

Parent–Child Interactions, Peripheral Serotonin, and Self-Inflicted Injury in Adolescents

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Self-inflicted injury in adolescence indicates significant emotional and psychological suffering. Although data on the etiology of self-injury are limited, current theories suggest that the emotional lability observed among self-injuring adolescents results from complex interactions between individual biological vulnerabilities and environmental risk. For example, deficiencies in serotonergic functioning, in conjunction with certain family interaction patterns, may contribute to the development of emotional lability and risk for self-injury. The authors explored the relation between peripheral serotonin levels and mother–child interaction patterns among typical ($n = 21$) and self-injuring ($n = 20$) adolescents. Findings revealed higher levels of negative affect and lower levels of both positive affect and cohesiveness among families of self-injuring participants. Peripheral serotonin was also correlated with the expression of positive affect within dyads. Furthermore, adolescents' serotonin levels interacted with negativity and conflict within dyads to explain 64% of the variance in self-injury. These findings underscore the importance of considering both biological and environmental risk factors in understanding and treating self-injuring adolescents.

Keywords: self-injury, adolescent, serotonin, family, discussion

Adolescent self-inflicted injury (SII), including suicide attempts and nonsuicidal self-harm, represents a significant public health concern. In addition to the emotional toll on adolescents and their families, adolescent SII costs the United States healthcare system over \$150 million per year in inpatient hospitalization costs alone (Olfson, Gameroff, Marcus, Greenberg, & Shaffer, 2005). Furthermore, adolescents who engage in SII are at high risk for eventual suicide (Berman, Jobes, & Silverman, 2006; Comtois, 2002). Among those between ages 15 and 24 years, suicide is the third leading cause of death, with 3,971 suicides in this age group in 2001 (Anderson & Smith, 2003).

Despite being a leading cause of death among youths, suicide is a low base-rate phenomenon. Epidemiological data suggest that

1.6/100,000 youths ages 10–14 and 9.7/100,000 youths ages 14–19 die by suicide each year (U.S. Public Health Service, 1999). Although nonfatal self-injury is more common than completed suicide, with as many as 8.8% of teens reporting a “suicide attempt” (Grunbaum et al., 2002), accurately predicting suicide and self-injury on the basis of known risk factors is currently not possible. Given the significance of this public health concern, specifying etiological factors that could improve our understanding of and our ability to prevent SII should become a national priority.

Despite the urgency in furthering our understanding of SII, current data are quite limited. In all likelihood, future studies will identify etiological pathways to SII through detailed analyses of both biological vulnerabilities and environmental risk factors, as well as Biology \times Environment interactions. Indeed, research suggests that many psychopathological outcomes are influenced by the interaction of biological and environmental influences (Kendler, Prescott, Myers, & Neale, 2003). Thus, etiological models of SII must address the complex interrelations among dynamic biological, psychological, and social systems. Although longitudinal data sets will ultimately be needed to identify developmental trajectories in SII, cross-sectional research identifying interactions between biological and psychological variables may help guide future studies.

Disruptions of the serotonin (5-HT) system are consistently associated with nonsuicidal self-injury, suicide attempts, and suicide, at least among adults (Mann, Brent, & Arango, 2001). However, there has been little research with adolescent samples (Mann, 2003). Findings from the adult literature suggest that peripheral

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5-HT is significantly lower among impulsive, aggressive, and self-injuring populations (Stoff & Mann, 1997). Reduced peripheral 5-HT has also been found in those with disorders characterized by self-injury, including depression, substance use, and both borderline and antisocial pathology (Heninger, 1995). However, there are currently no data on interactions between 5-HT and environmental risk factors such as family context.

Considerable research on environmental risk factors contributing to adolescent SII has focused on family context (see Berman et al., 2006). This likely follows from theories suggesting that family factors contribute to the emergence of emotional lability and associated risk for psychopathology among vulnerable individuals (Fruzzetti, Shenk, & Hoffman, 2005; Linehan, 1993a). Suicide victims are also more likely to have encountered familial stressors, including parent-child conflict, physical abuse, and divorce (Brent et al., 1994). Finally, familial psychopathology is associated with risk for both fatal and nonfatal self-injury (Brent et al., 1988, 1994), with at least half of adolescent suicide completers having a family history of psychiatric morbidity (Houston, Hawton, & Shepperd, 2001).

