Published in final edited form as:

Physiol Behav. 2010 June 1; 100(3): 225–233. doi:10.1016/j.physbeh.2010.01.006.

Interparental Aggression and Parent-Adolescent Salivary Alpha Amylase Symmetry

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Abstract

The present study examined salivary alpha-amylase (sAA), a putative marker of adrenergic activity, in family members engaging in family conflict discussions. We examined symmetry among family members' sAA levels at baseline and in response to a conflict discussion. The relation between a history of interparental aggression on parent-adolescent sAA symmetry also was examined. Participants were 62 families with a mother, father, and biological child age 13-18 ($n = 29$ girls). After engaging in a relaxation procedure, families participated in a 15-minute triadic family conflict discussion. Participants provided saliva samples at post-relaxation/pre-discussion, immediately post-discussion, and at 10 and 20 min post-discussion. Participants also reported on interparental physical aggression during the previous year. Across the sample we found evidence of symmetry between mothers' and adolescents' sAA levels at baseline and around the discussion. Interparental aggression was associated with lower sAA levels among fathers. Interparental aggression also affected patterns of parent-child sAA response symmetry such that families reporting interparental aggression exhibited greater father-adolescent sAA symmetry than did those with no reports of interparental aggression. Among families with no interparental aggression history, we found consistent mother-adolescent symmetry. These differences suggest different patterns of parent-adolescent physiological attunement among families with interparental aggression.

Keywords

Salivary alpha-amylase; interparental aggression; sympathetic nervous system; family conflict and sympathetic activity

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Douglas A. Granger discloses that he is the founder and current president of (and correspondingly holds an equity position in) Salimetrics LLC.

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No other conflicts of interest exist in this study.

The literature on parent-infant interaction documents that emotional, behavioral, and physiological attunement between mothers and infants represents an important mechanism for the development of emotion regulation skills¹. Virtually no information exists about attunement among family members with older children. The present study examines symmetry among family members' sympathetic nervous system (SNS) activity around a laboratory-based family conflict. We examine the degree of symmetry between parents' and children's SNS responses via salivary alpha amylase (sAA), a putative indicator of adrenergic activity. We define symmetry as the extent to which a child who has a relatively low or high pre-discussion, post-discussion peak, total sAA output and change from before to after the conflict discussion has a parent who is also relatively low or high, respectively, on these indices. Further, we examine the degree to which interparental aggression in the family affects the degree of symmetry between the child's sAA activity and each parent's sAA activity. Whereas we discuss research in which researchers also use the terms concordance, attunement, and synchrony, sometimes interchangeably, our own hypotheses are about symmetry regarding total output and change from before to after the family conflict discussion.

Parents play a critical role in helping offspring learn to regulate their emotions. Drawing from the infant literature, one way parents do this is by demonstrating attunement with the child. Field¹ defines attunement as occurring when family members are "coordinated behaviorally and/or are concordant physiologically during early interactions" (p. 209). As Field notes, many terms, including the terms *synchrony* and *concordance*, have been used to describe this same phenomenon. Behaviorally, attunement refers to the parent matching behavior and affect to the infant's in order to provide appropriate stimulation and help the infant self-regulate. Attunement thus involves the parent and the child exhibiting similar or parallel behaviors and emotions. Researchers have documented the importance of mother-infant affective attunement for emotion regulation and social and cognitive development^{1,2,3}. For example, the degree to which mothers' affective states matched those of their infants related to children's play quality and verbal IQ later in development², and maternal-infant affect synchrony has been related to the development of child self-control at 2 years⁴.

Attunement in parent and child physiological systems relevant to affective states and stress, notably the autonomic nervous system (ANS) and the hypothalamic-pituitary-adrenal (HPA) axis, is herein considered symmetric activation in these systems, such that the child and the parent both exhibit relatively high or low activity biological responses to extrinsic stimulation. Attunement between parents and infants in these physiological systems has received some attention in the infant literature and early childhood literature. For example, respiratory sinus arrhythmia (RSA), a parasympathetic indicator, demonstrates some concordance between mothers and children during infancy and early childhood, at baseline and in response to a sustained attention task⁵.

Whereas mother-infant attunement appears to be important for the infant's development of emotional regulation skills, we know much less about the meaning of parental emotional attunement and physiological symmetry in families with older children and adolescents. Attunement may indicate the parent's attentiveness and concern for the child's emotional experiences and affective stages. Alternatively, attunement may reflect the degree of attachment between the parent and child. Mothers' emotional attunement, as defined by the ability to share and reflect the child's inner experience, has been shown to contribute to older children's adjustment among children exposed to domestic violence⁶. Mothers' awareness of their adolescent children's self-perceptions, representing attunement to the adolescents' internal states, has also been shown to account for adolescents' attachment security, independent of adolescents' self-perceptions⁷. The adolescent's attunement to parental states

is rarely considered but is an important dimension of family interactions and potentially to the adolescent's overall adjustment. Adolescents are seeking independence from parents, yet self-regulation via parents' examples remains a critical dimension of adolescents' own self regulation.

Although questionnaire based studies suggest that mother-adolescent attunement may be important for the development of secure relationships, we know little about physiological symmetry between parents and adolescents. Drawing from the infant literature,¹ symmetry in physiological systems relevant to affect and stress, such as the SNS, may indicate shared affective states between the parent and adolescent or parents' attentiveness to their adolescent child. Alternatively, given that adolescents are more autonomous than are infants and have the cognitive capacity to understand more about their parents' affective states, such SNS symmetry may reflect other processes, for example adolescents' increased reactivity to parents' affective states due to conflict or fear, or, given that SNS is not valence specific, shared states of interest and engagement.

