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# Dynamics of Affective Reactivity During Mother-Daughter Interactions:The Impact of Adolescent Non-Suicidal Self-Injury

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## Abstract

Non-suicidal self-injury (NSSI) is an alarming public health concern that is particularly widespread among adolescents. The current study examined affective responses during mother-daughter interactions in adolescent girls with and without a history of NSSI. Participants were 60 girls aged 13–17 with ($n$ = 27) and without ($n$ = 33) a history of NSSI and their mothers. Adolescents and their mothers completed two interaction tasks: one positive and one negative. During these interactions, facial affect was assessed via electromyography (EMG). Results of Actor-Partner Interdependence Modeling (APIM) revealed several intra- and interpersonal disruptions in affect during both tasks among dyads in which the adolescent had an NSSI history. Findings suggest deficits in both self- and co-regulation of facial affect during mother-daughter interactions involving dyads in which the adolescents reports NSSI. Ultimately, if replicated and extended in longitudinal research, these disruptions may prove to be promising targets of intervention to reduce risk for future NSSI in adolescent girls.

### Keywords

non-suicidal self-injury; mother-daughter interaction; facial electromyography; adolescence

Non-suicidal self-injury (NSSI) is a transdiagnostic behavior characterized by purposeful self-injury without the intent to die (Nock, et al., 2006). NSSI poses a serious threat to one's physical and emotional well-being and amplifies risk for future NSSI and suicide attempts

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*Ethical Approval:* All procedures were reviewed and approved by Binghamton University's Institutional Review Board prior to recruitment and data collection.

*Informed Consent and Assent.* All participants were fully informed about the process and purpose of the study. Written consent/assent was obtained.

Statements and Declarations:

*Conflict of Interest:* The authors declare that they have no competing or conflicts of interests.

(Ribeiro et al., 2016). Critically, rates of NSSI increase dramatically between childhood and adolescence, especially for girls (Barrocas et al., 2012), with lifetime prevalence rates of NSSI among adolescents estimated to be around 18% (Swannell et al., 2014). This increase coincides with a rise in the emotional intensity of parent-child conflict that also occurs during adolescence (Laursen et al., 1998) as well as with the heightened emotional reactivity that adolescents experience in response to interpersonal stress more generally (Larson & Ham, 1993).

Conceptual models of NSSI highlight the role of interpersonal and emotion regulatory factors in risk for self-injury. Specifically, in their Benefits and Barriers Model (2018), Hooley and Franklin identify both benefits of NSSI (e.g., improved affect, self-punishment, peer group affiliation, and communication) and factors that mitigate risk (e.g., desire to avoid pain/blood, positive self-view, and social norms). This model incorporates interpersonal and emotion regulatory components from earlier models, such as the Four Functions Model and emotion regulation models. For instance, in the Four Functions Model (Nock & Prinstein, 2004, 2005), NSSI is viewed as a maladaptive response to a social environment (e.g., seeking to increase attention, reduce punishment or conflict). Accordingly, this model highlights the potential influence of an individual's social environment on NSSI risk, suggesting undesirable or negative social environments fuel the desire for interpersonal and emotion regulatory benefits of NSSI (Nock & Prinstein, 2004, 2005). Notably, emotion regulation models of NSSI (Hasking et al., 2016; Selby & Joiner, 2009) those at risk for NSSI may self-injure as a maladaptive method of regulating negative emotions resulting from heightened reactivity to stressful social environments (Hasking et al., 2016; Nock & Prinstein, 2004; Selby & Joiner, 2009).

Although studies demonstrate a link between parent-child relational factors and NSSI in youth (for a review see, James & Gibb, in press), this research has primarily focused on broad measures of the parent-child relationship (e.g., retrospective self-report of relational dynamics/behaviors occurring over a large period of time), and less is known about more fine-grained processes that occur during actual parent-child interactions. Nonetheless, a perceived lack of parental support and general conflict within the parent-child relationship are frequently associated with youth engagement in NSSI (e.g., Ammerman & Brown, 2018; Andrews et al., 2013; Hilt et al., 2008; Tatnell et al., 2014; You & Leung, 2012). Specifically, lower perceived parental support is associated with youth NSSI history (Ammerman & Brown, 2018), and predicts youth engagement in NSSI 12-months later (Andrews et al., 2013; Tatnell et al., 2014). Similarly, higher levels of perceived parental invalidation predict youth engagement in NSSI one year later (You & Leung, 2012). Finally, youth who engage in NSSI report worse parent-child relationship quality than youth who do not engage in NSSI (Hilt et al., 2008).

To address methodological gaps and expand up on these well-established relations, the present study focuses on understanding dynamics of affective reactivity during positive and negative mother-daughter interactions, as facial affect is a key process involved in social communication. Supporting this focus, research has shown that those who engage in NSSI display elevated levels of negative affect relative to individuals who do not (Klonsky & Olino, 2008; Nock & Mendes, 2008). Additionally, one study found that mother-adolescent

dyads in which the adolescent engaged in self-injury exhibited higher overall levels of negative affect and lower levels of positive affect during a mother-adolescent interaction than dyads without adolescent self-injury (Crowell et al., 2008). These results are consistent with theories highlighting the key role of heightened levels of negative affect among individuals who engage in NSSI (Hasking et al., 2016; Selby & Joiner, 2009), and illustrate a need for more research examining levels of positive and negative affect among youth with NSSI during actual interactions. To provide a fine-grained evaluation of dynamic changes in positive and negative facial affect, we used facial electromyography (EMG), which allowed us to index second-to-second changes in facial musculature associated with positive and negative affect during positive and negative interpersonal mother-daughter interactions. Facial EMG allows for greater temporal resolution than can be achieved through even a detailed behavioral coding system (Cacioppo et al., 1986). Specifically, electrodes placed over the corrugator supercilii muscle, which contracts during frowning as one's eyebrows come together, provided an index of negative facial affect. And, electrodes placed over the zygomaticus major muscle, which contracts during smiling as the corners of the mouth pull upward, provided an index of positive facial affect (Cacioppo et al., 1986; Dimberg, 1990). Increased zygomaticus activity is associated with viewing facial displays happiness (Gantiva et al., 2021; Rymarczyk et al., 2011), which are coherent with participants' self-reported happiness (Gantiva et al., 2021). In contrast, corrugator activity is associated with facial displays of sadness, fear, anger, and disgust (Ekman & Friesen, 1978; Neumann et al., 2014).

