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Attachment Style, Vagal Tone, and Empathy During Mother–Adolescent Interactions

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We tested associations among empathic responsiveness, attachment style, and vagal tone (a physiologic index of emotion regulation) in 103 mother–adolescent dyads. Dyads discussed positive and negative topics and then separately reviewed a videotape of the interaction and rated their own and the other person's affect at one-minute intervals. We used multilevel modeling to analyze the association between one's rating of the other person's affect and the other person's affect (empathic sensitivity), and the association between one's rating of the other person's affect and one's own affect (perceived concordance). Adolescents' empathic responsiveness was predicted by attachment style, vagal tone, and interactions between them. Adolescents with the greatest empathic responsiveness had low levels of attachment insecurity and high levels of vagal tone.

Empathy, typically conceptualized as the ability to accurately perceive and respond to another person's affective state, is a fundamental component of social competence and a precursor to moral reasoning (van IJzendoorn, 1997; Mehrabian, Young, & Sato, 1988), which plays a critical role in close relationships by promoting mutual understanding and sensitivity (Britton & Fuendeling, 2005; Davis & Oathout, 1987). Adolescence is a particularly important period for investigating variability in empathic capacities, particularly in the context of parent–child interactions. Interactions with parents are characterized by high levels of negativity and conflict during the adolescent years (Conger & Ge, 1999; Kim, Conger, Lorenz, & Elder, 2001; Laursen & Collins, 1994; Steinberg, 1988, 1990a), making it increasingly valuable for youths to accurately *interpret* their parents' emotional states while still *differentiating* these states from their own. Hence, understanding the factors which predict adolescents' empathic capacities within parent–child interactions is important for understanding the interpersonal foundations of socioemotional functioning.

However, research on adolescent empathy remains somewhat underdeveloped, and has notable conceptual and methodological limitations. In particular, most previous studies have treated adolescent empathy as a static, trait-like capacity, and have measured it with questionnaires assessing youths' real or imagined responses to other individuals' experiences or emotional displays (Laible, Carlo, & Roesch, 2004; Markiewicz, Doyle, & Brendgen, 2001; Soenens, Duriez, Vansteenkiste, & Goossens, 2007). This stands in notable contrast to the more dynamic, process-oriented, interpersonally based approaches to empathy increasingly taken with adults. Such approaches are exemplified by the *Empathic Accuracy* paradigm of Ickes and colleagues (Ickes and Simpson, 2004a, 2004b; Simpson, Ickes, & Grich, 1999; Simpson, Ickes, & Orina, 2001; Simpson, Orina, & Ickes, 2003), in which romantic couples or friendship pairs estimate each other's affective states during—or immediately after—a naturalistic interaction with one another. Variations on this methodological strategy have been adopted by numerous researchers aiming to capture different facets and predictors of empathic responding (Hall & Schmid Mast, 2007; Neyer, Banse, & Asendorpf, 1999; Ponnet, Buysse, Roeyers, & De Clercq, 2008; Zaki, Bolger, & Ochsner, 2008). However, only a handful of these studies have involved adolescents (Sillars, Koerner, & Fitzpatrick, 2005; Vervoort et al., 2007).

Another gap in previous research on adolescent empathy is the lack of attention to individual differences in emotion regulation which may help to explain variations in empathic capacities during

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the adolescent years, most notably *attachment style* and *vagal tone*. Attachment theory suggests that both attachment anxiety and avoidance should be associated with deficits in empathy, albeit through different mechanisms, owing to the distinctive emotion regulation strategies associated with each dimension (Becker-Stoll, Delius, & Scheitenberger, 2001; Joireman, Needham, & Cummings, 2002; Mikulincer, Shaver, & Pereg, 2003; Westmaas & Silver, 2001). However, previous investigations of empathy and attachment have focused on global reports of empathic capacities (Britton & Fuendeling, 2005; Joireman et al., 2002) rather than "on-line" empathic responsiveness between social partners (with some exceptions, such as Laible, 2007; Markiewicz et al., 2001). Individual differences in *vagal tone* (i.e., tonic parasympathetic control of heart rate) are also likely to relate to adolescent empathy. "Vagal" refers to the functioning of the 10th cranial nerve, which provides inhibitory input to the heart via the parasympathetic nervous system (PNS) and helps to regulate metabolic output in response to environmental events. Vagal tone is thought to provide a physiologic substrate for emotion regulation (Appelhans & Luecken, 2006; Hastings et al., 2008; Lewis, Lamm, Segalowitz, Stieben, & Zelazo, 2006; Ochsner & Gross, 2008; Porges, 2007; Thayer & Lane, 2000), and is associated with children's socioemotional behavior and empathic capacities (Eisenberg, Fabes, Karbon, & Murphy, 1996a; Eisenberg et al., 1996b; Fabes, Eisenberg, & Eisenbud, 1993). No previous research has investigated links between vagal tone and empathy among adolescents.

