Published in final edited form as:

J Child Psychol Psychiatry. 2020 February ; 61(2): 167–174. doi:10.1111/jcpp.13121.

Life stress moderates the effects of preschool behavioral inhibition on anxiety in early adolescence

Emma E. Mumper², Margaret W. Dyson¹, Megan C. Finsaas², Thomas M. Olino³, Daniel N. Klein²

¹Child Mind Institute, New York, NY, USA;

²Department of Psychology, Stony Brook University, Stony Brook, NY, USA;

³Department of Psychology, Temple University, Philadelphia, PA, USA

Abstract

Background: Although a robust body of literature implicates temperamental behavioral inhibition (BI) as a prominent risk factor for anxiety disorders, many children with heightened BI do not develop anxiety. The current study examines the role of two forms of life stress (life events and natural disaster exposure) in moderating the relationship between BI in preschoolers and anxiety in early adolescence.

Method: A community sample of 392 3-year old children was administered a laboratory observational assessment of temperament. When children were a mean age 10, the region was struck by a devastating hurricane and exposure to disaster-related stress was assessed. In early adolescence, youth and a parent were administered the UCLA Life Stress Interview (LSI) to assess behaviorally independent and dependent negative life events during the prior year and youth completed the Screen for Child Anxiety Related Disorders (SCARED).

Results: The association between early childhood BI and anxiety symptoms in early adolescence was moderated by both independent life events and disaster-related stress. Children high in BI at age 3 reported greater anxiety symptoms at age 12 after exposure to higher levels of both forms of stress.

Conclusions: Stress moderated the association between early BI and later anxiety. Importantly, this was evident for two different kinds of stressors that were independent of the child's behavior that increases confidence in the causal role of stress in the development of anxiety in high BI children.

Keywords

Temperament; behavioral inhibition; stress; anxiety; adolescence; natural disaster

Correspondence: Emma Mumper, Department of Psychology, Stony Brook University, Stony Brook, NY 11794-2500, USA; emma.mumper@stonybrook.edu.

Conflict of interest statement: No conflicts declared.

Supporting information

Additional supporting information may be found online in the Supporting Information section at the end of this article:

Introduction

Behavioral inhibition (BI) is a temperament trait characterized by a proclivity to respond with fearfulness, wariness, and withdrawal in novel situations or with unfamiliar people (Fox, Henderson, Marshall, Nichols, & Ghera, 2005). Approximately 15–20% of children exhibit high levels of BI (Kagan, Reznick, Clarke, Snidman, & Garcia-Coll, 1984), and for many it is an enduring trait (Fox, Henderson, Rubin, Calkings, Schmidt, 2001; Klein & Mumper, 2018).

BI in early childhood is a well-established antecedent of anxiety in middle childhood and adolescence (Clauss & Blackford, 2012; Klein & Mumper, 2018; Muris, van Brakel, Arntz, & Schouten, 2011; Prior, Smart, Sanson, & Oberklaid, 2000). However, many children with BI do not develop anxiety disorders (Biederman et al., 1993; Clauss & Blackford, 2012; Prior et al., 2000). This has led investigators to consider the role of other factors that might moderate the relationship between BI and anxiety (Buss & Kiel, 2013; Degnan & Fox, 2007; Lahat, Hong, & Fox, 2011).

One potentially important moderator is exposure to life stress. A substantial body of literature suggests that stress plays a role in the development of anxiety (Allen, Rapee, & Sandberg, 2008; Broeren, Newall, Dodd, Locker, & Hudson, 2014; Murray, Creswell, & Cooper, 2009). However, it can be difficult to ascertain the temporal relationship between stress and symptom development (Boer et al., 2002) as anxiety disorders also predict the occurrence of subsequent negative life events (Kim, Conger, Elder, & Lorenz, 2003; Uliaszek et al., 2012). One approach to clarifying the direction of this relationship is to distinguish events that are behaviorally independent of the child's behavior (e.g., death of a family member; parent losing a job) from those that are entirely or partially due to the child's behavior (i.e., behaviorally dependent events such as interpersonal conflicts and academic failure; Brown & Harris, 1978; Rudolph et al., 2000).

Whereas the majority of research on anxiety and stress in youth has focused on relatively common life events, exposure to natural disasters also confers risk for internalizing psychopathology in children and adolescents (Kopala-Sibley et al., 2016; Wang, Chan, & Ho, 2013). Importantly, fateful life events, such as natural disasters, allow for stronger causal inferences as disasters cannot be influenced by the child's pre-existing characteristics, such as temperament and psychopathology.