In addition to examining group differences in average levels of positive and negative affect during the discussion, we also examined the dynamics of affective exchange between adolescent girls and their mothers, and whether these dynamics differ based on adolescents' NSSI history. It is important to recognize that adolescents' affective reactions occur within the context of an interaction with their mothers, so focusing only on adolescent responses or average levels of affect may disregard important components of the mother-adolescent relationship. To this end, several studies demonstrate a relation between psychopathology and reduced parent-child synchrony (i.e., reciprocal responsivity to verbal and non-verbal cues from both the parent and the child; Deater-Deckard et al., 2004; James et al., 2021; Kudinova et al., 2019; Leclère et al., 2014; Woody et al., 2016). Nonetheless, just one study has examined the role of adolescent self-injury in mother-daughter concordance of facial affect during a standardized interaction task (Haines et al., 2019). In this study, Haines et al (2019) employed automated facial affect coding of 10 second segments to examine affective dynamics in three groups of mother-daughter dyads: those with adolescent self-injury, those with adolescent depression but no self-injury, and psychiatric controls. All three groups demonstrated strong correspondence of positive facial affect during a conflict discussion, though only dyads with adolescent self-injury exhibited correspondence of negative facial affect. Importantly, mothers in control dyads demonstrated greater positive facial affect during the discussion, whereas no group differences in mothers' negative facial affect emerged. This finding of strong correspondence of mothers' and daughters' negative facial affect in dyads with self-injuring adolescents aligns with previous findings from the same dataset employing human coders (Crowell et al., 2013). Together, these studies suggest specific alterations in dynamic displays of facial affect during mother-adolescent interactions

that may be associated with adolescent self-injury. However, because these studies focused on self-injury broadly rather than NSSI specifically, it is unclear whether similar findings would be observed in adolescents specifically engaging in NSSI. This differentiation is important given that "self-injury" encompasses both suicide attempts and NSSI. Though highly comorbid, NSSI and suicide attempts are distinct behaviors with separate theoretical foundations and numerous distinguishing criteria (i.e., intent, function, chronicity, potential for death, etc.; Halicka & Kiejna, 2018; Nock et al., 2006; Wichstrøm, 2009). In addition, given that facial affect can shift quickly and dramatically, a 10 second window, like that used is previous research (e.g., Haines et al., 2019), is quite large when trying to understand the dynamic changes in facial affect that occur during mother-adolescent interactions. Our use of facial EMG allows a much more fine-grained examination of these dynamics.

To do so, the present study employed a dynamical systems approach using actor partner interdependence modeling (APIM; Kenny et al., 2006) to examine patterns of change in intra- and interpersonal dynamics of facial affect (i.e., facial EMG) in mother-adolescent dyads during standardized laboratory-based interaction tasks. This approach allows for the examination of both morphostatic (stability) and morphogenetic (change) dyadic processes, reflecting dynamic changes within a system (Butler & Randall, 2013). For example, to the extent that adolescents and mothers can each be conceptualized as systems with homeostatic setpoints of EMG, dynamical systems modeling can be used to identify (a) how each individual responds to shifts in context (e.g., discussing positive versus negative topics) while simultaneously striving to maintain their homeostatic setpoint, and (b) how individual factors (e.g., NSSI) might influence the ability to maintain a homeostatic setpoint. Further, an APIM framework can demonstrate both intrapersonal (i.e., actor) and interpersonal (i.e., partner) effects, as well as whether these effects differ in dyads with and without adolescent NSSI. Therefore, this type of statistical modeling has utility in differentiating intra- and interpersonal influences on the maintenance of a homeostatic setpoint as well as ongoing changes in facial affect within the dyadic system.

The overall goal of this study was to examine the extent to which levels of positive and negative affect and dynamics of affective exchange during positive and negative mother-adolescent interactions are disrupted in mother-daughter dyads in which the daughter has a history of NSSI. Relational factors (i.e., maternal criticism, familial emotional climate) have been linked to NSSI in girls, but not boys (James et al., 2018; Sim et al., 2009), and in a study of adolescent girls, frequency of NSSI associated with greater parent-child stress, prospectively (Miller et al., 2018). Given these associations, combined with evidence of gender differences in interpersonal stress reactivity, with girls exhibiting greater reactivity than boys (Rose & Rudolph, 2006), we limited our sample to mother-daughter pairs to reduce sample heterogeneity. In terms of overall affect and consistent with Crowell et al (2008), we predicted that dyads with an adolescent NSSI history would exhibit less positive facial affect and more negative facial affect across both mother-adolescent interactions than dyads without adolescent NSSI. To complement the facial EMG, we also asked mothers and daughters to self-report their affect (sadness, anxiety) after each phase of the interaction task and predicted that dyads with adolescent NSSI would report higher levels of negative affect throughout the interactions. Additionally, the mother-adolescent interaction paradigm allowed for the examination of intra- and interpersonal dyadic influences during

each interaction using Actor-Partner Interdependence Modeling. Building from Haines et al (2019), we predicted that all dyads would demonstrate similar levels of correspondence of positive affect. However, in terms of negative affect, we predicted dyads with adolescent NSSI would demonstrate stronger correspondence than dyads without adolescent NSSI. Given the lack of extant research in this area, however, hypotheses were not made about other dynamics during the interactions (e.g., strength of actor effects).

## Method

### Participants

Participants were 61 mother-daughter dyads recruited from the community based on girls' NSSI history through advertisements on social media and brochures placed in the community (e.g., gyms, hair salons, medical offices, therapist waiting rooms). All daughters were required to be between the ages of 13 and 17 years. To meet criteria for inclusion in the NSSI group, girls had to report a history of self-injurious cutting behavior (at least two distinct episodes) without intent to die ($n = 27$). One additional adolescent was excluded from analyses due to ambiguous engagement in NSSI. The remaining thirty-three participants had no history of NSSI. Therefore, the final sample comprised 60 adolescents (27 with NSSI; 33 without NSSI). Adolescents were, on average, 15.23 years ($SD = 1.30$). Of the adolescents, 78.7% were White, 6.6% were African American/Black, 4.9% were Asian, and 9.8% were multiracial or from another racial group. Additionally, 8.5% of adolescents were Hispanic. Of the mothers, 90% were White, 3.3% were African American/Black, 1.7% were Asian, and 5.1% were multiracial or from another racial group. Additionally, 5.1% of mothers identified as Hispanic. Demographic and clinical characteristics of each group are provided in Table 1.

### Measures

**Adolescents' NSSI History—**Adolescents' lifetime NSSI was assessed using the Self-Injurious Thoughts and Behaviors Interview (SITBI; Nock et al., 2007). Specifically, adolescents' NSSI history was probed with the question "*Have you ever actually engaged in NSSI?*" where NSSI is defined as "*purposely hurting yourself without wanting to die.*" Twenty-seven adolescents reported at least two lifetime NSSI episodes (Range: 2–400; *Median = 9*) with 15 adolescents reporting past year NSSI (Range: 5 days-4 years). All 27 girls reported cutting themselves at least twice, eight (30%) of whom also reported additional NSSI methods (e.g., burning, hitting self on purpose, scrapping skin).

**Discussion Paradigm—**Adolescents and their mothers completed a standardized Discussion Paradigm that included positively- and negatively-valenced interactions (Robin & Foster, 1989). During this paradigm, mother-adolescent dyads first participated in a 2-min resting baseline task during which they viewed a nature video featuring landscape footage from Olympic National Park. Subsequently, dyads engaged in a 4-min Vacation Planning task in which they were asked to plan a "dream vacation" for just the two of them. Finally, dyads completed a 6-min Conflict Resolution task centered around a selected topic from each dyad's responses to an Issues Checklist that was completed separately by both the adolescent and mother prior to beginning the Discussion Paradigm. This Issues Checklist

presents typical areas of disagreement (e.g., lying, homework, chores, etc.). Participants indicate both the frequency and intensity of their conflicts over each presented domain. The topic mutually endorsed with the highest frequency and intensity ratings was selected for the Conflict task, and mother-adolescent dyads were asked to talk about the topic, describe a recent disagreement, and attempt to resolve it. Adolescents and their mothers from both groups all endorsed the same three topics with the highest frequency: helping out around the house (e.g., putting things away, chores, etc.), taking care of things (e.g., room, pets, etc.), and friends. Intensity ratings did not differ between groups (lowest $p = .11$). Dyads were prompted to either elaborate or, in the case of the Conflict task, discuss another topic of disagreement from the Issues Checklist if they finished their conversation during either Vacation or Conflict prior to the required length of time (i.e., four or six minutes, respectively). Dyads were interrupted and encouraged to continue their conversation at a later time if they were still engaged in the task at 4- or 6- minutes. The same protocol was followed across dyads with and without adolescent NSSI.

