

Suicidal Behavior and Stress Generation in Adolescents

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Abstract

Stress generation has potential to account for recurrent suicidal behavior. The current study represents a first step toward evaluating this possibility in a sample of adolescent psychiatric inpatients ($n = 99$; 79.80% female) followed over 6 months. At index admission, participants completed baseline measures of depressive symptom severity, suicidal ideation, lifetime history of suicide attempts, and negative life events using a contextual threat life stress interview. Negative life events since baseline were assessed at the follow-up assessment. Consistent with the stress generation hypothesis, lifetime number of suicide attempts prospectively predicted higher rates of dependent but not independent stress. Bayesian analyses also yielded substantial support for an association with overall dependent stress but provided more modest support for specificity to this form of life stress relative to independent stress. Implications of these findings and directions for future research further clarifying the role of stress generation in suicidal behavior are discussed.

Keywords

Bayesian analysis, life events, suicide, suicide attempts, stress generation

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One of the most robust predictors of future suicide attempts in the empirical literature is a past history of this behavior. Indeed, in a recent meta-analysis (Ribeiro et al., 2016), a medium to large pooled effect was observed for this relationship across a median follow-up period of 2 years. Although the raw number of suicides is higher among older adults (Nock et al., 2008), it is a particular concern in adolescence because it is the second leading cause of death at this age (Centers for Disease Control and Prevention, 2017) and the onset of suicidal behavior increases markedly during this period of development (Nock et al., 2008). Adding to this concern, the national suicide rate has increased 24% over the past 15 years, with females aged 10 to 14 experiencing the greatest increase during this time period (Centers for Disease Control and Prevention, 2016). Within this context and given the current want of evidence-based psychosocial treatments for adolescent suicidal behavior (Ougrin, Tranah, Stahl, Moran, & Asarnow, 2015), elucidating the processes underlying the association between past and future suicidal behavior remains a high priority for the potential to inform future intervention strategies for addressing this major public health concern.

One potential mechanism underlying the recurrence of suicidal behavior is stress generation (Hammen, 1991, 2005), the tendency for certain individuals to experience higher rates of dependent stress (i.e., life stressors that are at least in part influenced by their own behaviors), such as the dissolution of a romantic relationship, but not to differ in terms of rates of independent stress (i.e., life stressors that occur outside the influence of the their behavior), such as the death of a close relative. This stress generation hypothesis was originally conceived as a theoretical framework to account for the tendency for a past history of depression to be associated with a heightened risk for its future occurrence (Hammen, 1991, 2005). Specifically, not only are life stressors an established risk factor for depression (Hammen, 2005), but depression itself may pose a risk for the future occurrence of dependent stress in what is essentially a reciprocal relationship.

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Furthermore, stress generation in depression has been found in several studies to be particular to dependent stress within interpersonal domains (i.e., interpersonal dependent stress; Hankin, Stone, & Wright, 2010; Hernandez, Trout, & Liu, 2016; Rudolph, 2008; Shih, 2006). This specificity of stress generation to dependent stress is of etiological importance because this type of stress appears to be particularly relevant to risk for depression (Hammen, 2009a; Sheets & Craighead, 2014; Vrshek-Schallhorn et al., 2015). That is, depression may lead to the generation of the very stressors that confer greatest risk for depressive recurrence (Hammen, 1991, 2006). In the first study empirically to evaluate the stress generation hypothesis, depressed individuals were found prospectively to experience higher levels of dependent stress, particularly interpersonal ones, but not independent stress over a 1-year period (Hammen, 1991). In the decades since this original study, the role of stress generation in depression has received considerable empirical support (Liu & Alloy, 2010).

Although stress generation has yet to be empirically examined in relation to suicidal behavior, there are several notable phenomenological similarities between suicidal behavior and depression as well as their respective relation with life stress. Both are often episodic and frequently follow a recurrent course: Just as a past history of depression is a strong predictor of its future recurrence (Burcusa & Iacono, 2007), so too is a history of suicidal behavior associated with risk for its recurrence, with one study finding risk of suicide attempts increasing by approximately 32% with each attempt (Leon, Friedman, Sweeney, Brown, & Mann, 1990). The potential involvement of dependent stress in accounting for repeat suicidal behavior is an intriguing possibility warranting investigation given findings supporting the relevance to suicide risk of life stressors, particularly within interpersonal domains, even after accounting for psychopathology (Gould, 2003; Liu & Miller, 2014). The generation of these stressors in at-risk individuals may in some measure account for the link between past suicide and future suicidal behavior. Indeed, several researchers have either posited a role for stress generation in the recurrence of suicide attempts (Liu & Miller, 2014) or noted that certain diatheses for suicidal behavior (e.g., impaired decision making and interpersonal problem solving) are associated with greater difficulties in interpersonal relationships (Jollant et al., 2007; Pollock & Williams, 2004), consistent with stress generation, and may thereby potentially worsen risk for future suicidal behavior (van Heeringen, 2012). Still others have commented on how several interpersonal tendencies that often characterize suicidal individuals (e.g., excessive reassurance seeking) may lead to greater interpersonal difficulties in their lives (e.g., experiencing interpersonal

rejection; Stellrecht, Joiner, & Rudd, 2006). Furthermore, these behavioral tendencies, as viewed within the interpersonal theory of suicide, may in part be motivated by feelings of thwarted belongingness (Stellrecht et al., 2006). Of particular relevance for the potential role of suicidal behavior in stress generation, some of these same risk factors have been previously implicated in stress generation (Eberhart & Hammen, 2009; Hernandez et al., 2016), including in children (Shih, Abela, & Starrs, 2009).

