procedure (Version 22; IBM Corp, 2013). Preliminary analyses examined the potential impact of age, gender, socioeconomic status (SES), baseline PA, and CDI-2 and MASC scores as covariates predicting happy or sad behavior. Only significant covariates were retained in final models. Final happy behavior models included age and baseline PA as covariates, and final sad behavior models included, gender, baseline PA, CDI-2, and MASC as covariates. No intercept models were used for post hoc analyses of group effects.

Variability of behavior during each task was examined by using the mean estimate of squared successive differences (MSSD) at each time point nested within persons as the outcome variable (Koval, Butler, Hollenstein, Lanteigne, & Kuppens, 2015).[1] Behavioral inertia was modeled as the relationship between the prior timepoint (lagged variable) and the current timepoint (e.g., Kuppens et al., 2010). Reactivity was modeled as current affective behavior controlling for baseline.

Results

Demographic and Clinical Characteristics

Remitted probands were, on average, older ($M = 17.11$, $SD = 1.35$), more likely to be male (64.5%), and from families with lower SES (indexed by parental education; $M = 2.78$, $SD = 1.17$) compared to control youth (age: $M = 15.92$, $SD = 2.13$; gender: 61.6% male; SES: $M = 3.73$, $SD = 1.09$; $ps < .05$). Siblings were more likely to be female (46.5% male) and were approximately 1 year younger than probands ($M = 15.92$, $SD = 2.15$; $ps < .05$). Probands reported more depressive symptoms on the CDI-2 ($M = 9.28$, $SD = 6.34$), more anxiety symptoms on the MASC ($M = 31.79$, $SD = 13.41$), and lower baseline PA levels ($M = 3.27$, $SD = 1.56$) than controls (CDI-2: $M = 4.83$, $SD = 4.29$; MASC: $M = 28.75$, $SD = 10.56$; baseline PA level: $M = 4.33$, $SD = 1.33$; $ps < .05$). Siblings and probands did not differ on current depression scores, and the three groups did not differ on baseline negative affect (NA) ($ps < .05$). However, siblings reported higher baseline PA level ($M = 3.69$, $SD = 1.36$) and higher anxiety symptoms ($M = 34.07$, $SD = 14.16$) relative to probands. Finally, biological mothers of probands and siblings had fourfold odds of a lifetime depressive disorder relative to control mothers (32% vs. 9%, $\chi^2 = 31.7$, $p < .001$, odds ratio = 4.8).

Happy Behavioral Reactivity

We predicted decreased happy behavioral reactivity during positive stimuli as a function of depression history, with probands displaying the least overall reactivity. However, the groups were indistinguishable in their overall emotional behavioral response to the three hedonic probes ($ps > .05$). Although our results reflected a group-by-task effect ($B = -.03$, $SE = .01$, $t = -3.76$, $p < .001$), post hoc analyses did not find group differences in happy behavioral reactivity for any of the specific tasks ($ps > .05$).

Happy Behavioral Dynamics

For the trajectory of happy behaviors over the course of each of the three hedonic tasks, group effects were consistent with hypotheses: A group effect was observed during hedonic probes, with post hoc analyses highlighting that both probands and siblings showed faster decreasing happy behavior over the course of each of the hedonic tasks relative to controls. No differences were observed between siblings and probands ($p < .05$). Since we did not find a task effect, we did not further investigate group effects within task.

Inconsistent with our prediction that increased depression risk would be associated with lower inertia of happy behaviors, no group differences were observed ($ps > .05$). We also predicted lower variability (MSSD), and while we did not find an overall group effect, our findings did highlight a group-by-task effect, suggesting that variability fluctuated across tasks ($B = -.23$, $SE = .07$, $t = -3.15$, $p < .01$). However, post hoc analyses did not reveal any significant within-task group effects ($ps > .05$). See Table 1.

Sad Behavioral Reactivity

For sad behavioral reactivity, a significant group-by-task interaction indicated that findings varied across the three tasks ($B = .01$, $SE = .002$, $t = 8.13$, $p < .001$). However, post hoc analyses did not reveal any significant within-task group effects ($ps > .05$). See Table 1.

Sad Behavioral Dynamics

In examining sad behavior over time across the three hedonic tasks, a significant group effect was noted (see Table 1). Post hoc analyses indicated that probands and siblings exhibited faster increasing sad behaviors relative to controls across all hedonic tasks but were indistinguishable from each other. However, variability of sad behavior (MSSD) was unrelated to group status ($ps > .05$).