The present study employs a modification of the empathic accuracy paradigm to address these gaps in the literature. We assess mothers' and adolescents' affect, and their estimates of *one another's* affect, immediately after a naturalistic interaction. Both partners' empathic responsiveness is analyzed with multilevel random coefficient modeling (MRCM, sometimes known as hierarchical linear modeling), which allows us to model both mothers' and adolescents' empathic responding as a function of adolescents' attachment style and vagal tone.

CONCEPTUALIZING EMPATHY

Empathy incorporates multiple, interrelated processes (which we collectively denote *empathic responsiveness*). The present research concerns the cognitive component of empathy, which involves the capacity to take the perspective of another person and accurately interpret his or her affective cues. We focus on two related capacities: The first is empathic *sensitivity*, meaning the ability to accurately perceive another person's affective states across a range of different specific moments. The second dimension is *perceived concordance*, representing the degree to which individuals perceive the other person's affective state as corresponding to their own. Perceived concordance can be interpreted as either facilitating or hindering empathy, based on how and why it comes about. Specifically, if perceived concordance results from one person authentically "matching" the affective state that they perceive in their partner, it should facilitate empathy by promoting shared perspective taking. However, if concordance results from an excessive focus on (and inability to regulate) one's own state, such that the individual "projects" his or her state onto the other person (Acitelli, Douvan, & Veroff, 1997; Hoch, 1987; Levinger & Breedlove, 1966; Neyer et al., 1999; Sillars, Folwell, Hill, & Maki, 1994; Sillars, Pike, Jones, & Murphy, 1984; Thomas, Fletcher, & Lange, 1997), then it can interfere with empathic responsiveness by distorting attention to the other person's *distinct and independent* affective cues (Zahn-Waxler, Radke-Yarrow, & King, 1979). As Hoffman (1990) describes, empathy requires that the individual acknowledge that "although he or she feels distressed *it is not he or she but someone else* who is in actual danger or pain" (p. 150, emphasis added). Hence, when an individual's self-focus interferes with his or her ability to perceive the other person's emotions as independent from his/her own, this interferes with empathy (Hoch, 1987; Hoffman, 1990; Thomas et al., 1997; Zahn-Waxler et al., 1979). We expect that mothers may be more conciously motivated to understand and relate to their children than vice versa (although this supposition has not been empirically tested), and hence we expect that perceived concordance is more likely to reflect empathy-promoting "affective matching" among mothers, but empathy-hindering "projection" and poor self-other differentiation among adolescents.

ATTACHMENT STYLE AND EMPATHY

Attachment styles are conceived as trait-like expectations concerning the responsiveness of attachment figures (Ainsworth, Blehar, Waters, & Wall, 1978), which come to organize the encoding, storage, retrieval, and manipulation of information related to affective states (see reviews in Bartholomew & Horowitz, 1991; Mikulincer, 1998; Mikulincer et al., 2003). Attachment styles are typically

represented in terms of the dimensions of *anxiety* and *avoidance.* Individuals with high attachment anxiety often have a history of inconsistent caregiving, and do not feel secure in the availability and responsiveness of their caregiver. They tend to maximize the experience and expression of negative affect and to be hypervigilant to threat cues (Shaver & Mikulincer, 2002). Individuals with high attachment avoidance often did not receive adequate, sensitive caregiving, and may have been directly rebuffed in their bids for contact and security. As a result, they learned not to seek such contact when distressed.