In addition to being of particular clinical importance to suicidal behavior, adolescence may be an age especially relevant to stress generation because this period of transition is marked by increased autonomy and individuation (Grotevant & Cooper, 1985; Steinberg, 2002; Steinberg & Silverberg, 1986; Wray-Lake, Crouter, & McHale, 2010), decreased parental monitoring (Parke & Bhavnagri, 1989), and a greater focus on peer relations and social networks (B.B. Brown, 1990). Concomitant with this larger role in navigating and shaping the social environment is a greater opportunity for the occurrence of dependent stress (e.g., conflicts with parental authorities as a consequence of striving for greater autonomy). Indeed, adolescence has generally been viewed as a period accompanied by higher rates of life stress (Compas, Davis, & Forsythe, 1985). Moreover, in one study examining independent and dependent stress separately in preadolescent and adolescent children (Rudolph & Hammen, 1999), adolescents experienced greater dependent stress than their preadolescent counterparts.

Also worth noting is that several methodological limitations characterize much of the suicide–life stress and stress generation literatures, respectively. First, in both cases, a minority of studies featured interview-based measures of life stress, the majority adopting self-report measures of life stress (Liu, 2013; Liu & Miller, 2014). Even rarer still are studies utilizing contextual threat approaches to measuring life stress, with only three (3.2%) identified in a recent systematic review of studies of life stress and suicidal ideation and behavior (Liu & Miller, 2014). Contextual threat life stress interviews involve drawing from the individual a narrative of the context within which each event occurred and its consequences (G.W. Brown & Harris, 1978). This technique produces detailed information surrounding each event, thus allowing for a much more sensitive evaluation of the event's impact on the individual (e.g., the loss of a close friend of several years because of betrayal and no other friends in the individual's social network is likely to have a considerably higher impact than the loss of a friend of several weeks because of mutual drifting apart and several close friends remaining in the individual's social network).

In the context of stress generation research, such considerations have added importance for accurately differentiating between dependent and independent stress. For example, determining whether a child changed schools because of expulsion from a previous school (i.e., dependent stress) or because of the child's parents' job change requiring a move to a different city (i.e., independent stress) would be impossible with other life stress methodologies.

Another major limitation that constrains interpretability of much of the research in these areas is the considerable temporal overlap in assessment of suicidal behavior and depression, respectively, in relation to life stress. In the case of the empirical literature on life stress and suicide, only 9.5% of studies employed a prospective design, allowing for clean temporal separation of life stress from suicidal behavior (Liu & Miller, 2014). Among studies of stress generation and depression, 55% examined depression in relation to temporally preceding life stress (Liu, 2013), which is problematic insofar as stress generation is conflated with stress exposure in these studies.

The third methodological concern is a statistical one. The stress generation hypothesis involves contrasting predictions for dependent and independent stress; dependent stress is predicted to occur at higher levels in at-risk individuals, and just as importantly, stress generation posits no differences to occur in rates of independent stress. This second component of stress generation is essentially a null hypothesis. All the studies to date to have included an evaluation of this second component of the stress generation hypothesis have done so, without exception, using null hypothesis significance testing (NHST). This is a concern because of the standard prohibition against accepting the null hypothesis with NHST (Gallistel, 2009; Wilkinson & the Task Force on Statistical Inference, 1999). That is, NHST becomes particularly problematic in situations in which the predicted result is a null effect. Consequently, more advanced statistical techniques are required to evaluate adequately this aspect of the stress generation hypothesis. One statistical approach well suited for addressing this limitation of NHST in providing support for the null hypothesis is Bayesian analysis (Dienes, 2011). With NHST, a p value is used to quantify the probability that the observed data (or a more extreme set of results) would occur if the null hypothesis were true. In contrast, Bayesian statistics allows for a direct evaluation of the strength of support for a hypothesis (i.e., H_1) relative to the null hypothesis (i.e., H_0) based on observed data, with Bayes factors used to quantify the strength of empirical support for H_1 relative to H_0 (i.e., BF_{10}) as well as H_0 relative to H_1 (i.e., BF_{01} ; for a guide to Bayesian statistics, see Jarosz & Wiley, 2014).

The objective of the current study was to provide an essential first step toward evaluating the applicability of stress generation to suicidal behavior. That is, it examined whether lifetime number of suicide attempts was prospectively associated with higher rates of dependent stress but not independent stress in a sample of adolescent psychiatric inpatients. In so doing, the current study also aimed to address methodological limitations of past research in this area, adopting a contextual threat life stress interview to assess for the prospective occurrence of life stress over a 6-month interval. To address statistical limitations in prior stress generation studies, the current investigation supplemented conventional statistical analyses (NHST) of the study hypotheses with Bayesian analysis.

Method

Participants

Participants included 99 adolescents (79.8% female; 22.5% Hispanic) ages 13 to 17 years (mean age = 14.68, $SD = 1.50$). Approximately 78.4% of participants were White, 3.4% were African American, 4.6% were Asian American, and 13.6% were mixed/other. All participants were recruited from a university-affiliated adolescent psychiatric inpatient facility. Acute suicidality was high in this sample, being a primary reason for hospitalization. Patients were ineligible for recruitment if they were acutely psychotic, had intellectual or developmental disabilities, or were under the guardianship of child protective services. Parental consent and adolescent assent were obtained from all participating families.