To our knowledge, only four studies have examined whether stress moderates the association between BI and anxiety (Brozina & Abela, 2006; Broeren, et al., 2014; Edwards, Rapee, & Kennedy, 2010; Muris et al., 2011), and only one study has examined the moderating effects of a natural disaster (Kopala-Sibley et al., 2016; Meyer et al., 2017). Brozina and Abela (2006) reported that stress moderated the effects of BI on anxiety, such that youth high in BI who experienced stressful life events reported greater anxiety symptoms than their low-BI counterparts. In contrast, Broeren et al. (2014), Edwards et al. (2010), and Muris et al. (2011) found that BI and life stress had independent effects on anxiety. The one study of a natural disaster reported that the effects of early childhood fearfulness were moderated by disaster-related stress such that fearful children with high stress exposure exhibited the

greatest anxiety symptoms several weeks later (Kopala-Sibley et al., 2016; Meyer et al., 2017).

The discrepancies between studies may be due, in part, to methodological limitations. For example, many of these studies relied on parent reports of BI, questionnaire measures of life events, and brief follow-up intervals. Additionally, few studies (see Brozina & Abela, 2006 for an exception) examined independent (or fateful) events separately from dependent events. The present study expands on prior research by testing a diathesis-stress model across a 9-year span in a large community sample. We assessed BI at age 3 using a laboratory observation procedure, and anxiety symptoms at age 12 via youth report. A natural disaster, Hurricane Sandy, struck the region when the sample was a mean age of 10, and mothers completed a measure of stress exposure. Life events were assessed for the year prior to the age 12 assessment using a gold standard, semi-structured interview that combined youth and parent reports, and independent and dependent events were examined separately (Harkness & Monroe, 2016). We previously reported the short-term effects of Hurricane Sandy on children with high and low levels of temperamentally fearfulness (Kopala-Sibley et al., 2016). This paper extends those findings by examining the longer-term effects of this fateful event on anxiety in early adolescence as a function of early childhood BI.

Methods

Participants

As part of a larger longitudinal study of temperament and risk for psychopathology (Klein & Finsaas, 2017), families with a 3-year-old child were recruited using commercial mailing lists. Families were eligible if the child lived with an English-speaking, biological parent and did not have a significant developmental disability or medical condition. Of the initial 559 children recruited at the first assessment wave, 392 participated in a laboratory observation of temperament at a mean age of 3.55 ($SD = .26$) and returned at a mean age of 9.17 ($SD = .37$) and 12.67 ($SD = .42$) for further assessments. A total of 313 mothers completed an assessment of disaster-related stress after Hurricane Sandy when children were a mean age of 10.29 ($SD = .76$). The sample of 392 children (184 females) was 94.9% Caucasian, 2.3% African American, 2.6% Asian, and 0.3% Native American; 8.7% were of Hispanic ethnicity. At the age 3 assessment, 70.4% of families had at least one parent with a college degree. Differences between participants in the current study and the larger sample were minimal, and are detailed in Appendix S1 in the Supporting Information.

Procedure

During the age 3 assessment, children completed the Laboratory Temperament Assessment Battery (Lab-TAB; Goldsmith, Reilly, Lemery, Longley, & Prescott, 1995) as a measure of BI. During the age 9 assessment, children completed the Screen for Child Anxiety Related Emotional Disorders (SCARED; Birmaher et al., 1997). Approximately 8 weeks after Hurricane Sandy (and 64.9 weeks [$SD = 31.2$] after the age 9 assessment), mothers completed a measure of hurricane-related stress (Kopala-Sibley et al., 2016). Finally,

children completed the SCARED and UCLA life stress interview (LSI; Hammen et al., 1987) at the age 12 assessment.

Ethical consideration

Parents provided informed consent and children provided assent; study procedures were approved by the Stony Brook University Institutional Review Board. Families were compensated for participation.

Measures

Lab-TAB.—At age 3, BI was assessed using the Lab-TAB (Gagne, Van Hulle, Aksan, Essex, & Goldsmith, 2011; Goldsmith et al., 1995). Children participated in a 2-hour observation of temperament, which included three episodes designed to assess BI (*Risk Room*, *Stranger Approach*, and *Exploring New Objects*). Each episode was video recorded for coding. Coders rated emotional responses and behaviors including intensity of facial, bodily, and vocal fear, latency to touch objects, tentative play, gaze aversion, latency to vocalize, approach tendencies, and avoidance of strangers on a 3- or 4- point scale for consecutive 20–30 second epochs within each episode (see Olino, Klein, Dyson, Rose, & Durbin, 2010). BI was measured as the average of standardized ratings across epochs and episodes. Internal consistency, indexed by coefficient alpha, was .80 and the intraclass correlation for interrater reliability was .88 ($n = 28$).