Both anxiety and avoidance have implications for adolescents' empathic capacities, but for different reasons. Avoidance is likely to interfere with empathy because high-avoidant individuals show inhibition of affective experience and poor attention to and concern with the affective expressions of others (Becker-Stoll et al., 2001; Joireman et al., 2002; Mikulincer et al., 2003; Westmaas & Silver, 2001). Hence, during an emotion-relevant interaction, an avoidant adolescent should show low interest in and attention to his or her partner's verbal, facial, and expressive cues of emotion, leading to deficits in his or her abilty to infer the other person's state. Attachment anxiety, however, is likely to interfere with empathy because high-anxious individuals tend to become preoccupied with their *own* unregulated distress when faced with the distress of others, and to "project" this state onto their partner rather than sensitively attending to the partner's distinct and independent affective cues (Joireman et al., 2002; Mikulincer & Shaver, 2003; Westmaas & Silver, 2001). Accordingly, attachment anxiety has been found to be associated with projective identification and with self-other boundary slippage, both of which hinder the ability of anxious individuals to differentiate themselves from others (Berant & Wald, 2009). Furthermore, these tendencies are highly consistent with the fact that anxiously attached individuals tend to cope with their insecurity by seeking to merge with the attachment figure (Bartholomew & Horowitz, 1991), further demonstrating that perceived self-other concordance for anxious individuals is motivated by the anxious individual's own psychologic state, and not by an attempt to empathize with the other. This may be why anxiously attached individuals are particularly likely to show deficits in empathy when they are themselves distressed (Joireman et al., 2002).

As a result of the different mechanisms through which anxiety and avoidance should interfere with empathy, it is likely that both high-anxious and high-avoidant adolescents will show low empathic sensitivity (i.e., the ability to accurately estimate the other person's affect), but that *only* high-anxious adolescents will show high perceived concordance (i.e., reflecting a heightened focus on their own affective state which biases their estimation of the other person's affect). The present study represents the first direct test of associations between adolescent attachment anxiety, attachment avoidance, and adolescent empathy. Although our research does not directly address the potential mechanisms underlying such associations (and potentially differentiating anxiety from avoidance), it nonetheless makes an important contribution to understanding the basic linkage between attachment style and empathy during this stage of life.

Another important, long-standing question in the literature on attachment and empathy concerns whether *mothers'* empathic capacities relate to their children's attachment style. Attachment theory suggests that maternal sensitivity to the child's needs helps to establish the child's emotional security (as demonstrated by Oppenheim, Koren-Karie, & Sagi, 2001). Accordingly, one might expect that the children of mothers with low levels of empathic responsiveness will have developed high levels of anxiety or avoidance. This is consistent with the findings of several studies of adolescents demonstrating that maternal characteristics suggestive of low responsiveness, attentiveness, nurturance, and autonomy-granting are associated with adolescent attachment anxiety and avoidance (Allen & Hauser, 1996; Karavasilis, Doyle, & Markiewicz, 2003; Matsuoka et al., 2006; Muris, Meesters, Morren, & Moorman, 2004). Although a mother's empathic sensitivity during her child's adolescent years may not reflect the same degree of sensitivity that she showed during the child's first year of life, during which individual differences in attachment security are thought to develop, it is reasonable to expect that throughout the mother–child relationship, and perhaps especially during adolescence, a mother's ability to accurately detect her child's emotional states may continue to influence the child's feelings of attachment security (Allen & Land, 1999).

VAGAL TONE AND EMPATHY

Individual differences in vagal tone should also be associated with adolescent empathy. The functioning of the parasympathetic nervous system in maintaining chronotropic control of the heart (sometimes called cardiac vagal control) has become one of the most widely researched physiologic indices of affect

regulation. The specific relevance of vagal regulation for affect regulation, specifically in the context of social behavior, has been set forth by Thayer and Lane's (2000) neurovisceral integration model and Porges' Polyvagal Theory (Porges, 2003). These models suggest that both *tonic* levels of vagal functioning (i.e., vagal tone, indexed by baseline levels of respiratory sinus arrhythmia, or RSA, which refers to respiration-related variability in heart rate) and acute *changes* in vagal functioning (indexed by RSA reactivity to environmental challenges) play a role in coordinating attention and behavior in the service of goal attainment, although the present study focuses exclusively on vagal tone.