Measures

Lifetime history of psychiatric disorders. Adolescents were interviewed with the Schedule for Affective Disorders and Schizophrenia for School-Age Children (KSADS-PL; Kaufman et al., 1997) to assess lifetime history of diagnoses according to the criteria of the fourth edition of the *Diagnostic and Statistical Manual of Mental Disorders (DSM-IV)*; American Psychiatric Association, 1994). κ was determined based on interrater reliability between interviewers and an experienced licensed clinical psychologist for interviews randomly selected from 20% of the sample. In the current sample, mean κ across diagnoses was .92.

Depressive symptom severity. The Children's Depression Rating Scale-Revised (CDRS-R; Poznanski & Mokros, 1995) was used to assess current depressive symptom severity. This measure is a 17-item semi-structured interview that encompasses all fifth edition of the *Diagnostic*

and *Statistical Manual of Mental Disorders (DSM-5;* American Psychiatric Association, 2013) depressive symptoms and includes three items based on behavioral observation (i.e., depressed facial affect, listless speech, and hypoactivity). Items are rated on 5- or 7-point scales, and individual items are summed and converted to a *T* score. Greater *T* scores on this scale are indicative of greater depressive symptom severity, with scores ≥ 65 indicating clinical severity. This measure demonstrated good internal consistency in the current study (Cronbach's $\alpha = .83$).

Suicidal ideation. The Suicidal Ideation Questionnaire Jr. (SIQ Jr.; Reynolds, 1988) was used to measure current suicidal ideation. This measure is a 15-item self-report scale of current severity of suicidal ideation, with each item rated on a 7-point Likert scale ranging from 0 to 6. Clinical significance is indicated by scores ≥ 31 . Internal consistency in the current sample was high (Cronbach's $\alpha = .95$).

Suicide attempt history. Lifetime number of suicide attempts was assessed using the Columbia-Suicide Severity Rating Scale (C-SSRS; Posner et al., 2011), a semi-structured interview assessing suicidal thoughts and behaviors. Following the standard conventions of the field, suicide attempts were defined as any "self-destructive behavior with at least implied intent to die" (Posner, Oquendo, Gould, Stanley, & Davies, 2007). All interviewers received extensive training and supervision from the first author in the administration of this interview and rating of its data. A rigorous protocol developed by the first author was implemented, with an average training period of 3 to 4 months before interviewers administered the measure independently. Given the centrality of this measure to the study and to prevent interviewer drift, each interview was reviewed soon after its administration by the first author while blind to participants' data for all other study variables, and individualized feedback was provided as needed. Interviewers conferred with the first author whenever coding questions arose. This measure has been found to be reliable for use with adolescent psychiatric samples, with $\kappa = .88$ for suicide attempts (Posner et al., 2011), as well as to possess predictive validity (Brent et al., 2009; Posner et al., 2011).

Life stress. The adolescent version of the UCLA Life Stress Interview (LSI; Hammen & Brennan, 2001) was used to assess the occurrence of life stressors. The LSI is a semi-structured interview that uses a contextual threat approach (G.W. Brown & Harris, 1978) to allow for the assessment of life stressors across a wide range of content domains relevant to adolescents (e.g., friendships, romantic relationships, family, academics, and physical health). Structured initial probes, temporal anchors (e.g.,

generally salient dates such as holidays and personally salient ones such as birthdays), and a calendar were used to increase accuracy in dating of events as well as ensure that the events fell within the assessment period. Adolescents were also presented with a standard list of developmentally relevant stressors to facilitate recall. Contextual narratives of stressors reported during the interview were presented to a rating team blind to each participant's psychopathology (including suicide attempt history) and subjective response to prevent subjective rating biases (G.W. Brown, 1989; Hammen, 2006; Harkness & Monroe, 2016). The rating team scored each event on 5-point Likert scales for the objective severity of the event (from 1 = *no or minimal impact* to 5 = *severe impact*) as well as dependence versus independence (from 1 = *entirely independent of the person* to 5 = *entirely dependent on the person*). For several reasons, we focused our analyses on non-mild life stress (i.e., moderate to severe stressors), operationalized as events with objective severity ratings ≥ 3 (Stroud, Davila, Hammen, & Vrshek-Schallhorn, 2011). First, previous stress generation studies have used this approach (e.g., Uliaszek et al., 2012). Second, there is evidence of specificity of stress generation to severe life stress (Uliaszek et al., 2012). Third, insofar as moderate to severe life stress relative to mild stress is more etiologically relevant to stress-related psychopathology (e.g., depression and suicidal behavior; Hammen, 2005; Paykel, Prusoff, & Myers, 1975), demonstrating the role of moderate to severe life stress to stress generation in suicidal behavior is important for establishing its clinical relevance. Also consistent with prior studies of life stress (Conway, Hammen, & Brennan, 2012; Hammen, 1991; Hammen, Henry, & Daley, 2000), events with independence versus dependence ratings ≥ 3 were categorized as dependent for the purposes of analysis. Finally, the rating team also categorized each event as interpersonal (i.e., events that primarily involve another person) or non-interpersonal (i.e., events that primarily relate to other domains, e.g., academics). The objective severity ratings of relevant events within each category of life stress were summed to create the dependent variables for analysis. The LSI has been used with suicidal adolescent inpatient samples (Pettit, Green, Grover, Schatte, & Morgan, 2011). Such contextual threat life stress interviews are widely regarded as the gold standard in the field (Dohrenwend, 2006; Hammen, 2005; Kessler, 1997; Monroe, 2008) and are less susceptible than self-report checklists to idiosyncratic or subjective response biases (G.W. Brown & Harris, 1978; Harkness & Monroe, 2016; Johnson & Roberts, 1995). In the current sample, intraclass correlation coefficients were .87 and .93 for severity and dependence, respectively. Reliability was determined by having a second rating team, blind to the ratings of the initial rating team, separately rate LSI data for 20% of the sample.

