Mechanisms of Contextual Risk for Adolescent Self-Injury: Invalidation and Conflict Escalation in Mother-Child Interactions

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Abstract

OBJECTIVE: According to developmental theories of self-injury, both child characteristics and environmental contexts shape and maintain problematic behaviors. Although progress has been made toward identifying biological vulnerabilities to self-injury, mechanisms underlying psychosocial risk have received less attention. **METHOD**: In the present study, we compared self-injuring adolescents (*n*=17) with typical controls (*n*=20) during a mother-child conflict discussion. Dyadic interactions were coded using both global and microanalytic systems, allowing for a highly detailed characterization of mother-child interactions. We also assessed resting state psychophysiological regulation, as indexed by respiratory sinus arrhythmia (RSA). **RESULTS**: Global coding revealed that maternal invalidation was associated with adolescent anger. Furthermore, maternal invalidation and coerciveness were both related to adolescent opposition/defiance. Results from the microanalytic system indicated that self-injuring dyads were more likely to escalate conflict, suggesting a potential mechanism through which emotion dysregulation is shaped and maintained over time. Finally, mother and teen aversiveness interacted to predict adolescent resting RSA. Low-aversive teens with highly aversive mothers had the highest RSA, whereas teens in high-high dyads showed the lowest RSA. **CONCLUSIONS**: These findings are consistent with theories that emotion invalidation and conflict escalation are possible contextual risk factors for self-injury.

KEYWORDS: adolescent self-injury, conflict discussion, respiratory sinus arrhythmia, observational coding.

Adolescent self-inflicted injury (SII) is a significant clinical and public health concern (Goldsmith, Pellmar, Kleinman, & Bunney, 2002). Broadly defined, SII encompasses all intentional self-injurious acts, including non-suicidal self-injury (NSSI) and suicidal behaviors, where there is ambivalent or certain suicidal intent (Linehan, Comtois, Brown, Heard, & Wagner, 2006). According to epidemiological surveys, 6.3% of high schools students report a "suicide attempt" and nearly 14% seriously consider suicide (Centers for Disease Control and Prevention [CDC], 2012). Furthermore, for every completed suicide among youth, there are at least 100-200 non-fatal self-injuries (Goldsmith et al., 2002). Self-inflicted injury is also the most reliable predictor of later suicide (Cooper et al., 2005; Hamza, Stewart, & Willoughby, 2012), and may be a developmental precursor to adult psychopathology, including borderline personality disorder (Crowell, Beauchaine, & Linehan, 2009). Therefore, effective intervention with self-injuring adolescents is critical, and will require attention to both biological vulnerabilities and psychosocial risk factors.

Although there are several reviews outlining biological correlates of suicide and related behaviors (e.g., Crowell et al., 2009; Currier & Mann, 2008; Mann, 2003), mechanisms underlying psychosocial risk have received less attention recently. This is unfortunate, given evidence that Biology × Environment interactions frequently account for more variance in health outcomes then either main effect alone (see Beauchaine, Neuhaus, Brenner, & Gatzke-Kopp, 2008 for a review). Environmental risk factors can also be targeted with psychosocial interventions, which often provide lasting benefit to adolescents and families. Thus, a detailed understanding of contextual risk can inform etiological models of SII and may improve intervention and prevention efforts.

To date, the research on contextual risk factors has focused primarily on broad correlates of SII. These include family histories of completed suicide, psychopathology among first-degree relatives, physical or sexual abuse, neglect, lack of warmth or connectedness, family discord or dysfunction, and poor parent-child communication (Adams, Overholser, & Lehnert, 1994; Gratz, 2006; Hollis,

1996; Martin, Rotaries, Pearce, & Allison, 1995; Mittendorfer-Rutz, Rasmussen, & Wasserman, 2008; Wagner, 1997). However, most of these studies rely upon the participant's perception of family context, which may be correlated with their psychopathology. In contrast, observational coding of parent-child conflict is an established and potentially more objective means of characterizing problematic interaction patterns (e.g., Snyder, Schrepferman, & St. Peter, 1997). That said, there are also limitations associated with observational coding, which is difficult, expensive, and can only capture a select number of behaviors within a complex interaction (see Furr & Funder, 2007). For this reason, it is important to select observational coding systems carefully, and with attention to established theory.

In the literature on self-injury, one predominant etiological theory was outlined by Linehan (1993). She and others have suggested that SII emerges among biologically vulnerable individuals who are reared within invalidating family contexts (Beauchaine, Klein, Crowell, Derbidge, & Gatzke-Kopp, 2009; Crowell et al., 2009; Linehan, 1993). These invalidating contexts increase risk for emotion dysregulation and, consequently, self-injury can emerge as one means of reducing emotional distress. There are three specific components to *the invalidating environment theory*. First, invalidating environments eschew and/or reject children's emotional expressions, which can be frequent, intense, and at times overwhelming. In other words, the emotional needs of the child may exceed the family's capacity to provide consistent support and validation. Second, invalidating environments are characterized by intermittent reinforcement of extreme expressions of negative affect. For the child, negative outbursts may function as a means of avoiding parent demands or eliciting emotional support. For example, extreme emotional distress may promote greater parental attention or solicitousness. Third, over time, these parent-child interaction patterns lead to more severe emotion dysregulation. This is defined as high baseline sensitivity to emotional stimuli, an intense response to emotion evocation, and a slow return to emotional baseline (see e.g., Kuo &

Linehan, 2009).

Despite these well-articulated hypotheses, to our knowledge there have been very few tests of the invalidating environment theory of self-injury. In partial support, Wedig and Nock (2007) found that high levels of parental expressed emotion, including criticism and emotional over-involvement, were associated with the presence and frequency of adolescent SII. Moreover, the authors found that parental criticism interacted with self-criticism to predict the highest rates of self-injury. Similarly, in a sample of Chinese adolescents, self-reports of family invalidation were found to predict the occurrence, but not the frequency, of non-suicidal self-injury one year later (You & Leung, 2012). However, a more thorough test of the invalidating environment theory would include an examination of parental invalidation, a moment-to-moment tendency to escalate conflict (consistent with the hypothesized reinforcement history), and psychophysiological dysregulation as predicted by characteristics of the child and parent. We therefore sought to test the theory by evaluating each of its three components. This necessitated an examination of behavior at three levels of analysis, each associated with a specific approach.