One factor that may affect the degree of physiological symmetry between family members is interparental aggression. Interparental conflict and aggression may affect family members' experiences of subsequent interactions and in particular conflict. Aggression between parents is a stressor that puts youth at risk for a variety of negative outcomes, including aggression, delinquency, anxiety, and depression^{8,9,10}. Even during conversations that are not physically violent, couples who have been physically aggressive with each other behave more negatively toward each other^{11, 12}. Children exposed to high levels of conflict and aggression tend to be more fearful and upset even by subsequent non violent anger and conflict^{13, 14, 15}. Marital violence also compromises parent-child relationships¹⁶, and the possibility of conflict erupting into violence likely changes the tone and threat value of even non violent conflictual interactions⁹.

Physiologically, a history of interparental physical violence may sensitize family members' responses to subsequent conflict, as indicated by larger autonomic nervous system responses. For example, wives from physically violent marriages have been shown to exhibit faster finger pulse transit times and larger finger pulse amplitudes than have wives from non violent marriages during non violent discussions in the lab¹². Children from homes with higher levels of interparental conflict and violence and lower marital satisfaction have been shown to have higher urinary catecholamines¹⁷ and to demonstrate more cardiovascular reactivity to subsequent conflict stimuli¹². This literature suggests that children exposed to higher levels of marital conflict and aggression may exhibit increased SNS activity in response to subsequent conflict situations.

Given that the context of interparental violence likely affects family members' responses to even non violent conflict, this context may also affect the degree of SNS symmetry that family members exhibit during family conflict. A child who is sensitized to conflict due to the possibility of violence may be hypervigilant to a parent's SNS arousal and negative affect, particularly if the child senses threat from that parent. Moreover, the context of violence may limit a parent's ability to be attentive to the child's emotional state due to his or her own sense of threat. Parent-child attunement can be disrupted when the mother becomes emotionally unavailable to the child, for example due to depression or physical separation¹. Interparental aggression may be a stressor that can so disrupt attunement.

We know little about attunement in family units larger than mother-child dyads. The relationship of one parent with the child is affected by the presence of the other parent¹⁸. With three people in the room, each family member has two people with whom to relate. Conflict may affect the degree to which affective and physiological states are shared by each

parent and the child. Thus, examining the effects of interparental aggression on parent-child SNS symmetry during triadic family conflict provides information about family functioning and parent-child attunement that more closely approximates then natural ecology of family functioning. Although recruiting mother-father-child triads into the lab can be challenging, triadic data are particularly relevant when examining effects of interparental conflict and aggression on family relations.

To date, most studies of the effects of family conflict and aggression on sympathetic arousal examine electrophysiological measures, such as skin conductance and heart rate¹² with a few examining plasma levels of neurotransmitters such as E and NE¹⁹. Recently, investigators have begun to incorporate sAA to examine stress responses in studies of child and adolescent development^{20, 21, 22, 23}. Salivary AA is an enzyme produced by the parotid gland and is a putative indicator of sympathetic activity during parasympathetic activity. Some researchers report correlations between sAA and plasma NE²⁴, though this link has not been consistently demonstrated²⁵. The release of sAA in response to stress correlates with cardiovascular measures of autonomic activity²⁶, and propranolol, a beta-adrenergic antagonist, suppresses resting and stress-response levels of sAA²⁷. Animal research has demonstrated that sAA increases in response to sympathetic activation during parasympathetic activation²⁸, and research with humans indicates that sAA increases in response to stress^{29, 30}.

The present study examines parent-adolescent sAA symmetry before and after a conflictual triadic family discussion. We define symmetry as significant correlations between corresponding sAA indices, such that adolescents with relatively low or high pre-, post-, and pre- to post- discussion change in sAA activity will have parents with relatively low or high corresponding indices, respectively. In addition, we examine the effect of a history of interparental aggression on family members' sAA levels at baseline and in response to the conflict discussion and on parent-adolescent sAA symmetry. We propose the following hypotheses: 1) Parent-adolescent dyads will exhibit symmetry in sAA indices; 2) Consistent with sensitization, a history of interparental aggression during the previous year will be associated with higher sAA levels and change from before to after the discussion; 3) Interparental aggression will disrupt parent-adolescent child symmetry in sAA responses such that among families reporting interparental aggression, correlations between corresponding parent and adolescent sAA indices will be smaller than those in families reporting no interparental aggression.

Method and Materials

Participants

Participants were father-mother-adolescent child triads recruited from the community to take part in a study on the effects of exposure to family and community violence on adolescent development. Of the original 119 families who participated in the first wave of data collection, 77 participated in these procedures (4 refused participation in wave 4; 6 families participated in wave 4 but declined to provide saliva samples; 4 participated only in procedures that did not require a visit to our lab, and 32 did not participate in wave 4 due to scheduling difficulties or difficulties contacting them). Eight of the families did not include a child with both biological parents coming in to the lab together to participate in the procedures, and these families were excluded. Saliva data from 7 children were not usable due to the quality of the saliva or the child's use of medications that might affect sAA. Thus, the sample for the current analysis is 62 families, though other individual missing data points for parents result in some lower ns for particular analyses. Ethnic composition of families was 23% Caucasian (Non-Hispanic/Latino), 16% Hispanic/Latino, 16% African-American, 10% Asian/Pacific American, and 35% of multiple ethnicities. Average age of

adolescents was 15.2 years (range = 13.8 to 18.6), and 47% ($n = 29$) were girls. Mothers' average age was 45.2 years (range = 30.8 to 58.8). Fathers' average age was 47.2 years (range = 35.2 to 61.8). Parents had been married or living together an average of 14.9 years (range = 9.0 to 25.0, $SD = 4.2$). Mothers averaged 14.3 years of education (range = 10 to 20; $SD = 2.4$). Fathers also averaged 14.3 years of education (range = 9 to 20; $SD = 2.4$). Yearly family income ranged from \$8,700 to 165,000 (mean = 71,585, $SD = 35,582$). All data were collected at Wave 4. The aim was for Wave 4 to come approximately one year after Wave 3, but there was some variability depending on when families could return to the lab. Thus, the time between wave 3 and wave 4 averaged 2.70 years ($SD = .47$, range = 1.58 to 3.75). Families did not differ systematically on key demographic variables from families in the original sample except regarding fathers' mean years of education. For families who participated in all 4 waves, fathers' mean education was 14.48 years, and for those who participated in wave 1, 2, or 3 the mean was 13.37 years, $t = -3.20$, $p = .023$, $df = 117$.