Briefly, both the PNS and the sympathetic nervous system (SNS) are involved in the moment-by-moment physiologic changes triggered by environmental demands—changes in heart rate, blood pressure, sweating, etc. However, the SNS and the PNS have antagonistic effects on autonomic functioning, and thus stress responses such as heart rate acceleration can be brought about by activation of the SNS, withdrawal of the PNS, or some combination of the two. The tonic inhibitory control of cardiac output provided by the PNS is highly adaptive in that it allows for rapid and efficient modulation of cardiovascular activity to meet changing environmental demands. Hence, individuals with particularly robust vagal regulation of cardiac output—greater "vagal tone"—are conceptualized as having nervous systems that respond quickly and flexibly to environmental demands, recover more effectively from emotional arousal (Porges, Doussard-Roosevelt, & Maiti, 1994; Thayer & Lane, 2000), and show more adaptive patterns of socioemotional functioning (Beauchaine, 2001). This is borne out by studies relating vagal tone (indexed by resting levels of RSA) to psychosocial outcomes. For example, infants and children with low resting levels of RSA show compromised self-soothing after psychologic stress and are less easily and effectively soothed by others (reviewed in Porges et al., 1994). They have poorer emotional control and higher behavioral inhibition (Fox, 1989; Snidman, 1989), and display less sympathy to the distress of others (Eisenberg et al., 1996a; Fabes & Eisenberg, 1997; Fabes et al., 1993). Adults with low vagal tone have higher levels of depression, anger, mental stress, generalized anxiety, and panic anxiety (reviewed in Brosschot & Thayer, 1998; Friedman & Thayer, 1998; Horsten et al., 1999).

Although individual differences in vagal tone appear to be preserved from childhood to adolescence (El-Sheikh, 2005), relatively few studies of vagal tone have been conducted among adolescents. These studies have found that adolescents with lower vagal tone have greater problems with affective, attentional, and behavioral regulation (Allen, Matthews, & Kenyon, 2000; Beauchaine, Katkin, Strassberg, & Snarr, 2001; Beauchaine, Gatzke-Kopp, and Mead, 2007; Kibler, Prosser, & Ma, 2004; Mezzacappa, Tremblay, Kindlon, & Saul, 1997; Tobin & Graziano, 2006). These deficits have direct implications for empathy: Adolescents who struggle to regulate their own affect and attention may have difficulty detecting and interpreting the affective cues of social partners, especially during emotion-relevant interactions, and instead may show a heightened focus on their *own* affective experience. Accordingly, we expect that adolescents with low vagal tone will show lower levels of empathic sensitivity *and* higher levels of perceived concordance during mother–adolescent interactions. Notably, this prediction parallels the prediction we made for high-anxiety adolescents, which raises intriguing questions about potential *interactions* between attachment anxiety and vagal tone. Specifically, the emotion regulation deficits associated with attachment anxiety and avoidance might prove to be particularly detrimental for empathic responsiveness among youths who *also* have suboptimal physiologic substrates for emotion regulation. We plan to test for this possibility.

It bears noting that an increasing body of research has focused on *changes* in vagal regulation triggered by stress and other environmental demands (i.e., vagal reactivity). Vagal reactivity appears to index a different set of emotion-regulatory capacities than vagal tone, specifically having to do with active regulatory effort in the face of stress, rather than ongoing empathic capacity (Beauchaine, 2001; Kettunen, Ravaja, Naeaetaenen, & Keltikangas Jaervinen, 2000; Segerstrom & Nes, 2007; Thayer & Lane, 2000). Hence, given the lack of a strong empirical or theoretic basis for expecting links between vagal reactivity and empathy, the present study focuses exclusively on vagal tone. We did, however, have data on participants' RSA reactivity to stress, as our laboratory protocol included a stress assessment. We conducted ancillary analyses to check for any associations between empathic responsiveness and RSA reactivity; we found none.