**EMG Signal Recording and Processing—**Facial electromyography data were also recorded simultaneously from adolescents and their mothers using Biopac M150 wireless recording systems (BIOPAC Systems Inc., Goleta, CA). The EMG signal was recoded using miniature (4mm) surface bipolar Ag/AgCl electrodes following standard procedures and placement (Cacioppo et al., 1986). Electrodes filled with electrode gel were attached over the corrugator supercilii and zygomaticus major muscles via adhesive rings (Cacioppo et al., 1986). MindWare EMG 3.0.12 (Mindware Technologies Ltd., Gahanna, OH) was used to transform and analyze EMG signals, which were sampled at 1000 Hz and band-pass filtered within the frequency range of 20–500 Hz. Additionally, a 60-Hz notch filter was applied to remove the power line noise, after which the EMG signal was rectified and integrated. These data were binned into 1 second epochs for each of the three stages of the Discussion Paradigm, which were used for the APIM analyses. Further, overall averages of EMG during each task were calculated by averaging across 1 second epochs from each task, resulting in separate EMG averages for zygomaticus and corrugator activity during Rest, Vacation, and Conflict. Means and standard deviations for adolescents' and mothers' zygomaticus and corrugator activity during each task are presented by group in Table 2.

**State Affect—**Adolescents and their mothers independently rated their state levels of sadness and anxiety using a Visual Analog Scale (VAS) after each phase of the Discussion Paradigm (e.g., Rest, Vacation, Conflict). Specifically, participants rated how they were feeling from "very happy" to "very sad" and from "very calm" to "very anxious" on a scale measuring 100mm in length. Participants' ratings were measured from left to right on the scale to calculate state sadness and anxiety with higher numbers indicating greater state sadness and anxiety. Means and standard deviations of adolescents' and mothers' self-reported sadness and anxiety during each task are also presented by group in Table 2.

**Symptoms—**To more fully characterize the sample, adolescents' current and lifetime episodes of major depressive disorder were assessed using the Schedule for Affective Disorders and Schizophrenia for School-Age Children – Present and Lifetime Version (K-SADS-PL;Kaufman et al., 1997). Adolescents' symptoms of depression and anxiety

were assessed using the Children's Depression Inventory (CDI; Kovacs, 1981) and the Multidimensional Anxiety Scale for Children (MASC; March, Parker, Sullivan, Stallings, & Conners, 1997). The CDI and MASC demonstrated excellent internal consistency ($\alpha$s = .91 and .91, respectively). Adolescents' traits of borderline personality disorder were assessed using the Borderline Personality Features Scale for Children – Short Version (BPFSC-11; Sharp et al., 2014), which demonstrated good internal consistency ($\alpha$ = .85). Mothers' symptoms of depression and anxiety were assessed using the Beck Depression Inventory-II (BDI-II; Beck et al., 1996) and the Beck Anxiety Inventory (BAI; Steer & Beck, 1993). Both measures exhibited excellent internal consistency ($\alpha$s = .92 and .92, respectively). Adolescents' current and lifetime suicidal thoughts and behaviors, and their mothers' histories of suicide attempts were assessed using the Self-Injurious Thoughts and Behaviors Interview (SITBI; Nock et al., 2007).

## Procedure

Adolescents' NSSI was first identified during a phone screen with the adolescents' mothers, in which mothers were asked, "Has your daughter ever hurt herself without wanting to die, such as cutting or burning herself?" This screening question was followed by questions about method, recency, and frequency of NSSI. Eligible participants were then invited for a laboratory visit, at the beginning of which participants were fully informed about the process and purpose of the study. After providing written consent/assent, adolescents and mothers separately completed a series of interview and questionnaire assessments, including the Issues Checklist. Then, dyads completed the standardized Discussion Paradigm during which ECG and facial EMG data were simultaneously and continuously recorded. Adolescents and mothers were compensated $30 and $25, respectively. Each dyad was given a $10 gas card. All study procedures were approved by Binghamton University's Institutional Review Board.

## Analytic Plan

To examine overall levels of self-reported affect during the Discussion Paradigm and as a manipulation check of the Discussion Paradigm prior to examining facial affect, we conducted two separate 2 (NSSI: yes, no) × 2 (Emotion: Sadness, Anxiety) × 3 (Task: Rest, Vacation, Conflict) repeated measures ANOVAs with participants' VAS score serving as the dependent variable. Separate analyses were conducted for adolescents and mothers.

Next, to examine adolescents' and mothers' overall levels of facial affect across the three Discussion Paradigm tasks and determine whether levels of facial affect differed depending on adolescents' history of NSSI, we conducted two separate 2 (NSSI: Yes, No) × 3 (Task: Rest, Vacation, Conflict) × 2 (Muscle: Corrugator, Zygomaticus) repeated measures ANOVAs with average EMG activity serving as the dependent variable. Separate analyses were conducted for adolescent and mother EMG activity.

Finally, we employed a dynamical systems approach using actor partner interdependence modeling (APIM; Kenny et al., 2006) to examine patterns of change in facial EMG in mother-adolescent dyads during the Discussion Paradigm. Using this approach, we examined both intrapersonal (i.e., actor) and interpersonal (i.e., partner) effects, and whether

these effects differed in dyads with and without adolescent NSSI. First, we conducted a series of repeated-measures change-as-outcome actor-partner interdependence models (RM-APIM) in which ΔEMG ($EMG_{t+1}$ – EMG) served as the primary outcome. Separate models were conducted for each muscle (i.e., zygomaticus and corrugator) during each task. Adolescents' NSSI history was included as a moderator in all models to determine whether the setpoint and/or stability differed depending upon NSSI history. This approach allowed us to examine the extent to which one partner's facial affect during a given time in the Discussion Paradigm predicted subsequent changes (i.e., trajectory and rate) in (a) their own EMG (i.e., actor effects) while controlling for the influence of their partner's EMG, and (b) their partner's EMG (i.e., partner effects) while controlling for the influence of their own EMG. Thus, in the current study, dynamical systems modeling was used to describe adolescents' and their mothers' setpoints and stability of EMG in the context of positively- and negatively-valenced interaction tasks (Figure 1). Additional information about these analyses and results from Rest are provided in the Supplement.

## Results

### Preliminary Analyses

An initial review of the data indicated several variables were significantly skewed ($z > 3.29$; cf. Tabachnick & Fidell, 2007). These variables were transformed prior to further analysis in order to satisfy the assumptions of normality (log10: mother and child EMG). This initial inspection of the data also revealed some missing questionnaire data (MASC: 6.6%, BDI-II: 4.9%, BAI: 3.3%). Therefore, we assessed whether the data were missing at random, thereby justifying the use of data imputation methods for estimating missing values (cf. Schafer & Graham, 2002). Little's missing completely at random (MCAR) test, for which the null hypothesis is that the data are MCAR (Little & Rubin, 1987) was nonsignificant, $\chi^2(295) = 270.61$, $p = .843$, providing support for the imputation of maximum likelihood estimates of missing values. These estimates were created and used in all subsequent analyses (see Schafer & Graham, 2002).