Given the importance of both biological vulnerabilities and environmental risk in contributing to SII, it is essential that potential risk factors be outlined at multiple levels of analysis. Suicidal behavior is most often triggered when proximal risk factors, such as fights with parents, are combined with more distal risk factors, such as biological or temperamental vulnerabilities (Miller, Rathus, & Linehan, 2007). However, when compared with developmental models proposed for many psychiatric disorders, research on the etiology of SII is extremely limited. For example, there is a large body of literature outlining processes by which emotional lability is shaped within the families of youths at risk for antisocial pathology (Patterson, Dishion, & Bank, 1984; Snyder, Edwards, McGraw, & Kilgore, 1994; Snyder, Schrepferman, & St. Peter, 1997). Emotional lability observed in externalizing disorders is shaped by family interactions that reinforce escalating negative emotion and aggression (Beauchaine, Gatzke-Kopp, & Mead, 2007; Patterson, DeBaryshe, & Ramsey, 1989). Family interaction patterns that reinforce escalating negative emotions may also occur in families of self-injuring adolescents (Crowell, Beauchaine, & Lenzenweger, in press).

In this article, we examine both the quality of mother-child interaction patterns and peripheral 5-HT as predictors, both alone and in combination, of self-injuring behaviors in adolescents. To our knowledge, this is the first study to explore interactions between two theoretically important biological and environmental risk factors in this population. We hypothesized that (a) families of self-injuring adolescents would show higher levels of negative affect and lower levels of positive affect compared with those of typical families, and (b) peripheral 5-HT would correlate with more positive affect and less negative affect within dyads. We also explored whether the interaction between negative affect and peripheral 5-HT is related to self-injury, over and above the effects of negative affect and peripheral 5-HT alone. Such a finding would support a Biological Vulnerability \times Environmental Risk model of self-injury. It should be noted, however, that peripheral 5-HT is affected by a number of influences, including genetic, epigenetic, and environmental effects. Thus, although relations between peripheral 5-HT and behavior may suggest a biological vulnerability, they are not proof of genetic effects.

Method

Participants included 20 self-injuring adolescents and 21 age-matched control participants recruited from the Adolescent Patterns of Self-Harm Project. A thorough description of the project is outlined in detail by Crowell et al. (2005). Briefly, self-injuring participants were included if they had harmed themselves three or more times in the past 6 months or five or more times in their lifetime. Thus, the recruitment strategy targeted adolescents who engaged in repetitive, nonsuicidal self-injury, although adolescents who had also made suicide attempts were not excluded. Self-injuring adolescents were excluded if they had a diagnosis of mental retardation, a schizophrenia spectrum disorder, or if they reported current use of benzodiazepines, beta blockers, or mood stabilizers. Because many self-injuring adolescents are prescribed antidepressants, participants were not excluded on the basis of their use. All self-injuring adolescents were recruited from Seattle-area inpatient and outpatient facilities. Control participants were excluded if they had a history of self-injury or any of the assessed mental disorders (see below). Control participants were recruited through brochures handed out in the Seattle public schools. Participants who met inclusion criteria were invited to Seattle Children's Hospital and Regional Medical Center for a 1–2-hr assessment. The invitation included a \$25 monetary incentive. The study was approved by the Seattle Children's Hospital and Regional Medical Center Institutional Review Board, and all participants and their mothers provided written informed assent and consent, respectively.