Analyses of sad behavior inertia during hedonic tasks yielded an overall group effect. Consistent with hypotheses, post hoc analyses revealed higher inertia among probands relative to both siblings and controls when tasks were combined. Unexpectedly, siblings showed the lowest overall inertia of sad behavior and significantly differed from both probands and controls. There was also a significant group-by-task interaction, with post hoc analyses revealing that probands showed higher inertia of sad behavior during PAM and the happy film but lower inertia during the prize, relative to controls. Within-task analyses revealed that probands were indistinguishable from siblings during the prize; however, probands exhibited higher inertia during PAM and the happy film compared to siblings. See Table 1.

Discussion

Affective behavioral dynamics may provide an unobtrusive window into affective functioning that may be critical for

[1] Given that MSSD is composed of both variance and inertia (e.g., Jahng, Woods, & Trull, 2008), we also conducted parallel analyses for variance, but there were no significant group effects.

Table 1
Emotional Behavioral Reactivity, Trajectory, Inertia, and Variability as a Function of Depression Risk

Parameter	Estimate	*SE*	*t*	Significance	95% CI LB	95% CI UB
Happy behavior						
Trajectory						
Group × Epoch	−.021***	.005	−4.08	<.001	−.032	−.011
Probands-Sibs × Epoch	.016	.011	1.43	.152	−.006	.038
Probands-Ctrl × Epoch	−.045***	.012	−3.78	<.001	−.068	−.022
Sibs-Ctrl × Epoch	−.061***	.012	−5.24	<.001	−.084	−.038
Group × Task × Epoch	<.001	.002	.18	.858	−.003	.004
Sad behavior						
Reactivity						
Group	.041	.022	1.89	.060	−.002	.083
Group × Task	.013***	.002	8.13	<.001	.010	.016
PAM (Group)	.025	.013	1.85	.065	−.002	.051
Prize (Group)	−.004	.012	−.33	.742	−.027	.019
Happy Film (Group)	.068	.042	1.62	.105	−.014	.151
Trajectory						
Group × Epoch	.005***	.001	4.49	<.001	.003	.007
Probands-Sibs × Epoch	.004	.003	1.34	.182	−.002	.009
Probands-Ctrl × Epoch	.011***	.003	4.01	<.001	.005	.016
Sibs-Ctrl × Epoch	.007**	.003	2.61	.009	.002	.012
Group × Task × Epoch	<−.001	<.001	−.36	.722	−.001	.001
Inertia						
Group × AB_t	.148***	.007	21.31	<.001	.134	.162
Probands-Sibs × AB_t	.240***	.011	21.34	<.001	.218	.262
Probands-Ctrl × AB_t	.180***	.015	12.35	<.001	.151	.209
Sibs-Ctrl × AB_t	−.060***	.016	−3.76	<.001	−.092	−.029
Group × Task × AB_t	−.022***	.002	−8.91	<.001	−.027	−.017
PAM						
Group × AB_t	.296***	.015	20.31	<.001	.268	.325
Probands-Sibs × AB_t	.604***	.040	14.95	<.001	.525	.684
Probands-Ctrl × AB_t	.493***	.030	16.66	<.001	.435	.551
Sibs-Ctrl × AB_t	−.112*	.046	−2.46	.014	−.201	−.023
Prize						
Group × AB_t	−.112***	.013	−8.34	<.001	−.138	−.085
Probands-Sibs × AB_t	.041	.026	1.58	.113	−.010	.093
Probands-Ctrl × AB_t	−.216***	.026	−8.19	<.001	−.268	−.164
Sibs-Ctrl × AB_t	−.258***	.026	−9.87	<.001	−.309	−.206
Happy film						
Group × AB_t	.129***	.012	10.43	<.001	.105	.153
Probands-Sibs × AB_t	.231***	.015	15.82	<.001	.202	.260
Probands-Ctrl × AB_t	.080***	.020	3.94	<.001	.040	.120
Sibs-Ctrl × AB_t	−.151***	.020	−6.88	<.001	−.194	−.108

Note. Results are adjusted for the following covariates: Happy: age, baseline positive affect (PA); Sad: gender, Children's Depression Inventory–2, Multidimensional Anxiety Scale for Children, baseline PA (included in the final models as appropriate). CI = confidence interval; LB = lower bound; UB = upper bound; AB = affective behavior; PAM = positive autobiographical memory.
* $p < .05$. ** $p < .01$. *** $p < .001$.

understanding risk for depression. Our study was the first to examine positive and negative affective behavioral dynamics during hedonic laboratory probes among youth varying in their depression risk status. Overall, this study advances the field in four distinct ways.