In terms of overall levels of self-reported affect during the Discussion Paradigm, among adolescents, there was a significant main effect of task, $F(2, 116) = 21.55$ $p < .001$, $\eta_p^2 = .27$ with adolescents reporting improvements in affect (collapsed across sadness and anxiety ratings) from Rest ($M = 25.29$, $SD = 2.16$) to Vacation ($M = 19.26$, $SD = 2.15$), and worsened affect following Conflict ($M = 36.28$, $SD = 3.40$). Affect ratings differed significantly across all three tasks (all $p$s < .001). Additionally, there was a significant NSSI × Task interaction, $F(2, 116) = 3.43$, $p = .036$, $\eta_p^2 = .06$. Follow-up tests revealed that adolescents with a history of NSSI reported significantly higher levels of negative affect following Conflict ($M = 41.17$) than following Rest ($M = 24.23$; $p = .002$) or Vacation ($M = 21.21$; $p < .001$). Their levels of negative affect did not significantly differ from Rest to after Vacation ($p = .289$). In contrast, adolescents without this history reported significantly less negative affect following Vacation ($M = 17.25$) than following Rest ($M = 26.99$) or Conflict ($M = 30.54$; $p$s < .001). Their levels of negative affect did not significantly differ between Rest and Conflict ($p = .36$). None of the other main or interactive effects were significant (lowest $p = .157$).

Similarly, among mothers, there was a significant main effect of task, $F(2, 116) = 24.13$ $p < .001$, $\eta_p^2 = .29$. However, this main effect was qualified by significant NSSI × Task, $F(2, 116) = 4.80$, $p = .010$, $\eta_p^2 = .08$, Emotion × Task, $F(2, 116) = 3.77$, $p = .026$, $\eta_p^2 = .06$, and NSSI × Task × Emotion, $F(2, 116) = 3.10$, $p = .049$, $\eta_p^2 = .05$, interactions. None of the other main or interactive effects were significant (lowest $p = .271$). Breaking down the NSSI × Task × Emotion interaction, we examined the NSSI × Task interaction separately for self-reported sadness and anxiety. The NSSI × Task interaction was significant for anxiety, $F(2, 116) = 7.14$, $p = .001$, $\eta_p^2 = .10$, but not sadness, $F(2, 116) = 2.01$, $p = .139$, $\eta_p^2 = .03$. In terms of anxiety, although mothers of adolescents with and without an NSSI history did not differ significantly in their levels of anxiety following any of the tasks considered individually (lowest $p = .080$), the two groups of mothers did differ in their patterns of anxiety across the tasks. Specifically, as expected, mothers of control adolescents demonstrated significantly lower levels of anxiety following Vacation ($M = 16.21$) than following Rest ($M = 26.24$) or Conflict ($M = 30.02$; $p$s < .002). Their levels of anxiety did not significantly differ between Rest and Conflict ($p = .214$). In contrast, mothers of adolescents with an NSSI history demonstrated significantly higher levels of anxiety following Conflict ($M = 41.16$) than following Rest ($M = 16.56$) or Vacation ($M = 19.15$; $p$s < .001), with their levels of anxiety not differing significantly between Rest and Vacation ($p = .39$).

## Overall Levels of Facial Affect during the Discussion Paradigm

For adolescents, there were significant main effects of NSSI, $F(1, 56) = 4.92$, $p = .031$, $\eta_p^2 = .08$, Task, $F(2, 112) = 112.93$, $p < .001$, $\eta_p^2 = .67$, and Muscle, $F(1, 56) = 35.88$, $p < .001$, $\eta_p^2 = .39$. There were also significant Task × Muscle, $F(2, 112) = 89.30$, $p < .001$, $\eta_p^2 = .62$ and NSSI × Task × Muscle interactions, $F(2, 112) = 3.62$, $p = .030$, $\eta_p^2 = .06$. Neither of the other interaction effects was significant (lowest $p = .065$). Assessing the form of the NSSI × Task × Muscle interaction, we examined the NSSI × Task interaction separately for corrugator and zygomaticus activity. The NSSI × Task interaction was significant for zygomaticus activity, $F(2, 112) = 5.99$, $p = .003$, $\eta_p^2 = .10$, but not for corrugator activity, $F(2, 112) = 0.87$, $p = .422$, $\eta_p^2 = .02$. For zygomaticus activity, although the two NSSI groups did not differ significantly during Rest, $F(1, 57) = 0.12$, $p = .735$, $\eta_p^2 = .002$, there were significant group differences during both Vacation, $F(1, 57) = 6.58$, $p = .013$, $\eta_p^2 = .10$, and Conflict, $F(1, 56) = 9.07$, $p = .004$, $\eta_p^2 = .14$, with adolescents with an NSSI history exhibiting less zygomaticus activity during both of these interactions than control adolescents. In contrast, none of the main or interactive effects for adolescents' corrugator activity were significant (lowest $p = .097$).

Turning next to mothers, there were significant main effects of Task, $F(2, 116) = 99.40$, $p < .001$, $\eta_p^2 = .63$, and Muscle, $F(1, 58) = 20.93$, $p < .001$, $\eta_p^2 = .27$, as well as significant NSSI × Muscle, $F(1, 58) = 6.31$, $p = .015$, $\eta_p^2 = .10$, and Task × Muscle, $F(2, 116) = 72.55$, $p < .001$, $\eta_p^2 = .56$, interactions. None of the other main effects or interactions were significant (lowest $p = .580$). Focusing first on determining the form of the NSSI × Muscle interaction revealed significant NSSI group differences in mothers' corrugator activity, $F(1, 58) = 5.16$, $p = .027$, $\eta_p^2 = .08$, such that mothers of adolescents with an NSSI history exhibited more corrugator activity across all three tasks than mothers of control adolescents.

In contrast, the NSSI group difference in zygomaticus activity was not significant, $F(1, 58) = 1.35$, $p = .251$, $\eta_p^2 = .02$. Turning next to the Task × Muscle interaction, follow-up tests revealed a significant main effect of Task for zygomaticus activity, $F(2, 116) = 132.21$, $p < .001$, $\eta_p^2 = .70$, such that mothers exhibited increases in zygomaticus activity from Rest to Vacation and decreases in activity during Conflict to levels lower than those observed during Rest (all $p$s < .001). In contrast, the main effect of Task was not significant for corrugator activity, $F(2, 116) = 2.02$, $p = .137$, $\eta_p^2 = .03$.