Hurricane Sandy.—Hurricane Sandy struck the Northeastern United States in October, 2012 inflicting nearly \$70 billion (USD) in damage (NOAA National Centers for Environmental Information, 2018). Six weeks after the hurricane, mothers were asked to report on their family's exposure to the disaster using an 11-item web-based questionnaire (see Kopala-Sibley et al., 2016 for items). The scale was developed using questionnaires designed for Hurricanes Ike (Norris, Sherrieb, & Galea, 2010) and Katrina (Galea, et al., 2007). Participants reported on stressors experienced during and immediately after the hurricane, including evacuation from home, property damage, and difficulty obtaining food, water, heat, or power. Scores ranged from 0–11 with higher scores reflecting a greater number of stressors. The questionnaire had adequate internal consistency ($\alpha = .73$).

Life stress interview.—At the age 12 wave, the LSI (Hammen et al., 1987) was used to assess episodic life stress during the prior year. The life events assessment period did not overlap with Hurricane Sandy. Interviewers held a bachelors or master's degree in psychology and were trained to collect detailed information about each event in separate interviews with the youth and a parent. Following Brown and Harris' (1978) contextual threat approach, events were presented to an independent rating team, omitting the adolescent's subjective reactions to the stressor. The degree of impact, or contextual threat, that each event likely would have on a typical youth in a comparable context was rated by the team using a scale ranging from 1 (*none*) to 5 (*extremely severe*). Events with scores of three or greater were considered moderate/severe. Additionally, the extent to which each event was independent of the youth's behavior was rated on a scale ranging from 1 (*independent of the person*) to 3 (*dependent on the person*). Studies using adolescent

samples have demonstrated good interrater reliability (Hammen et al., 1999; Rudolph & Hammen, 1999).

SCARED.—At age 9 and 12 waves, youth completed the SCARED (Birmaher et al., 1997) which consists of 41 items assessing the severity of anxiety symptoms in youth aged 8–18. Items are rated on a 3-point scale. In our sample, internal consistency (alpha) was .89 at age 9 and .90 at age 12. At the age 9 wave, participant scores ranged from 1 to 53 and at age 12, scores ranged from 0 to 60

Data analyses

As in our previous papers, BI was treated as a continuous variable, rather than imposing a relatively arbitrary cutoff on the distribution of scores (Olino et al., 2010). To normalize the distribution for the Lab-TAB BI variable, a log transformation was applied. All other study variables were normally distributed. Hierarchical multiple regression was used to examine the longitudinal associations between BI at age 3, stress in the year prior to the age 12 wave, and anxiety at age 12. Sex was included as a covariate due to associations with a number of key study variables, and age 9 SCARED was included to adjust for anxiety symptoms prior to stress exposure. As there was a small but significant difference in age at the last assessment wave between those who participated and did not participate in that wave (see Appendix S1), we adjusted for potential attrition bias by include age at the final assessment in the regression models as a covariate. Hurricane Sandy models included the LSI and BI x LSI interaction as covariates to examine the longer-term effects of the disaster after adjusting for more proximal life stress. BI at age 3 and LSI impact score at age 12 or the hurricane-related stress score at age 10 were entered in the first step. The BI X stress interaction was entered in the second step. BI, the stress measures, and anxiety symptoms were mean centered prior to inclusion in the regression models. Significant interactions were probed by examining simple slopes with the moderator (stress) plotted at 1 SD above and below the mean (Aiken, West, & Reno, 1991). Ordinary Least Square (OLS) regression assumptions of multivariate normality and multicollinearity were satisfied.

Total life events and hurricane-related stress were examined in separate models. The significant total life events x BI interaction was followed up by examining independent and dependent events in a third separate regression model. The Bonferroni procedure was applied to the model examining independent and dependent events separately. With two interaction effects being tested, alpha was set at $p < .025$. To test the limits, analyses using episodic stress were repeated excluding low impact stressors. As the results were similar, these analyses are reported in Appendix S2, Table S1, and Figures S1 and S2.

To minimize the limitations associated with single-method measurement of temperament (Rothbart & Bates, 2006), we conducted parallel analyses substituting a parent-report measure of BI for the Lab-TAB (see Appendix S3, Table S2, and Figures S3 and S4). Regression analyses were also repeated substituting total number of stressful life events for the degree of impact. The results were the same in all analyses. Finally, we conducted exploratory analyses examining whether sex and parental education (as a proxy for

socioeconomic status) further moderated the relationship between BI and life stress in predicting age 12 anxiety symptoms, but this did not yield any significant findings.

Results

Descriptive statistics

Bivariate correlations, means, and standard deviations of key variables are displayed in Table 1.

Lab-TAB BI.—In the regression model incorporating Lab-TAB BI and total LSI (see Table 2), female sex, greater age 9 anxiety, and greater life stress during the past year predicted higher anxiety symptoms on the SCARED at age 12. However, these results were qualified by a significant BI x LSI total stress interaction. As shown in Figure 1.A, BI predicted greater anxiety at higher levels of life stress ($B = 7.73$, $t(385) = 2.08$, $p = .04$), but not at lower levels of stress ($B = -4.55$, $t(385) = -1.23$, $p = .22$).

