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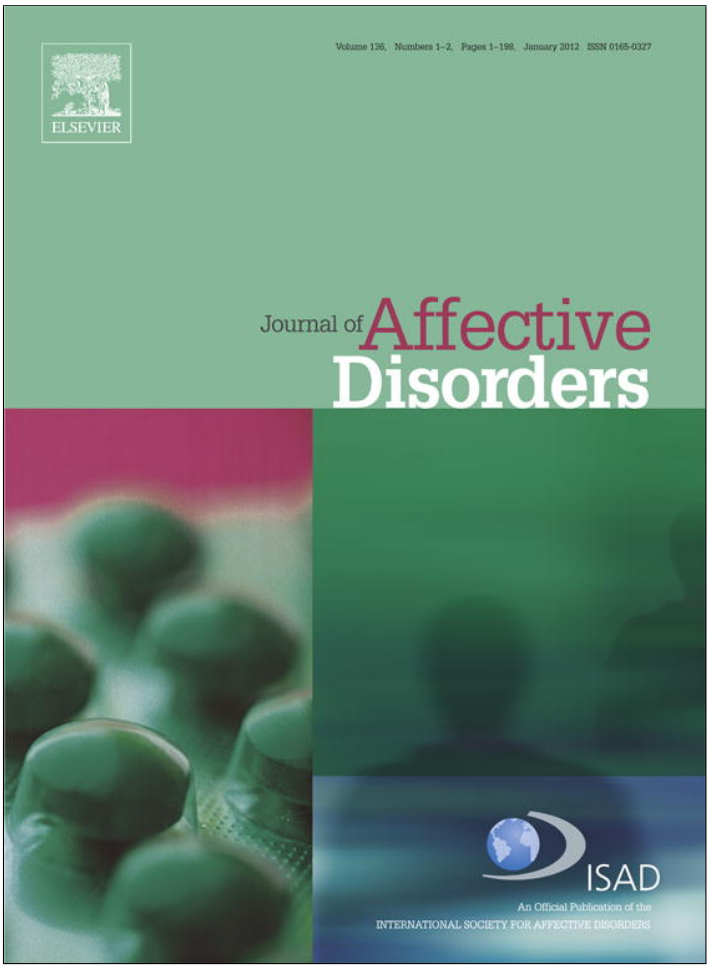

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Research report

Predicting suicide attempts in depressed adolescents: Clarifying the role of disinhibition and childhood sexual abuse

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ABSTRACT

Background: Suicide is the second leading cause of death among adolescents, and depressed youth are six times more likely to make suicide attempts as compared to non-depressed adolescents. The present study examined the unique and interactive effects of two well-established correlates of suicidality – childhood sexual abuse (CSA) and disinhibition – in predicting suicide attempts among depressed adolescents.

Method: Participants were 163 adolescents (125 females) aged 13–18 ($M=15.60$, $SD=1.27$) diagnosed with Major Depressive Disorder ($n=95$, 58.3%) and/or Dysthymia ($n=69$, 42.3%) recruited from an acute residential treatment service. Participants completed interviews assessing psychopathology and suicidality, self-report measures of depressive symptoms and CSA, and a computerized disinhibition task.

Results: Consistent with hypotheses, CSA moderated the association between disinhibition and adolescents' report of their past year and lifetime suicide attempts. Specifically, higher disinhibition was associated with a greater likelihood of having made a suicide attempt among adolescents with a history of CSA, but not among those without. The same pattern of results held in analyses of suicide attempt frequency.

Limitations: Primary findings were based on observational, cross-sectional data, and therefore, causal relationships cannot be inferred. The gender imbalance in the sample precluded stratifying our analyses by gender. CSA was ascertained by self-report; replication of the results with more objective measures is warranted.

Conclusions: Our findings indicate that CSA and disinhibition may work together to predict elevated suicide risk, and these results have implications for early identification efforts in youth at high risk for suicide.

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1. Introduction

In 2013, more than 1500 American adolescents committed suicide, making this the second leading cause of death for individuals 13–18 years old (Centers for Disease Control and Prevention (CDC) 2013). For every completed suicide among youth, there are 100–200 attempts (Crosby et al., 2011), and a recent epidemiological study indicated that 4.1% of adolescents make at least one attempt by the age of 18 (Nock et al., 2013). Mood disorders, particularly Major Depressive Disorder (MDD), are a well-established risk factor for attempts, and among adolescents with MDD, there is a 6-fold greater risk for suicide attempts as compared to non-depressed youth (Nock et al., 2013).

Given the alarming rates of suicide attempts and completions among adolescents diagnosed with MDD, identifying core risk factors for suicidal behaviors among these individuals is essential. One promising marker of risk for suicide is impulsiveness (Gvion and Apter, 2011; Mann et al., 1999), which is often defined as a trait tendency towards unplanned responses to internal and external stimuli with little regard for negative consequences (Braquehais et al., 2010). However, it is important to note that impulsiveness is a heterogeneous construct that is comprised of related but separable dimensions in emotion-relevant (e.g., negative and positive urgency) and non-emotion-relevant (e.g., distractibility, lack of self-control, non-planning) domains (e.g., Carver et al., 2011; Whiteside and Lynam, 2001). Nevertheless, research on suicidality has most often focused on overall trait impulsiveness and viewed this characteristic as a diathesis that predisposes individuals to act on their suicidal thoughts (Mann et al., 1999). In

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support of this idea, studies have consistently shown that self-reported trait impulsiveness is associated with adolescent suicidality, even when controlling for depression (e.g., Brent et al., 2003; Sourander et al., 2001).