## Intra- and Interpersonal Dynamics during the Discussion Paradigm

**Zygomaticus Activity—**These RM-APIM models are presented in Figure 2. Full details of the analyses from the models are presented in Supplemental Table 1. Adolescents' NSSI history significantly moderated the adolescent zygomaticus setpoint during both Vacation and Conflict (Vacation: $B = -.03$, $p = .034$; Conflict, $B = -.03$, $p = .006$), indicating that adolescents with NSSI demonstrated a lower zygomaticus setpoint during both tasks than adolescents without this history. In contrast, there were no significant adolescent NSSI group differences in mothers' zygomaticus setpoints (lowest $p = .740$). Looking next at intrapersonal dynamics, across adolescents and mothers, actor effects were negative during both Vacation (Adolescent: $B = -.21$, $p < .001$, Mother: $B = -.26$, $p < .001$) and Conflict (Adolescent: $B = -.13$, $p < .001$, Mother: $B = -.26$, $p < .001$). These effects suggest that, across groups, adolescents and their mothers were attracted to their own zygomaticus activity setpoints and demonstrated stability of zygomaticus activity within the intrapersonal system. Importantly, however, adolescents' NSSI history moderated the adolescent actor effect during Vacation ($B = -.03$, $p = .028$) and Conflict ($B = -.08$, $p < .001$), indicating that, although all adolescents were attracted to their own zygomaticus setpoints, adolescents with NSSI demonstrated greater stability/less variability in zygomaticus activity than control adolescents. NSSI history also moderated the mother actor effect during Vacation ($B = .04$, $p < .001$), but in the opposite direction as that observed for adolescents. Specifically, although all mothers were attracted to their setpoints during Vacation, the impact of adolescent NSSI was opposite in mothers compared to in adolescents themselves, with mothers of adolescents with an NSSI history demonstrating less stability/more variability in zygomaticus activity than mothers of control adolescents during Vacation.

Turning next to interpersonal (partner) effects, there were positive mother-to-adolescent partner effects during Vacation ($B = .05$, $p < .001$) and Conflict ($B = .02$, $p = .008$). There were also positive adolescent-to-mother partner effects during Vacation ($B = .08$, $p < .001$) and Conflict ($B = .06$, $p < .001$). These results provide evidence for coupling such that increases in both adolescents' and mothers' zygomaticus activity predicted a quicker return to the zygomaticus set point in their partner, reflecting co-regulation. Moreover, although all adolescents' zygomaticus activity was influenced by their mothers' zygomaticus activity, this mother-to-adolescent partner effect during Conflict was moderated by adolescent NSSI history ($B = .03$, $p < .001$) such that it was stronger for dyads with adolescent NSSI ($B = .05$, $p < .001$) than dyads without adolescent NSSI ($B = .02$, $p = .007$), indicating a slower return to a (lower) zygomaticus activity setpoint among adolescents with an NSSI history in response to increases in their mothers' zygomaticus activity.

Finally, follow-up tests were conducted to determine whether the significant effects would be maintained after statistically controlling for the potential impact of mothers' and adolescents' current symptoms of depression and anxiety, as well as adolescents' symptoms of borderline personality disorder. The results were all maintained (all *p*s ≤ .04), suggesting that our findings are at least partially independent of the influence of these variables.

**Corrugator Activity—**These RM-APIM models are presented in Figure 2. Full details of these analyses are presented in Supplemental Table 2. Neither adolescents' nor mothers' corrugator intercepts differed based on adolescents' NSSI history during Vacation (lowest $p = .201$). However, during Conflict, adolescents' NSSI history moderated mothers' corrugator setpoint ($B = .04$, $p = .049$), indicating that mothers of adolescents with NSSI demonstrated a higher corrugator setpoint than mothers of adolescents without this history. Looking at intrapersonal dynamics, across adolescents and mothers, actor effects were negative during both Vacation (Adolescent: $B = -.42$, $p < .001$, Mother: $B = -.45$, $p < .001$) and Conflict (Adolescent: $B -.25$, $p < .001$, Mother: $B = -.36$, $p < .001$). Across groups, therefore, adolescents and their mothers were attracted to their own corrugator activity setpoints and demonstrated stability of corrugator activity within the intrapersonal system. Importantly, however, adolescents' NSSI history moderated the adolescent actor effect during Conflict ($B = -.06$, $p < .001$). Specifically, although all adolescents demonstrated stability of corrugator activity during Conflict, adolescents with NSSI demonstrated a stronger attractor toward their corrugator setpoint than control adolescents. Additionally, adolescents' NSSI history moderated the mother actor effect during both Vacation ($B = .06$, $p < .001$) and Conflict ($B = .03$, $p = .007$) such that although all mothers also demonstrated stability of corrugator activity across both tasks within the intrapersonal system, mothers of adolescents with an NSSI history demonstrated a weaker attractor to their own corrugator setpoint than mothers of control adolescents. Thus, paralleling zygomaticus results during Vacation, mothers with adolescents with an NSSI history demonstrated less stability/more variability of corrugator activity within the intrapersonal system than mothers with control adolescents.

Looking at interpersonal (partner) effects, although the mother-to-adolescent partner effects were not significant during Vacation ($B = .01$, $p = .175$) or Conflict ($B = .00$, $p = .881$), which suggests the absence of significant mother-to-adolescent influences of corrugator activity during either task overall, adolescents' NSSI history moderated the mother-to-adolescent partner effect during Conflict ($B = .03$, $p = .006$) such that a significant mother-to-adolescent partner effect was only present for dyads with adolescent NSSI ($B = .03$, $p < .001$) and not for dyads without adolescent NSSI ($B = -.001$, $p = .915$), indicating a slower return to the corrugator activity setpoint among adolescents with an NSSI history in response to increases in their mothers' corrugator activity. Finally, and in contrast, there were positive adolescent-to-mother partner effects during Vacation ($B = .02$, $p = .028$) and Conflict ($B = .02$, $p < .001$), neither of which were moderated by adolescents' NSSI history (lowest $p = .186$). These effects provide evidence for interpersonal influences of corrugator activity, such that change in mothers' corrugator activity was impacted by adolescent's corrugator activity, regardless of adolescents' NSSI history.

Follow-up tests were again conducted to determine whether the significant effects would be maintained after statistically controlling for the potential impact of mothers' and

adolescents' current symptoms of depression and anxiety, as well as adolescents' symptoms of borderline personality disorder. All results were maintained (all *p*s ≤ .05), suggesting that our findings are at least partially independent of the influence of these variables.

## Discussion

Our goal was to examine whether adolescents' NSSI history moderated overall levels of, and second-to-second changes in, facial affect during the mother-daughter interactions. These analyses provide three main points of discussion. First, there were significant differences in overall levels of positive and negative facial affect as a function of adolescents' NSSI history. In terms of positive facial affect, as expected, adolescents and their mothers exhibited higher levels of positive facial affect during Vacation compared to baseline, which was followed by a decrease in positive facial affect during Conflict. Despite following this same pattern of changes in expressed positive facial affect, adolescents with an NSSI history displayed lower levels of positive facial affect across both interactions, which is consistent with previous research examining facial affect during mother-adolescent interactions (Crowell et al., 2008). Moreover, this difference is particularly notable given that adolescents with an NSSI history self-reported similar levels of sadness and anxiety at each phase of the interaction as control adolescents. That adolescents with and without NSSI differ in their expression of positive facial affect, but not their reported experience of emotions suggests that, among adolescents with an NSSI history, there may be a discrepancy between the facial expressions they are conveying to others and the emotions they report themselves as experiencing.