The sample described herein includes a different but overlapping set of the participants described by Crowell et al. (2005). This is because some participants declined further participation in the discussion task, which has not been reported previously, and because the present sample includes 4 male participants (2 in each group) who were excluded from previous analyses. Given differences between the current sample and the sample reported previously, all relevant descriptive characteristics are reported in Table 1. The mean age of both groups was 15.3 years ($SD = 1.1$). Participants were 78% Caucasian, 3% African American, and 19% other ethnicities. Groups were matched on age and race, so there were no significant differences on these variables. Mean family incomes, in thousands, were 84.7 ($SD = 2.8$) for the control group and 62.1 ($SD = 3.7$) for the self-injuring group. This difference in income was significant, $F(1, 36) = 5.91, p < .05$. Thus, all analyses were run both with and without income as a covariate.

Table 1
Demographic Data Relevant to the Study

Item	Self-injuring adolescents	Control adolescents
Age, <i>M</i> (<i>SD</i>)	15.2 (1.0)	15.7 (1.2)
Sex, <i>n</i> (% Female)	18 (90.0%)	19 (90.5%)
Income, <i>M</i> (<i>SD</i>)	5.9 (3.6)	8.6 (2.6)
Race, <i>n</i> (%)		
Caucasian	14 (70%)	16 (76.2%)
African American	2 (10%)	2 (9.5%)
Latino/Latina	0 (0%)	0 (0%)
Asian	0 (0%)	0 (0%)
Other	4 (20%)	3 (14.3%)

Because the pattern of results was unchanged, all analyses are reported without income included in the models.

Child Psychopathology

Adolescent-report measures of psychopathology included the Youth's Inventory (YI; Gadow et al., 2002) and the Youth Self-Report (YSR; Achenbach, 1991c). The YI is a 120-item checklist that yields dimensional scores and diagnostic cutoffs for the *Diagnostic and Statistical Manual of Mental Disorders* (4th ed., American Psychiatric Association, 2000) disorders. Symptoms are rated on a 4-point scale ranging from 0 (*never*) to 3 (*very often*), with ratings of 2 or higher considered positive for a given diagnostic criterion. The YSR is a 112-item measure of behavior problems that yields psychopathology subscales and both internalizing and externalizing scores. Parent-report measures included the Adolescent Symptom Inventory (Gadow et al., 2002), and the Child Behavior Checklist (Achenbach, 1991a), which are parent-report versions of the YI and YSR, respectively. Teachers completed the Teacher Report Form (Achenbach, 1991b).

Self-Injurious Behaviors

Data on SII were collected by a trained graduate research assistant with the Lifetime Parasuicide Count (Linehan & Comtois, 1996). This interview assesses number, lethality, suicidal intent, and medical attention received for intentional self-injury during the adolescent's life. Both the mother and adolescent completed the interview because each provides unique information. The full interview was not conducted with control participants, who were screened for no self-injury. Adolescent reports of SII were used for analyses in which self-injury was the criterion variable. This is because adolescent reports are more reliable than parent reports for internalizing psychopathology, suicidal urges, and self-injurious behaviors (Prinstein, Nock, Spirito, & Grapentine, 2001; Sou-rander, Helstelä, & Helenius, 1999).

Mother-Child Discussion

Discussion topics were identified with the modified revealed differences task (Strodbeck, 1951), a 44-item questionnaire de-

signed to elicit areas of conflict between parents and teenagers (e.g., chores, curfew). Responses are ranked on two scales: Frequency, rated from 1 (*never*) to 5 (*very often*), and Intensity, rated between 0 (*calm*) and 40 (*very intense*), based on the typical intensity of family discussions. Items rated as most contentious for the dyad, and therefore most likely to elicit emotional reactions, were selected as discussion topics. Dyads were videotaped for 10 min while they discussed their topic.

Data from the modified revealed differences task were coded by two trained research assistants by using the System for Coding Interactions and Family Functioning (Lindahl & Malik, 1996). Coders were blind to study hypotheses and to all family information. The System for Coding Interactions and Family Functioning was used to rate the discussion on 12 variables (see Table 2). These include 3 dyad, 4 parent, and 5 child codes, all of which are rated on 5-point scales ranging from 1 (*low*) to 5 (*high*). Interrater reliability was consistent with the System for Coding Interactions and Family Functioning training manual, with intraclass correlation coefficients ranging from .63 to 1.0.