THE CURRENT STUDY

We conducted an experimental study of 103 mother–adolescent dyads who engaged in a videotaped discussion of a recent positive event and also a

frequent topic of conflict. Mothers and adolescents watched the videotapes immediately after the discussion, in separate rooms, and provided ratings of their own positive and negative affect at one-minute intervals. Then they watched the videotapes a second time and provided ratings, at the exact same intervals, of the other person's positive and negative affect. All adolescents also underwent a physiologic assessment of resting RSA during the beginning of the laboratory visit to provide a measure of their vagal tone. We used a parallel process multilevel model to analyze each partner's empathic responsiveness, treating the mother–adolescent dyad as the unit of analysis. This analytical approach is ideally suited to representing the dyadic context of interpersonal empathy, and makes it possible to simultaneously analyze both *empathic sensitivity* (the degree to which Partner A's moment-by-moment estimates of B's affect are associated with corresponding fluctuations in B's moment-by-moment self-reports) and *perceived concordance* (the degree to which Partner A's moment-by-moment estimates of B's affect are associated with corresponding fluctuations in A's *own* moment-by-moment self-reports).

Our first hypothesis was that adolescents with higher attachment anxiety, higher attachment avoidance, or lower vagal tone would show less *empathic sensitivity* to their mothers' affective states. Our second hypothesis was that adolescents with high attachment anxiety or low vagal tone would show higher *perceived concordance* between their own affective state and that of their mothers, reflecting a tendency to project their states onto their mothers (Lopez, 2001; Mikulincer & Horesh, 1999; Mikulincer, Orbach, & Iavnieli, 1998; Skowron & Dendy, 2004). Our third hypothesis was that mothers with greater empathic sensitivity and lower perceived concordance would have adolescents with lower levels of attachment anxiety and avoidance.

In addition to these hypotheses, several ancillary analyses were planned: First, given previous research suggesting gender differences in empathy (Chase-Lansdale, Wakschlag, & Brooks-Gunn, 1995; Ickes, Gesn, & Graham, 2000) and in the links between vagal tone and empathy (Eisenberg et al., 1996a), we planned to explore potential gender differences in empathic sensitivity and perceived concordance, as well as interactions between gender and both attachment style and vagal tone. Second, we planned to test for interactions *between* anxiety and avoidance to investigate the potential importance of combined patterns of anxiety and avoidance (i.e., the secure, fearful, preoccupied, and dismissive subtypes identified by Bartholomew & Horowitz, 1991). Lastly, because processes of empathic responsiveness may unfold differently during positively vs. negatively valenced exchanges, we planned to examine whether any of our hypothesized effects varied as a function of discussion topic.

METHOD

Participants

Participants were 103 14-year-old youths (51 boys and 52 girls) and their mothers, who were enrolled as part of an ongoing longitudinal study of adolescent relationships and development. We employed power calculations designed for covariance structure analyses (Satorra & Saris, 1985), and found that the present sample size provided sufficient power (between .7 and .9) to test medium-sized main and moderating effects. Announcements about the study were mailed to parents of all 9th graders in the Salt Lake City, UT school district, and were distributed to local charter and private schools. Approximately 20% of families contacted our office in response to the announcement to request additional information about the study. Potential participants were screened for health status. Youths with major psychiatric illness, who had endocrine or cardiovascular disorders, or who were taking medications with cardiovascular or endocrine side effects were excluded from the study, because the larger study involved collection of cardiovascular and endocrine measures. Participants were required to be living with their (natural or adopted) mother. In all, 13 families were excluded from the study for these reasons, and an additional four families qualified for the study, but decided not to enroll after hearing more details about the specific time commitment involved. As IRB procedures precluded us from collecting demographic data from families who did not enroll in the study, it is unknown whether these 17 families differed significantly from those who enrolled in the study. To ensure consistency in age, 9th graders who were 15 years of age were excluded. Several 9th graders were 13 years of age when they volunteered for the study; if they were within 6 months of their 14th birthday, we waited for them to turn 14, and then enrolled them at that time. In all, 82% of the sample were White, 3% were African American, 1% were Asian American, 7% were Latino or Latina, and 7% had another or mixed ethnicity. Regarding household income, 13% of families had a household

income of less than $20,000, 25% had incomes between $20,000 and $50,000, 29% had incomes between $50,000 and $75,000, and 31% had incomes over $75,000. The average age of mothers was 45 (SD = 6.7). In all, 31% of youths were living in single-parent households; all of these households had experienced parental divorce. An additional 12% of youths were currently living with their mother and either a stepfather or a cohabiting male partner. Boys and girls were equally distributed among these residency types.