Although this study did not yield the anticipated pattern of increased levels of negative facial affect in adolescents with an NSSI history, we found that mothers of adolescents with NSSI exhibited elevated levels of negative facial affect across all tasks compared to control mothers. Mothers of adolescents with NSSI also exhibited different patterns of self-reported anxiety than control mothers across the Discussion Paradigm. Specifically, whereas control mothers reported a decrease in anxiety from before to after Vacation relative to baseline, mothers of adolescents with NSSI did not report any change in self-reported anxiety from before to after Vacation. Additionally, whereas control mothers did not indicate a change in their self-reported anxiety following Conflict relative to baseline, mothers of adolescents with NSSI indicated feeling increased anxiety following Conflict relative to baseline. Therefore, Vacation functioned as a positive mood induction for control mothers, but not for mothers of adolescents with an NSSI history, and the Conflict discussion functioned as a stressor for mothers of adolescents with NSSI, but not for control mothers. This elevation in negative facial affect coupled with mothers' subjective experience of anxiety may reflect the increased hypervigilance that is common in parents of youth who self-injure (Oldershaw et al., 2008; Waals et al., 2018). Consistent with this interpretation, among adolescent girls, NSSI has been linked to increased parent-child stress nine months later (Miller et al., 2018). Thus, to the extent that the experience of anxiety among these mothers is expressed as negative facial affect during interactions with their daughters, there is a need for future research examining differences in how adolescent girls with and without an NSSI history may perceive their mothers' facial affect. Indeed, there is ample support for a link between adolescent NSSI and perceived lack of parental support or general conflict within the parent-

child relationship (Ammerman & Brown, 2018; Claes et al., 2015; Tatnell et al., 2014). There is also preliminary evidence that adolescents with NSSI exhibit deficits in recognizing facial displays of negatively-valenced emotions (Seymour et al., 2016). Therefore, research is needed to determine whether adolescents who engage in NSSI are more likely to interpret parental concern and anxiety as threatening or unsupportive.

Second, there were context-specific differences in dynamic intrapersonal processes during the positively- and negatively-valenced interactions, some of which were moderated by NSSI group. Across dyads, all adolescents and mothers demonstrated *intra*personal influences of positive and negative facial affect during both interactions (significant actor effects), suggesting that all participants had the tendency to return to their homeostatic setpoints of positive and negative facial affect following deviations. Additionally, most of the actor effects for both adolescents and mothers were moderated by adolescents' NSSI, though the direction of this moderation differed for adolescents and mothers. Specifically, adolescents with NSSI, compared with control adolescents, returned more quickly to their positive facial affect setpoint during the Vacation, and their positive and negative facial affect setpoint during Conflict, indicating blunted positively- and negatively-valenced affective reactivity (i.e., less variability in facial expressions) during these interactions. Although deficits in affective expressivity are potentially problematic across contexts, disruptions in positive affective expressivity may be particularly maladaptive in the context of positively-valenced interactions (cf. James et al., 2021; Kudinova et al., 2019).

Mothers' intrapersonal processes were also moderated by adolescents' history of NSSI. However, in contrast to what was observed among adolescents, mothers of adolescents with NSSI were *slower* to return to their positive facial affect setpoint during Vacation and their negative facial affect setpoint during both interactions. Considering these results in the context of patterns of overall levels of affect, these mothers may both express higher levels of overall negative facial affect and greater instability or fluctuations of facial affect. Consequently, although all participants demonstrated stability of facial affect within the intrapersonal system, adolescents' and mothers' intrapersonal processes in dyads with adolescent NSSI appeared less synergistic than the intrapersonal processes in control dyads.

Third, there were significant context-specific dynamic interpersonal processes during both the positively- and negatively-valenced interactions. Specifically, across groups, there were significant daughter-to-mother influences of positive and negative facial affect during both the Vacation and Conflict discussions. Phrased differently, daughters' facial affect influenced their mothers' return to their facial affect setpoint across both interactions. Patterns of mother-to-daughter influences were similar, particularly for positive facial affect. Specifically, there was evidence for mother-to-daughter influences of positive affect during both tasks. These results align with previous research showing strong correspondence of positive facial affect in mother-daughter dyads, regardless of the adolescents' history of self-injury (Haines et al., 2019). Notably, however, during Conflict this partner effect was moderated by adolescents' NSSI such that mothers' positive facial affect slowed the adolescents' return to her positive facial affect setpoint more for dyads with adolescent NSSI than control dyads, which may be adaptive given the lower overall zygomaticus setpoint observed in adolescents with NSSI. Finally, in contrast to the consistent adolescent-

to-mother partner effects observed for negative facial affect, there was only one significant mother-to-adolescent partner effect observed for negative facial affect, and this was only significant for dyads with adolescent NSSI. Specifically, the influence of mothers' negative facial affect on adolescents' return to their setpoint (i.e., decreasing the velocity of return) was only significant for adolescents with an NSSI history and, only during the negative discussion (Conflict) and not during the positive discussion (Vacation), again reflecting a slower return to the corrugator activity setpoint among adolescents with an NSSI history in response to increases in their mothers' corrugator activity. This result is again consistent with prior findings showing that mother-adolescent dyads in which the adolescent self-injures demonstrate greater correspondence of negative facial affect during conflict discussions than dyads in which the adolescent has no such history (Haines et al., 2019).

The group differences in these interpersonal influences underscore important disruptions in dyadic processes. For example, in the context of negatively-valenced interactions, mothers' positive and negative facial affect slowed their daughters' return to their facial affect setpoint. Therefore, to the extent that facial EMG reliably indicates pleasant and unpleasant emotional states, and the intensity of those states (Barrett et al., 2019), adolescents with an NSSI history have prolonged experiences of both positive and negative emotions in response to mothers' affect, despite exhibiting more restricted facial affect overall compared to control adolescents. Finally, there were group differences in mother-to-daughter influences of negative facial affect during Conflict, which are particularly noteworthy in the absence of any other mother-to-daughter influences of negative affect during either task. This group difference suggests adolescents with an NSSI history may be attuned and responsive to their mothers' expressions of negative facial affect during negatively-valenced interactions whereas maternal expressions of negative facial affect are not salient to control adolescents or in the context of positively-valenced interactions.

This study exhibited several strengths, including the multi-modal approach to examining intra- and interpersonal processes during actual mother-adolescent interactions and the inclusion of adolescents with current and past psychopathology as well as suicidal ideation in both groups. This type of integrative investigation is well-suited to provide a more nuanced understanding of adolescents' responses during interpersonal interactions, and how these may be disrupted in those with a history of NSSI. Moreover, despite some group differences in other relevant sources of distress (e.g., suicidal ideation), this design was selected to increase the specificity of our findings to NSSI by accounting for other sources of distress. In addition to these strengths, limitations should also be noted as they provide valuable direction for future studies. First, the current study is limited by its cross-sectional design. Therefore, longitudinal research is needed to determine whether the disrupted affective processes identified in this study are a risk factor for, and/or consequence of, NSSI in adolescence. Second, we note several limitations related to our sample, which was limited to mother-daughter dyads. As a result, although the exclusion of fathers and sons increased the homogeneity of the sample and specificity of the findings, it is unclear whether similar patterns would be observed for father-son dyads or dyads of opposite genders. Participants in our sample also predominantly identified as White, and it is unclear whether similar findings would generalize to more diverse populations. Moreover, because eligibility for participation was determined through a phone screen with the adolescents' mothers,

all mothers in the current sample were aware of their daughters' NSSI. Therefore, we are unable to determine whether the observed pattern of findings is a function of mothers' knowledge of the adolescents' NSSI or simply adolescents' NSSI more generally. Larger future studies will provide opportunities to address these sample related limitations and should also examine the extent to which certain characteristics of adolescents' NSSI (e.g., timing) moderate overall levels of (or changes in) facial affect during dyadic interaction. Third, the current study did not include a measure assessing adolescents' or mothers' perceptions of their relationship, which could have influenced participants' facial affect during interaction. Finally, although a strength of the current study is the inclusion of self-reported state affect in addition to facial EMG, the VAS was only used to assess state sadness and anxiety in mothers and adolescents, and did not measure levels of anger or frustration, which may be particularly relevant during the conflict discussion. This design limited inferences about which negatively-valenced emotions participants were experiencing when exhibiting higher levels of corrugator activity, as increased corrugator activity is linked to anger, fear, and disgust in addition to sadness (Ekman & Friesen, 1978; Neumann et al., 2014).