Caregiver Invalidation and Conflict Escalation

The invalidating environment theory suggests that caregiver invalidation *and* conflict escalation each play a role in shaping emotion dysregulation, psychopathology, and self-injury. However, in spite of its prominence in the theoretical literature, there are few methods for assessing parental invalidation in a manner that is consistent with Linehan's description. Indeed, many studies use abuse, neglect, an absence of parental support, or emotional underinvolvement as proxies for invalidation (see e.g., Fruzzetti, Shenk, & Hoffman, 2005 for a review). One global coding system (The System for Coding Interactions in Family Functioning [SCIFF]; Lindahl & Malik, 2000) operationalizes parental invalidation in a manner that approximates Linehan's account. This makes it possible to test the first hypothesis of the invalidating environment theory: environments that

reject or negate the child's emotional expressions may promote higher rates of dysregulated child behaviors. However, with global coding systems behavioral rankings are made across an entire interaction, rendering this type of coding scheme ineffective for testing the moment-to-moment behavior patterns characteristic of operant reinforcement.

The second hypothesis of the invalidating environment theory is that parents inadvertently reinforce extreme expressions of emotion. Microanalytic coding systems allow one to examine whether aversive strategies occur in sequence, revealing processes through which negative affect is de-escalated or intensified. One method of evaluating these interaction patterns follows from work on coercion theory, which characterizes developmental trajectories leading to externalizing behavior problems (Patterson, DeBaryshe, & Ramsey, 1989; Snyder et al., 1997). Coercion theory scholars describe the development of emotion dysregulation in a manner that is similar to Linehan's invalidating environment theory (1993). Specifically, coercive processes are defined as patterns of interaction in which the use of aversive tactics becomes increasingly frequent due to their effectiveness at reducing similarly aversive behaviors of other family members. According to coercion theory, the most successful way to end a disagreement is to escalate the conflict, from which the other dyad member is then motivated to escape. Thus, negative operant reinforcement processes ultimately shape aversive strategies for the end goal of conflict reduction (Patterson, Reid, & Dishion, 1998). The intermittent success of these behaviors makes it difficult for families to alter such patterns once they become entrenched.

Psychophysiological Dysregulation

The invalidating environment theory states that families may inadvertently teach and reinforce dysregulated emotions, thoughts, and behaviors. Similarly, developmental models of SII hypothesize that emotion dysregulation emerges gradually, across thousands of interactions between the child and the environment (Crowell et al., 2009). Over time, these social learning processes are

believed to produce dysregulated biological response patterns. This is consistent with a cognitive-behavioral understanding of psychopathology, in which thoughts, behaviors, emotions, and physiological responses presumably form a coherent system.

Although observed behavior can reveal the social mechanisms that shape dysregulation, many emotional responses are automated, rapid, and dynamic—allowing a person to act quickly and flexibly to salient information (e.g., Gross, 1998). For this reason, autonomic nervous system (ANS) measures are widely used indices of emotional vulnerability (see e.g., Beauchaine & Gatzke-Kopp, 2012). The parasympathetic branch of the ANS is of particular interest because of its role in physiological regulation (Porges, 2007). Parasympathetic influences on cardiac output can be assessed with respiratory sinus arrhythmia (RSA)—a measure of heart rate variability mediated by the vagus nerve (Porges, 2007). At rest, vagal inhibition of cardiac output is typically high, which allows for maximal flexibility when attending to and engaging with the environment (Porges, 1995). High RSA may also be one marker of resilience in the face of contextual risks (Shannon, Beauchaine, Brenner, Neuhaus, & Gatzke-Kopp, 2007).

In contrast, attenuated resting RSA is believed to index a less adaptive physiological state and is associated with emotion dysregulation, psychopathology, lower social competence, and poor executive functioning (e.g., Beauchaine, 2001; 2012; Calkins, Graziano, & Keane, 2007; Crowell et al., 2005; Hansen, Johnsen, & Thayer, 2003). As with all psychophysiological measures, the interpretation of RSA as an index of psychological states depends largely upon the stimulus conditions (Beauchaine & Gatzke-Kopp, 2012) and the social and cultural context (e.g., Barrett, 2012). However, several well designed studies have found that resting RSA is a reliable correlate of a person's baseline regulatory capacity and lower scores are associated with conduct problems, trait hostility, anxiety disorders, and other adverse outcomes (see e.g., Beauchaine, 2001; 2012).

Hypotheses

With the present study, we seek to test core components of the invalidating environment theory. We hypothesize the following: First, negative maternal behaviors, including rejection/invalidation and coercion, will be associated with higher levels of observed dysregulation among adolescents (e.g., anger/frustration, opposition/defiance), independent of group status. Second, both mothers and adolescents in SII dyads will exhibit more aversive utterances compared with controls, whereas control dyad members will engage mostly in low-level aversiveness. Third, SII dyads will be more likely than controls to match or escalate conflict, whereas control dyads will be more likely to de-escalate conflict. Finally, observed mother and child behavior will interact to predict resting state RSA. Specifically, RSA will be more strongly linked with teen behavior in the context of highly invalidating and aversive mother behavior than in the context of less invalidating and aversive mother behavior.

Method

Participants

All study procedures were approved by the Seattle Children's Hospital Institutional Review Board. Consent and assent were obtained from the mother and the child, respectively. All data were collected as part of a study on adolescent SII. Readers are referred to additional publications for extensive descriptive details about the sample and methods (Crowell et al., 2005; Crowell et al., 2008)[a]. Briefly, this study included 17 self-injuring adolescents and 20 controls between the ages of 14 and 17, and their mothers. Adolescents were recruited from local clinics, psychiatric hospitals, public school newsletters, and newspaper advertisements. Self-injurers were included if they engaged in SII 3 or more times in the past six months. This recruitment strategy was designed to identify adolescents who engaged in repetitive NSSI. However, in our NSSI group we did not

[a]This sample includes participants described previously by Crowell et al. (2005) and Crowell, Beauchaine, McCauley et al. (2008), where more detailed descriptive statistics are provided. Although certain results from global coding were reported in the latter publication, none of the prior analyses included the tests presented here. Results from the microanalytic coding system have not been reported elsewhere.

exclude adolescents who had also engaged in suicidal self-injury because the two behaviors co-occur at high rates (Hamza et al., 2012). Exclusion criteria included mental retardation, a schizophrenia spectrum disorder, or use of medications such as beta blockers, mood stabilizers, tricyclic antidepressants, or stimulants, which could alter physiological functioning. We did not exclude for selective serotonin reuptake inhibitor (SSRI) use, given experimental evidence that SSRIs do not alter RSA (Udupa et al., 2011). Control participants were excluded if they had any of the assessed psychiatric disorders (see below), or if they had ever engaged in SII. All participants were required to have resided with their mother for at least two days per week over the prior year. Participants who met these criteria were invited to Seattle Children's Hospital for a 1-2 hr assessment. Adolescents received $25 for the time they and their mother spent participating in the study.