Procedures

All procedures were carried out with the approval of the university IRB. Before the scheduled lab appointment, we asked participants not to eat or smoke for one hour before their appointment, and not to consume alcohol or caffeine for 24 hours before the scheduled appointment. Families arrived in the lab, where research assistants explained the study and obtained parents' consent and adolescents' assent. As part of a longer protocol, parents and adolescents completed questionnaires and engaged in a family discussion task, around which we collected saliva samples.

The family discussion task was designed to engage both parents and the adolescent, and was structured to elicit conflict among family members. Researchers worked with each family member individually, including the child, during 5-minute "priming interviews" to identify issues in the family that were of concern to the family member and that were a source of conflict with the other family members. The researchers identified the 3 topics that were most conflictual across all three of the family members and brought the family members together to the discussion room. The researchers gave the family members the following instruction: "Although we know that this room does not look like your home, we are interested in how families really talk about or fight about problem areas. All of the families who come here have disagreements and we find that these frequently are not calm discussions. Some of these discussions get quite heated. Our purpose in having you do this discussion is to understand family disagreements and family members' different points of view. So please make sure that each of you gets your points across. You will have 15 minutes to discuss one or more of these topics. You can spend as much or as little time on the different topics."

Participants provided saliva samples while alone in their individual rooms, and timers were set at the beginning of each lab session to help ensure the timely collection of all samples. In the present study we examine sAA around the family discussion via four saliva samples: A post-relaxation/pre-discussion sample and three post-discussion samples. We followed the following protocol. The family as a group viewed a 10-minute relaxation video that displayed nature images. Participants provided a saliva sample after the relaxation video ($T = 0$). The family members then engaged in the priming interviews and discussion. After the 15 minute discussion, participants provided a second saliva sample ($T = 40$). Participants provided two more samples, at 10 minute intervals ($T = 50$ and $T = 60$). Salivary AA peaks immediately to 5 minutes post stressor and recovers by 10 min post-stressor^{20:29}. We collected saliva immediately after the 15 minute discussion because we suspected that for many of the families, conflict might occur during the first 10 minutes of the discussion. Therefore, we might expect sAA to peak by the end of the discussion. Collecting saliva at 10 and 20 minutes post discussion allowed us to capture recovery without overly taxing

participants. Participants provided the first two samples via passive drool through a short straw into a cryovial and the last two samples via sorbettes. SAA follows a diurnal pattern of variability, such that levels decrease within an hour of waking up and then increase throughout the day, with the increase being curvilinear but more stable in the afternoon³². For this reason we limited the hours in which we collected saliva primarily to the afternoon and evening. We collected the earliest T = 0 at 1154 , and the latest T = 0 sample at 1947. We collected 89% of T = 0 samples between 1200 and 0700. In our sample, time of day was not significantly correlated with sAA level ($r_s = -.04$ to $.15$, $p_s > .2$, though time of day was marginally correlated with fathers' pre-discussion sample ($r = .25$, $p = .075$). Quadratic relations between time and sAA levels were nonsignificant. Although we did restrict the time of collection, given the steady increase of sAA through these hours, we controlled for time of day in all multivariate analyses. Samples were frozen at -20 degrees C and shipped to Salimetrics LLC to be assayed for sAA.

Measures

Salivary alpha-amylase—Samples were assayed for sAA using a commercially available kinetic reaction assay (Salimetrics, State College PA). The assay employs a chromagenic substrate, 2-chloro-p-nitrophenol, linked to maltotriose. The enzymatic action of sAA on this substrate yields 2-chloro-p-nitrophenol, which can be spectrophotometrically measured at 405 nm using a standard laboratory plate reader. The amount of α -amylase activity present in the sample is directly proportional to the increase (over a 2 minute period) in absorbance at 405 nm. Results are computed in U/mL of α -amylase using the formula: [Absorbance difference per minute $\times$ total assay volume (328 ml) $\times$ dilution factor (200)]/[millimolar absorptivity of 2-chloro-p-nitrophenol (12.9) $\times$ sample volume (.008 ml) $\times$ light path (.97)]. Intra-assay variation (CV) computed for the mean of 30 replicate tests was less than 7.5%. Inter-assay variation computed for the mean of average duplicates for 16 separate runs was less than 6%.

We examined sAA levels at post-relaxation/pre-discussion baseline (T = 0), post-discussion (T = 40), post-discussion + 10 min (T = 50) and post-discussion + 20 min (T = 60). In addition, to examine symmetry among family members sAA activity, we calculated post-discussion peak sAA levels as the maximum sAA level after the discussion, and area under the curve scores with respect to ground (AUCg) and with respect to increase (AUCi)³³. These two AUC scores provide information about total output and overall increase during the procedures.

$$AUC_g = \sum_{i=1}^{n-1} ((m_{(i+1)} + m_i) * t_i) / 2$$

and AUCi measures total increase and is given by:

$$AUC_i = \left(\sum_{i=1}^{n-1} ((m_{(i+1)} + m_i) * t_i) / 2 \right) - \left(m_1 * \sum_{i=1}^{n-1} t_i \right)$$

where there are n measures m at time i, and t_i is the time interval between m_i and $m_{(i+1)}$.