In summary, building from models of NSSI (Hasking et al., 2016; Nock & Prinstein, 2004; Selby & Joiner, 2009), the current study helps to identify processes involved in parent-child interactions that may increase NSSI risk in adolescent girls. Combined self-report and facial EMG indices of affective responses illustrated significant disruptions in affective reactivity among these adolescents and their mothers. Additionally, adolescents with an NSSI history evidenced maladaptive interpersonal dynamics across facial EMG indices of dyadic processes with their mothers, such that, generally, adolescents with an NSSI history demonstrate less variation in expressions of positive and negative facial affect across interactions, whereas their mothers demonstrate more variation across interactions (with the exception of positive facial affect during negative interactions). Moreover, maternal expressions of positive and negative facial affect during negative interactions have a greater influence on their daughters' return to homeostasis (i.e., slower return to baseline) among dyads with adolescent NSSI. If replicated and extended, these findings could provide several specific prevention and intervention targets capable of disrupting a broader mechanism of risk (e.g., emotion regulation difficulties), which may, in turn, reduce future NSSI risk.

## Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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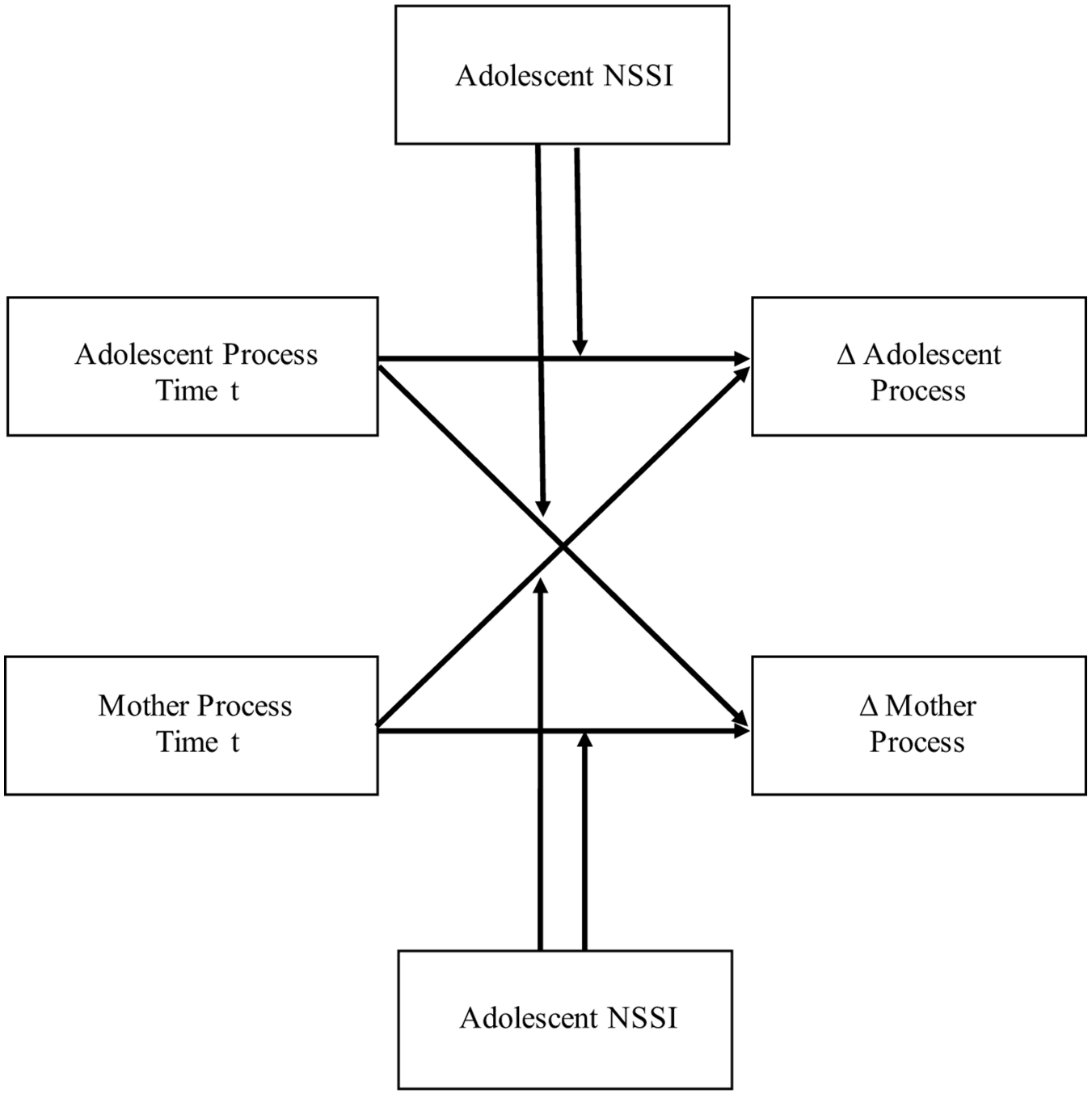