Participants included 17 SII (82.4% female) and 20 control (95.0% female) adolescents ages 14-18 (M = 15.3, SD = 1.1). The sample was 74% Caucasian (n = 27), 4% African American, (n = 2), 4% Latino/a (n = 2), and 16% of mixed heritage (n = 6). Groups were matched at study entry on age, race, and sex. The original sample included 21 controls and 20 SII participants. This sample size was selected based on published effect sizes for RSA (e.g., Beauchaine et al., 2001). However, due to failure of video recording equipment (2 SII, 1 control) or participant refusal (1 SII), four participants enrolled in the original sample are not included for these analyses. These participants were similar to the overall sample on all demographic variables (all $ps \geq .17$) except for income $F(1, 34) = 6.84$, $p < .05$. Video recording failed for one low-income control family. Thus, for the current sample, mean family incomes, in thousands, were 80.0 (SD = 3.1) for controls and 51.0 (SD = 3.4) for the SII group. Analyses were run both with and without income as a covariate. All analyses are reported without income in the models because the pattern of results was unchanged. The small number of males in each group precluded analyses of sex differences.

Child Psychopathology and Self-Injurious Behaviors

Measures of psychopathology and SII were collected for descriptive purposes (see Tables 1 & 2) and for statistical control (described below). Adolescents reported on their psychopathology using the Youth Self-Report (YSR; Achenbach, 1991c), a widely used 112-item checklist assessing internalizing and externalizing behaviors. Adolescents also completed the Child Depression Inventory (CDI; Kovacs, 1992), which is a 27-item questionnaire that assesses difficulties associated with depression. Mothers reported on child psychopathology using the Child Behavior Checklist (Achenbach, 1991a), which is an informant-report version of the YSR. Participants selected one teacher who completed the Teacher Report Form (Achenbach, 1991b). The CDI, CBCL, YSR, and TRF are well validated measures with excellent psychometric properties.

For purposes of statistical control, a composite measure of overall psychopathology was created by averaging scores on the internalizing and externalizing scales of the CBCL, the internalizing and externalizing scales of the YSR, and the total score on the CDI. Missing data for one participant was imputed using the EM algorithm (Enders, 2010). The composite measure had excellent internal reliability ($\alpha = .91$) and was scaled such that higher scores indicate higher levels of psychopathology.

A trained graduate research assistant collected all data on SII with the Lifetime Suicide Attempt Self-Injury Interview (L-SASI; formerly the Lifetime Parasuicide Count; Linehan & Comtois, 1996). This interview evaluates the frequency, lethality, suicidal intent, and level of medical care for all self-injurious acts during the adolescent's life. The mother and adolescent report separately on the adolescent's SII. Control participants were screened to confirm a negative SII history over the phone and during the visit, and therefore did not complete the full L-SASI. There are no psychometric studies of the L-SASI. However, items that require interviewer judgment (lethality and intent) are identical to a longer measure, the *Suicide Attempt Self-Injury Interview* (SASII;

Linehan et al., 2006), which has very good inter-rater reliability and adequate validity. Because interviews were conducted by a single interviewer and at one time-point, test-retest and interrater reliabilities were not calculated for this sample.

Psychophysiological Assessment

During psychophysiological assessments, adolescents were seated alone in a comfortable, sound-attenuated room equipped with audio/video monitoring equipment. Electrodes were placed in a standard spot configuration on the child's torso (Qu, Zhang, Webster, & Tompkins, 1986). The ECG signal was sampled at 1kHz using a BioPac MP100 system (Goleta, CA). Respiratory sinus arrhythmia was measured during a 5 min resting baseline. In order to capture the parasympathetic component of heart rate variability, spectral analysis is applied to the R-wave time series, isolating the high frequency band (≥ 0.15 Hz; see Berntson et al., 1997). Because participants were at rest, respiration rates were well within the expected respiratory band for all participants (Berntson, Quigley, & Lozano, 2007). Respiratory sinus arrhythmia was calculated using software developed by Richard Sloan and colleagues at Columbia University. Data were collected in 30 s epochs and then averaged across the 5-min baseline. We entered a single RSA variable into regression analyses.

Mother-Child Discussion Task

Topics for the conflict discussion were identified using the Issues Checklist (Prinz, Foster, Kent, & O'Leary, 1979). This is a 44-item questionnaire designed to identify areas of conflict between mothers and adolescents (e.g., cleaning the room, privacy). Responses are rated on two scales: frequency, ranked from 1 (*never*) to 5 (*very often*) and intensity, ranked between 0 (*calm*) and 40 (*very intense*). Topics were selected by a trained graduate research assistant based on the best match between the mother and adolescent on both intensity and frequency. When possible, the discussion topic was chosen based on an intensity level of ≤ 20 as reported by both participants. This minimized the possibility of extreme distress. Dyads were seated in a comfortable room while they

completed the task. Conversations were 10 min and videotaped for later coding. Coders were blind to study hypotheses and group status.

Coding

Evaluating parental invalidation *and* conflict escalation most effectively required two distinct coding systems. The first system is a global approach (SCIFF; Lindahl & Malik, 2000). Global systems are well suited for describing more general qualities of an interaction and also apply descriptive labels, such as "rejection/invalidation" that match with developmental theories. The second is a microanalytic system (Stubbs, Crosby, Forgatch, & Capaldi, 1998), in which raters assign both a behavior and an affect code to each verbal utterance. This moment-to-moment approach provides a highly detailed evaluation of microprocesses that may be occurring within environmental contexts.

Global coding. Global coding was completed by two trained research assistants using the SCIFF (Lindahl & Malik, 2000). SCIFF training was conducted by the lead author based upon the schedule outlined in the training manual. First, coders were required to review the manual in detail and become familiarized with the codes. Second, several tapes were reviewed and discussed, item by item, with the coders. Those tapes had been collected for other projects and were scored in advance of the meeting by the lead author. Third, the coders met as a group with the lead author and coded three criterion tapes. Fourth, the coders were required to code three additional criterion tapes individually and discrepancies were discussed in weekly meetings. Once coders achieved an adequate level of reliability, they were assigned two tapes per week, including one overlapping tape. The shared tape was discussed to resolve disagreements and prevent observer drift.