Next, analyses were conducted using independent and dependent life events in place of total life events (see Table 2). Again, female sex and age 9 SCARED predicted scores on the SCARED at age 12, qualified by a significant BI x independent life events interaction. BI at age 3 predicted greater anxiety at higher levels of independent life stress, (see Figure 1.B; $B = 9.06$, $t(383) = 2.56$, $p = .01$), but not at lower levels of stress ($B = -6.56$, $t(383) = -1.79$, $p = .07$). Main and interaction effects involving dependent life events were not significant. The interaction effects of independent stress and BI remained significant after Bonferroni correction.

Hurricane Sandy

To further examine whether another type of fateful life stressor, a natural disaster, moderated the association between BI and anxiety, we re-ran the models substituting Hurricane Sandy stress for the LSI. To account for more proximal life stress, we adjusted for the main and interaction effects of LSI total life stress. These analyses also served to test whether the effects we reported in the immediate aftermath of the hurricane (Kopala-Sibley et al., 2016) were again evident a mean 2 years later.

In the regression model incorporating the Lab-TAB BI and Hurricane Sandy stress (see Table 3), female sex, greater age 9 anxiety, greater LSI total stress, and the BI x LSI total stress interaction again predicted higher anxiety symptoms on the SCARED at age 12. In addition, there was a significant BI x Hurricane Sandy stress interaction (see Figure 2). BI predicted significantly greater anxiety at age 12 at higher levels of exposure to hurricane-related stress ($B = 9.56$, $t(304) = 2.70$, $p < .01$), but not at lower levels of Sandy-related stress ($B = -4.00$, $t(304) = -1.14$, $p = .26$).

Discussion

A large literature has documented links between BI and anxiety symptoms from childhood to adolescence (Clauss & Blackford, 2012; Klein, & Mumper, 2018). However, approximately half of children with high BI do not develop anxiety, suggesting that other

factors moderate this association (Buss & Kiel, 2013; Lahat et al., 2011). Extending previous research, we examined whether stress moderates the association between BI in early childhood and anxiety symptoms in early adolescence, adjusting for anxiety in the prior assessment wave. We found that among children with higher levels of stress, early BI significantly predicted greater anxiety, while there was no association between BI and later anxiety in children with lower levels of stress. These effects were evident for independent, but not dependent, life events during the prior year. This is important in that independent life events are unlikely to have been caused by the youth's temperament or prior anxiety symptoms. Moreover, these findings remained significant when considering only moderate and severe events, indicating that the effects were not driven by mild, low impact stressors (see Appendix S2).

To extend these results, we also examined the effects of exposure to a natural disaster, Hurricane Sandy, as another independent stressor, and found that hurricane-related stress moderated the effect of early BI on anxiety symptoms at age 12. Importantly, these effects persisted after adjusting for the effects of proximal (past year) life events. In addition to supporting our findings for more common and proximal independent life events, this extends prior reports from this project showing that Hurricane Sandy-related stress moderated the effects of laboratory-observed temperamental fearfulness on anxiety symptoms an average of 8 weeks after the disaster (Kopala-Sibley et al., 2016; Meyer et al., 2017) by demonstrating that this effect continued to be apparent approximately 2 years post-hurricane.

Taken together, these findings indicate that temperamental diatheses are evident early in life and confer risk for anxiety after exposure to a variety of environmental adversities, including common life events and natural disasters. Moreover, this study is one of the first to suggest an enduring impact of hurricane-related stress on anxiety several years after exposure. These results provide strong support for a diathesis-stress conceptualization of the relationships between BI, life stress, and anxiety in youth and may help account for why only a subset of children with high levels of BI subsequently develop anxiety disorders.

Researchers examining the role of stress in anxiety have long struggled with the question of whether anxiety disorders are preceded by life stress or if anxiety generates negative life events (Boer et al., 2002; Kim et al., 2003; Sandberg, McGuinness, Hillary, & Rutter, 1998). Distinguishing between independent and dependent stressors is helpful in supporting a causal relationship. This study is one of the first to examine independent and dependent life stressors separately in predicting anxiety. Our results are consistent with a previous longitudinal study suggesting that severe independent events were associated with the onset of anxiety disorders during childhood (Allen et al., 2008).