For baseline, post-discussion, post-discussion + 10 min, post-discussion + 20 min, peak, and AUCg, we square root transformed indices to address moderate skew^{20, 34}. For AUCi, one outlier for each of mother and child data and two for father data were recoded to 2 SD from the mean or the closest value in the data that was not an outlier, whichever was further from

the mean³⁵. Fathers' AUCi scores were still moderately skewed and were subjected to square root transformation after addition of a constant.

Interparental aggression during the previous year—Parents completed the Domestic Conflict Inventory (DCI)³⁶, and adolescents completed a modified version of the Conflict Tactics Scale (CTS)^{37, 38}. Participants completed these measures via computerized administration. We used these measures to group families according to whether any family member endorsed any interparental physical aggression during the previous year.

The DCI is a 61-item index of inter partner conflict behaviors that includes many of the items from the original CTS³⁷ plus some additional items. The present study examines the 15-item index of physical aggression. First, each parent is presented the list and indicates whether he or she has engaged in each behavior toward the spouse during the previous year on a scale of 0 (never), 1 (once), 2 (2-5 times per year), 3 (6-12 times per year), 4 (2-4 times per month), or 5 (greater than once per week). Next, each parent reads the same list, indicating whether the spouse has engaged in each behavior toward the respondent during the previous year. We therefore have two reports for each person's behavior regarding each item. We take the sum of the maximum reports per item, under the assumption that for these behaviors, underreporting is more likely than is over reporting. Thus, if the father indicates that he has not slapped the mother during the previous year, but the mother indicates that he has slapped her, we count her response. Fathers' DCI physical aggression scores averaged 0.85 (SD = 2.22) and mothers' scores averaged 0.55 (SD = 1.3). Fathers' and mothers' scores correlated at .40 ($p < .05$).

The CTS³⁷ is a 19-item index of inter partner conflict behavior containing a 3-item index of minor violence and a 6-item index of severe violence. We modified the original measure for the purpose of obtaining adolescents' responses regarding their parents' behavior toward each other during the previous year³⁹. We administered five items from the violence scale to the adolescents. We administered fewer of the items to the adolescents due to the sensitive nature of their reporting on severe physical aggression between their parents.

We grouped families based on whether any of the members endorsed that physical aggression had occurred during the previous year. In 18 families, at least one family member endorsed that some interparental physical aggression had occurred (9 with female adolescents), and in 44 families, no family member endorsed any interparental physical aggression (20 with female adolescents). Nine adolescents endorsed at least one marital aggression event.

Data analysis

To test hypothesis 1, the degree of symmetry between parents' and adolescents' sAA responses to the discussion, we conducted zero order and partial correlation coefficients, controlling for time of sample, sex and age of the adolescent, among corresponding sAA indices among family members. We examined the following indices: post-relaxation/pre-discussion baseline ($T = 0$), post-discussion peak, AUCg, and AUCi²³.

To test hypothesis 2, regarding the effects of family aggression on family members' sAA indices, we conducted a repeated measures analysis of covariance with repeated measures of saliva sample and family member and a between groups factor of interparental aggression. These analyses controlled for child sex and time of day. We followed up this analysis with repeated measures and one-way ANCOVAs.

To test hypothesis 3, the effect of interparental aggression on parent-adolescent symmetry in sAA response, we conducted multiple regression analyses to examine the potential

moderating effect of interparental aggression on relations between each parent's and the adolescent's corresponding sAA index. Specifically, we regressed each adolescent index on the parent's corresponding index, as well as interparental physical aggression (coded as -1 for no aggression and $+1$ for any aggression) and the interaction between the parent sAA index and interparental physical aggression. As above, we examined pre-discussion ($T = 0$), post-discussion peak, AUCg, and AUCi. These analyses control for child sex, time of sample, and child age. Significant interaction effects would be consistent with interparental aggression as a moderator of parent-child sAA symmetry. We follow up significant interaction effects by presenting correlations separated by group.

Results

Preliminary descriptive data

We examined sAA levels before and after the discussion. Overall, 75.8% of adolescents, 81.0% of mothers, and 67.9% of fathers exhibited a 10% or greater increase from pre-discussion in sAA to the maximum post-discussion level. Paired t-tests reveal that across the sample, mothers', fathers', and children's sAA levels rose significantly from pre- to post-discussion (adolescents' pre- versus post-discussion $t = 2.34$, $n = 62$, $df = 61$, $p = .023$; fathers pre- versus post-discussion $t = 3.54$, $n = 52$, $df = 51$, $p = .001$; mothers pre- versus post-discussion $t = 4.14$, $n = 58$, $df = 57$, $p < .001$). Figure 1 presents the sAA levels of adolescents, father, and mothers at pre-discussion (baseline; $T = 0$), post-discussion ($T = 40$), post-discussion + 10 min ($T = 50$), and post discussion + 20 min ($T = 60$). Table 1 presents descriptive information for pre-discussion, peak, AUCg and AUCi scores across the sample. Salivary AA was not correlated with ethnicity. Boys exhibited higher overall levels of sAA than did girls at each time point and index.

Parent-Adolescent symmetry of sAA response among family members (hypothesis 1)

Correlations and partial correlations, controlling for child age, sex, and time of day, among family members' sAA levels appear in Table 2. Children's pre-discussion, post-discussion peak, and AUCg scores were significantly, positively correlated with mothers' corresponding indices, demonstrating symmetry. Children's pre-discussion scores were correlated with fathers' pre-discussion scores but were not correlated with other indices of fathers.