However, research on impulsiveness and suicidality, particularly among adolescents, is limited by almost exclusively employing self-report measures. Self-report measures rely on respondents' self-awareness and recall of complex behavioral patterns and are therefore often biased (Wilson and Dunn, 2004). As an alternative, a small group of studies on suicidality have used performance-based measures of impulsiveness to capture specific elements of this construct. In particular, three adult studies unpacking this relationship probed behavioral disinhibition (i.e., acting without thinking), which is one facet of impulsiveness. Participants reporting a history of suicide attempts made more commission errors (i.e., false alarms) but did not differ in their rates of correct detections (Dougherty et al., 2004; Swann et al., 2005; Wu et al., 2009). Furthermore, behavioral measures of disinhibition also differentiated adolescent suicide attempters from non-attempters (Dougherty et al., 2009; Horesh, 2001). Taken together, these findings suggest that behavioral disinhibition may provide important insights into the study of suicide, but additional research is warranted with adolescents.

The vast majority of adolescents with high levels of disinhibition do not engage in suicidal behaviors, and thus, there is likely an array of factors that may strengthen or weaken the association between behavioral disinhibition and suicide attempts. One possibility is that the relationship between disinhibition and suicidality is shaped by early adverse experiences. Experiencing neglect and abuse in childhood is, in itself, a robust predictor of adolescent suicidality (Miller et al., 2013). Furthermore, early maltreatment has substantial effects on the neurobiological stress response system, and specifically, on the functioning of the hypothalamic–pituitary–adrenal (HPA) axis. Briefly, early maltreatment disrupts the natural negative feedback system within the HPA axis, ultimately contributing to a prolongation of the biological stress response to environmental triggers (Braquehais et al., 2010). Such heightened stress sensitivity may lead people to experience greater negative affect in response to negative life events and to perceive stressors as more aversive, contributing to suicidal impulses (Mann et al., 1999). Supporting this theoretical framework, Giletta et al. (2015) found that adolescent girls who exhibited hyperresponsive HPA axis activity to a laboratory stressor were at heightened risk for increases in future suicidal ideation. For individuals already sensitized to stress due to adverse experiences like maltreatment, it is possible that high disinhibition increases the likelihood that these individuals act impulsively and make attempts. We propose that disinhibition may be an especially strong predictor of suicidal behavior among those with a history of childhood maltreatment.

Although research on suicidality has amassed a large amount of univariate risk factors, there is a paucity of information about how these predictors work in concert to potentially increase risk. Thus, the primary aim of the present study was to examine the unique and interactive effects of impulsiveness and childhood maltreatment in predicting a history of suicide attempts in a sample of depressed adolescent inpatients. Consistent with previous research (Dougherty et al., 2004, 2009; Horesh, 2001; Swann et al., 2005; Wu et al., 2009), we focused on disinhibition and assessed this construct using a continuous performance task. Measures of maltreatment are not associated with behavioral assessments of disinhibition (Auerbach et al., 2014), which further supports testing a moderation model with these constructs. Some prior research has suggested that childhood sexual abuse (CSA) may be a stronger risk factor for suicidal behaviors than physical abuse (Hacker et al., 2006) and emotional abuse (Joiner et al., 2007), and thus, we chose to focus analyses on sexual abuse. We tested the following hypotheses in a sample of depressed adolescent inpatients. In line with prior studies, we hypothesized that CSA and disinhibition each would be significantly, uniquely associated with adolescents' previous suicide attempts (i.e., past year and lifetime). Additionally, we tested whether CSA moderated the effect of disinhibition to predict past suicide attempts.

2. Method

2.1. Participants

Participants were 163 adolescents (38 male, 125 female) recruited from an acute adolescent residential treatment program. Adolescents in this program receive a combination of psychotherapy and pharmacotherapy interventions for approximately 10–14 days before being discharged to outpatient services. Participants were 13–18 years old ($M=15.60$, $SD=1.27$) and their racial/ethnic distribution included: 76.2% White, 11.0% Asian, 6.1% multicultural (i.e., more than one race endorsed), 4.3% Black, 0.6% Native American and 0.6% Pacific Islander. Participants were included if they met Diagnostic and Statistical Manual of Mental Disorders – Fourth Edition (DSM-IV-TR; American Psychiatric Association, 2000) diagnostic criteria for current MDD ($n=95$, 58.3%) and/or Dysthymia ($n=69$, 42.3%) according to the Mini International Neuropsychiatric Interview for children and adolescents (MINI-KID; Sheehan et al., 2010). Participants were excluded if they reported current or past mania, psychosis or pervasive developmental disorder.