From the full SCIFF, we calculated 12 variables, including 4 parent, 5 child, and 3 dyad codes. These were rated on 5-point scales ranging from 1 (*low*) to 5 (*high*). We were interested specifically in two mother and two child variables, each of which are described in the invalidating environment

and/or coercion theories. For the mother, we selected (1) rejection/invalidation and (2) coerciveness. According to the SCIFF training manual (Lindahl & Malik, 2000), rejection/invalidation is defined as parental behaviors that are "cruel, critical, insulting, blaming, unkind, rude, or insensitive…[or] dismissive or ignoring of the child's feelings" (p. 20). Invalidating statements include those that criticize the child's character rather than their behavior (e.g., "you embarrass me," "stop crying like a baby"). In contrast, coerciveness includes behaviors that are "threatening, bullying, shaming, embarrassing, or manipulative" (p.22). Coercive statements may include questions to which there is only one correct answer (e.g., "you do want to get better grades, don't you?") or overly punitive statements (e.g., "if you act like a brat, you'll be punished like one"). For the child, we examined (1) anger/frustration and (2) opposition/defiance. The anger/frustration code is operationalized as "the overall level of negative affect" expressed by the child, including any overt behaviors, body language, or facial expressions that convey anger, frustration, anger, and irritation (p. 29; e.g., whining, yelling, "I hate talking about this"). Opposition/defiance includes child behaviors that are "insulting, distracting, disrespectful, noncompliant, disobedient, argumentative, annoying, blaming, angry, or vindictive" (p. 32; e.g., swearing, blaming others for mistakes, "I won't clean my room tonight"). Inter-rater reliabilities in this sample were consistent with those in the SCIFF training manual, with intraclass correlation coefficients ranging from .63 to 1.0.

Microanalytic coding. Microanalytic coding was conducted by two different trained research assistants using the Family and Peer Process Code (FPPC; Stubbs et al., 1998). Prior to coding, raters received three months of training for approximately 15 hours per week. Reliability training followed a stepwise process similar to that described for global coding. In addition, coders were required to meet a minimum 10-key typing speed of 8,000 keystrokes per hour with 95% accuracy. All tapes were coded 3 times to ensure accuracy of coding and typing. Weekly sessions were conducted in order to maintain coding fidelity. Reliability between the two coders on content was κ

= .69 (range = .56 to .86). Reliability for affect was κ = .68 (range = .31 to .94). These reliabilities are consistent with other published research (Snyder, Edwards, McGraw, & Kilgore, 1994).

The FPPC assigns a five digit numerical code to each verbal utterance. These digits represent the speaker (e.g., mother; first number), content of the utterance (e.g., negative interpersonal; second two numbers), listener (e.g., daughter; fourth number), and affect (e.g., distress; fifth number). The code shifts whenever there is a change across any of these dimensions, such as a new speaker or a change in affect. The computerized output consists of a real-time numerical transcript capturing content and affect of all verbal behaviors that occurred during the 10 min interaction. Number codes generated during a 10 min interaction typically range from 60-100 codes. The FPPC contains 25 content codes describing verbal behaviors, and 6 affect codes including 2 positives, 1 neutral, and 3 negatives. Affect codes can then be reduced into a 3-point scale (*positive*, *neutral*, *negative*). This results in a total of 25 content × 3 affect combinations.

To examine escalation of conflict we followed a strategy that was developed and validated by Snyder and colleagues (1994). Each of the 75 (25 content × 3 affect) codes were collapsed into a single number on a 10-point scale ranging from highly positive or endearing utterances (*0*), to coercive or attacking utterances (*9*). These numbers were derived empirically for a related version of the FPPC (FPC; Dishion, Gardner, Patterson, Reid, & Thibodeaux, 1983). By collapsing codes into a single scale it was possible to evaluate each utterance on a continuum ranging from the most positive (an aversiveness ranking of *0*) to the most aversive (*9*). Unlike descriptive codes, the 0-9 scale is appropriate for statistical analyses.

In addition to the continuous variable, which was used for analyses of overall aversiveness, we also calculated several unconditional probabilities to evaluate patterns of conflict escalation. These included the total number of aversive utterances (*3-9*), and also high-level aversives (*7-9*), intermediate-level aversives (*5-6*), and low-level aversives (*3-4*). Although a rating of 3 captures

neutral utterances, we considered it a low-level aversive because of the nature of our task—a conflict discussion. Next, numbers were entered into two separate 2 × 2 lag + 1 probability matrices, as described by Bakeman and Gottman (1997). One captured the probability of the mother's verbal behavior following the adolescent's, and the other captured the reverse pattern. From these matrices we calculated transitional probabilities, which quantify the likelihood of specific maternal behaviors immediately following (i.e., given) specific teen behaviors (and vice versa). This is referred to as a lag + 1 model. From these probabilities, we examined transitions between low-level, intermediate-level, and high-level aversives. For example, a transition would be calculated as the probability of the mother responding with a low-level aversive given that the teen initiates with a high-level aversive, divided by the probability of the mother responding at any level to the teen's high-level aversive. Tests of conflict escalation were conducted on these probabilities.

Results

All statistical analyses reported below were performed with and without the composite psychopathology factor included as a covariate. Inclusion of the psychopathology factor as a covariate did not meaningfully change the direction, magnitude, or significance level of any predictors, and the psychopathology factor was not significant in any model. Since inclusion of the psychopathology factor did not change other parameter estimates or affect substantive conclusions, results from models excluding the psychopathology factor are presented.

Self- and Mother-Report Data

Diagnostic and SII data are reported in Tables 1 and 2. These results are a subset of those reported previously by Crowell et al. (2005; 2008), where more detailed descriptive information can be found. Because specific patterns of self-injury and psychopathology are not a central focus of the current study, we review these findings only briefly. For SII participants, results revealed wide ranges in methods, suicidal intent, lethality, and need for medical attention. All self-injuring

participants reported cutting as their primary method of SII but every participant had used more than one method. Puncturing and overdosing were the next most common methods of SII. Many adolescents reported a high number of self-injurious events, consistent with daily or weekly SII across months or years. As expected, given the high-risk sample, scores across all measures of psychopathology were elevated among self-injuring adolescents compared with controls.

Mother-Child Discussion: Global Coding

Basic group comparisons using the global coding system are presented elsewhere (see Crowell et al., 2008). In prior analyses, MANOVAs revealed group differences for both dyadic and adolescent behavioral codes, but not for maternal behavioral codes. For the present study we sought to test the hypotheses that across groups, maternal invalidation and coerciveness would be related to adolescent anger and opposition. Results were consistent with this hypothesis; greater maternal invalidation was associated with more teen anger (R^2 = .16, p = .01). Furthermore, higher levels of maternal invalidation and coerciveness were both related to more teen opposition/defiance (R^2 = .22, p = .006; R^2 = .12, p = .045, respectively). Mother coerciveness was not associated with teen anger (R^2 = .02, p = .415).