First, our findings highlight sources of variation in affective behavioral dysregulation of happy behaviors. Curiously, despite prior findings that youth with remitted depression exhibit a dampened experiential response to positive stimuli (e.g., Kovacs et al., 2016), they appeared very much like their healthy peers in their overall happy behavioral reactivity. However, novel findings highlighted more subtle alterations in behavioral dynamics. For example, we found evidence of a more rapid cessation of happy behaviors during a positive task for probands, which supports previous evidence of positive experiential dysregulation in remitted youth (Kovacs et al., 2016). Our findings suggest that, indeed, a focus on the magnitude of emotional response alone may lead to misleading conclusions (e.g., Schepman, Taylor, Collishaw, & Fombonne, 2012).

Second, while dysphoric affect has been the focus of studies investigating mood repair (probands reported deficient mood repair during PAM; Kovacs et al., 2015), our examination of sad behavioral dynamics during multiple hedonic laboratory tasks is novel. Overall, we found that remitted youth exhibited inert sad behaviors that tended to persist over the course of our

hedonic tasks. This pattern of rapid cessation of happy behaviors and high inertia of sad behaviors during positive contexts is consistent with prior evidence of negative affect inflexibility (Kuppens et al., 2012) and emotion regulation deficits (Bylsma et al., 2016; Kuppens et al., 2010) in previously depressed youth and fits well with models of depression that feature context insensitivity (Rottenberg et al., 2005). Findings also highlight the importance of examining both negative and PA dynamics to hedonic stimuli.

Third, our findings also highlighted variation among the tasks we employed, which indicates the importance of including multiple affective laboratory stimuli of varying strengths. Specifically, probands exhibited the lowest inertia of sad behavior relative to both controls and siblings during the prize while exhibiting greater inertia during the PAM and humorous film. Notably, while our manipulation checks and prior work (Kovacs et al., 2016) have demonstrated that all our hedonic probes elicited significant increases in self-reported positive affect and behavior, the prize was the most potent task overall. Given that emotional expressive behaviors have been posited to trigger emotional experiences as much as communicate emotions (e.g., Eckman & Rosenberg, 1997; Gruber & Keltner, 2007), it is possible that our findings may be highlighting differences in how depression impacts emotional experiences versus emotion communication among youth with remitted depression. Specifically, probands appeared behaviorally more like healthy youth during laboratory tasks, possibly through interpersonal cues and intention to communicate positive emotions (while experiencing dampened positive emotions; Kovacs et al., 2016). Alternatively, null results for some tasks may signal that certain aspects of hedonic functioning remain intact, such as brief enthusiasm to self-relevant rewards, especially given the brevity of the prize task. It may be that youth who are at greater risk for depression show more deficits in their PA dynamics for milder positive experiences but are still able to experience positive affect for stronger hedonic probes. If they are less likely to experience such positive reactions, it may be that when they do occur, they exhibit even stronger reactions relative to their peers. Indeed, there is some evidence that depressed adults experience greater decreases in negative affect in response to self-identified positive daily life events (Bylsma, Taylor-Clift, & Rottenberg, 2011).

Fourth, our investigation of high-risk (but yet unaffected) siblings of youth with remitted depression was an important and novel feature of the current study. Siblings appeared much like the controls when investigating happy behavioral dynamics. Specifically, while we found that siblings' happy behaviors across tasks were indistinguishable from those of controls, they exhibited lower inertia of sad behaviors across tasks. Given our expectations that high-risk siblings would show some deficits, the observed patterns of behavioral dynamics of siblings relative to those of the remitted youth were surprising. Prior studies often report low or absent positive behaviors among infants or children at high familial risk for depression (due to a parental history of depression; e.g., Jones et al., 2001). However, our approach was distinct from prior studies in that we directly compared family members with and without a depression history. One possible explanation is that siblings also reported the highest current levels of anxiety symptoms, although we attempted to address this by covarying current anxiety symptoms in the analyses. While anxiety has been proposed as prodromal to depression in at-risk youth (Kovacs, Gatsonis, Paulauskas, & Richards, 1989), recent work provides more insight into potential mechanisms, such that increased reactivity among youth with anxiety symptoms appeared to be protective (Morris, Bylsma, Yaroslavsky, Kovacs, & Rottenberg, 2015). Indeed, it may also be that the siblings represent a particularly resilient group, as they have not yet been affected by depression despite their increased risk. However, given heightened risk for depression later in life among youth with familial depression, continued monitoring of depression over time, especially given observed heightened depressive and anxiety symptoms among siblings, is warranted.[2]