2.2. Measures

Mini International Neuropsychiatric Interview for children and adolescents (MINI-KID; Sheehan et al., 2010). The MINI-KID is a structured diagnostic interview designed to capture current and past psychopathology among youth. All interviews were conducted by BA-level research assistants or graduate students after receiving 25 h of training (e.g., didactics, mock-interviews, direct supervision). The MINI-KID has demonstrated good psychometric properties in regards to diagnosing psychopathology in outpatient (Sheehan et al., 2010) and inpatient (Auerbach et al., 2014) adolescents.

Center for Epidemiologic Studies Depression Scale (CES-D; Radloff, 1977). The CES-D is a 20-item self-report inventory assessing depressive symptom severity. Each item is rated on a scale from 0 (rarely or none of the time) to 3 (almost or all of the time), and scores range from 0 to 60, with higher scores indicating more severe depressive symptoms. In our sample, the internal consistency of the CES-D items was excellent ($\alpha=.92$).

Gradual Onset Continuous Performance Task (gradCPT; Esterman et al., 2013). Participants viewed a series of gray scale images of mountain (10%) and city (90%) scenes. Over 800 ms, the images transitioned from one to the next and participants were instructed to make a button press to city scenes and withhold responses to mountains. Overall, participants completed two 30-s practice blocks, followed by a single 6-min block with 450 trials. The gradCPT has been used to measure disinhibition and sustained attention in both adults (Esterman et al., 2013; Esterman et al., 2014) and adolescents (Auerbach et al., 2014). Studies have employed several different indicators to measure performance on the task, including the rate of commission errors (i.e., when participants respond incorrectly to mountains), d' (i.e., a ratio of correct responses to commission errors) and the slope of commission errors over the task.

We focused our analyses on the slope of commission errors

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because this index is unaffected by participant motivation (Esterman et al., 2014). Thus, we were able to capture disinhibition independent of individual differences in motivation to perform well. Following Esterman et al. (2014), we first computed the commission error rate for each of the 2-min quartiles of the task, and then used these to determine the slope over the task. A negative slope indicated that participants committed fewer commission errors (improved) over time, while a positive slope value corresponded to more commission errors (worsened) over time. Participants were labeled as belonging to the "high disinhibition" group ($n=103$) if they had positive slope values and belonging to the "low disinhibition" group ($n=58$; 2 participants did not complete the gradCPT) if they had negative slope values. We analyzed this dichotomy, specifically, as we wanted to examine the distinction between those who became more disinhibited over the course of the task versus those who did not (which would be otherwise lost when averaging the performance across the task).

Childhood Trauma Questionnaire (CTQ; Bernstein et al., 1994). The CTQ is a 25-item self-report questionnaire used to assess childhood experiences of abuse and neglect. We focused on the 5-item sexual abuse subscale of the CTQ, wherein adolescents rated each item based on their experiences in childhood and adolescence on a 5-point scale (1=never true to 5=very often true). Scores on the subscale range from 5 to 25, with higher scores reflecting more reported CSA. In our sample, the internal consistency of the CSA subscale was excellent ($\alpha=.96$). Following the CTQ guidelines (Bernstein and Fink, 1998) CTQ scores were dichotomized to indicate the presence (CTQ ≥ 6) or absence (CTQ=5) of CSA. Forty-five (28.3%; 4 participants had missing data) participants reported a history of CSA[1].

Self-Injurious Thoughts and Behaviors Interview (SITBI; Nock et al., 2007). The SITBI is a structured clinical interview that quantifies the presence, frequency and severity of suicidal thoughts and behaviors, and it has demonstrated adequate concurrent validity (i.e., medium to large correlations with other interview-based and self-report measures of suicidality) in an adolescent inpatient sample (Venta and Sharp, 2014). The current study assessed the frequency of suicide ideation and plans, as well as the presence/absence and frequency of suicide attempts that participants reported in the past year and in their lifetimes. Based on the SITBI, we generated 4 dependent variables of interest: (1) the presence/absence (dichotomous) of at least one suicide attempt in the past year, (2) the presence/absence (dichotomous) of at least one lifetime suicide attempt, (3) the total number of suicide attempts in the past year and (4) the total number of lifetime suicide attempts.

2.3. Procedure

The Institutional Review Board approved this study and treatment of participants was in accordance with the American Psychological Association ethical standards. All participants were recruited from an inpatient residential program, and prior to participation, legal guardians and adolescents aged 18 years provided written, informed consent, and adolescents 13–17 years provided assent. Within approximately 2 days of admission, all participants completed the structured interviews (MINI-KID, SITBI), the behavioral disinhibition task (gradCPT), and self-report measures (CTQ, CES-D) during a single laboratory session.

2.4. Data analysis

Continuous suicide plans and attempts variables were first transformed to reduce their positive skew and limit the impact of outliers. Following recommendations for treating outliers (Tabachnick and Fidell 2013), scores greater than 3 standard deviations from the mean were assigned less extreme values that maintained their relative ranking in the distribution. Next, we applied a logarithmic transformation of the variables so that their distributions approximated normality. We then conducted a series of 2 logistic regression analyses to predict attempter status from CSA, disinhibition, and their interaction. In Step 1 of these models, we entered depressive symptoms and suicidal ideation and planning for the relevant period (past year or lifetime) from the SITBI. This conservative approach ensured that results were independent of state-based effects. In Step 2, we entered the main effects of CSA and disinhibition, and then in Step 3, entered the *CSA* × *disinhibition* interaction. We conducted 2 multiple regression analyses to predict the frequency of suicide attempts. Predictor variables were entered in a stepwise fashion in the same manner as the logistic regression analyses. We probed significant interaction effects using simple slopes analyses (Aiken and West, 1991).