Effect of interparental aggression on sAA (hypothesis 2)

Repeated measures ANCOVAs examining the effect of interparental aggression across sAA saliva samples and family members, controlling for time of day and child sex, revealed a significant 2-way interaction of saliva sample $\times$ interparental aggression group (Wilks' Lambda = .80, $F = 4.91$, $df = 2,38$, $p = .013$), and a significant 3-way interaction effect of saliva sample $\times$ family member $\times$ interparental aggression (Wilks' Lambda = .63, $F = 3.35$, $df = 6,34$, $p = .011$.) To understand these interactions, we followed up with repeated measures ANCOVAs to examine differential effects of saliva sample and interparental aggression within family member. For mothers, we found no main effects or interactions. For fathers, we found no main effect of saliva sample, but we did find a main effect of interparental aggression ($F = 4.82$, $df = 1,46$, $p = .033$, $n = 50$, 16 from families reporting interparental aggression). Fathers in the group reporting interparental aggression had lower sAA indices overall than did fathers in the group not reporting interparental aggression. Specifically, fathers in the group reporting interparental aggression had significantly lower sAA levels at pre-discussion ($F(1,50) = 9.31$, $p = .004$) and at post discussion ($F(1,51) = 9.26$, $p = .004$) but not at other time points. Moreover, in the group reporting interparental aggression, fathers' sAA levels did not rise significantly from pre-discussion to post-discussion (paired $t = -1.33$, $n = 17$, $df = 16$, $p = .20$) and did not decline after 10 minutes

(paired $t = .47$, $n = 16$, $df = 15$, $p = .65$) whereas fathers' sAA levels among the group reporting no interparental aggression did rise significantly (paired $t = -3.32$, $n = 36$, $df = 35$, $p = .002$) and declined after 10 minutes (paired $t = -4.30$, $n = 36$, $df = 35$, $p < .000$). Among adolescents, we found a significant 2-way interaction between saliva sample and interparental aggression group. In the group reporting interparental aggression, adolescents' sAA levels rose significantly from pre-discussion to post-discussion (paired $t = 3.88$, $n = 18$, $df = 17$, $p = .001$) and then declined significantly after 10 minutes (paired $t = 3.96$, $n = 18$, $df = 17$, $p = .001$). In the group reporting no interparental aggression, adolescents' sAA levels did not rise significantly pre-discussion to post-discussion ($t = .49$, $n = 44$, $df = 43$, $p = .63$) but then did decline after 10 minutes ($t = 3.15$, $n = 43$, $df = 42$, $p = .003$). Mean sAA levels at all time points and on AUC scores for all family members in families reporting marital aggression versus not reporting marital aggression appear in Table 3. Figure 2 displays the response curves for adolescents, fathers, and mothers from families with versus without interparental aggression during the previous year.

Effect of interparental aggression on parent-child sAA symmetry (hypothesis 3)

Regression analyses examining the effect of interparental aggression on parent-adolescent sAA symmetry around the discussion appear in Table 4. We conducted regression analyses of the adolescent's index onto the parent's corresponding index, interparental aggression, and their interaction, controlling for age and sex of adolescent and time of day. SAA indices were centered and multiplied with interparental aggression group ($-1 =$ no interparental aggression, $+1 =$ interparental aggression) to calculate the interaction. In equations examining symmetry between father and adolescent post-discussion peak, AUCg, and AUCi, the two way interactions between the father index and interparental aggression were significant in accounting for the adolescent index. For mothers, the interaction was not significant in any equation, though AUCg exerted a significant main effect. Follow up correlations, which appear in Table 5, reveal that among families reporting interparental aggression, adolescents exhibit symmetry with fathers with regard to post-discussion peak, AUCg and AUCi scores. Among families reporting no interparental aggression, the only significant correlation between fathers' and adolescents' corresponding indices was a significant partial correlation at pre-discussion baseline. Among mothers, AUCg scores were significantly or marginally correlated in both the groups reporting interparental aggression and those reporting no such aggression. In addition, among the group reporting no interparental aggression, adolescents' and mothers' baseline and peak were significantly positively correlated, whereas they were not correlated in the group reporting interparental aggression.

Discussion

The findings of this study suggest symmetry in the SNS among family members before and after a family conflict discussion, but that a context of interparental physical aggression affects the nature of this symmetry. Overall, we found that in a majority of families, family members exhibit an increase in sAA from before to after a conflict discussion, though a minority of participants did not exhibit such an increase in sAA. Across the entire sample, we found that adolescents and their mothers exhibited moderate symmetry in sAA before and after the conflict discussion, as measured by correlated sAA pre-discussion, post-discussion peak, and AUCg scores. Results suggest less evidence for symmetry between fathers and adolescent children. However, in multiple regression analyses, interparental aggression interacted with fathers' corresponding sAA indices in accounting for adolescents' indices, consistent with a moderating effect of interparental aggression on father-adolescent sAA symmetry. Consistent with our hypothesis, mother-adolescent sAA symmetry was lower in families with interparental aggression. However, in families reporting interparental

aggression, adolescents and fathers exhibited more consistent sAA than in those not reporting interparental aggression. In families reporting interparental aggression, fathers and adolescents exhibited more consistent sAA symmetry than did mothers and adolescents. In families reporting no interparental aggression, mothers and adolescents exhibited more consistent sAA response symmetry than did fathers and adolescents. We also found an effect of interparental aggression on fathers' sAA, such that fathers from families reporting interparental aggression exhibited lower pre-discussion baseline, post discussion, and peak levels of sAA and lower AUCg scores, than did fathers in families reporting no such aggression. In contrast, adolescents in families reporting interparental aggression exhibited a significant sAA increase from pre- to post- discussion, whereas in families reporting no such aggression, adolescents did not exhibit this sAA increase.