Procedure

Youths and their mothers completed a laboratory visit. After undergoing informed consent, they completed questionnaire packets including a series of self-report measures described below (along with additional measures not used in the present analyses). Next, adolescents underwent an assessment of vagal tone. After verifying that youths had followed our instructions to refrain from eating, smoking cigarettes, or consuming caffeinated beverages within 2 hours of the assessment, youths were fitted with physiologic equipment (described below) and seated alone on a small couch, where they were instructed to relax for 5 minutes. They then spent 3 minutes rating their liking of landscape photographs to engage their attention in a restful, pleasant task. Finally, the assessment of vagal tone was begun by asking youths to breathe slowly (4 seconds per inhalation, 4 seconds per exhalation) in time with a pre-recorded tape. As respiratory parameters are known to influence RSA, this technique for pacing and controlling respiration frequency is recommended for measuring tonic RSA (Grossman, Stemmler, & Meinhardt, 1990a). By the time the formal assessment of vagal tone was under way, at least 20 minutes had passed since adolescents completed their questionnaire measures, making it highly unlikely that their levels of RSA were directly related to the process of completing the questionnaire. After the assessment of vagal tone was completed, youths' physiologic reactivity was measured during a series of challenging tasks (reported elsewhere). Afterward, youths were unhooked and their mothers were escorted into the experimental room where they received instructions for the discussion task.

First, they were asked to fill out forms which asked them to list frequent areas of disagreement between them, to rate how strongly they disagreed about each topic, and to indicate whether they were willing to discuss the topic while being videotaped (common topics listed included restrictions on the adolescent's social activities, such as curfew times or limitations on the types of events or parties the adolescent could attend, and bodily modifications such as shaving one's legs or dying one's hair). The experimenter reviewed both partners' forms and selected an area of disagreement that was highly rated for both partners, and which both were willing to discuss. The experimenter reviewed the selection with both partners, to make sure they were comfortable with the selected topic. If either partner did not want to discuss the chosen topic, the experimenter selected the next most highly rated topic and went through the same confirmation procedure. After the conflict topic had been selected and confirmed, the videotaped assessment began with the positive event discussion. Adolescents were instructed to speak to their mothers for a few minutes about a recent positive experience, such as a movie they saw together, something that happened at school, etc., regardless of whether their mother already knew about it. They were instructed to describe the experience in detail. Their mothers were instructed to contribute to the conversation in whatever way felt natural (asking questions, making comments, etc.). The conversation lasted 5 minutes. After that period, they were instructed via intercom to switch to the conflict topic, which also lasted 5 minutes. If the conversation died down at any point, participants were prompted via intercom to continue elaborating on the issue at hand. Throughout the entire interaction, the experimenter kept track of the specific video time codes corresponding to one-minute intervals, and wrote these codes onto the dyad's video rating forms.

Immediately after the conclusion of the entire 10-min interaction, the adolescent and his or her mother were escorted to separate rooms. Following standard practice for studies employing the empathic accuracy paradigm (for example Simpson et al., 2003), participants were each given a set of video rating forms and instructed to watch the videotape the entire way through (beginning with the positive event discussion and continuing through to the end of the conflict discussion), stop the tape at the specific intervals indicated on the forms, and rate how they had felt at that particular moment while the interaction had been going on (specifics on the rating scales are provided below, in the Measures section). Immediately after making their affect ratings, the experimenter re-entered the room and informed the participants that they would now be making the same affective judgments with

regard to what they thought the other person had been feeling, at exactly the same moment. The tape was rewound and the same procedure was followed. Hence, after the procedure was completed, we had eight ratings of positive and negative affect from each partner, and eight rated estimates of the other person's positive and negative affect. After the participants completed all measures and procedures (including an at-home diary assessment, reported elsewhere), youths and mothers received $90 and $70, respectively.