3. Results

3.1. Preliminary analyses

Correlations among CSA, disinhibition, depressive symptoms, and suicidality are presented in Table 1. Consistent with previous research, CSA was significantly associated with lifetime suicide attempts; however, CSA was not associated with suicide ideation or planning. The lack of significant correlations among disinhibition and the moderator (CSA) and outcome (attempts) further supports the rationale for testing moderation (Tabachnick and Fidell, 2013).

Adolescents reporting at least one lifetime suicide attempt did not differ from non-attempters as a function of their gender, ethnicity or age (all p's $>.25$). Consistent with previous research (Nock et al., 2010), attempters and non-attempters also did not differ in their lifetime or past year suicidal ideation, their past year suicide planning, or their total CES-D scores (all p's $>.27$) However, attempters reported significantly more lifetime suicide plans than non-attempters ($t(156)=-2.66$, $p=.009$). Attempters and non-attempters did not differ in their distributions of adolescents in the high and low disinhibition groups $\chi^2(1, n=158)=.32$, $p=.57$; however, adolescents reporting a history of CSA were significantly over-represented among attempters versus non-attempters ($\chi^2(1, n=156)=8.36$, $p=.004$). Finally, the relative distribution of adolescents in the high disinhibition group did not differ between those with a history of CSA ($n=28/43$, 65.1%) and those without (72/114, 63.2%) ($\chi^2(1, n=157)=.05$, $p=.82$).

3.2. Predicting the occurrence of suicide attempts in the past year and lifetime

We first estimated a logistic regression model of suicide attempt occurrence in the past year. In Step 1, depressive symptoms, past year suicidal ideation, and past year number of suicide plans did not predict attempts ($\chi^2(3, n=149)=2.02$, $p=.57$, $R^2_{C\&S}=.01$). In Step 2, we included CSA and disinhibition, which significantly improved the model ($\chi^2(2, n=149)=6.15$, $p=.046$, $R^2_{C\&S}=.05$). Specifically, the presence of past CSA, but not disinhibition ($B=.22$,

[1] Eighty-two (50.0%) adolescents in our sample reported emotional abuse and 27 (16.5%) reported physical abuse. Among those reporting CSA, 20 (45.5%) reported emotional abuse and 14 (31.1%) reported all three forms of abuse. We ran all primary analyses controlling for emotional and physical abuse and our results were unchanged. Further, we ran the same models we present below replacing CSA with physical abuse and emotional abuse. There were no significant main effects of either physical or emotional abuse in any of these models, nor did these forms of abuse interact with disinhibition to predict suicidality.

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Table 1
Correlations and descriptive statistics for the sample, stratified by suicide attempter group.

	1	2	3	4	5	6	7	8	9
1. Childhood sexual abuse (CTQ)	–	.02	**.19***	.13	.01	-.06	.01	-.04	-.09
2. Disinhibition (gradCPT)		–	.02	.02	.02	-.05	-.08	-.13	-.03
3. Lifetime attempts[a] (SITBI)			–	**.89*****	.13	.14	**.28*****	-.12	.04
4. Past year attempts[a] (SITBI)				–	.08	**.17***	**.28*****	-.10	.12
5. Lifetime suicidal ideation (SITBI)					–	**.77*****	**.57*****	-.09	**.26****
6. Past year suicidal ideation (SITBI)						–	**.56*****	-.06	**.42*****
7. Lifetime suicide plans[a] (SITBI)							–	-.15	**.33*****
8. Past year suicide plans[a] (SITBI)								–	.03
9. Depressive symptoms (CES-D)									–
Lifetime suicide attempters (n=59)									
Mean	24[b]	39[c]	3.24	2.69	307.28	116.29	38.92	29.25	33.02
SD	42.9[b]	66.1[c]	5.83	5.83	486.91	122.78	108.53	65.11	13.21
Range	–	–	1 – 40	0 – 40	0 – 1826	0 – 365	0 – 550	0 – 365	3 - 56
Lifetime non-attempters (n=101)									
Mean	21[b]	61[c]	–	–	368.32	95.70	47.17	31.51	32.93
SD	21.0[b]	61.6[c]	–	–	487.83	116.63	100.23	66.82	12.32
Range	–	–	–	–	1–1825	0–365	0 – 549	0–300	2–55

* $p<.05$;
** $p<.01$;
*** $p<.001$; CTQ=childhood trauma questionnaire; gradCPT=gradual onset continuous performance task; SITBI=self-injurious thoughts and behaviors interview; CES-D=center for epidemiologic studies depression scale.
[a] Listed means and standard deviations are untransformed values.
[b] Denotes number and percentage of participants who reported a history of childhood sexual abuse; 1 lifetime non-attempter and 3 lifetime attempters had missing CTQ data.
[c] Denotes number or percentage of participants in the high disinhibition group; 2 lifetime non-attempters had missing gradCPT data.