**Figure 1.**
Conceptual model of these repeated-measures actor-partner interdependence models

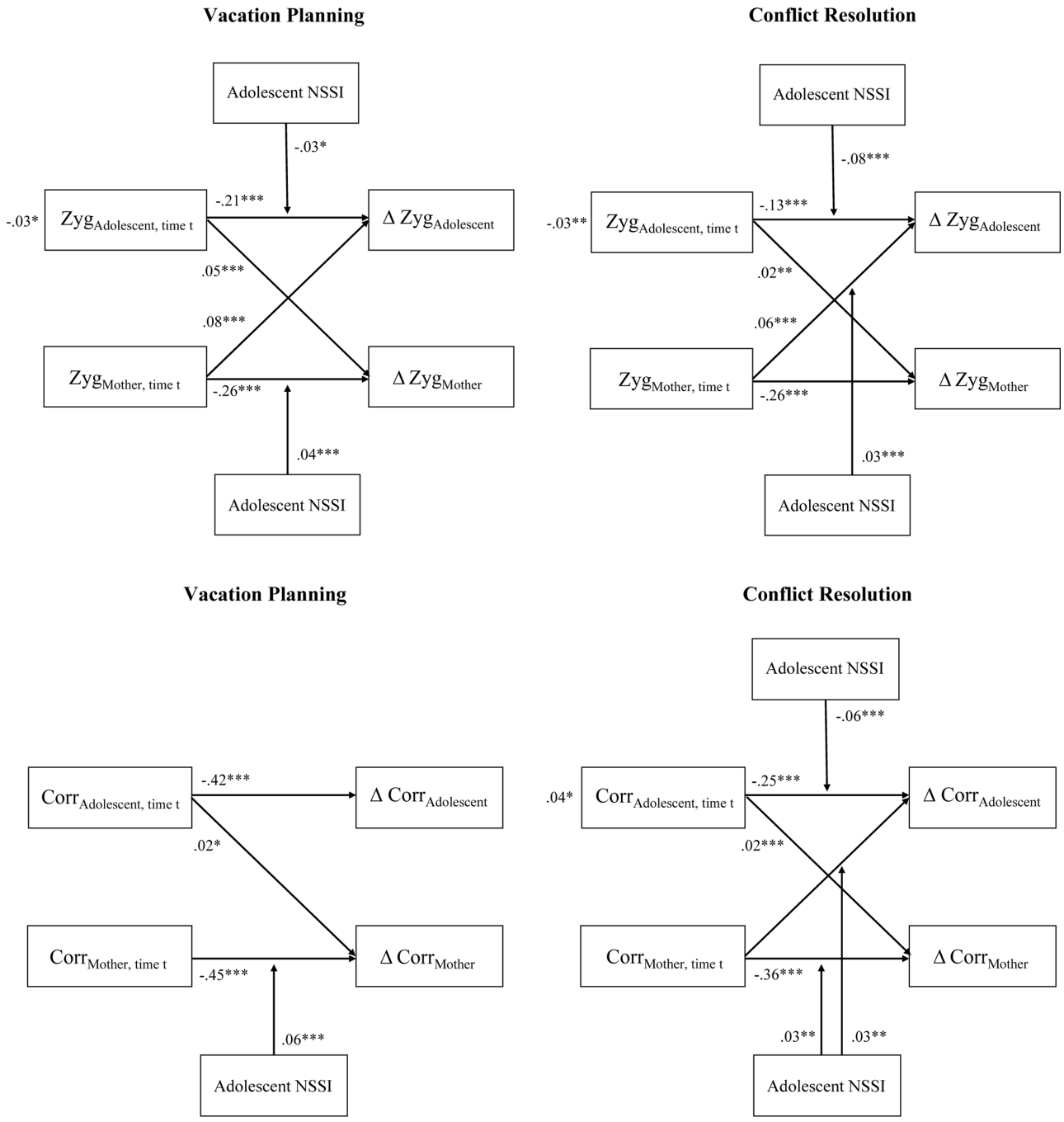


**Figure 2.**

Top: Repeated-measures actor-partner interdependence models with change during Vacation (left) and Conflict (right) for zygomaticus activity. Bottom: Repeated-measures actor-partner interdependence models with change during Vacation (left) and Conflict (right) for corrugator activity. Values in all figures represent unstandardized betas and only significant effects are depicted. Significant NSSI moderation of the setpoint is shown to the left of the time t zygomaticus/corrugator box.

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

**Table 1.**

Descriptive statistics

| | NSSI (*n* = 27) | No NSSI (*n* = 33) | Cohen's *d* |
|---|---|---|---|
| Adolescent Age | 15.20 (1.37) | 15.22 (1.25) | −0.02 |
| Mother Age | 45.15 (7.39) | 42.40 (7.83) | 0.37 |
| Adolescent Race (% White) | 77.8% | 78.8% | 0.56* |
| Mother Race (% White) | 92.6% | 84.8% | 0.41 |
| Family Income (median) | $60,001-$65,000 | $70,001- $75,000 | −0.18 |
| Adolescent Current MDD Dx | 37.0% | 6.1% | 0.85** |
| Adolescent Lifetime MDD Dx | 85.2% | 42.4% | 0.98*** |
| CDI | 19.11(8.80) | 10.24 (7.19) | 1.12*** |
| MASC | 60.95 (18.10) | 45.84 (14.95) | 0.93*** |
| BPFSC | 36.41 (7.64) | 26.24 (6.04) | 1.50*** |
| Adolescent Current SI | 37.0% | 9.1% | 0.72** |
| Adolescent Lifetime SI | 81.5% | 37.5% | 0.95** |
| Adolescent Lifetime SA | 14.8% | 3.0% | 0.43 |
| BDI-II | 10.38 (8.79) | 10.55 (10.86) | 0.22 |
| BAI | 10.38 (8.79) | 9.48 (10.40) | 0.10 |
| Mother Lifetime SA | 22.2% | 21.2% | 0.02 |

*Note.* MDD = Major Depressive Disorder. Dx = diagnosis. CDI = Children's Depression Inventory. MASC = Multidimensional Anxiety Scale for Children. BPFSC = Borderline Personality Features Scale for Children. SI = suicidal ideation. BDI = Beck Depression Inventory. BAI = Beck Anxiety Inventory. SA = suicide attempt.

* $p < .05$.

** $p < .01$.

*** $p < .001$.

**Table 2.**

Means and standard deviations for affect variables by group

| | NSSI (*n* = 27) | No NSSI (*n* = 33) | Cohen's *d* |
|---|---|---|---|
| **Adolescent** | | | |
| Sadness – Rest | 23.88 (15.10) | 24.09 (19.05) | −0.13 |
| Sadness – Vacation | 17.76 (15.04) | 14.37 (14.75) | 0.10 |
| Sadness – Conflict | 39.43 (29.00) | 26.47 (19.50) | 0.31 |
| Anxiety – Rest | 24.58 (24.47) | 26.24 (22.76) | −0.15 |
| Anxiety – Vacation | 24.67 (21.75) | 16.21 (17.65) | 0.31 |
| Anxiety – Conflict | 42.90 (29.62) | 30.02 (23.44) | 0.46 |
| Zygomaticus – Rest | 9122.50 (4032.88) | 9477.71 (4404.47) | −0.08 |
| Zygomaticus – Vacation | 29189.16 (13664.91) | 41000.59 (22010.76) | −0.63* |
| Zygomaticus – Conflict | 23054.44 (13483.87) | 36715.44 (22112.08) | −0.74** |
| Corrugator – Rest | 10920.98 (5342.43) | 11614.83 (6416.20) | −0.12 |
| Corrugator – Vacation | 11009.06 (5821.68) | 18876.47 (41429.22) | −0.25 |
| Corrugator – Conflict | 13291.65 (6733.20) | 14888.80 (19245.90) | −0.11 |
| **Mother** | | | |
| Sadness – Rest | 23.16 (18.43) | 25.93 (17.47) | −0.05 |
| Sadness – Vacation | 14.27 (17.41) | 16.20 (17.37) | −0.01 |
| Sadness – Conflict | 36.03 (21.77) | 31.22 (25.02) | 0.47 |
| Anxiety – Rest | 16.56 (18.51) | 28.05 (21.34) | −0.47 |
| Anxiety – Vacation | 19.15 (22.01) | 18.29 (20.09) | 0.15 |
| Anxiety – Conflict | 41.16 (25.11) | 29.87 (27.98) | 0.47 |
| Zygomaticus – Rest | 7422.08 (3273.65) | 8931.24 (4379.86) | −0.39 |
| Zygomaticus – Vacation | 27806.22 (22210.31) | 29414.07 (21413.22) | −0.07 |
| Zygomaticus – Conflict | 21124.34 (20110.34) | 21988.58 (14547.86) | −0.05 |
| Corrugator – Rest | 12065.93 (4690.90) | 9671.75 (7681.16) | 0.37 |
| Corrugator – Vacation | 12096.40 (5985.12) | 10479.94 (5257.33) | 0.29 |
| Corrugator – Conflict | 13374.07 (6878.24) | 10539.13 (5299.75) | 0.47 |

Note:

* $p < .05$.

** $p < .01$.