Peripheral Serotonin

Assessment of 5-HT followed the full interview, including the mother-child discussion. Adolescents were taken to a private room where a registered nurse drew a 4-ml sample of blood. Samples were assayed at Seattle Children's Hospital and Regional Medical Center for levels of whole-blood 5-HT. Adolescents were instructed not to have a snack or meal until after the blood sample was complete. Because 14 of the 21 self-injuring adolescents were taking SSRIs, which can affect peripheral 5-HT, antidepressant status was recorded for later statistical control in analyses of the 5-HT data. In these analyses, antidepressant use was coded as a dichotomous covariate, both because several different SSRIs were being taken and because verifying exact doses was difficult. Although peripheral 5-HT is not a direct indicator of central nervous system 5-HT, there is a substantial literature linking peripheral 5-HT to traits of interest in the present study, including impulsivity, aggression, and self-injurious behavior (see Joiner, Brown, & Wingate, 2005).

Table 2
Incidents Reported on the Lifetime Parasuicide Count by Self-Injuring Participants

Item	<i>n</i> (%) ^a	<i>M</i>	<i>SD</i>	Range
Self-report				
Total self-injury events	18 (100%)	140.8	218.3	4-839
Events with intent to die	14 (80%)	22.3	72.4	0-310
Events with ambivalence	17 (95%)	51.6	111.4	0-402
Events without intent to die	13 (75%)	70.6	111.1	2-447
Events requiring medical attention	13 (75%)	4.7	6.9	0-25
Parent report				
Total self-injury events	17 (95%)	38.3	66.3	0-282
Events with intent to die	6 (30%)	5.6	21.1	0-90
Events with ambivalence	8 (40%)	8.8	20.0	0-65
Events without intent to die	17 (95%)	23.1	34.8	0-117
Events requiring medical attention	11 (65%)	3.8	5.5	0-18

^a Number (and percentage) of participants reporting at least one incident of this type.

Data Analyses

Analyses proceeded in three phases. First, multivariate analyses of variance were used to test the hypothesis of group differences in family interaction patterns between self-injuring and typical adolescents at (a) the dyad level, (b) the parent level, and (c) the child level. Given significant Wilks's lambdas, follow-up analyses were conducted to determine which specific variables yielded group differences. This approach provided for control of familywise alpha error rates. Second, correlations were computed between peripheral 5-HT and variables extracted from the interaction task. Next, interactions between peripheral 5-HT and family interaction quality were tested in the full sample by using multiple linear regression techniques described by Aiken and West (1991). Evaluating the significance of the interaction was accomplished by regressing the dependent variable (self-injury) on the two predictors (5-HT, family interaction quality) and on the Predictor \times Predictor Product vector (5-HT \times Family Interaction Quality). An interaction model is supported when the product vector is significant, regardless of the significance of the main effects. Prior to analyses, self-injury events were log transformed because of high skew (3.91), resulting in an acceptable skew value (0.52).

Results

Data on self-injury are reported in Tables 3 and 4. These results reveal a wide range in SII reported by participants. As expected, mothers reported a lower number of and less suicidal intent for SII episodes, indicating less awareness of the extent of their child's SII. Considerable variability in the method, intent, and lethality were reported. Although the preferred method of self-injury was cutting (100%), the number of episodes varied widely. The lethality

Table 4
System for Coding Interactions in Family Functioning (SCIFF)
Scale Scores

SCIFF scales	Self-injuring (n = 20)		Control (n = 21)	
	M	SD	M	SD
Dyad codes				
Negativity and conflict	2.1	1.5	1.2	0.6
Positive affect	2.4	1.3	3.9	0.7
Cohesiveness	3.2	1.3	4.2	0.7
Parent codes				
Rejection/invalidation	1.7	1.2	1.4	0.5
Coerciveness	1.4	1.0	1.4	0.8
Emotional support	3.4	1.2	3.8	1.0
Withdrawal	1.0	0.0	1.0	0.0
Child codes				
Anger	2.1	1.2	1.5	0.9
Sadness	1.2	0.7	1.1	0.2
Withdrawal	1.6	0.9	1.2	0.4
Opposition/defiance	2.2	1.5	1.2	0.7
Positive affect	2.6	1.3	3.7	1.0

of SII was generally low, yet values across the entire range from 1 (*very low*) to 6 (*severe*) were observed.