Table 2
Logistic regression analyses predicting dichotomous suicide attempter status.

	$B(SE)$	Wald	p	OR	CI_{95}
Suicide attempt(s) past year (y/n)					
CES-D total	–.01 (.02)	.30	.59	.99	.96–1.02
Ideation past year	.003 (.002)	2.27	.13	1.00	1.00–1.01
Plans past year	–.09 (.29)	.10	.75	.91	.52–1.62
CSA	–.65 (.74)	.78	.38	.52	.12–2.21
Disinhibition	–.50 (.46)	1.20	.27	.61	.25–1.49
CSA × disinhibition	2.36 (.89)	7.08	**.008**	**10.63**	**1.86–60.65**
Suicide attempt(s) lifetime (y/n)					
CES-D total	–.02 (.02)	2.09	.15	.98	.95–1.01
Ideation lifetime	–.006 (.02)	.10	.75	.99	.96–1.03
Plans lifetime	.87 (.32)	7.49	**.006**	**2.37**	**1.28–4.41**
CSA	–.50 (.71)	.49	.48	.61	.15–2.44
Disinhibition	–.33 (.46)	.52	.47	.72	29–1.78
CSA × disinhibition	2.44 (.89)	7.47	**.006**	**11.49**	**2.00–66.14**

Note. CES-D=center for epidemiological studies depression scale; CSA=childhood sexual abuse (absence versus presence); disinhibition=low versus high levels, measured using the gradual onset continuous performance task.

SE=.38, Wald(1)=.33, p=.56, OR=1.25, CI_{95}=1.32–6.21), was associated with higher odds of making a suicide attempt in the past year (B=.92, SE=.38, Wald(1)=5.77, p=.016, OR=2.51, CI_{95}=1.18–5.32). Further, when controlling for depressive symptoms, suicide ideation, and past year number of suicide plans, the *CSA × disinhibition* interaction significantly predicted suicide attempts in the past year ($\chi^2(1, n=149)=7.84$, p=.005, $R^2_{C\&S}$=.10; see Table 2). Among adolescents with no history of CSA, the effect of disinhibition was non-significant (B=–.50, SE=.46, Wald(1)=1.20, p=.27, OR=0.61, CI_{95}=0.25–1.49). However, among adolescents reporting CSA, disinhibition significantly predicted a greater likelihood of attempting suicide in the past year (B=1.86, SE=.76, Wald(1)=5.94, p=.015, OR=6.45, CI_{95}=1.44–28.83; see Fig. 1a).

For lifetime attempts, Step 1 was significant ($\chi^2(3, n=145)$=10.19, p=.017, $R^2_{C\&S}$=.07; see Table 2). Lifetime frequency of suicide plans was significantly associated with greater odds of a lifetime suicide attempt (B=.85, SE=.30, Wald(1)=8.11, p=.004, OR=2.34, CI_{95}=1.30–4.21). In Step 2, the addition of the main effects of CSA and disinhibition significantly improved the model ($\chi^2(2, n=145)=8.41$, p=.015, $R^2_{C\&S}$=.12). A history of CSA was associated with greater odds of making a lifetime suicide attempt (B=1.05, SE=.40, Wald(1)=7.03, p=.008, OR=2.86, CI_{95}=1.32–6.21), but disinhibition was not (B=.42, SE=.39, Wald(1)=1.18, p=.28, OR=1.52, CI_{95}=0.71–3.24). The addition of the *CSA × disinhibition* interaction in Step 3 also was statistically significant ($\chi^2(1, n=145)=8.05$, p=.005, $R^2_{C\&S}$=.17). There was no effect of disinhibition among adolescents without CSA (B=–.33, SE=.46, Wald(1)=.52, p=.47, OR=0.72, CI_{95}=0.29–1.78); however, among adolescents with CSA, high disinhibition was associated with a higher odds of a lifetime suicide attempt (B=2.11, SE=.76, Wald(1)=7.76, p=.005, OR=8.23, CI_{95}=1.87–36.26; see Fig. 1b).

3.3. Predicting frequency of suicide attempts in past year and lifetime

Step 1, including depressive symptoms and past year suicidal ideation and plans, was not significant (R^2=.04, $F(3, 145)$=2.13, p=.10). The addition of CSA and disinhibition in Step 2 did not improve the model overall (ΔR^2=.03, $\Delta F(2, 143)$=2.04, p=.13), but there was a unique effect of CSA such that reporting a history of CSA was associated with a greater number of suicide attempts in the past year (B=.09, SE=.04, $t(143)$=2.02, p=.045, r_{sp}=.16). In contrast, there was no unique effect of disinhibition in Step 2 (B=.003, SE=.04, $t(143)$=.06, p=.95, r_{sp}=.01). In Step 3, the *CSA × disinhibition* interaction improved the model (ΔR^2=.03, $\Delta F(1, 142)$=4.66, p=.033; see Table 3). For adolescents with no CSA, disinhibition was not associated with number of past year attempts (B=–.05, SE=.05, $t(142)$=–1.08, p=.28, r_{sp}=–.09). However, among adolescents with CSA, high disinhibition was associated with more attempts in the past year at a statistical trend (B=.14, SE=.08, $t(142)$=1.86, p=.065, r_{sp}=.15).