Across the whole sample, we found evidence of sAA symmetry between mothers and adolescent children, consistent with previous research on mother-child attunement in typical samples. Emotional and behavioral attunement between mothers and infants is thought to be positive for infant social development and ability to learn to regulate affect and feel secure¹. Research on emotional attunement suggests that attunement has benefits for children and adolescents as well. Mother-child emotional attunement appears to account for the development of behavior problems among children⁶. Mothers' attunement with adolescents may also contribute to attachment security⁷.

Symmetry in SNS activity around family conflict interactions may reflect a dimension of parent-child attunement. A symmetric sAA response indicates that adolescents with higher levels of SNS activity also have mothers exhibiting higher SNS activity, suggesting a shared physiological state, which is consistent with the idea of attunement¹. However, the implications of this shared physiological state remain unclear. The symmetry in sAA between mothers and adolescents across the whole sample suggests that relative to the rest of the sample, mothers who have higher levels of sAA have adolescent children with higher levels of sAA. This symmetry could suggest that the mother is aware of and responsive to the adolescent's emotional state. It could also suggest that the mother exhibits SNS activity in response to the adolescent's distress, which may be responsive but also may interfere with her ability to calm and help the adolescent self-regulate. Moreover, to the extent that mothers and adolescents experience conflict, the symmetry in SNS activity may reflect the mothers' negative reactivity to the adolescent's negativity. This symmetry also may reflect shared genetic influences on the functioning of the SNS⁴⁰. Moreover, because SNS is not necessarily reflective of negative emotional states, this symmetry could reflect shared positive engagement or interest.

Among the full sample, we found evidence of SNS symmetry primarily between adolescents and their mothers, and not their fathers. The finding of mother-adolescent SNS symmetry is not surprising given the literature suggesting the importance of mother-child attunement in dyadic settings. However, the presence of the father in this triadic setting has the potential to disrupt mother-child SNS symmetry given that the mother and the child each may attend differently to each other with the father in the room, particularly in the context of a family conflict discussion. However, across the whole sample, the father's presence did not appear to interrupt mother-adolescent SNS symmetry.

The significant interaction effect between interparental aggression and corresponding parent sAA index in accounting for variance in the child's corresponding index suggests that in the context of interparental aggression, SNS symmetry patterns in the family were different. Contrary to our hypothesis, symmetry between fathers and adolescents was more consistent than among those reporting no such aggression; consistent with our hypothesis, symmetry with mothers was less consistent. Interparental aggression may disrupt mothers' ability for

attunement, as the threat of aggression may cause fear and tax mothers' resources, making them less available for what Field¹ calls a "dyadic sharing of behavior states" (p. 220) as has been reported among depressed mothers. In addition, the context of interparental aggression may cause adolescent children to be more vigilant and attentive to fathers' emotional states. Even in the context of bidirectional violence, fathers may be more likely to carry threat value because of their greater capacity for physical damage to children and to their mothers. To the extent that adolescents feel threatened by the possibility of their fathers becoming aggressive toward their mothers, adolescents may be hypervigilant to fathers' SNS arousal. Consistent with this idea, researchers have found cognitive biases toward threat-related stimuli among maltreated children and have speculated that they are hypervigilant to threat cues⁴¹. Whereas different patterns of parent-adolescent sAA symmetry emerged among families reporting versus not reporting interparental aggression, exploratory analyses revealed little evidence for symmetry in sAA between parents in either aggression group. Correlations between mothers' and fathers' sAA indices were not significant.

We were surprised that we did not find more differences in sAA indices based on the history of family aggression. Consistent with the literature suggesting heightened SNS activity in response to conflict among family members from families with higher levels of marital conflict and aggression, we expected participants from families with interparental aggression to exhibit higher SNS activity around this conflict situation, as measured by higher sAA levels and pre-post change indices, but this was not the case for the most part. We did find that children from families reporting interparental aggression exhibited an increase in sAA from pre- to post-discussion, whereas children from families who did not report such aggression did not exhibit such an increase. These data are consistent with the idea that the context of violence in the family may cause these youth to be sensitized to situations related to family conflict^{14, 31}. However, this finding was the only one consistent with that hypothesis.

In contrast to the finding regarding a significant increase in sAA from pre- to post-discussion only among adolescents from families reporting interparental aggression, we found that fathers in aggressive interparental relationships tend to have lower sAA levels. This finding is consistent with the idea that autonomic hypoarousal is a risk factor for aggressive and antisocial behavior⁴². Autonomic hypoarousal may be partly due to genetic factors⁴⁰. Alternatively, these fathers have experienced higher levels of stress over time due to increased interpersonal conflict, resulting in attenuated SNS levels and responses due to allostatic load^{43, 44}. It is curious that we observe attenuated sAA levels in fathers but not mothers. Although wives and husbands may exhibit different patterns of SNS responses to marital conflict, some data suggest that wives may demonstrate more reactivity to marital conflict and hostility compared to other stressors and compared to husbands' reactivity, in a variety of physiological systems, including adrenocortical measures, cardiovascular measures such as systolic blood pressure, and serum levels of epinephrine and norepinephrine¹⁹. However, we currently know little regarding gender differences in SNS attenuation to allostatic load.