Because patterns of psychopathology in this sample have been reported previously (Crowell et al., 2005), and because psychopathology scores were not of central interest for current study hypotheses, we include only a brief summary here. Results across the Child Behavior Checklist, Teacher Report Form, YSR, YI, and Adolescent Symptom Inventory indicated that self-injuring adolescents had significantly more psychopathology than did control

Table 3
Summary of Self-Injury Data for both Parent- and Child-Reports

Method	n (%)	M (events)	SD (events)	Total (events)	Intent to die	Ambivalent	No intent	Medical attention?	Highest lethality
Adolescent report									
Cut	18 (100%)	109.2	174.1	2-700	0-300	0-350	0-215	0-15	2-3
Overdose	13 (65%)	5.1	10.8	0-43	0-20	0-5	0-37	0-7	1-4
Burn	8 (40%)	3.3	2.3	0-7	0	0-1	0-7	0-1	1-2
Strangulation	3 (15%)	4.7	4.5	0-11	0-6	0-5	0	0	1-6
Shot self with gun	1 (5%)	1		1	1	0	0	0	1
Swallow poisons/caustic substances	5 (25%)	1.2	0.4	0-2	0-1	0-1	0-2	0	1-3
Asphyxiation/smother	2 (10%)	1.5	0.7	0-2	0-1	0-2	0	0	1-1
Drowning	1 (5%)	4		4	1	0	0	0	5
Stab/puncture	12 (60%)	31.3	66.8	0-225	0-2	0-47	0-225	0-1	1-3
Bang head/hit self	9 (45%)	12.6	15.1	0-50	0-10	0-10	0-30	0-2	1-3
Other	0 (0%)			0	0	0	0	0	0
Parent report									
Cut	18 (100%)	35.8	64.3	1-282	0-90	0-65	0-117	0-15	1-3
Overdose	7 (35%)	1.6	0.7	0-3	0-3	0-1	0-2	0-2	1-3
Burn	2 (10%)	1		0-1	0	0-1	0	0-1	1-2
Strangulation	0 (0%)			0	0	0	0	0	0
Shot self with gun	1 (5%)	1		1	1	0	0	0	1
Swallow poisons/caustic substances	1 (5%)	1		1	1	0	0	0	3
Asphyxiation/smother	0 (0%)			0	0	0	0	0	0
Drowning	0 (0%)			0	0	0	0	0	0
Stab/puncture	2 (10%)	10.5	2.5	0-13	0	0	0-13	0-3	1-3
Bang head/hit self	3 (15%)	1.7	0.9	0-3	0	0	0-3	0	1-1
Other	3 (15%)	1.3	0.5	0-2	0-1	0-1	0	0-1	1-2

participants on all assessed scales and diagnoses. This was consistent across reporters and extended to both internalizing and externalizing behaviors. A reanalysis of all psychopathology scores with the current sample did not change the pattern of results.

Parent-Child Discussion

Dyad effects. Descriptive statistics for the mother-child interaction task are reported in Table 2. The multivariate analysis of variance testing for differences in family interaction quality during the task was significant (Wilks's $\lambda = .64, p < .001$), indicating that 36% of the variance in self-injury was accounted for. Follow-up contrasts indicated that families of self-injuring adolescents displayed less positive affect, $t(33) = 4.27, p < .001, d = 1.53$; more negative affect, $t(33) = 2.33, p = .03, d = .86$; and lower cohesiveness $t(33) = 2.94, p = .006, d = 1.06$, than did control participants.