Mother-Child Discussion: Microanalytic Coding

Total aversive utterances. Our hypothesis was that both the mother and adolescent in SII dyads would exhibit more aversive utterances than controls. Table 3 presents results of the multilevel model (MLM) used to test this hypothesis. In this model, total aversiveness was regressed onto effect-coded variables representing the difference between mother (-.5) and teen (.5) and the difference between SII (-.5) and control (.5). The following equation describes the two-level MLM, which was conducted with Hierarchical Linear Modeling (HLM), version 6.09:

Level-1: $\text{total aversiveness}_{ij} = \beta_{0j} + \beta_{1j}*(\textit{family member}_{ij}) + r_{ij}$

Level-2: $\beta_{0j} = \gamma_{00} + \gamma_{01}*(\textit{group}_j) + u_{0j}$

$$\beta_{1j} = \gamma_{i0} + \gamma_{i1}*(group_j),$$

where *i* indexes individuals and *j* indexes families. Significant effects emerged for both family member ($B = 0.33$, $p < .001$) and group ($B = -0.30$, $p < .001$). These results indicate that (1) adolescents were more aversive than their mothers and (2) SII dyads were more aversive than control dyads. The interaction between family member (adolescent or mother) and group (SII or control) was non-significant ($p = 0.84$).

Low, intermediate, and high aversive utterances. After examining aversiveness continuously, we tested whether adolescents and mothers in SII dyads were more likely than controls to express low, intermediate, or high aversive utterances. We hypothesized that both members of control dyads would express more low-aversive utterances than members of SII dyads and that members of SII dyads would express more high-aversive utterances than controls. Table 4 presents results of the MLM used to test this hypothesis. Low, intermediate, or high aversive utterances were regressed onto effect-coded variables representing the difference between mother (-.5) and adolescent (.5) and the difference between SII (-.5) and control (.5)[b]. The two-level HLM follows the same structure as above, with low, intermediate, or high aversives as the outcome variable.

Significant effects emerged for family member on low and intermediate aversive utterances ($B = 0.33$, $p < .001$; $B = -0.31$, $p < .001$, respectively). Similar to above, these effects indicate that mothers exhibited more low-aversive utterances than adolescents and adolescents exhibited more intermediate-aversive utterances than mothers. Significant effects also emerged for group on low and intermediate aversive utterances ($B = -0.14$, $p = .006$; $B = 0.16$, $p < .001$, respectively). These results indicate that control dyads exhibited more low-aversive utterances than SII dyads, whereas

[b]This hypothesis was also tested by including all three forms of unconditional aversive utterances in the same model. In this model, low aversive utterances were used as the reference group and the differences between low, intermediate, and high aversive utterances was tested by including dummy coded variables to indicate intermediate and high aversive utterances. The magnitude, significance, and direction of all effects were substantively identical. We therefore report results from the separate models to ease presentation and interpretation.

SII dyads exhibited more intermediate-aversive utterances than control dyads. All interactions between family member and group were non-significant.

Conditional sequences of aversive utterances. Last, we examined whether conditional sequences of low, intermediate, and high aversive behaviors varied between adolescents and mothers and SII and control dyads. Prior to testing our hypotheses statistically, we characterized the two groups descriptively, based upon the unconditional and transitional probabilities described above. We present the most frequent pathways visually in Figure 1. Unconditional probabilities for high-, intermediate-, and low-level aversives are represented within the ovals and transitional probabilities are beside the arrows. The pathways we chose to represent are descriptive—based on frequency, rather than group differences (although significant findings are noted). The most frequent response for self-injuring teens was to escalate from low- to intermediate level aversiveness, match at the intermediate level, and de-escalate from the high to the intermediate level of aversiveness. Control teens were most likely to match at the low and intermediate level and de-escalate from the high to intermediate level of aversiveness. The most frequent pattern for control mothers was to de-escalate conflict to the lowest level of aversiveness. In contrast, mothers in self-injuring dyads most often matched their adolescent at the low and intermediate level and only de-escalated from the high to intermediate level of aversiveness.

To test these differences statistically, we used a similar two-level MLM to those described above, with aversive sequences as the outcome variable. We hypothesized that (1) control dyad members would be more likely to de-escalate conflict sequences than SII dyad members, and (2) SII dyad members would be more likely escalate conflict sequences. Table 5 presents results of the MLM used to test this hypothesis. Each conditional behavioral sequence was regressed onto effect-coded variables representing the difference between mother (-.5) and adolescent (.5) and the

difference between SII (-.5) and control (.5)[c].

Significant effects emerged for family member (mother or child) on high→intermediate (B = 0.25, p = .006), high→low (B = -0.20, p = .011), intermediate→high (B = -0.07, p = .003), intermediate→low (B = -0.27, p < .001), low→high (B = 0.08, p = .037), low→intermediate (B = 0.39, p < .001), and low→low sequences (B = -0.23, p = .002). These effects indicate that *mothers* (maternal behavior is *italicized*) exhibited more high→*low*, intermediate→*high*, intermediate→*low*, and low→*low* sequences than adolescents and that *adolescents* (adolescent behavior is *italicized*) exhibited more high→*intermediate*, low→*high*, and low→*intermediate* sequences than mothers.

Significant effects also emerged for group on high→intermediate (B = -0.31, p < .001), high→low (B = 0.24, p < .001), intermediate→high (B = -0.09, p = .008), intermediate→ intermediate (B = -0.32, p = .004), low→intermediate (B = -0.15, p < .001), and low→low sequences (B = 0.38, p < .001). These effects indicate that controls exhibited a pattern of de-escalating conflict or matching at a low-level of aversiveness compared with SII dyads (i.e., more high→low and low→low sequences). In contrast, SII dyads were more likely to escalate conflict (intermediate →high, low→intermediate). When SII dyads matched or descalated conflict, they were more likely than controls to stay at the intermediate-level (high→intermediate, intermediate→intermediate).

Finally, a significant Family Member × Group interaction emerged for low→low sequences. Control mothers exhibited more low→*low* sequences than control adolescents, $\chi^2(1) = 11.51$, p = 0.001, but there were no significant differences in low→low sequences between mothers and adolescents in SII dyads, $\chi^2(1) = 0.77$, $p > 0.50$). All other interactions between family member and

[c]Similar to the model testing unconditional behaviors, this hypothesis was tested by including all conditional sequences in the same model. In this model, the low-low sequence was used as the reference group and the differences between low-low and all other sequences were tested by including dummy coded variables. The magnitude, significance, and direction of all effects were substantively identical. We therefore report results from the separate models to ease presentation and interpretation.

group were non-significant.

Respiratory sinus arrhythmia. Our final hypothesis was that invalidating and aversive mother and teen behavior would interact to predict teen resting RSA. This hypothesis was tested using both global and microanalytic codes (see Table 6). For microanalytic codes, Table 6 shows results of the model in which teen baseline RSA was regressed onto group, mother total aversiveness, and teen total aversiveness. Consistent with our hypothesis, the main effect of teen aversiveness (β = -.45, p = .028) and the interaction between mother and teen aversiveness (β = -.50, p = .015) were significant. As shown in Figure 2, higher levels of teen aversiveness were associated with lower levels of teen RSA only at high levels of mother aversiveness (B = -4.70, p = 0.009); there was no significant association between teen aversiveness and teen RSA at low levels of mother aversiveness. For the global codes, Table 6 shows results of separate models in which teen baseline RSA was regressed onto group and (a) mother invalidation and teen anger, (b) mother aversiveness and teen opposition, and (c) mother coercion and teen opposition[d]. None of the main effects or interactions involving mother or teen behavior emerged as significant with global coding.