Measures

To measure the youths' attachment anxiety and avoidance toward their mothers, we administered a revised version of Miller and Hoicowitz's (2004) Adolescent Attachment Scale (AAS). Youths rated their agreement with a series of self-descriptive statements using a 7-point scale. Sample items assessing attachment anxiety include "I sometimes wonder if my mother really loves me" and "I worry that my mother doesn't care about me as much as I care about her." Sample items assessing avoidance include "It's hard for me to let myself count on my mother," and "I don't feel comfortable opening up to my mother." Youths completed the measure separately in relation to their mother and father; only mother ratings are used in the present study. Reliability was .65 for the 8-item anxiety dimension and .87 for the 7-item avoidance dimension.

The AAS is similar to other questionnaire measures of adolescent attachment style (Berman, Weems, Rodriguez, & Zamora, 2006; Doyle, Lawford, & Markiewicz, 2009; Ducharme, Doyle, & Markiewicz, 2002; Gwadz, Clatts, Leonard, & Goldsamt, 2004; Weems, Berman, Silverman, & Rodriguez, 2002) which have been adapted from either the ECR (Fraley, Waller, & Brennan, 2000b) or the Relationship Style Questionnaire (Bartholomew & Horowitz, 1991). These studies have all detected meaningful, theory-consistent associations between adolescent attachment style and psychosocial functioning, and yet none has been the subject of formal analyses of reliability and validity. To provide more information on whether anxiety and avoidance, as measured by the AAS, was capturing patterns of associations with other aspects of adolescent functioning and mother–adolescent relationship quality that are consistent with the predictions of attachment theory, we calculated correlations with other measures available in the current study. We found, for example, that adolescent attachment anxiety is significantly correlated with perceptions of maternal unpredictability (.44) and maternal psychologic control (.25), assessed with Schludermann and Schludermann's (1983) measure of parenting style. These correlations are consistent with the notion that attachment anxiety stems from inconsistency and non-contingency in caregiver responsiveness, along with caregiver intrusiveness. However, attachment anxiety was not associated with adolescents' ratings of conflict with their parents, nor was it related to ratings of companionship or support, assessed with the Networks of Relationships Inventory (Furman & Buhrmester, 1992). Avoidance was negatively correlated with companionship and support, consistent with the notion that avoidance develops as a result of parental emotional distance and non-involvement, and was also negatively correlated with maternal warmth (−.60). Notably, these findings are highly consistent with the findings of other published research using similarly adapted measures of adolescent attachment style. Doyle and Markiewicz (2005) measured attachment style with a questionnaire adapted from the Relationship Questionnaire designed by Bartholomew and Horowitz (1991), whose items are similar in content to the ECR. Directly paralleling our own results, they found that psychologic control showed a correlation of .20 with adolescent attachment anxiety, but was uncorrelated with attachment avoidance. Avoidance, however, was strongly correlated with low parental warmth, −.54, again directly paralleling our own findings. As for reliability, we have collected 18-month follow-up data on all of our participants, and so we calculated correlations between youths' ratings for anxiety and avoidance across this 18-month interval. The correlations were quite high: .44 for attachment anxiety and .56 for avoidance, which is comparable to the 18-month reliabilities for other individual difference and family environment constructs in the present data set, such as internalizing and externalizing problems (.48 and .66, respectively), parental discipline (.49), parental warmth (.56), and parental psychologic control (.46).

To measure participants' positive and negative affect—and their estimates of their partners' affect—during the re-viewing of their discussion task, they rated (on a 5-point scale) the degree to which they felt angry or irritated, relaxed and content, sad or disappointed, attentive or interested, guilty and ashamed, understood, happy or pleasant, worried or concerned, and close and connected to the other person. The positively valenced items were aggregated to form a single positive affect dimension, and the negatively valenced items were