In sum, depression risk was associated with alterations in affective behavioral dynamics. This was especially notable among remitted depressed youth and, to a lower extent, among unaffected siblings who also exhibited some possibly protective features. These findings are consistent with the idea that depression risk involves a loss of behavioral flexibility critical for psychological health (Houben et al., 2015; Kashdan & Rottenberg, 2010).

Our current findings also highlight that the idea that depression is associated with reduced positive reactivity, as predicted by motivational (Gray, 1994) or emotion theories of depression (Emotion Context Insensitivity [ECI]; Rottenberg, 2005, 2017), may need to be to be qualified. It seems that in certain contexts, such as brief, highly motivating rewards, high-risk youth actually exhibit intact behavioral responses. This indicates that these youth may retain some capacity for adaptive hedonic functioning, which is consistent with naturalistic investigations of emotional reactivity showing evidence for a "mood-brightening" effect characterized by large decreases in negative affect among depressed individuals in response to positive events (e.g., Bylsma, Taylor-Clift, & Rottenberg, 2011). Other affective scientists have also emphasized the important role of context in emotional reactivity and regulation. For example, Gross's (2015) extended process model acknowledges the importance of temporal dynamics and context sensitivity in the development of emotional processes, such as hedonic functioning. Furthermore, Hollenstein, Lichtwarck-Aschoff, and Potworowski's (2013) model of socioemotional flexibility highlights the importance of both proximal and distal contextual factors (rapid changes vs. developmental changes) in affective functioning. Our findings reflect this potentially dynamic interplay between internal and external contextual factors; given that high-risk youth showed larger changes in both positive and negative emotional behaviors during intense and brief reward contexts, which were not sustained during longer tasks, may reflect unsuccessful deployment of emotion regulation strategies over time (see Rottenberg, 2017, for a review). Future research should utilize multiple methods with high temporal

[2] Although our study speaks to mechanisms that are at play in the development and maintenance of depression, our design did not permit us to directly investigate the proximal risk mechanisms. For example, temperament is one variable that could explain restricted emotional behavioral dynamics and continued experience of low PA, even beyond depression remission. Indeed, in prior work, low positive emotionality predicted high depressive symptoms over time in young children (Dougherty, Klein, Durbin, Hayden, & Olino, 2010). Although our study did not assess the temperament of the youth, our youth with remitted depression reported the lowest baseline PA, potentially consistent with this explanation.

precision longitudinally in order to further clarify how hedonic processes are altered in depression risk and how these processes change across development and with the onset of new episodes of depression, possibly guided by well-established models (e.g., Gross, 2015; Hollenstein et al., 2013).

References

American Psychiatric Association. (2000). *Diagnostic and statistical manual of mental disorders* (4th ed., text rev.). Washington, DC: Author.

Achenbach, T. M., McConaughy, S. H., & Howell, C. T. (1987). Child/adolescent behavioral and emotional problems: implications of cross-informant correlations for situational specificity. *Psychological bulletin, 101,* 213.

Bylsma, L. M., Taylor-Clift, A., & Rottenberg, J. (2011). Emotional reactivity to daily events in major and minor depression. *Journal of abnormal psychology, 120,* 155.

Bylsma, L. M., Yaroslavsky, I., Rottenberg, J., Kiss, E., Kapornai, K., Halas, K., . . . Kovacs, M. (2016). Familiality of mood repair responses among youth with and without histories of depression. *Cognition and Emotion, 30,* 807–816. http://dx.doi.org/10.1080/02699931.2015.1025707

Clark, L. A., Watson, D., & Mineka, S. (1994). Temperament, personality, and the mood and anxiety disorders. *Journal of Abnormal Psychology, 103,* 103–116. http://dx.doi.org/10.1037/0021-843X.103.1.103

Compas, B. E., Connor-Smith, J., & Jaser, S. S. (2004). Temperament, stress reactivity, and coping: Implications for depression in childhood and adolescence. *Journal of Clinical Child and Adolescent Psychology, 33,* 21–31. http://dx.doi.org/10.1207/S15374424JCCP3301_3

Dougherty, L. R., Klein, D. N., Durbin, C. E., Hayden, E. P., & Olino, T. M. (2010). Temperamental positive and negative emotionality and children's depressive symptoms: A longitudinal prospective study from age three to age ten. *Journal of Social and Clinical Psychology, 29,* 462–488. http://dx.doi.org/10.1521/jscp.2010.29.4.462

Ekman, P., & Rosenberg, E. L. (Eds.). (1997). *What the face reveals: Basic and applied studies of spontaneous expression using the Facial Action Coding System (FACS)*. New York, NY: Oxford University Press.