Prior studies have provided mixed support for a diathesis-stress model of temperament as a risk factor for anxiety (Brozina & Abela, 2006; Broeren et al. 2013; Edwards et al., 2010; Muris et al., 2011). Our findings are consistent with prior work examining stress and anxiety in late childhood/early adolescence (Brozina & Abela, 2006), as opposed to studies focusing on anxiety in early and middle childhood (Broeren et al., 2013; Edwards et al., 2010; Muris et al., 2011). This raises the possibility that stressors may be more salient or impactful in older youth, and that other environmental factors (e.g., parenting, chronic adversity) may

play a greater role earlier in development. However, these studies have also varied considerably with respect to study design and methods, including varying approaches to assessing BI, stress, and anxiety, and differences in interval duration between assessments of temperament, stress, and anxiety.

Unlike most previous studies, life events were assessed using an interview-based measure, which is the gold standard compared to self-report measures (Harkness & Monroe, 2016). Furthermore, we distinguished between independent and dependent events, considered the role of stressor severity, and examined both common life events and exposure to a natural disaster. Importantly, the predictor and outcome measures were deliberately selected to minimize shared method variance, thus the analyses were particularly conservative. Additionally, previous longitudinal research on BI, stress, and anxiety has used relatively short follow-up periods; the current study is the first to test diathesis-stress models across a 9-year span from initial measurement of temperament in early childhood to anxiety symptoms in early adolescence, the beginning of a period of increased risk for anxiety disorders (Beesdo-Baum & Knappe, 2012).

Although we identified associations between early childhood BI and life stress, the interaction effects were relatively modest in magnitude. The length of the interval between assessments may have reduced the magnitude of the effects. More importantly, anxiety disorders are complex conditions that are shaped by a range of factors over the course of development, and a single set of risk factors (early temperament and life events) are not expected to account for **a majority of possible etiological pathways**.

Our study also had some notable limitations. First, the use of a community sample meant that the prevalence of clinically significant anxiety, although reasonable (18.9%), was considerably lower than within a clinical sample, and it is unknown if these results will generalize to anxiety disorder diagnoses. Second, we used a self-report measure of children's anxiety symptoms, rather than a diagnostic interview. Third, BI was assessed at a single time point, hence we did not examine whether the effects of stress varied as a function of the stability of BI over time. Fourth, although we adjusted for anxiety symptoms at age 9, we did not systematically assess anxiety during the interval between the age 9 and age 12 waves, hence we did not have a measure of anxiety symptoms immediately prior to the occurrence of the stressors. Fifth, we did not explore factors that may mediate the BI X hurricane stress effect on later anxiety, such as continuing financial or family problems stemming from the hurricane. Finally, as our sample was relatively homogeneous, we do not know if our findings will generalize to a more diverse sample.

In conclusion, this study demonstrated that the relationship between early childhood BI, assessed using laboratory observations, and anxiety symptoms in early adolescence is moderated by independent, or fateful, stressors spanning relatively common life events to exposure to a natural disaster. This supports the view that BI is a diathesis evident early in life that confers risk for later anxiety (Buss & Kiehl, 2013; Klein & Mumper, 2018; Lahat et al., 2011), and that exposure to life stress might explain the heterogeneity of outcomes for children with high BI. Behaviorally inhibited children may experience greater reactivity to stress or have fewer tools to effectively cope or self-regulate after stressful life events. This

finding is consistent with prior evidence suggesting individuals with inhibited temperaments exhibit high reactivity and arousal to unexpected and threatening situations, leading to avoidance and withdrawal coping, rather than using active and approach-oriented coping strategies (Compas, Connor-Smith, Saltzman, Thomsen, & Wadsworth, 2001). Identifying behaviorally inhibited children prior to the development of clinically significant anxiety symptoms and providing early intervention may help mitigate the impact of future stressors and prevent the development of anxiety disorders.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

Acknowledgements

This study was supported by National Institute of Mental Health grant RO1 MH069942 (D. N. K.). The authors have declared that they have no competing or potential conflicts of interest.