Several limitations bear mentioning. First, we lack information regarding the degree of conflict and negative behavior during the discussion. Because family members choose their own discussion topics, families vary in the degree of negative affect and tension exhibited during the discussions, and this variation may affect sAA levels. In addition, the sample is small. Thus, we cannot examine other factors that are relevant, such as sex of the child. Relatedly, because the sample is small, we have limited power to detect effects. We also do not examine how sAA levels and parent-adolescent symmetry relate to outcomes. We were unable to control for smoking and body mass index, factors that some researchers have found to be related to sAA⁴⁵. In addition, the level of aggression in the families is relatively

low, as one might expect in a community sample. Finally, we do not know exactly what the SNS activity, as measured by sAA, means subjectively for individuals, or what sAA symmetry or lack thereof means for the individual or family. Such symmetry could signify attunement, but it could mean increased negative reactivity between conflictual family members, or states of engagement or interest. Because SNS tends to increase in response to both positively and negatively valenced states of interest or stress, families members could exhibit symmetric increases in sAA despite having quite different emotional experiences.

Despite these limitations, the study has notable strengths. Few studies have examined SNS responses around family conflict, and even fewer expand the field of inquiry to triadic settings with both parents and the child together in the room. Given that exposure to marital conflict is known to have negative consequences for development, examining the setting of the child's responses in the presence of both parents is important. Another strength of the study is that our measure of interparental aggression relies on reports of both parents and the child. We thus do not rely on the word of only one respondent and are more likely to have an accurate picture of whether families have experienced this kind of aggression.

Future studies should examine relationship correlates and consequences of these altered patterns of SNS symmetry among family members. Our findings suggest that expected patterns of attunement may be disrupted by interparental physical aggression, such that family discussions are characterized by alterations in shared physiological states, and possibly tensions, between family members. Intervention with families might focus on fostering healthy attunement between family members and addressing contextual factors, such as interparental aggression, that may compromise attunement.

Acknowledgments

This research was supported in part by the Behavioral Endocrinology Laboratory and the Child Youth and Families Consortium at the Pennsylvania State University, by NIH grants R01 HD046807 and K23 HD41428, and by grant 00-12802 from the David and Lucile Packard Foundation. We thank Becky Hamilton and Mary Curran for biotechnical support with immunoassays, Deborah Chien, Sarah Duman, Angèle Fauchier, Catherine Delsol Haudek, Anna Marie Medina, Laura Proctor, Michelle Ramos, Martha Rios, Laura Spies, and Molly Swanston for their input and work with participant families, and Adabel Lee, Mona Elyousef, and Jenie Wall for their work as project coordinators. We deeply appreciate the generosity of the participant families.

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Figure 1.
sAA Response Curves for Mothers, Fathers, and Adolescent Children across Whole Sample

Figure 2. sAA Response Curves for Mothers, Fathers, and Adolescent Children in Families Reporting Interparental Aggression vs. Reporting No Interparental Aggression during the Previous Year

Table 1

Means, standard deviations and ranges on sAA levels and indices

	Mean	SD	Range	N
Adolescent sAA				
Pre-discussion	71.6	66.6	7.2-345.8	62
Post-discussion	85.6	70.2	5.1-293.9	62
Post-discussion + 10	57.8	53.2	5.0-233.4	61
Post-discussion + 20	62.4	58.0	6.7-348.1	60
Post-discussion Peak	95.9	75.9	5.1-348.1	62
AUCg	80.5	58.0	9.5-258.0	59
AUCi	2.7	39.9	-198.5-129.4	59
Fathers				
Pre-discussion	73.8	44.7	4.6-181.2	53
Post-discussion	103.1	80.4	7.4-311.9	55
Post-discussion + 10	69.7	68.2	7.1-283.2	53
Post-discussion + 20	67.1	56.8	4.8-241.3	54
Post-discussion Peak	112.4	84.8	7.4-311.9	56
AUCg	90.5	57.7	7.6-271.9	50
AUCi	12.2	35.3	-41.8-114.4	50
Mothers				
Pre-discussion	69.4	58.1	5.3-324.7	58
Post-discussion	91.2	65.5	14.8-300.6	58
Post-discussion + 10	58.0	48.9	4.5-211.4	55
Post-discussion + 20	62.3	46.0	4.5-212.2	56
Post-discussion Peak	102.9	64.9	21.3-300.6	58
AUCg	77.8	49.0	12.7-247.3	54
AUCi	8.0	32.6	-180.7-87.9	54

Note: sAA = Salivary alpha amylase, AUCg = area under the curve with respect to ground. AUCi = area under the curve with respect to increase.

Table 2

Correlations between corresponding sAA indices between adolescents and parents and partial correlations controlling for child sex, child age, and time of day

Adolescent	Father		Mother	
	<i>R</i>	Partial <i>r</i>	<i>r</i>	Partial <i>r</i>
Pre-discussion	.32 ^{a*}	.30 ^{b*}	.43 ^{c**}	.39 ^{d**}
Post-discussion Peak	.13 ^e	.11 ^f	.44 ^{g**}	.35 ^{h*}
AUGg	.23 ^j	.21 ^k	.53 ^{l**}	.43 ^{m**}
AUCi	.22 ^j	.19 ^k	.08 ^l	.01 ^m

*
 $p < .05$.

**
 $p < .01$.

^a
 $n = 53$;

^b
 $df = 48$;

^c
 $n = 58$;

^d
 $df = 52$;

^e
 $n = 56$;

^f
 $df = 50$;

^g
 $n = 58$;

^h
 $df = 52$;

^j
 $n = 48$;

^k
 $df = 43$;

^l
 $n = 52$;

^m
 $df = 47$;

Table 3

Means and SDs for sAA indices for family members from families reporting any versus no interparental aggression during the previous year.