Parent and adolescent effects. Next, two multivariate analyses of variance were conducted on variables specific to the mother and the adolescent. For the parental variables, the omnibus effect was not significant (Wilks's $\lambda = .96, p = .95$), indicating no differences between parents of control participants and parents of self-injuring adolescents on rejection/invalidation, withdrawal, coerciveness, or emotional support. In contrast, the omnibus child effect was significant (Wilks's $\lambda = .69, p < .05$), accounting for 31% of the variance in self-injury. Follow-up contrasts indicated more opposition/defiance, $t(33) = 2.46, p = .02, d = .90$; and less positive affect, $t(33) = 2.82, p = .008, d = .92$, among self-injuring teens.

Peripheral Serotonin

As expected, 5-HT levels were lower in the SII group ($M = 45.8$ ng/ml, $SD = 41.4$) than in the control group ($M = 134.4$ ng/ml, $SD = 51.5$). This difference was significant, $F(1, 35) = 31.72, p < .001, d = 1.91$. Moreover, the group difference remained significant when controlling for antidepressant use in an analysis of covariance, $F(1, 34) = 4.00, p < .05$.

Correlations Between Peripheral Serotonin Levels and Parent-Child Discussion Variables

Because 5-HT expression has been linked specifically with both mood quality and affectivity, we computed correlations between peripheral 5-HT and both dyad-level affective expression (negativity and conflict, positive affect) and child-level affective expression (sadness, withdrawal, positive affect). Of these five correlations, two were significant. These included the correlation between adolescent peripheral 5-HT and dyadic positive affect ($r = .39, p < .05$), and the correlation between adolescent peripheral 5-HT and child positive affect ($r = .31, p < .05$).

Parent-Child Discussion \times Peripheral Serotonin Interaction Effects

For the interaction analyses, we again focused on both dyad-level affective expression (negativity and conflict, positive affect) and child-level affective expression (sadness, withdrawal, positive affect). Only the Peripheral 5-HT \times Dyadic Negativity and Con-

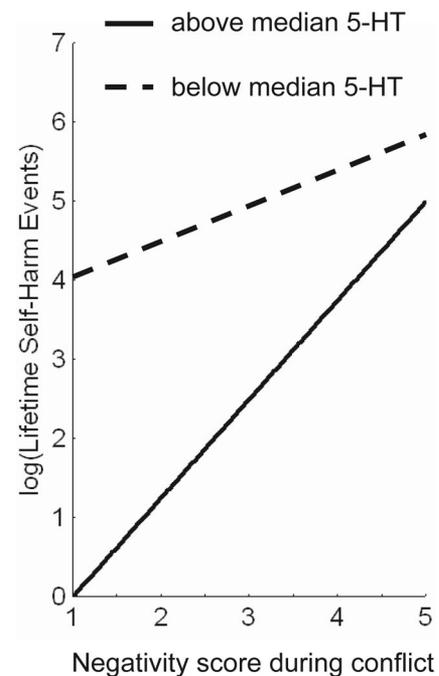


Figure 1. Relation between dyadic negativity and log-transformed lifetime self-injury events for adolescents above the sample median of 82 nanograms per milliliter (solid line) and below the sample median (dashed line) on peripheral serotonin (5-HT).

flict interaction was significant. The nature of this interaction is depicted in Figure 1. The interaction was computed with all participants. Predictors of self-injury included (a) peripheral 5-HT, (b) negativity during the discussion, (c) the Peripheral 5-HT \times Negativity interaction, and (d) group. The full model accounted for 88% of the variance in self-injury events, and the interaction term was significant ($\beta = .80, p = .03$). For adolescents who scored above the sample median on peripheral 5-HT, there was a strong correspondence between dyadic negativity and lifetime self-injury events ($\beta = .80, p < .001, R^2 = .64$). In contrast, for those who scored below the sample median on peripheral 5-HT, there was no significant relation between dyadic negativity and self-injury ($\beta = .27, p = .31, R^2 = .01$). Rather, these participants tended to score high on self-injury events regardless of the level of negativity exhibited in the discussion.