When examining the frequency of lifetime suicide attempts, Step 1 was significant (R^2=.11, $F(3, 141)$=5.50, p=.001); however, the addition of the main effects of CSA and disinhibition was non-

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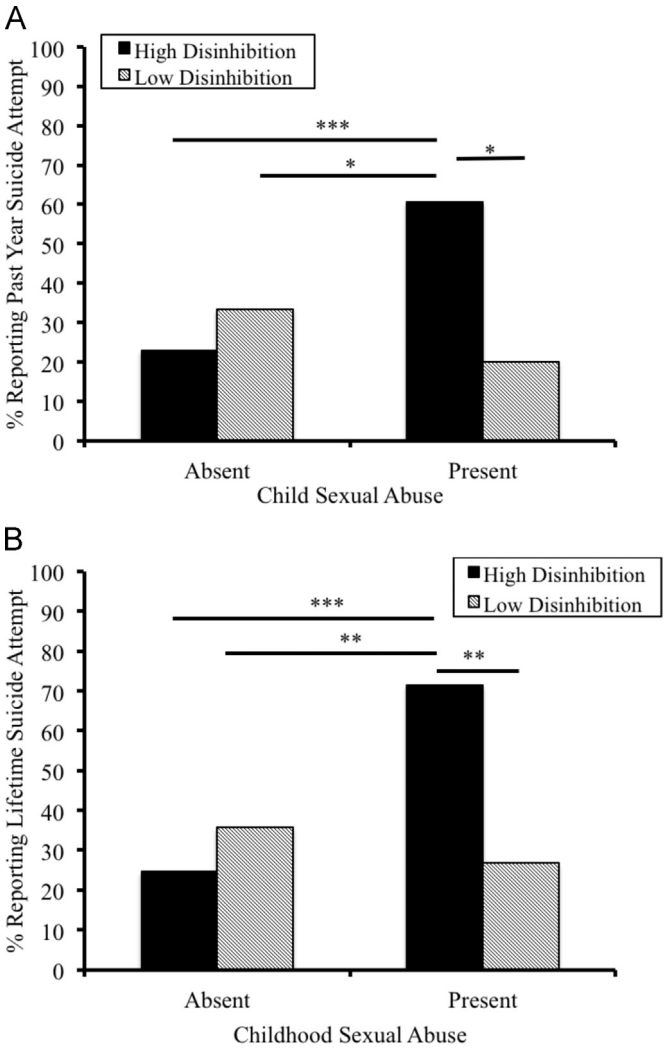

Fig. 1. Percentages of adolescents reporting at least one suicide attempt in the past year (A) and in their lifetimes (B), stratified by childhood sexual abuse and disinhibition. *Note.* $^{*}p < .05$, $^{**}p < .01$, $^{***}p < .001$.

Table 3
Multiple regression analyses predicting the frequency of reported suicide attempts.

	B(*SE*)	*t*	*p*	r_{sp}
Number of suicide attempts past year				
CES-D total	.001 (.002)	.34	.73	.03
Ideation past year	.0003 (.0002)	1.83	.07	.15
Plans past year	–.04 (.03)	–1.26	.21	–.10
CSA	–.04 (.07)	–.52	.60	–.04
Disinhibition	–.05 (.05)	–1.08	.28	–.09
CSA × disinhibition	.19 (.09)	2.16	**.033**	**.17**
Number of lifetime suicide attempts				
CES-D total	–.002 (.002)	–1.19	.24	–.09
Ideation past year	–.001 (.002)	–.50	.62	–.04
Plans past year	.13 (.04)	3.59	**< .001**	**.28**
CSA	–.01 (.04)	–.33	.74	–.03
Disinhibition	–.02 (.05)	–.45	.66	–.04
CSA × disinhibition	.19 (.10)	1.92	.058	.15

Note. CES-D = center for epidemiological studies depression scale; CSA = childhood sexual abuse (absence versus presence); Disinhibition = low versus high levels, measured using the gradual onset continuous performance task.

significant ($\Delta R^2 = .03$, $\Delta F(2, 139) = 2.32$, $p = .102$). Again, in Step 2, the presence of CSA was uniquely associated with a greater frequency of lifetime suicide attempts ($B = .05$, $SE = .02$, $t(139) = 2.02$, $p = .046$, $r_{sp} = .16$) and there was no effect of disinhibition ($B = .03$, $SE = .05$, $t(139) = .71$, $p = .48$, $r_{sp} = .06$) In Step 3, the *CSA × disinhibition* interaction predicted the frequency of lifetime suicide attempts at a statistical trend ($\Delta R^2 = .02$, $\Delta F(1, 138) = 3.67$, $p = .058$; see Table 3). Among adolescents with no history of CSA, disinhibition was not associated with number of lifetime attempts ($B = -.02$, $SE = .05$, $t(138) = -.45$, $p = .66$, $r_{sp} = -.04$). However, among adolescents with a history of CSA, high disinhibition was significantly associated with attempts (($B = .17$, $SE = .08$, $t(138) = 2.00$, $p = .047$, $r_{sp} = 16$); see Fig. 2)[2].