Procedures

Baseline assessments were conducted during participants' index hospitalization. At the baseline assessment, participants completed measures of current depressive symptom severity (CDRS-R), lifetime history of major depression (K-SADS-PL), suicidal ideation (SIQ Jr.), and suicide attempt history (C-SSRS) as well as negative life events during the 6 months immediately preceding their index hospital admission (LSI). At a 6-month follow-up ($M_{\text{Days}} = 199.43$, $SD = 20.27$),¹ participants completed the LSI for negative life events that had occurred since the baseline evaluation. The 6-month follow-up interval was specifically chosen based on evidence that recollection of major life events tends to fade in adolescents after approximately 7 months (Monck & Dobbs, 1985). At the same time, this time interval allowed for sufficient variability in the occurrence of stressful life events under consideration.

Data analysis

A series of χ^2 and independent samples t tests were conducted to evaluate whether participants who attrited and those who completed the 6-month follow-up assessment differed in demographic and baseline study characteristics (i.e., sex, age, depressive symptom severity, suicidal ideation, and lifetime number of suicide attempts). Spearman and Pearson correlations were conducted to examine bivariate relationships between study variables.

To evaluate the study hypotheses that lifetime number of suicide attempts prospectively predicted higher levels of dependent stress, this latter variable was entered into a multivariate linear regression model as the criterion variable, with baseline age, sex, depressive symptom severity, suicidal ideation, and dependent and independent life stress in the preceding 6 months included as covariates and lifetime number of suicide attempts as the predictor. To assess the hypothesis that lifetime number of suicide attempts did not prospectively predict independent stress, this analysis was repeated with independent stress as the criterion variable. Sensitivity analyses were conducted with these models reassessed with lifetime history of major depression substituting for current depressive symptom severity as a covariate. Finally, all analyses were repeated using Bayesian analysis (JASP Team, 2016), with Bayes factor used to quantify the strength of the evidence in favor of the study hypothesis relative to the null hypothesis (BF_{10}) in the case of dependent stress as the criterion variable (i.e., $BF_{10} = \text{likelihood of the data given } H_1 \div \text{likelihood of the data given } H_0$). Bayes factor was also used to quantify the empirical support for the null

hypothesis (BF_{01}) in the case of independent stress (i.e., $BF_{01} = \text{likelihood of the data given } H_0 \div \text{likelihood of the data given } H_1$). When $BF_{10} = 1$, the data are neither supportive of H_1 nor H_0 , and when $BF_{10} < 1$, the data are supportive of H_0 over H_1 . A BF_{10} falling between 1 and 3 provides anecdotal support, between 3 and 10 indicates substantial evidence, between 10 and 30 reflects strong support, between 30 and 100 is indicative of very strong evidence, and above 100 offers extreme evidence in support of H_1 (Jeffreys, 1961; Wagenmakers, Wetzels, Borsboom, & van der Maas, 2011). For prior probability, given that no prior studies of suicidal behavior and stress generation have been conducted, equal likelihood of the predictor variable—suicidal behavior—being included and not included in the final model was assigned (i.e., 0.5).

Results

Descriptive statistics and bivariate correlations

At baseline, 54.55% of adolescents had a lifetime history of attempted suicide,² of which 44.45% were repeat attempters ($M_{\text{Number of attempts}} = 1.82$, $SD = 4.59$, range = 0 to 35),³ and depressive symptom severity and suicidal ideation were both, on average, clinically elevated ($M_{\text{CDRS-R T-score}} = 73.44$, $SD = 8.87$, range = 50 to 85; $M_{\text{SIQ Jr.}} = 42.87$, $SD = 24.15$, range = 0 to 77). Frequency of current diagnoses at baseline was: 73.8% for unipolar depression, 42.6% for generalized anxiety disorder, 23.9% for social anxiety disorder, 19.1% for oppositional defiant disorder, 18.3% for attention deficit/hyperactivity disorder, 17.2% for posttraumatic stress disorder, 17.0% for panic disorder, 8.1% for specific phobia, 7.5% for agoraphobia, 3.3% for conduct disorder, 3.2% for obsessive-compulsive disorder, and 2.1% for bipolar disorder. Among the participants who completed the baseline assessment, 83.8% provided 6-month follow-up data.

Participants who completed the 6-month follow-up assessment did not differ at baseline from those who attrited in terms of sex ($\chi^2 = 0.27$, $p = .60$), age ($t = 0.33$, $p = .74$), depressive symptom severity ($t = 1.00$, $p = .32$), suicidal ideation ($t = 1.02$, $p = .31$), baseline dependent stress ($t = -0.25$, $p = .80$), baseline independent stress ($t = 0.26$, $p = .80$), or lifetime number of suicide attempts ($t = 0.59$, $p = .56$).