Discussion

Adolescent SII is a worrisome and potentially lethal behavior. Therefore, identifying effective prevention and intervention strategies is of utmost importance (Mann et al., 2005). Because understanding etiology is often a necessary antecedent to effective prevention (see e.g., Beauchaine et al., 2008), studies that identify potential pathways to SII have translational implications. Our findings are consistent with developmental models, which suggest that self-injuring adolescents and their mothers engage in patterns of interaction that reinforce irritability, anger, and emotional outbursts. Such styles are likely to emerge gradually and inadvertently—even among well-

[d] This combination of codes was selected based on the significant associations between these variables, reported above, and to maximize the similarity of the global and microanalytic codes examined for these models.

intentioned people (Linehan, 1993; Patterson, Dishion, & Bank, 1984).

Although our sample size was relatively small, the results of this study are consistent with hypotheses derived from Linehan's (1993) invalidating environment theory and more recent Biology × Environment interaction models of SII (Beauchaine et al., 2009; Crowell et al., 2009). Across groups, maternal rejection/invalidation was associated with more adolescent anger/ frustration. Furthermore, mother invalidation and coercion were both related to higher levels of teen opposition/defiance. Results from the microanalytic coding system revealed that adolescents and mothers in SII dyads were more aversive than controls, suggesting that the mother-child interactions of self-injuring teens are marked by greater conflict than typical families. Mothers in SII dyads were also more likely to match or escalate conflict than controls. Finally, control mothers matched at the lowest level or de-escalated the conflict, regardless of adolescent behavior. In contrast, mothers in SII dyads de-escalated the discussion primarily in response to extreme adolescent behavior. Indeed, the only significant de-escalation by mothers in the SII group was from adolescent high- to mother intermediate-level aversiveness. This supports theories that dysregulated teen behavior may function to reduce conflict and, consequently, is inadvertently reinforced by the parent.

Developmental psychopathologists theorize that parent-child interaction patterns may promote better or worse emotion regulation across time (e.g., Beauchaine, Gatzke-Kopp, & Mead, 2007). With this study, we tested the hypothesis that mother and child behavior would interact to predict resting RSA, a physiological index of regulatory capability. Results from the microanayltic coding system revealed that higher teen aversiveness was associated with lower teen RSA, only at high levels of maternal aversiveness. There was no association between adolescent aversiveness and RSA at low levels of mother aversiveness. We tested parallel models using the global coding system but no significant findings emerged. This may be due to reduced measurement precision with the global coding system, which assigns a single number to a lengthy interaction. In contrast,

the microanalytic data produces 20-50 numbers capturing the verbal behavior of each dyad member.

Indeed, the use of two coding systems highlights important differences between methods of behavioral observation. With the global system we found group differences in codes for adolescent and dyad behavior, but not maternal behavior (see Crowell et al., 2008). Had we analyzed the data with this system alone, as is the standard in observational studies, our findings would have been inconsistent with developmental theories of SII. The microanalytic system revealed that—even though mothers are generally more restrained than teens—the moment-to-moment behaviors of mothers in SII dyads are different from those of controls. We hypothesize that these differences are important, but subtle, and were missed with the global approach. Another possibility is that the microanalytic code overestimated the maternal contribution to conflict due to unknown or unmeasured methodological artifacts. This is unlikely, given that the global system revealed the expected relations between problematic mother and child behaviors (e.g., mother invalidation was related to child anger across groups), but requires further exploration. Perhaps mothers of self-injuring adolescents are more likely to match/escalate conflict but are not more invalidating than controls. Future studies should examine whether observed invalidation is a risk factor for SII.

It is important to note that our work is cross-sectional. Without longitudinal data it is impossible to determine whether causal associations exist between invalidation, conflict escalation, and the development of SII. We found that maternal behavior was related to the adolescent's displays of anger/frustration and opposition/defiance. However, the reverse pattern may also be operative: as adolescent emotional expressions become angrier and more oppositional, parental invalidation and coerciveness may increase in response. Thus, one possibility is that, when faced with extreme adolescent behaviors, invalidation may be a normative parental reaction.

A strength of this study was the use of two coding systems conducted with well-trained, independent teams. The independence of teams was necessary in order to reduce any cross-over

effects between the coding systems. However, disparities between systems could reflect systematic coder differences rather than real effects. Though unlikely given the regimented training and blindness of coders, such an effect cannot be ruled out. One important limitation is the lack of a clinical comparison group. Although controlling for psychopathology did not alter our results, it is not possible to determine whether these findings are specific to self-injuring adolescents or common across different diagnostic groups. Indeed, conflict escalation and negative reinforcement of emotional lability have also been identified among externalizing youth and their parents (Snyder et al., 1994; Snyder et al., 1997; Zahn-Waxler, Usher, Suomi, & Cole, 2005).

It is possible that escalating disagreements occur in many families with clinical issues and is a non-specific marker of risk for psychopathology. Alternatively, conflict escalation may mark specific risk for externalizing behavior problems, including aggression and self-injury. There is accumulating evidence that self-injuring females show elevated rates of externalizing psychopthology (Crowell et al., 2012). Moreover, longitudinal studies with girls find that combined type ADHD predicts self-injury ten years later (Hinshaw et al., in press) and childhood ADHD and ODD predict adolescent BPD symptoms (Stepp, Burke, Hipwell, & Loeber, 2012). Taken together, our results are consistent with theories that conflict escalation is a shared mechanism of contextual risk for self-injury and aggressive behaviors (Beauchaine et al., 2009).

The small sample size reduced our statistical power and may have obscured some effects, especially with the global coding system. However, similar sample sizes are often reported for studies that use complex coding systems (Snyder et al., 1994). To our knowledge, there are no studies that report results from two unique, time-intensive coding systems and include a physiological assessment with a high-risk clinical sample. All of the participants in our sample had engaged in repetitive SII and all used self-cutting as the primary method of harm. Although most of the participants also reported suicidal behaviors, our results may not generalize to suicidal

adolescents who have not engaged in non-suicidal self-injury (Hamza et al., 2012). The small number of male participants also precluded evaluation of sex effects. Future research should examine differences between self-injuring males and females in family interaction patterns. Subsequent studies should also include fathers, since father-child interactions are critical to emotional development and well-being (Lamb, 2010).