References

- Aiken LS, & West SG (1991). Multiple regression: Testing and interpreting interactions. Newbury Park, CA: Sage
- Allen JL, Rapee RM, & Sandberg S (2008). Severe life events and chronic adversities as antecedents to anxiety in children: A matched control study. *Journal of Abnormal Child Psychology*, 36(7), 1047. [PubMed: 18521739]
- Beesdo-Baum K, & Knappe S (2012). Developmental epidemiology of anxiety disorders. *Child and Adolescent Psychiatric Clinics*, 21(3), 457–478.
- Birmaher B, Khetarpal S, Brent D, Cully M, Balach L, Kaufman J, & Neer SM (1997). The screen for child anxiety related emotional disorders (SCARED): Scale construction and psychometric characteristics. *Journal of the American Academy of Child & Adolescent Psychiatry*, 36(4), 545–553. [PubMed: 9100430]
- Biederman J, Rosenbaum JF, Bolduc-Murphy EA, Faraone SV, Chaloff J, Hirshfeld DR, & Kagan J (1993). A 3-year follow-up of children with and without behavioral inhibition. *Journal of the American Academy of Child & Adolescent Psychiatry*, 32(4), 814–821. [PubMed: 8340303]
- Bishop G, Spence SH, & McDonald C (2003). Can parents and teachers provide a reliable and valid report of behavioral inhibition? *Child Development*, 74(6), 1899–1917. [PubMed: 14669903]
- Boer F, Markus MT, Maingay R, Lindhout IE, Borst SR, & Hoogendijk TH (2002). Negative life events of anxiety disordered children: bad fortune, vulnerability, or reporter bias? *Child Psychiatry and Human Development*, 32(3), 187–199. [PubMed: 11894841]
- Broeren S, Newall C, Dodd HF, Locker R, & Hudson JL (2014). Longitudinal investigation of the role of temperament and stressful life events in childhood anxiety. *Development and Psychopathology*, 26(2), 437–449. [PubMed: 24382091]
- Brown GW, & Harris TO (1978). *Social Origins of Depression: A Study of Psychiatric Disorder in Women*. New York: Free Press.
- Brozina K, & Abela JR (2006). Behavioural inhibition, anxious symptoms, and depressive symptoms: A short-term prospective examination of a diathesis-stress model. *Behaviour Research and Therapy*, 44(9), 1337–1346. [PubMed: 16337606]
- Buss KA, & Kiel EJ (2013). Temperamental risk factors for pediatric anxiety disorders In Vasa RA & Roy AK (Eds.), *Current Clinical Psychiatry. Pediatric Anxiety Disorders: A Clinical Guide* (pp. 47–68). Totowa, NJ, US: Humana Press.
- Clauss JA, & Blackford JU (2012). Behavioral inhibition and risk for developing social anxiety disorder: a meta-analytic study. *Journal of the American Academy of Child & Adolescent Psychiatry*, 51(10), 1066–1075. [PubMed: 23021481]

- Compas BE, Connor-Smith JK, Saltzman H, Thomsen AH, & Wadsworth ME (2001). Coping with stress during childhood and adolescence: problems, progress, and potential in theory and research. *Psychological Bulletin*, 127(1), 87. [PubMed: 11271757]
- Degnan KA, & Fox NA (2007). Behavioral inhibition and anxiety disorders: Multiple levels of a resilience process. *Development and Psychopathology*, 19(3), 729–746. [PubMed: 17705900]
- Edwards SL, Rapee RM, & Kennedy S (2010). Prediction of anxiety symptoms in preschool-aged children: examination of maternal and paternal perspectives. *Journal of Child Psychology and Psychiatry*, 51(3), 313–321. [PubMed: 19769584]
- Fox NA, Henderson HA, Marshall PJ, Nichols KE, & Ghera MM (2005). Behavioral inhibition: linking biology and behavior within a developmental framework. *Annual Review of Psychology*, 56, 235–262.
- Fox NA, Henderson HA, Rubin KH, Calkins SD, & Schmidt LA (2001). Continuity and discontinuity of behavioral inhibition and exuberance: Psychophysiological and behavioral influences across the first four years of life. *Child Development*, 72(1), 1–21. [PubMed: 11280472]
- Gagne JR, Van Hulle CA, Aksan N, Essex MJ, & Goldsmith HH (2011). Deriving childhood temperament measures from emotion-eliciting behavioral episodes: Scale construction and initial validation. *Psychological Assessment*, 23(2), 337. [PubMed: 21480723]
- Galea S, Brewin CR, Gruber M, Jones RT, King DW, King LA, McNally RJ, Ursano RJ, Petukhova M., & Kessler RC (2007). Exposure to hurricane-related stressors and mental illness after Hurricane Katrina. *Archives of General Psychiatry*, 64(12), 1427–1434. [PubMed: 18056551]
- Goldsmith HH, Reilly J, Lemery KS, Longley S, & Prescott A (1995). Laboratory temperament assessment battery: Preschool version. Unpublished manuscript. Department of Psychology, University of Wisconsin, Madison.
- Hammen C, Adrian C, Gordon D, Burge D, Jaenicke C, & Hiroto D (1987). Children of depressed mothers: maternal strain and symptom predictors of dysfunction. *Journal of Abnormal Psychology*, 96(3), 190. [PubMed: 3680756]
- Hammen C, Rudolph K, Weisz J, Rao U, & Burge D (1999). The context of depression in clinic-referred youth: Neglected areas in treatment. *Journal of the American Academy of Child and Adolescent Psychiatry*, 38, 64–71. [PubMed: 9893418]
- Harkness KL, & Monroe SM (2016). The assessment and measurement of adult life stress: Basic premises, operational principles, and design requirements. *Journal of Abnormal Psychology*, 125(5), 727. [PubMed: 27254487]
- Kagan J, Reznick JS, Clarke C, Snidman N, & Garcia-Coll C (1984). Behavioral inhibition to the unfamiliar. *Child Development*, 2212–2225.
- Kim KJ, Conger RD, Elder GH Jr, & Lorenz FO (2003). Reciprocal influences between stressful life events and adolescent internalizing and externalizing problems. *Child Development*, 74(1), 127–143. [PubMed: 12625440]
- Klein DN, & Finsaas MC (2017). The Stony Brook Temperament Study: Early antecedents and pathways to emotional disorders. *Child Development Perspectives*, 11, 257–263. [PubMed: 29151849]
- Klein DN, & Mumper EE (2018). Behavioral Inhibition as a Precursor to Psychopathology In Pérez-Edgar K Fox N (Ed.), *Behavioral Inhibition* (pp. 283–307). Springer, Cham.
- Kopala-Sibley DC, Danzig AP, Kotov R, Bromet EJ, Carlson GA, Olin TM, Bhatia V, Black SR, & Klein DN (2016). Negative emotionality and its facets moderate the effects of exposure to Hurricane Sandy on children's postdisaster depression and anxiety symptoms. *Journal of Abnormal Psychology*, 125(4), 471. [PubMed: 27030993]
- Lahat A, Hong M, & Fox NA (2011). Behavioural inhibition: is it a risk factor for anxiety? *International Review of Psychiatry*, 23(3), 248–257. [PubMed: 21923226]
- Muris P, van Brakel AM, Arntz A, & Schouten E (2011). Behavioral inhibition as a risk factor for the development of childhood anxiety disorders: A longitudinal study. *Journal of Child and Family Studies*, 20(2), 157–170. [PubMed: 21475710]
- Murray L, Creswell C, & Cooper PJ (2009). The development of anxiety disorders in childhood: an integrative review. *Psychological Medicine*, 39(9), 1413–1423. [PubMed: 19215631]