Table 1 presents zero-order correlations between the study variables. Depressive symptoms severity was higher in females compared with males and positively correlated with suicidal ideation and lifetime number of suicide attempts. Suicidal ideation was also correlated with lifetime frequency of suicide attempts. As for

Table 1. Bivariate Correlations Between Study Variables

Variable	1	2	3	4	5	6	7	8
1. Age	—							
2. Sex (female)	-.03	—						
3. Depressive symptoms	.18	.22*	—					
4. Suicidal ideation	-.08	.19	.49***	—				
5. Lifetime number of suicide attempts	-.05	.18	.25*	.24*	—			
6. Baseline dependent stress	.11	.13	.05	.06	.15	—		
7. Baseline independent stress	-.07	.05	-.02	< .01	-.09	.10	—	
8. Follow-up dependent stress	< .01	.07	.05	.11	.28*	.15	.09	—
9. Follow-up independent stress	-.26*	.15	.07	.12	.15	.12	.01	.06

Note: Spearman correlations are reported for analyses with sex. Pearson correlations are reported for all remaining analyses.

* $p < .05$. *** $p < .001$.

the different forms of life stress at the bivariate level, consistent with study hypotheses, prospective dependent stress but not independent stress was correlated with lifetime number of suicide attempts. Dependent and independent stress at the time of the index hospitalization (i.e., baseline), however, were not. Means, standard deviations, and percentage of participants prospectively experiencing each stressor type at follow-up were: $M_{\text{Dependent Stress}} = 2.87$, $SD = 4.23$ and $M_{\text{Independent Stress}} = 1.30$, $SD = 2.23$.

Multivariate analyses

In the multivariate linear regression model with dependent stress as the criterion variable, only lifetime number of suicide attempts significantly predicted prospectively occurring dependent stress with conventional NHST such that a higher number of suicide attempts was associated with higher rates of dependent stress. A medium effect size was found for this association. In corresponding Bayesian analysis, we also quantified the strength of the evidence in favor of the study hypothesis that lifetime number of suicide attempts would be prospectively associated with greater dependent life stress (i.e., stress generation) relative to the null hypothesis that there was no association between lifetime number of suicide attempts and prospective dependent life stress. This analysis yielded a BF_{10} of 4.01, indicating that the stress generation hypothesis was 4.01 times more likely than the null hypothesis (i.e., substantial support in favor of the study hypothesis).

In the multivariate regression analysis with independent stress as the criterion variable, lifetime number of suicide attempts was not predictive of this outcome. Corresponding Bayesian analysis was conducted evaluating the strength of evidence in favor of the data supporting the null hypothesis (i.e., lifetime number of suicide attempts being not predictive of prospectively occurring independent life stress). In this analysis, $BF_{01} = 1.50$,

indicating that it was 1.5 times more likely that there was no association between lifetime number of suicide attempts and prospective independent stress than that an association existed. Thus, although $p = .41$ in conventional NHST and Bayesian analysis was similarly supportive of the null hypothesis, the strength of this support in the Bayesian analysis was only anecdotal. Results of multivariate analyses are presented in Table 2.⁴

Discussion

The objective of the current study was to provide the first empirical evaluation of suicidal behavior within the context of stress generation. In this initial step toward determining the applicability of the stress generation hypothesis to recurrence of suicidal behavior, we assessed whether a greater lifetime history of suicidal behavior was prospectively associated with higher rates of dependent stress but not independent stress in an adolescent psychiatric inpatient sample.

We found support for the study hypotheses, with the evidence strong for associations with dependent stress and relatively modest for the absence of associations with independent stress. Both conventional NHST and Bayesian analyses were consistent in yielding significant medium effects and substantial support, respectively, for lifetime number of suicide attempts being positively associated with prospective dependent stress. Although NHST yielded a nonsignificant p value and a small effect size and Bayesian analyses similarly supported the absence of an association between lifetime number of suicide attempts and independent stress, the Bayes factor was modest despite the corresponding relatively large p value. Collectively, these findings are indicative of the limitations of NHST and the importance of more advanced statistical methodology in evaluating the stress generation hypothesis, especially the component involving independent stress. Given the modest support from Bayesian analyses for the

Table 2. Conventional and Bayesian Multivariate Linear Regression Models for the Prediction of Dependent and Independent Stress

Predictor	<i>b</i>	<i>SE</i>	<i>p</i>	BF
Of prospectively occurring dependent stress				
Age	0.14	0.36	.70	BF ₁₀ = 0.54
Sex (female)	0.84	1.29	.52	BF ₁₀ = 0.60
Baseline dependent stress	0.12	0.15	.44	BF ₁₀ = 0.64
Baseline independent stress	0.24	0.28	.39	BF ₁₀ = 0.67
Depressive symptoms	-0.03	0.07	.68	BF ₁₀ = 0.54
Suicidal ideation	< 0.01	0.02	.86	BF ₁₀ = 0.51
Lifetime number of suicide attempts ^a	0.28	0.12	.02	BF ₁₀ = 4.01
Of prospectively occurring independent stress				
Age	-0.30	0.18	.10	BF ₀₁ = 0.69
Sex (female)	0.55	0.66	.41	BF ₀₁ = 1.50
Baseline dependent stress	0.09	0.08	.25	BF ₀₁ = 1.17
Baseline independent stress	< 0.01	0.14	.96	BF ₀₁ = 1.96
Depressive symptoms	0.01	0.03	.84	BF ₀₁ = 1.93
Suicidal ideation	< 0.01	0.01	.95	BF ₀₁ = 1.96
Lifetime number of suicide attempts ^b	0.05	0.06	.41	BF ₀₁ = 1.50

^a $f^2 = .08$. ^b $f^2 = .01$.

hypotheses regarding independent stress, additional research replicating the current findings is required before greater confidence can be assigned to them.