Discussion

In this study, we examined (a) patterns of mother-child conflict discussions among typical and self-injuring adolescents, (b) relations between the affective quality of mother-child conflict discussions and peripheral 5-HT levels among adolescents, and (c) interactions between peripheral 5-HT and the affective quality of mother-child discussions in predicting self-injury. On the basis of current theories of the development of SII, we hypothesized differences between groups in the expression of both positive and negative affect within dyads. This hypothesis was confirmed. Families of self-injuring adolescents exhibited less positive affect, more negative affect, and lower cohesiveness than did control

participants. These findings are consistent with research suggesting that family dysfunction is a risk factor for self-injury (see Wagner, 1997).

In addition, self-injuring adolescents exhibited more opposition and defiance and less positive affect than did control participants during the conflict discussion. In contrast, no group differences were observed between mothers of self-injuring adolescents and mothers of control participants on any of the ratings of parental behavior. Given that the study occurred in a lab setting where both mothers and adolescents were aware of being videotaped, the finding of individual effects for adolescents but not parents should be interpreted with caution. It is possible that parents were more motivated to control their emotions in the lab than were adolescents or that the coding system was not sensitive enough to identify subtle characteristics of parental behavior, such as invalidation.

We also found significant relations between adolescent's peripheral 5-HT and expressions of positive affect both within dyads and by adolescents. Thus, higher 5-HT was linked to more positive affective engagement. Although no such main effects were found for negative affective expression, we found a significant interaction between dyad-level negativity and adolescent 5-HT in predicting SII, despite reduced statistical power associated with tests of interaction effects (Aiken & West, 1991; Whisman & McClelland, 2005). For adolescents above the sample median on 5-HT, there was a strong relation between dyadic negativity and SII—accounting for 64% of the variance in lifetime SII. In contrast, no relation was observed between dyadic negativity and lifetime SII for adolescents above the sample median on 5-HT. These adolescents reported high levels of SII regardless of dyadic interaction quality. This type of interaction reflects what Luthar, Cicchetti, and Becker (2000) refer to as a “protective but reactive” moderator. High levels of 5-HT may confer protection from self-injury, but the level of protection is reactive to the quality of parent–adolescent interactions.

This interaction is consistent with a Biological Vulnerability × Environmental Risk model of self-injury. Adolescents who are vulnerable to self-injury because of low 5-HT may be at especially high risk in family contexts characterized by negativity and conflict. Alternatively, interaction patterns within the family could influence 5-HT levels over time. Studies with animals suggest that organisms reared in stressful and chaotic conditions experience long-term alterations in several neurotransmitter systems, including norepinephrine, dopamine, and 5-HT (e.g., Kraemer, Schmidt, & Ebert, 1997). Disentangling these alternative explanations will require longitudinal research in which both biological and environmental risk factors are measured with greater precision (Shannon, Beauchaine, Brenner, Neuhaus, & Gatzke-Kopp, in press).

One possible clinical implication of this research is that both characteristics of the self-injuring adolescent and characteristics of their family should be assessed. Decreasing negativity and conflict may have the potential to reduce self-injurious behaviors among many, though not all, vulnerable adolescents. One method for achieving this might be to provide training to caretakers both in parenting strategies and in skills targeted to reduce their own emotion dysregulation, impulsivity, and interpersonal deficits (Linehan, 1993b).

However, there are several limitations to these findings that need to be considered. First, this sample consisted primarily of

female adolescents who engaged primarily in low-lethality self-mutilation. Second, more sophisticated measures of 5-HT are needed, such as the fenfluramine challenge tests or in-vivo imaging techniques. Finally, because the sample did not include a clinical comparison group it is unclear whether the results are specific to SII or to psychopathology in general. Yet to our knowledge, this is the first study to explore parent–child interaction patterns in an adolescent sample at high risk for suicide. Thus, despite these limitations, the identification of interactions between biological and environmental risk factors has implications for theories of self-injury. By identifying and exploring these risk factors, it may be possible to identify which youths are at risk for especially poor outcomes, including severe psychopathology and suicide.

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