Implications for Research, Policy, and Practice

Research on family conflict and SII is limited and has often focused on more extreme family struggles, such as neglect or abuse. Our findings suggest that family interaction patterns may be subtle and therefore may be more difficult for families to identify as problematic. This study highlights the need for further research on family processes in this population. A first step is to determine whether patterns of interacting can differentiate self-injuring adolescents from other clinical groups, such as depressed or anxious teens. Longitudinal research could also assess whether invalidating, high-conflict interactions can predict who will initiate or escalate SII and who will develop more severe and protracted forms of psychopathology. Self-injury is a complex, multidetermined phenomenon. However, invalidation, criticism, and a poor family alliance may contribute to suicidality (Gutierrez, Osman, Kopper, & Barrios, 2000; Wedig & Nock, 2007) and therapies that strengthen family relationships may reduce suicide risk. Similarly, early interventions targeted toward girls with externalizing behavior problems may prevent the emergence of self-injury or other BPD traits (Hinshaw et al., in press; Stepp et al., 2012).

Clinically, parents of self-injuring adolescents often express uncertainty regarding how to interact with their children. Moreover, providers report that changes in parental behavior, even when positive, often evoke a strong negative response from troubled adolescents. When these strong responses include suicide threats or attempts, a natural caregiver reaction is to revert to previous parenting strategies. However, our results indicate a strong need for parents to be coached toward a

different interaction style. It is essential to emphasize that transactional processes arise subtly across thousands of interactions—and therefore no one is to blame. Rather, such interaction patterns may be a common experience for SII families. Increasingly, therapeutic programs for adolescents are including a parenting skills component (e.g., Miller, Rathus, & Linehan, 2007). Our results lend support to the notion that increasing validation and consistently (rather than intermittently) deescalating conflict may be core strategies for parents of self-injuring teens.

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Table 1

Parent- Adolescent- and Teacher-Report of Psychopathology

Achenbach Scales[a]	Parent Report				Self-Report				Teacher Report			
	Self-Harm *n* = 16	Control *n* = 20	*F*	η^2	Self-Harm *n* = 16	Control *n* = 20	*F*	η^2	Self-Harm *n* = 9	Control *n* = 15	*F*	η^2
Withdrawn	70.0 (10.4)	52.6 (4.4)	46.1***	.58	63.3 (6.6)	52.8 (4.6)	31.6***	.61	60.0 (12.1)	51.9 (4.7)	5.6	.20
Somatic Complaints	69.3 (8.8)	54.8 (5.0)	39.0***	.60	62.9 (9.5)	54.5 (6.0)	10.7**	.37	55.9 (6.3)	50.0 (0.0)	13.6***	.38
Anxious/ depressed	73.1(9.7)	52.0 (3.8)	80.4***	.68	69.6 (14.8)	52.2 (3.5)	26.3***	.52	60.9 (11.4)	51.9 (3.9)	7.9**	.26
Attention problems	70.3 (10.5)	51.8 (3.8)	54.3***	.58	67.6 (10.1)	54.9 (8.0)	17.7***	.38	59.3 (8.6)	51.3 (3.8)	10.1**	.32
Delinquent behavior	70.1 (12.0)	54.7 (6.4)	24.8***	.47	75.2 (12.6)	57.4 (7.0)	29.1***	.41	59.4 (9.3)	51.6 (4.37)	7.9**	.26
Aggressive behavior	63.6 (11.0)	51.0 (1.7)	25.9***	.45	66.6 (12.3)	55.1 (6.3)	13.3***	.33	56.4 (5.8)	50.7 (2.1)	12.5**	.36
Total internalizing	73.6 (8.4)	47.1 (8.3)	90.0***	.73	67.9 (11.5)	48.7 (8.9)	32.4***	.58	59.7 (11.5)	45.4 (7.9)	13.1**	.37
Total externalizing	65.7 (12.4)	46.4 (8.2)	31.2***	.53	70.2 (15.1)	54.9 (7.6)	15.6***	.32	57.3 (6.5)	44.7 (5.6)	25.2***	.53

Note: T-scores for the Achenbach scales are reported as mean (*SD*).

[a]Self, parent-, and teacher-reports on the Achenbach scales were assessed using the Youth Self-Report (Achenbach, 1991a), the Child Behavior Checklist (Achenbach, 1991b), and the Teacher Report Form (Achenbach, 1991c), respectively.

Table 2

Self-Inflicted Injury as Reported on the L-SASI Interview

Item	*n* (%)[a]	*M*	*SD*	Range
Adolescent report				
Total self-injury events	17 (100%)	144.9	228.9	4-839
Events with intent to die	11 (73%)	25.1	79.0	0-310
Events with ambivalence	13 (87%)	46.7	102.6	0-402
Events without intent to die	17 (100%)	77.5	120.3	3-447
Events requiring medical attention	12 (80%)	4.3	6.6	0-25
Parent report				
Total self-injury events	16 (94%)	41.0	71.8	0-282
Events with intent to die	6 (40%)	8.2	23.6	0-90
Events with ambivalence	6 (40%)	11.1	22.8	0-65
Events without intent to die	10 (67%)	20.9	34.4	0-117
Events requiring medical attention	10 (67%)	4.9	7.1	0-22

[a] Number (and percentage) of self-injuring participants reporting at least one incident of this type.

Table 3

Results of multilevel models of total aversive behaviors

Variable	*B*	*SE B*
Intercept	0.48***	0.04
SII vs. control	-0.30***	0.08
Teen vs. mother	-0.33***	0.06
Teen vs. mother × SII vs. control	-0.03	0.13

Note: Robust standard errors are reported
* p < .05, ** p < .01, *** p < .001

Table 4

Results of multilevel models of unconditional aversive behaviors

Variable	*B*	*SE B*
Low aversive		
Intercept	0.45***	0.05
SII vs. control	0.28***	0.09
Teen vs. mother	0.33***	0.08
Teen vs. mother × SII vs. control	0.15	0.15
Intermediate aversive		
Intercept	0.39***	0.04
SII vs. control	-0.29***	0.09
Teen vs. mother	-0.31***	0.06
Teen vs. mother × SII vs. control	0.01	0.11
High aversive		
Intercept	0.14***	0.02
SII vs. control	-0.04	0.04
Teen vs. mother	-0.02	0.04
Teen vs. mother × SII vs. control	-0.17	0.08

Note: Robust standard errors are reported
* $p < .05$, ** $p < .01$, *** $p < .001$.