It should be noted that the possibilities of suicidal behavior being associated with elevated dependent and independent stress, respectively, are not mutually exclusive. Elucidating the relation between suicidal behavior and independent stress arguably has equally important theoretical implications, as does documenting its association with dependent stress. If suicidal behavior were predictive of prospectively occurring independent stress, it would not preclude the possible relevance of stress generation to this behavior, and it would be suggestive of the potential relevance of the harsh environment hypothesis, the notion that risk for recurrence of suicidal behavior may arise from being situated in an adverse environment wherein exposure to chronic external stressors is naturally more frequent (Grandin, Alloy, & Abramson, 2007).

This possibility of suicidal behavior prospectively predicting both dependent and independent stress may also be interpreted within the context of research on gene-environment correlation (rGE; Kendler, 2010; Rutter, Moffitt, & Caspi, 2006). rGE specifically refers to genetic influences on exposure to environmental risks through three processes. First, active rGE involves the individual actively selecting or shaping the environment in a manner consistent with his or her genetic predisposition. Second, evocative rGE refers to the tendency for the individual's genetic predispositions to elicit certain

environments. These concepts are congruent with the stress generation hypothesis inasmuch as the individual may self-select into environments that heighten the possibility of negative self-driven behavior (e.g., an adolescent being at greater risk of engaging in risky behavior in part because he or she self-selected into a deviant peer group) or the individual evokes negative interactions with others within their environment (e.g., an adolescent's aggressive tendencies shaping his or her peer social environment). Third, passive rGE involves differential exposure to an environment for reasons other than the individual's direct involvement (e.g., independent stress). Here, the individual's environment is shaped by other influences driven by shared genetic variance (e.g., parents or siblings). Within this framework, it is conceivable that individuals with a history of suicidal behavior are prospectively at greater risk for exposure to independent life stress because they are affected by stress generation in their familial network (e.g., parental job loss and marital conflict), especially insofar as suicidal behavior aggregates within families (Brent, Bridge, Johnson, & Connolly, 1996; Kim et al., 2005). Adding to this possibility is the finding that familial aggregation of suicide is in part influenced by cluster B personality traits (McGirr et al., 2009), which in turn have been implicated in stress generation (Liu & Alloy, 2010). Finally, independent stress is of clinical importance given the negative mental health impact it may have (Harkness, Bruce, & Lumley, 2006). Thus, in addition to the aforementioned statistical grounds, there are clear theoretical and clinical

reasons for further research to clarify the association between suicidal behavior and independent stress.

Although the current study is the first to provide empirical support for the role of suicidal behavior in the generation of dependent life stress, it provides only a partial evaluation of the etiological chain underlying the recurrence of suicidal behavior posited by the stress generation hypothesis. In this regard, it does not differ from the stress generation literature more generally, wherein there is a want of research fully evaluating the etiological chain linking past and future depressive episodes through the mediational effect of stress generation (Liu, 2013). That is, to our knowledge, only one study to date has examined whether stress generation mediates the association between past and future depression (Bos, Bouhuys, Geerts, van Os, & Ormel, 2007), doubtless a reflection of the significant challenge in capturing a sufficient number of prospectively occurring depressive episodes for statistically powered analyses. Similarly, the low base rate for suicidal behavior and attendant difficulties in achieving sufficient statistical power for meaningful analysis have long been recognized as a significant challenge inherent in studying this phenomenon (Borges et al., 2006; Klonsky, May, & Saffer, 2016; Nock et al., 2008; Prinstein, 2008; Prinstein et al., 2008). Nonetheless, to demonstrate the clinical significance of stress generation in recurrent suicidal behavior, this challenge would need to be addressed. It is imperative for future investigations to ascertain whether higher rates of dependent stress mediate the association between past and future suicide attempts. Given accumulating evidence that dependent stressors, particularly within interpersonal domains, are most etiologically relevant to suicidal behavior (Liu & Miller, 2014), there is particularly a need for future studies to evaluate the mediational role of these dependent stressors in the recurrence of this behavior. Such research has the potential to inform our understanding of how to break the link between past and future suicide attempts. Several methodological strategies should therefore be considered adequately to address this challenge in future research, including the adoption of substantially large samples, high-risk samples, and longer follow-ups (Bredemeier & Miller, 2015; Franklin et al., 2017; Glenn & Nock, 2014; Wenzel et al., 2011).