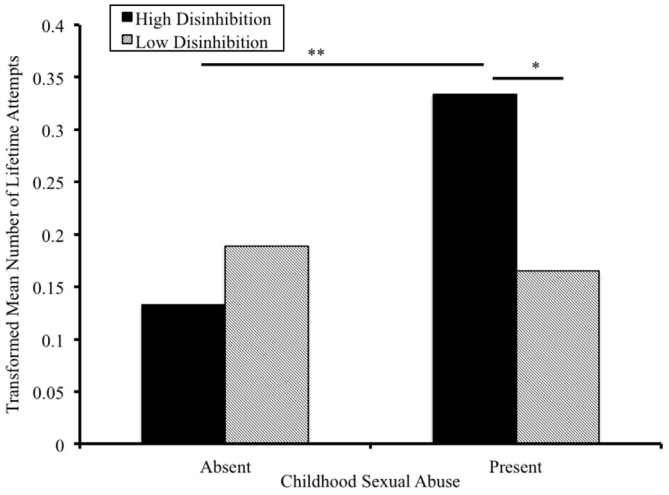

Fig. 2. Adolescents' mean number of lifetime suicide attempts (transformed), stratified by childhood sexual abuse and disinhibition. *Note.* $^{*}p < .05$; $^{**}p < .01$.

4. Discussion

In light of the prevalence and costly effects of suicidal behaviors among adolescents, the present study examined the unique and interactive effects of two well-established risk factors for suicide attempts: CSA and disinhibition. Specifically, we tested whether CSA moderated the association between disinhibition and (a) the occurrence of suicide attempts and (b) the frequency of attempts. Consistent with hypotheses, CSA was associated with suicide attempter status as well as the frequency of previous suicide attempts. However, contrary to hypotheses, disinhibition alone was not associated with attempts in any of our models. Furthermore, as hypothesized, disinhibition was associated with suicide attempter status among adolescents reporting a history of CSA but not those without a history of CSA. This same pattern emerged for the number of previous suicide attempts adolescents reported, although these effects were more modest and, in some cases, were at statistical trends.

An important strength of the present study is that our effects were significant when controlling for the frequency of suicidal ideation and plans as well as depressive symptom severity. These findings replicate studies that have shown that CSA is associated with adolescent suicidality, controlling for depressive symptoms (Miller et al., 2013) in a severely depressed adolescent inpatient sample. The effects of CSA remained when we controlled for other, co-occurring forms of abuse, and neither emotional nor physical abuse significantly predicted suicide attempts when entered in our

[2] Girls were more likely to report the presence of CSA than boys, $\chi^2(1, n = 159) = 13.06$, $p < .001$. However, our results were unchanged covarying gender: (a) presence of past year attempt, $\chi^2(1, n = 149) = 7.98$, $p = .005$, (b) presence of lifetime suicide attempt, $\chi^2(1, n = 145) = 8.06$, $p = .005$, (c) frequency of past year attempts, $\Delta R^2 = .03$, $\Delta F(1, 141) = 4.86$, $p = .029$, and (d) frequency of lifetime attempts, $\Delta R^2 = .02$, $\Delta F(1, 137) = 3.87$, $p = .051$.

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models alone. These results are inconsistent with a meta-analysis that found that both physical and emotional abuse increased the odds of making a suicide attempt by more than 3-fold (Norman et al., 2012). These findings thus require further study and replication in a larger sample of hospitalized adolescents. Nevertheless, highlighting psychosocial factors, such as CSA, that predict suicide attempts, as opposed to suicide ideation or plans, is critical given that: (a) only one third of adolescent suicide ideators go on to make attempts and (b) many clinical predictors of adolescent suicidal ideation and plans do not predict attempts among ideators (Nock et al., 2013). Refining the clinical picture of what features place youth at highest risk for suicide attempts will, ultimately, enhance our ability to direct cost-efficient services towards adolescents at highest risk.

The difference in suicide attempt rates between adolescents with and without a history of CSA was driven by a subset of individuals within the CSA group who also reported high disinhibition; adolescents with low disinhibition and CSA did not differ from adolescents without a history of CSA. Thus, our data support a moderation model wherein behavioral disinhibition increases the likelihood of suicide attempts exclusively among adolescents reporting a history of CSA. Although the underlying mechanisms driving this moderation effect were not explicitly explored, one possibility is that CSA sensitizes individuals to the effects of later psychosocial stress through its deleterious impact on HPA axis functioning (Braquehais et al., 2010). Alternatively, adolescents who experience CSA may be exposed to environmental factors that are categorically different than adolescents who do not experience CSA. Childhood maltreatment has been linked to impaired cognitive and academic functioning, drug use, risky sexual behaviors, and the development of sexually transmitted infections (Mills et al., 2011; Norman et al., 2012). Maltreated adolescents are therefore more likely to live in risky environments. Those within these environments who also tend to act without thinking may be at greatest risk for suicide. Future research simultaneously examining psychosocial, cognitive, behavioral, and biological factors is required to further explore the mechanisms underlying the effects of disinhibition and CSA on suicidality.