Forbes, E. E., Shaw, D. S., & Dahl, R. E. (2007). Alterations in reward-related decision making in boys with recent and future depression. *Biological Psychiatry, 61,* 633–639. http://dx.doi.org/10.1016/j.biopsych.2006.05.026

Gray, J. A. (1994). Three fundamental emotion systems. In P. Ekman & R. J. Davidons (Eds.), *The nature of emotion: Fundamental questions* (pp. 243–247). New York, NY: Oxford University Press.

Gross, J. J. (2015). The extended process model of emotion regulation: Elaborations, applications, and future directions. *Psychological Inquiry, 26,* 130–137. http://dx.doi.org/10.1080/1047840X.2015.989751

Gross, J. J., & Levenson, R. W. (1993). Emotional suppression: Physiology, self-report, and expressive behavior. *Journal of Personality and Social Psychology, 64,* 970–986. http://dx.doi.org/10.1037/0022-3514.64.6.970

Gruber, J., & Keltner, D. (2007). Emotional behavior and psychopathology: A survey of methods and concepts. In J. Rottenberg & S. L. Johnson (Eds.), *Emotion and psychopathology: Bridging affective and clinical science* (35–52). Washington, DC: American Psychological Association. http://dx.doi.org/10.1037/11562-002

Hankin, B. L., Wetter, E. K., & Flory, K. (2012). Appetitive motivation and negative emotion reactivity among remitted depressed youth. *Journal of Clinical Child and Adolescent Psychology, 41,* 611–620. http://dx.doi.org/10.1080/15374416.2012.710162

Hollenstein, T., Lichtwarck-Aschoff, A., & Potworowski, G. (2013). A model of socioemotional flexibility at three time scales. *Emotion Review, 5,* 397–405. http://dx.doi.org/10.1177/1754073913484181

Houben, M., Van Den Noortgate, W., & Kuppens, P. (2015). The relation between short-term emotion dynamics and psychological well-being: A meta-analysis. *Psychological Bulletin, 141,* 901–930. http://dx.doi.org/10.1037/a0038822

IBM Corp. (2013). *IBM SPSS Statistics for Windows* (Version 22.0). Armonk, NY: Author.

Jahng, S., Wood, P. K., & Trull, T. J. (2008). Analysis of affective instability in ecological momentary assessment: Indices using successive difference and group comparison via multilevel modeling. *Psychological methods, 13,* 354.

Jones, N. A., Field, T., Hart, S., Lundy, B., & Davalos, M. (2001). Maternal self-perceptions and reactions to infant crying among intrusive and withdrawn depressed mothers. *Infant Mental Health Journal, 22,* 576–586. http://dx.doi.org/10.1002/imhj.1019

Joormann, J., Talbot, L., & Gotlib, I. H. (2007). Biased processing of emotional information in girls at risk for depression. *Journal of Abnormal Psychology, 116,* 135–143. http://dx.doi.org/10.1037/0021-843X.116.1.135

Kashdan, T. B., & Rottenberg, J. (2010). Psychological flexibility as a fundamental aspect of health. *Clinical Psychology Review, 30,* 865–878. http://dx.doi.org/10.1016/j.cpr.2010.03.001

Kellough, J. L., Beevers, C. G., Ellis, A. J., & Wells, T. T. (2008). Time course of selective attention in clinically depressed young adults: An eye tracking study. *Behaviour Research and Therapy, 46,* 1238–1243. http://dx.doi.org/10.1016/j.brat.2008.07.004

Kovacs, M., Bylsma, L. M., Yaroslavsky, I., Rottenberg, J., George, C. J., Kiss, E., . . . Kapornai, K. (2016). Positive affectivity is dampened in youths with histories of major depression and their never-depressed adolescent siblings. *Clinical Psychological Science, 4,* 661–674. http://dx.doi.org/10.1177/2167702615607182

Kovacs, M., Gatsonis, C., Paulauskas, S. L., & Richards, C. (1989). Depressive disorders in childhood: IV. A longitudinal study of comorbidity with and risk for anxiety disorders. *Archives of General Psychiatry, 46,* 776–782. http://dx.doi.org/10.1001/archpsyc.1989.01810090018003

Kovacs, M., & MHS Staff. (2011). *Children's Depression Inventory 2nd Edition (CDI 2): Technical manual*. North Tonawanda, NY: Multi-Health Systems.