- Meyer A, Danielson C, Danzig AP, Bhatia V, Black SR, Bromet E, Carlson GA, Hajcak G, Kotov R, & Klein DN (2017). Neural biomarker and early temperament predict increased internalizing symptoms after a natural disaster. *Journal of the American Academy of Child and Adolescent Psychiatry*, 56, 410–416 [PubMed: 28433090]
- NOAA National Centers for Environmental Information (NCEI; 2018). U.S. Billion-Dollar Weather and Climate Disasters. Retrieved from <https://www.ncdc.noaa.gov/billions/>
- Norris FH, Sherrieb K, & Galea S (2010). Prevalence and consequences of disaster-related illness and injury from Hurricane Ike. *Rehabilitation Psychology*, 55(3), 221–230. [PubMed: 20804265]
- Olino TM, Klein DN, Dyson MW, Rose SA, & Durbin CE (2010). Temperamental emotionality in preschool-aged children and depressive disorders in parents: Associations in a large community sample. *Journal of Abnormal Psychology*, 119, 468–478. [PubMed: 20677836]
- Prior M, Smart D, Sanson A, & Oberklaid F (2000). Does shy-inhibited temperament in childhood lead to anxiety problems in adolescence?. *Journal of the American Academy of Child & Adolescent Psychiatry*, 39(4), 461–468. [PubMed: 10761348]
- Rothbart MK & Bates JE (2006). Temperament in children's development In Damon W, Lerner R, and Eisenberg N (Eds.), *Handbook of child psychology, sixth edition: Social, emotional, and personality development* (Vol. 3) (pp. 99–166). New York: John Wiley.
- Rudolph K, & Hammen C (1999). Age and gender as determinants of stress exposure, generation, and reactivity in youngsters: A transactional perspective. *Child Development*, 70, 660–677. [PubMed: 10368914]
- Rudolph KD, Hammen C, Burge D, Lindberg N, Herzberg D, & Daley SE (2000). Toward an interpersonal life-stress model of depression: The developmental context of stress generation. *Development and Psychopathology*, 12(2), 215–234. [PubMed: 10847625]
- Sandberg S, McGuinness D, Hillary C, & Rutter M (1998). Independence of childhood life events and chronic adversities: a comparison of two patient groups and controls. *Journal of the American Academy of Child & Adolescent Psychiatry*, 37(7), 728–735. [PubMed: 9666628]
- Uliaszek AA, Zinbarg RE, Mineka S, Craske MG, Griffith JW, Sutton JM, Epstein A, & Hammen C (2012). A longitudinal examination of stress generation in depressive and anxiety disorders. *Journal of Abnormal Psychology*, 121(1), 4–15. [PubMed: 22004114]
- Wang CW, Chan CL, & Ho RT (2013). Prevalence and trajectory of psychopathology among child and adolescent survivors of disasters: a systematic review of epidemiological studies across 1987–2011. *Social Psychiatry and Psychiatric Epidemiology*, 48(11), 1697–1720. [PubMed: 23824234]

a.

b.