In addition to determining the intrapersonal sequelae of stress generation, the potential interpersonal consequences of the stress generation effect of suicidal behavior warrant consideration in future research. One phenomenologically interesting and clinically important possibility is that stress generation may be a mechanism underlying psychopathological contagion effects (Liu, 2013). It could be that greater dependent stress, particularly within interpersonal domains, experienced by an individual with a history of suicidal behavior places

a strain on the individual's interpersonal relationships, which are likewise exposed to these same stressors. These stressors in turn may elevate risk of stress-related psychopathology (e.g., suicide and depression) within the individual's social network. Congruent with this possibility, stress shared by college roommates has been found in one study to function as a potential mechanism underlying contagion of suicidal ideation (Joiner, 2003). The potential interpersonal pathogenic effects of stress generation may be all the more important during adolescence given the heightened value placed on peer relationships at this developmental period (Choudhury, Blakemore, & Charman, 2006; Somerville, 2013).

Although not the principal focus of this study, depression was not associated with prospectively occurring dependent stress, an interesting finding when viewed within the context of the robustness of this association in the broader stress generation literature (Liu & Alloy, 2010). This was observed at the bivariate level and in multivariate models with both conventional NHST and Bayesian analysis. A probable explanation for these findings is the high levels of depression in the current sample, with the mean CDRS-R score being almost a full standard deviation above the clinical cut-point and 86.1% of the sample having a history of major depression. Although the high degree of depressive symptom severity is not unexpected in a clinically acute inpatient sample, its associated restricted range likely limited the ability to evaluate depressive symptoms in relation to stress generation. Caution should therefore be taken against interpreting the current findings as evidence against stress generation in depression.

Similarly, the absence of a significant association between dependent stress leading up to the baseline hospitalization and lifetime history of suicide attempts should not be taken to be inconsistent with the stress generation hypothesis. Rather, it is important to consider this finding within context of the fact that patients were systematically recruited into the study at one of the most stressful times in their lives (i.e., psychiatric inpatient hospitalization), regardless of their suicide attempt history or psychiatric presentation. In fact, significant recent elevations in life stress are characteristic of and indeed determining factors in the decision to hospitalize the study participants.

The finding that suicidal behavior rather than ideation was associated with stress generation also warrants discussion. Several considerations may be noted. First, from a clinical perspective, stress generation was proposed as a mechanism accounting for the often recurrent nature of depression (Hammen, 2006). If stress generation were only a proximal or temporally delimited phenomenon and insofar as depressive episodes often do not occur in close temporal proximity

to each other, stress generation would be limited in its ability to account for the etiological link between past and future depression. That is, stress generation would simply become a theory accounting for depressive relapse rather than recurrence. This seems unlikely to be the case because stress generation also appears to occur during depressive remission (Hammen, 2006). With respect to suicidal ideation, this phenomenon is often very time-delimited, in contrast to lifetime suicide attempt history. Indeed, recent ecological momentary assessment studies have found considerable fluctuations in ideation over the course of even a day (Kleiman et al., 2017). It may therefore be an unstable candidate for stress generation over a 6-month follow-up and less able than suicide attempt history to account for processes linking past and future suicidal behavior. Second, stress generation is an example of an action theory (Hammen, 2006) in that the individual is conceptualized as an active agent in shaping his or her environment rather than being a passive element in it. Thus, although cognitive factors have been implicated in stress generation, behavioral risk factors are likely more directly relevant to this phenomenon (Liu, 2013). Third, if suicidal ideation is involved in stress generation, we would be unlikely to observe this effect in the current study given that participants were drawn from a psychiatric inpatient unit and acutely suicidal, having been admitted for engaging in suicidal behavior or expressing ideation to a degree that prompted concerns regarding imminent risk. Consequently, although our sample is well suited for evaluating suicide attempt history in relation to stress generation, the limited range in ideation limited the likelihood that a stress generation effect for suicidal ideation would be observed. That is, the number of suicide attempts was more likely to differentiate these participants than an index of acute suicidality (i.e., current ideation) specifically because they were recruited at a time of particular acuity. This is not to say that suicidal ideation has no potential relevance to stress generation. Rather, it is unlikely to be the primary factor driving this phenomenon in individuals at risk for suicidal behavior but instead may heighten it during times of clinical acuity (e.g., in within-person analyses of suicidal ideation and prospective life stress at multiple time points).

Beyond establishing prior suicidal behavior as a predictor of stress generation, it would be important to identify the specific stress generation mechanisms underlying this relationship. That is, what is it about suicidal behavior that makes it associated with stress generation? Just as the relation between depression and stress generation may be primarily accounted for by third variables conferring risk for both (e.g., personality pathology; Hammen, 2006), we propose that rather than

inherently and directly driving stress generation, suicidal behavior may largely function as a proxy of risk for this phenomenon, with a greater number of suicide attempts being reflective of correspondingly greater risk. It then naturally follows to consider what these processes may be.

It is first important, however, to contextualize stress generation and the processes that precede and follow it along the pathway in its relation to suicidal behavior. Insofar as life stress may precipitate suicidal behavior (Bagge, Glenn, & Lee, 2013), stress generation may be conceptualized as a relatively proximal process in this pathway. If lifetime number of suicide attempts is a proxy for third-variable causal risk factors for suicidal behavior with stress generation serving as a mediating mechanism, these causal risk factors are necessarily distal and thus predominantly trait-like ones (Franklin et al., 2017; Glenn & Nock, 2014) in relation to suicidal behavior (although, as mentioned previously, this idea does not preclude the possibility of state influences intermittently exacerbating their effect on stress generation, e.g., as may potentially be the case with suicidal ideation).