Notably, our measure of disinhibition was neither significantly associated with CSA, nor did it uniquely predict suicide attempts. There are several factors that might explain these findings. Studies in adults (Dougherty et al., 2004; Swann et al., 2005; Wu et al., 2009) reporting an association between behavioral disinhibition and suicide attempts have used the Immediate and Delayed Memory Tasks (IMT/DMT; Dougherty and Marsh, 2003), and the unique methodological features of this measure compared to the gradCPT (i.e., greater working memory involvement) may potentially account for the differences. Specifically, the IMT/DMT employs catch trials (i.e., stimuli that are very similar to the target designed to elicit errors) while the gradCPT only requires a basic distinction between target and non-target stimuli. The rationale for catch trials is to increase commission error rates and eliminate floor effects (i.e., all participants making very few commission errors). Greater variance in commission error rates increases the probability of detecting associations between performance and suicidality. However, despite the absence of catch trials, the mean commission error rate for our sample ($M=34.29\%$, $SD=17.66\%$) was similar to studies employing the IMT/DMT (e.g., Dougherty et al., 2004).

Alternatively, as impulsiveness is a multifaceted construct, different domains of impulsiveness may be differentially associated with suicidality and the strength of these associations may change over development. Studies using self-report assessments of general impulsiveness suggest its association with suicidality is strongest among younger individuals (e.g., Kasen et al., 2011; McGirr et al., 2008). However, a study that measured response disinhibition, specifically, found no association between this facet of impulsiveness and having a history of suicide attempts among adolescents (Dougherty et al., 2009). Shedding further light on the potentially complex relations among domains of impulsiveness, age and suicidality may reconcile these findings. Another possibility is that the strength of the association between disinhibition and suicidality depends on the proportion of the sample with a history of maltreatment. Although CSA was unmeasured in the adult studies, it is possible that they included a higher percentage of people with CSA, which could explain the discrepant findings.

5. Limitations

The implications of our results need to be considered in light of several limitations. First, our findings are based on observational, cross-sectional data, and thus, we cannot infer a causal relationship between disinhibition, CSA and suicide attempts. This highlights a particularly important avenue for future research. To date, no study to our knowledge has examined whether behavioral measures of disinhibition are prospectively associated with suicidality. However, one large longitudinal study of adults found that several facets of self-reported impulsiveness (e.g., disinhibition, lack of premeditation) were associated with suicide attempts over a 7-year follow-up period (Yen et al., 2009). Furthermore, parent and teacher ratings of adolescent impulsiveness prospectively predict suicidality (Sourander et al., 2001). Developing reliable, objective behavioral measures of impulsiveness to identify individuals at the highest risk for suicide after hospitalization is critical as patients are at greatest suicide risk 1–3 months after discharge from inpatient care (Qin and Nordentoft, 2005).

Second, the gender imbalance in our sample meant that: (a) we could not examine whether our effects were moderated by participant gender and (b) the generalizability of our findings to the broader population of adolescents may be limited. However, this gender discrepancy reflects the gender difference in the prevalence of adolescent depression (Avenevoli et al., 2015) and including the effect of gender in our models did not alter the pattern of our results. Nonetheless, future research should re-examine our models stratifying by gender, as some studies suggest that CSA is a more potent risk factor for suicidal behavior among males versus females (Molnar et al., 2001). Third, we did not collect any data on psychoactive medications prescribed to study participants, the addition of new medications at the beginning of treatment, nor on medication adherence. Thus, we were unable to account for the potential impact of medications on gradCPT performance. Fourth, we chose to create meaningful, dichotomous groupings of our participants based on their performance on the gradCPT and their self-reported CSA. Although we dichotomized these variables at theoretically- and empirically-motivated cut-off points, the statistical limitations of this approach should be considered when interpreting our findings (e.g., MacCallum et al., 2002). Last, we assessed CSA using a brief self-report questionnaire that relied on adolescents' retrospective reporting. Although the subscales of the CTQ are significantly correlated with objective measures of abuse (Bernstein et al., 2003), employing structured contextual interviews and/or confirmation using legal records would strengthen our findings.

6. Conclusions

The present study provided the first evidence that CSA interacts with disinhibition to predict elevated risk for suicide attempts among adolescents. This effect was striking: among adolescents reporting CSA, those with high levels of disinhibition showed an

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8-fold increase in the odds of reporting at least one lifetime suicide attempt compared to those with low levels. Our findings underscore the need for more research investigating how markers of risk may interact to increase the likelihood of later suicidal behaviors. This line of research holds promise for creating increasingly accurate algorithms to predict suicide risk, which may ultimately be used to inform targeted interventions to reduce preventable loss of life.

Contributions

J. Stewart co-developed the concept for the study, conducted all of the primary statistical analyses and wrote the initial draft of the manuscript. J. Kim and E. Esposito collected and managed the data, assisted in data preparation, and provided critical revisions of the manuscript. Both J. Gold and M. Nock provided critical revisions to drafts of the manuscript. R. Auerbach co-developed the concept for the study, assisted with interpreting primary analyses and provided critical revisions of early drafts of the paper. All authors approved the finalized manuscript prior to its submission.

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Conflict of interest

none.

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