Interparental Aggression in the Last Year					No Interparental Aggression in the Last Year					
	M_{raw} in U/mL	SD_{raw}	$M_{transform}$	$SD_{transform}$	n	M_{raw} in U/mL	SD_{raw}	$M_{transform}$	$SD_{transform}$	n
Adolescent sAA										
Pre-discussion	54.4	47.6	6.7	3.1	18	78.7	72.2	8.2	3.4	44
Post-discussion	94.6	78.2	8.9	4.0	18	82.0	67.2	8.4	3.4	44
Post-discussion+10	61.3	69.1	6.9	3.8	18	56.4	45.8	7.0	2.7	43
Post-discussion+20	63.9	58.6	7.3	3.3	17	61.8	58.5	7.2	3.1	43
Post-discussion Peak	96.4	77.1	9.0	3.9	18	95.8	76.2	9.1	3.6	44
AUCg	80.6	63.9	8.4	3.4	17	80.4	56.3	8.5	2.9	42
AUCi	20.6	32.8	17.7 ^a	23.4	17	-4.5	40.1	-2.3 ^a	31.2	42
Father										
Pre-discussion	46.2	32.1	6.3 ^b	2.5	17	86.8	44.2	9.0 ^b	2.6	36
Post-discussion	58.5	46.7	7.1 ^b	3.0	17	123.0	84.7	10.4 ^b	4.0	38
Post-discussion+10	59.3	66.9	6.9	3.4	16	74.1	69.1	7.8	3.6	37
Post-discussion+20	51.9	43.2	6.7	2.8	16	73.5	61.0	7.9	3.3	39
Post-discussion Peak	75.4	64.7	8.1 ^c	3.3	17	128.5	88.2	10.6 ^c	4.1	38
AUCg	59.1	38.7	7.3 ^c	2.4	16	105.2	59.6	9.8 ^c	3.1	34
AUCi	7.8	31.8	7.4	1.8	16	14.2	37.2	7.7	2.4	34
Mother										
Pre-discussion	66.3	24.1	8.0	1.5	16	70.5	66.9	7.7	3.5	42
Post-discussion	87.3	44.7	9.1	2.3	16	92.7	72.3	9.0	3.5	42
Post-discussion+10	47.8	26.0	6.7	1.9	16	62.2	55.4	7.2	3.3	39
Post-discussion+20	76.0	45.0	8.4	2.4	16	56.8	45.8	7.0	2.9	40
Post-discussion Peak	101.3	52.1	9.8	2.6	16	103.5	69.7	9.7	3.2	42
AUCg	76.1	27.3	8.6	1.6	16	78.5	56.0	8.4	3.0	38
AUCi	6.5	21.7	6.5	21.7	16	8.7	36.5	12.3	20.5	38

Note: AUC_g = area under the curve with respect to ground. AUC_i = area under the curve with respect to increase. Transformed scores are square root transformations of the raw scores, except in the case of AUC_i, which are raw scores with one outlier recoded for mothers and one for adolescents. For fathers, AUC_i outliers were recoded, a constant added, and the data square root transformed due to skew. Raw means are presented for interpretability, but analyses are conducted on transformed scores.

^a Means in the same row sharing this coefficient are marginally different from each other ($p = .06$).

^b Means in the same row sharing this coefficient differ from each other ($p < .01$).

^c Means in the same row sharing this coefficient differ from each other ($p < .05$).

Table 4

Regression equations accounting for adolescent sAA index by corresponding parent index, interparental aggression, and interparental aggression X parent index interaction, controlling for child age, sex, and time of day

Index Main effect			Interparental Aggression			2 way Interaction			<i>F</i> (<i>df</i>)
<i>n</i>	β	<i>T</i>	β	<i>t</i>		β	<i>T</i>		
Fathers									
Pre-discussion	.30	1.96	.00	.02		.03	.21		1.69 (3,46)
Post-discussion Peak	.35	2.19*	.12	.88		.44	2.95**		3.05* (3,48)
AUGg	.50	3.05**	.38	2.55*		.34	2.38*		3.82* (3,41)
AUCi	.47	2.56*	.33	2.29*		.38	2.09*		3.74* (3,41)
Mothers									
Pre-discussion	.36	1.46	-.07	-.57		-.03	-.12		3.29* (3,50)
Post-discussion Peak	.29	1.74+	.07	.57		-.05	-.34		2.31+ (3,50)
AUGg	.58	2.53*	.02	.16		.18	.85		3.38* (3,44)
AUCi	-.05	-.26	.31	1.99+		-.14	-.85		1.35 (3,44)

Note: AUCg = area under the curve with respect to ground. AUCi = area under the curve with respect to increase.

* $p < .05$.

** $p < .01$.

+ $p < .10$.

Partial correlations among corresponding sAA indices between child and parents, controlling for adolescent sex and age, and time of day

Table 5

	Interparental Aggression			No Interparental Aggression				
	Father	Mother		Father	Mother			
	r^a	Partial r^b	r^c	Partial r^d	r^e	Partial r^f	r^g	Partial r^h
Adolescent								
Pre-discussion	.40	.43	.15	.21	.23	.27*	.49**	.47**
Peak	.67**	.62*	.34	.09	-.06	-.08	.47**	.38*
AUGg	.60*	.70*	.48 ⁺	.36	.16	.13	.57**	.50**
AUCi	.77**	.79**	.06	-.12	.11	.09	.14	.08

* $p < .05$.

** $p < .01$.

⁺ $p < .10$.

^a ns for pre-discussion and peak = 17 and for AUC scores = 15.

^b dfs for pre-discussion and peak = 12 and for AUC scores = 10.

^c ns for pre-discussion, peak, and AUC scores = 16.

^d dfs for pre-discussion, peak and AUC scores = 10.

^e ns for pre-discussion = 36, for peak = 39, and for and for AUC scores = 33.

^f dfs for pre-discussion = 31, for peak = 33, and for and for AUC scores = 28.

^g ns for pre-discussion and peak = 42 and for AUC scores = 36.

^h dfs for pre-discussion and peak = 37 and for AUC scores = 31.