Table 5

Results of multilevel models of conditional behavioral sequences

	Intercept		SII vs. control		Teen vs. mother		Teen vs. mother × SII vs. control	
	B	*SE B*	*B*	*SE B*	*B*	*SE B*	*B*	*SE B*
High-high	0.10***	0.02	-0.03	0.05	0.02	0.03	-0.05	0.06
High-intermediate	0.32***	0.04	-0.31***	0.08	0.25**	0.08	0.10	0.17
High-low	0.29***	0.05	0.24*	0.10	-0.20*	0.08	-0.18	0.15
Intermediate-high	0.08***	0.02	-0.09**	0.03	-0.07**	0.02	0.06	0.04
Intermediate-intermediate	0.32***	0.05	-0.32**	0.10	0.10	0.06	0.07	0.12
Intermediate-low	0.30***	0.05	0.11	0.10	-0.27***	0.07	-0.23	0.14
Low-high	0.08***	0.02	0.04	0.04	0.08*	0.04	0.12	0.08
Low-intermediate	0.29***	0.03	-0.15*	0.06	0.39***	0.10	-0.06	0.19
Low-low	0.40***	0.05	0.38***	0.10	-0.23**	0.07	-0.34*	0.14

Note: Robust standard errors are reported
* $p < .05$, ** $p < .01$, *** $p < .001$

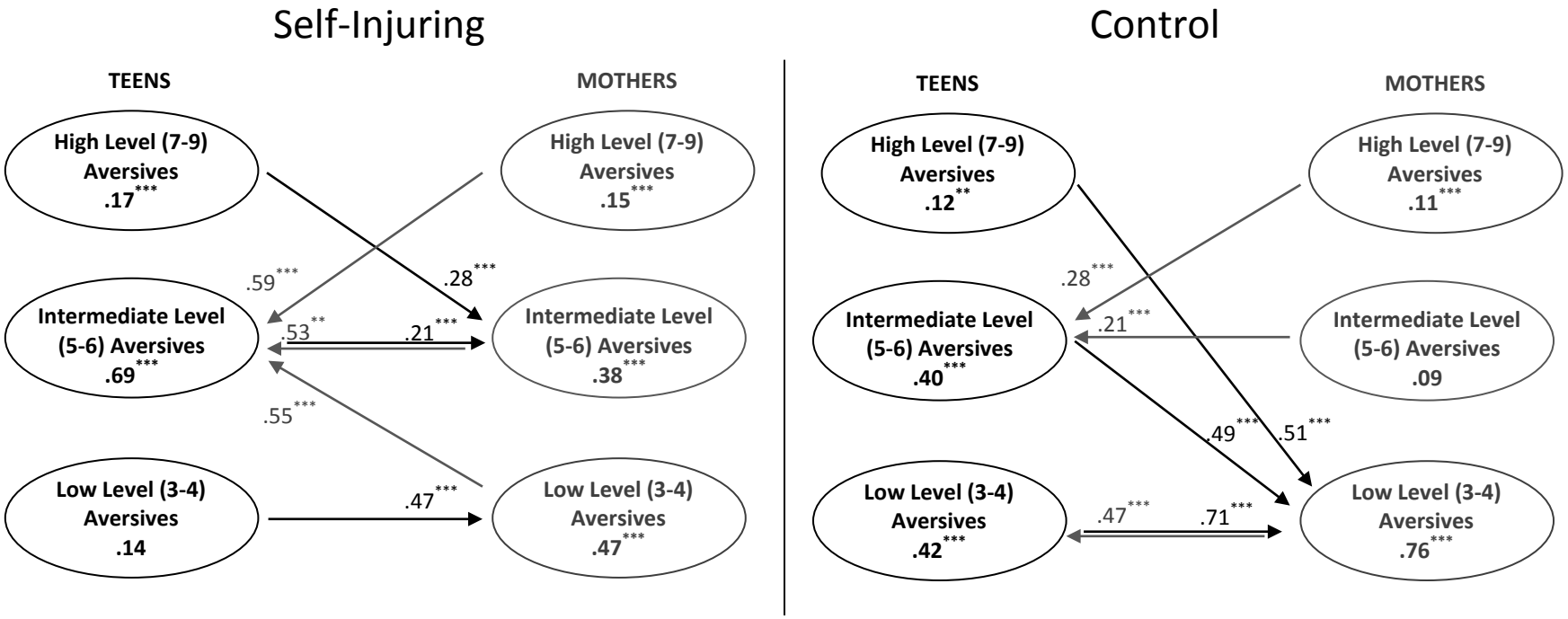
Table 6

Multiple regression results for the four different models predicting baseline RSA from mother and teen behavior

Variable	B	SE B	β
Intercept	6.96***	0.242	
Group	1.05	0.52	0.38
Mother total aversiveness	0.86	0.95	0.20
Teen total aversiveness	-2.01*	0.87	-0.45
Mother × teen total aversiveness	-8.48*	3.27	-0.50
Intercept	6.49***	0.26	
Group	1.69**	0.57	0.59
Mother coerciveness	0.11	0.33	0.08
Teen opposition and defiance	-0.03	0.22	-0.03
Mother coerciveness × teen opposition and defiance	0.17	0.14	0.27
Intercept	6.55***	0.26	
Group	1.68**	0.56	0.58
Mother invalidation	0.57	0.32	0.36
Teen opposition and defiance	-0.05	0.25	-0.05
Mother invalidation × teen opposition and defiance	0.00	0.18	-0.01
Intercept	6.56***	0.28	
Group	1.58**	0.54	0.55
Mother invalidation	0.63	0.33	0.39
Teen anger	-0.22	0.24	-0.18
Mother invalidation × teen anger	-0.01	0.33	0.00

Note. * $p < .05$, ** $p < .01$, *** $p < .001$

Figure 1. Descriptive representation of conversation tactics during conflict for both groups.



Note: Items in grey represent mother-initiated verbal behavior. Unconditional probabilities (ovals) represent the probability at each level of aversiveness, independent of the other dyad member's behavior. These can be understood as a percent of the total utterances by that member of the dyad. When totals do not add to 1 (e.g., control teens and mothers) it is due to non-aversive utterances that are not represented here (i.e., endearment). Transitional probabilities (arrows) represent the probability of an utterance given the other dyad member's previous utterance (e.g., in the SII group, 47% of the time the mother responded to a teen low-level aversive with a low-level aversive, control mothers responded in this way 71% of the time). In this diagram, all unconditional probabilities are presented. In contrast, of the 18 possible transitional probabilities, only the most frequently occurring patterns at each level are presented. This is descriptive, rather than statistical.

The full results from statistical analyses are presented in Table 5. Significant findings that co-occur with the most frequent interaction patterns are also noted in this figure (** $p < .01$, *** $p < .001$). One additional significant finding is presented in Table 5 but not depicted here. Mothers in SII dyads were also more likely than control mothers to respond to teen intermediate-level aversives with a high-level aversive ($p < .05$). This is not represented visually because it is not the most frequent pathway.

Figure 2. Simple slopes for interaction between mother and teen total aversiveness in predicting baseline RSA