Figure 1.

Interaction of age 3 Laboratory Temperament Assessment Battery (Lab-TAB) behavioral inhibition with (a) total and (b) independent life stress predicting age 12 anxiety.

Figure 2. Interaction of age 3 Laboratory Temperament Assessment Battery (Lab-TAB) behavioral inhibition and Hurricane Sandy stress predicting age 12 anxiety.

Table 1.

Descriptive statistics and intercorrelations between key study variables

Variables	1	2	3	4	5	6	7	8
1. Sex								
2. Lab-TAB BI	-.12 [*]							
3. Total Life Stress (LSI)	-.06	-.03						
4. Independent Life Stress (LSI)	-.08	.01	.81 ^{**}					
5. Dependent Life Stress (LSI)	-.01	-.06	.72 ^{**}	.18 ^{**}				
6. Hurricane Stress	.05	.04	.04	.03	.05			
7. SCARED Age 9	-.05	.05	.04	.05	.02	-.07		
8. SCARED Age 12	-.18 ^{**}	.06	.13 [*]	.12 [*]	.08	.01	.25 ^{**}	
Mean(SD)/%(N)	47(184)	.64(.20)	9.0(5.9)	5.2(4.2)	3.7(3.5)	2.2(2.2)	19(11)	16(10)

[^] $p < .10$,^{*} $p < .05$,^{**} $p < .01$

Note. BI = Behavioral Inhibition; SD = Standard Deviation; Lab-TAB = Laboratory Temperament Assessment Battery; LSI = UCLA Life Stress Interview; SCARED = The Screen for Child Anxiety Related Disorders.

Table 2.

Regression models predicting age 12 anxiety (SCARED) from age 3 behavioral inhibition and total and independent and dependent life stress

Predictors	R ² / R ²	B	SE	β	t	p
Total Life Stress						
<i>Step 1</i>	.10 **					
Sex		-3.35	1.02	-0.16	-3.30	.001 **
Age at age 12 Wave		0.40	1.20	0.02	0.34	.74
Anxiety (age 9)		0.22	0.05	0.23	4.75	<.001 **
Lab-TAB BI		1.56	2.52	0.03	0.62	.54
Total Life Stress		0.19	0.09	0.11	2.26	.02 *
<i>Step 2</i>	.01 *					
BI x Total Life Stress		1.04	0.46	0.11	2.26	.03 *
Independent versus Dependent Life Stress						
<i>Step 1</i>	.10 **					
Sex		-3.34	1.02	-0.16	-3.29	.001 **
Age at age 12 Wave		0.41	1.20	0.02	0.34	.73
Anxiety (age 9)		0.22	0.05	0.23	4.74	<.001 **
Lab-TAB BI		1.52	2.53	0.03	0.60	.55
Ind. Life Stress		0.22	0.12	0.09	1.77	.08 ^
Dep. Life Stress		0.18	0.15	0.06	1.26	.21
<i>Step 2</i>	.02 *					
BI x Ind. Life Stress		1.86	0.62	0.15	3.02	.003
BI x Dep. Life Stress		-0.14	0.77	-0.01	-0.18	.86

^ $p < .10$,

* $p < .05$,

** $p < .01$

Note. BI = Behavioral Inhibition; Lab-TAB = Laboratory Temperament Questionnaire; SCARED = Screen for Child Anxiety Related Emotional Disorders.

Table 3.

Regression model predicting age 12 anxiety (SCARED) from age 3 behavioral inhibition with Hurricane Sandy stress

Predictors	R ² / R ²	B	SE	β	t	p
<i>Step 1</i>	.12 **					
Sex		-2.89	1.12	-0.14	-2.60	.01 **
Age at 12 Wave		-0.44	1.42	-0.02	-0.31	.76
Anxiety Age 9		0.25	0.05	0.26	4.82	<.001 **
Lab-TAB BI		2.96	2.66	0.06	1.11	.27
Total Life Stress		0.20	0.10	0.12	2.14	.03 *
Hurricane Stress		0.11	0.25	0.03	0.46	.65
<i>Step 2</i>	.04 **					
Lab-TAB BI x Total Life Stress		1.32	0.47	0.15	2.84	.005 **
Lab-TAB BI x Hurricane Stress		3.06	1.08	0.15	2.84	.005 **

[^]
p = .05,

*
p < .05,

**
p < .01

Note. BI = Behavioral Inhibition; Lab-TAB = Laboratory Temperament Assessment Battery; SCARED = Screen for Child Anxiety Related Emotional Disorders