Kovacs, M., Yaroslavsky, I., Rottenberg, J., George, C. J., Baji, I., Benák, I., . . . Kapornai, K. (2015). Mood repair via attention refocusing or recall of positive autobiographical memories by adolescents with pediatric-onset major depression. *Journal of Child Psychology and Psychiatry, 56,* 1108–1117. http://dx.doi.org/10.1111/jcpp.12376

Koval, P., Butler, E., Hollenstein, T., Lanteigne, D., & Kuppens, P. (2015). Emotion regulation and the temporal dynamics of emotions: Effects of cognitive reappraisal and expressive suppression on emotional inertia. *Cognition & Emotion, 29,* 831–851. http://dx.doi.org/10.1080/02699931.2014.948388

Koval, P., Kuppens, P., Allen, N. B., & Sheeber, L. (2012). Getting stuck in depression: The roles of rumination and emotional inertia. *Cognition and Emotion, 26,* 1412–1427. http://dx.doi.org/10.1080/02699931.2012.667392

Koval, P., Pe, M. L., Meers, K., & Kuppens, P. (2013). Affect dynamics in relation to depressive symptoms: Variable, unstable or inert? *Emotion, 13,* 1132–1141.

Kuppens, P., Allen, N. B., & Sheeber, L. B. (2010). Emotional inertia and psychological maladjustment. *Psychological Science, 21,* 984–991. http://dx.doi.org/10.1177/0956797610372634

Kuppens, P., Sheeber, L. B., Yap, M. B., Whittle, S., Simmons, J. G., & Allen, N. B. (2012). Emotional inertia prospectively predicts the onset of depressive disorder in adolescence. *Emotion, 12,* 283–289. http://dx.doi.org/10.1037/a0025046

March, J. S., Parker, J. D. A., Sullivan, K., Stallings, P., & Conners, C. K. (1997). The Multidimensional Anxiety Scale for Children (MASC):

Factor structure, reliability, and validity. *Journal of the American Academy of Child & Adolescent Psychiatry, 36,* 554–565. http://dx.doi.org/10.1097/00004583-199704000-00019

Morris, B. H., Bylsma, L. M., Yaroslavsky, I., Kovacs, M., & Rottenberg, J. (2015). Reward learning in pediatric depression and anxiety: Preliminary findings in a high-risk sample. *Depression and Anxiety, 32,* 373–381. http://dx.doi.org/10.1002/da.22358

Rawal, A., Collishaw, S., Thapar, A., & Rice, F. (2013). A direct method of assessing underlying cognitive risk for adolescent depression. *Journal of Abnormal Child Psychology, 41,* 1279–1288. http://dx.doi.org/10.1007/s10802-013-9760-x

Rottenberg, J. (2017). Emotions in Depression: What Do We Really Know? *Annual Review of Clinical Psychology, 13,* 241–263.

Rottenberg, J., Gross, J. J., & Gotlib, I. H. (2005). Emotion context insensitivity in major depressive disorder. *Journal of Abnormal Psychology, 114,* 627.

Schepman, K., Taylor, E., Collishaw, S., & Fombonne, E. (2012). Face emotion processing in depressed children and adolescents with and without comorbid conduct disorder. *Journal of Abnormal Child Psychology, 40,* 583–593. http://dx.doi.org/10.1007/s10802-011-9587-2

Sheeber, L. B., Kuppens, P., Shortt, J. W., Katz, L. F., Davis, B., & Allen, N. B. (2012). Depression is associated with the escalation of adolescents' dysphoric behavior during interactions with parents. *Emotion, 12,* 913–918. http://dx.doi.org/10.1037/a0025784

Tamás, Z., Kovacs, M., Gentzler, A. L., Tepper, P., Gádoros, J., Kiss, E., . . . Vetró, A. (2007). The relations of temperament and emotion self-regulation with suicidal behaviors in a clinical sample of depressed children in Hungary. *Journal of Abnormal Child Psychology, 35,* 640–652. http://dx.doi.org/10.1007/s10802-007-9119-2

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