As for what may be the risk factors driving stress generation in suicidal behavior, this is a potential avenue for future empirical consideration. Given the aforementioned relationships between suicidal behavior and deficits in decision making and interpersonal problem solving as well as the associations between these suicide risk factors and difficulties in interpersonal relationships (Jollant et al., 2007; Pollock & Williams, 2004), these risk processes may be promising candidates. Similarly, given the association between personality pathology and suicide (McGirr et al., 2009) and stress generation (Liu & Alloy, 2010), respectively, dysfunctional interpersonal styles more broadly may also be important to evaluate in future research. Also a potential candidate for stress generation in suicidal behavior is impulsivity, among the most widely studied psychological constructs in relation to suicide (Wenzel & Beck, 2008). There is also preliminary evidence implicating impulsivity in stress generation (Liu & Kleiman, 2012). Furthermore, of relevance to the study of adolescent suicidal behavior, trait impulsivity is more strongly related to suicidality in this period of development than in early adulthood (Kasen, Cohen, & Chen, 2011; McGirr et al., 2008).

As for processes more proximally pertinent to the effect of stress generation on suicide risk (i.e., processes that account for why stress generation leads to suicidal behavior in certain individuals), deterioration of coping skills, particularly when confronted with negative affect produced by generated stress, may be a promising candidate for future investigation. Such

decline in coping skills when exposed to negative affect has been documented in individuals with a history of suicidality (Williams, Barnhofer, Crane, & Beck, 2005).

It is worth mentioning that if suicidal behavior should indeed prove to be a proxy of risk for stress generation rather than directly lead to this outcome, its importance in this phenomenon should not be discounted. Rather, its role as a proxy of risk may be of particular value in clinical contexts, in which determinations of clinical risk are reliant on brief assessments; assessments of suicide attempt history can generally be conducted more expediently than assessments of constructs potentially more directly driving stress generation (e.g., impulsivity and neuroticism).

Another intriguing avenue for future study may be to determine the types of the stressors most relevant to suicidal behavior and stress generation as well as developmental influences on the types of stressors most pertinent to this association. Interpersonal stressors in particular have been implicated in risk for suicidal behavior (Gould, 2003; Liu & Miller, 2014). Furthermore, among younger adolescents with suicidal behavior, parent-child conflict appears to be most commonly observed, whereas among older adolescent counterparts, romantic stressors feature more prominently (Gould, 2003). Similarly, fine-grained determinations of the stressors involved in stress generation in suicidal adolescents may advance strategies to detect particularly at-risk individuals as well as provide more precision to efforts to identify the areas of interpersonal functioning most in need of clinical intervention.

A limitation of the current study that would also be important to address in future investigations is whether a sex difference exists in the stress generation effect of suicidal behavior. The small proportion of males in the sample of the current study did not allow for an adequate assessment of this possibility. There is accumulating theoretical and empirical support, however, for sex differences in stress generation with depression, with the evidence to date indicating that this effect is stronger in females than in males (Hammen, 2009b; Hankin & Abramson, 2001; Liu & Alloy, 2010; Rudolph & Hammen, 1999; Shih, 2006). The extent to which female suicide attempters similarly experience greater stress generation than their male counterparts is of clinical relevance. Sex differences in stress generation may in some measure account for the sex difference in rates of attempted suicide that emerges in early adolescence, with girls engaging in nonfatal suicide attempts at a higher rate than boys (Nock et al., 2008).

Finally, further elucidating the involvement of stress generation and the potentially differential roles of dependent and independent stress in risk for recurrence of suicidal behavior has the potential to inform treatment directly. Dependent stressors, unlike independent

ones, are modifiable. Thus, support for stress generation in suicidal behavior suggests that intervention efforts with individuals with a history of this behavior would benefit from focusing on behavior modification strategies targeting stress generation mechanisms. Through such strategies, the severity and frequency of dependent stress may be reduced. If independent stress is relevant to recurrent suicidal behavior, intervention efforts with individuals with prior suicidal behavior may instead benefit from focusing on skills to cope with stressors when they do occur. Through such tailored strategies, vulnerability to these stressors may be reduced.

Action Editor

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Author Contributions

R. T. Liu developed the study concept. Both authors contributed to the study design. Data collection was conducted by R. T. Liu. R. T. Liu performed the data analysis, and both R. T. Liu and A. Spirito contributed to interpretation of the results. R. T. Liu drafted the manuscript, and A. Spirito provided critical revisions. Both the authors approved the final manuscript for submission.

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Supplemental Material

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Notes

1. When length of follow-up was included as a covariate in analyses, the results remained essentially unchanged, and this variable was not a significant predictor in any of the analyses (see Table S1 in the Supplemental Material available online).
2. Comparisons were conducted of adolescents with and without a history of suicide attempts on baseline study variables. These are presented in Table S2 in the Supplemental Material.

3. Four participants reported a high lifetime history of suicide attempts (i.e., > 8). When outliers in number of lifetime attempts were accounted for by winsorizing the data, the results remained essentially unchanged (see Table S3 in the Supplemental Material).

4. In sensitivity analyses, both multivariate models were reassessed with lifetime history of major depression substituting for current depressive symptom severity as a covariate. The results remained largely unchanged (see Table S4 in the Supplemental Material). Additionally, for the variables included in the multivariate models presented here, tolerance > .67 and variance inflation factor < 1.49.

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