aggregated to form a negative affect dimension (we adopted this approach, instead of examining each affective state separately, based on the extremely high reliabilities of the positive and negative affect measures, and also for consistency and comparability with previous research on empathic accuracy, Ickes and Simpson, 2004a, 2004b; Simpson et al., 1999, 2001, 2003). Hence, each person's emotional state during the entire interaction is represented by a total of eight positive affect ratings (four during the positive event discussion and four during the conflict discussion) and eight negative affect ratings (four during the positive event discussion and four during the conflict discussion). To assess reliability, Cronbach's alphas were computed separately for each of the eight time points, and averaged. The average Cronbach's alphas for youth's self-reported positive affect was .86 (range from .70 to 1.0), and for negative affect it was .90 (range from .68 to 1.0). For the mother, Cronbach's alphas were .94 for positive affect (range from .80 to 1.0) and .92 for negative affect (range from .84 to 1.0). Cronbach's alphas for youths' estimates of their mother's affect were .98 for positive affect (range from .96 to 1.0) and .98 for negative affect (range from .95 to .99). For mothers' estimates of youths' affect, Cronbach's alphas were .94 for positive affect (range from .80 to .97) and .96 for negative affect (range from .89 to 1.0).

To assess resting levels of RSA (the index of vagal tone), continuous recordings of ECG and respiration were amplified and filtered through a James Long Company (Caroga Lake, NY) 4-channel bioamplifier, model LMD-04, with the ECG channel high-pass filter set to .1 Hz and a low-pass filter set to 1000 Hz. ECG was recorded with disposable electrodes placed on the participant's chest in a triangular configuration. Respiration depth and frequency were measured using a latex rubber pneumatic bellows girth sensor fitted around the participant's chest. All physiologic signals were fed into an A-D interface box and stored on an IBM-compatible computer. The sampling rate was 1000 Hz for all channels. Data analysis was implemented using the James Long Company PHY General Physiology Analysis System software, which permits visual inspection and manual editing of artifacts. Approximately 1% of data were edited for artifacts using interpolation of adjacent points. RSA was assessed on the basis of the ECG and respiration data. Interbeat intervals (IBIs) were calculated as the time in milliseconds between successive R waves in the electrocardiogram, and the "peak-to-valley" method (Grossman & Svebak, 1987) was used to derive RSA on the basis of these IBIs. This method computes the difference (in milliseconds) in the heart period between inspiration onset and expiration onset. For any particular episode of time, the sum of these "peak-to-valley" measurements divided by the total number of breaths is calculated as an estimate of RSA for that episode. Peak-to-valley methods are widely used and show high correlations with other methods of assessing RSA (Grossman, van Beek, & Wientjes, 1990b). Following standard practice, RSA values were logged before analysis to normalize their distribution.

RESULTS

Model Definition

We used the multivariate module of HLM (i.e., hierarchical linear modeling), known as HMLM (Raudenbush and Bryk, 2002), to simultaneously estimate multilevel random coefficient models for the mother and adolescent within each dyad, controlling for within-dyad dependency. This technique is designed for data structures in which observations at one level of analysis (in this case, ratings of affect on moments 1 through 8) are nested within higher levels of analysis (individuals, which are then nested within dyads). We used a parallel process model (Raudenbush, Brennan, & Barnett, 1995). This model begins with a Level 1 equation that predicts the outcome variable (estimate of partner's affect) from two dummy codes, one for the Mother and one for the Adolescent, and excludes the intercept:

$$\begin{aligned} &\textit{Estimate of Partner's Affect}_{\textit{moment } i,\textit{dyad } j} \\ &\quad = \pi_{1ij}(\textit{Mother}) + \pi_{2ij}(\textit{Adolescent}) + e_{ij} \end{aligned}$$

The resulting coefficients for the dummy codes, π_{1ij} and π_{2ij}, represent the population true scores for Estimated Partner's Affect for each member of dyad j for moment i in the videotaped discussion, which become the dependent variables (DVs) for subsequent levels of analysis. (Although this example uses the general term "affect," models were calculated separately for positive affect and negative affect.) We centered the DV—individuals' estimates of their partners' affect—around their partner's within-person mean of self-reported affect. Hence, "levels" on the DV do not represent absolute levels of the estimated affect (for example, "3" on the 5-point scale) but instead, *deviation* of the estimated affect from the partner's average self-reported affect during the discussion. This model uses an unre-

stricted level 1 variance structure, which allows for a unique error variance for the adolescents and their mothers and a covariance between them.

Level 2 of the model represents within-person associations across the eight rated moments in the interaction: Regression equations are calculated for each separate individual, predicting the DV (the individual's estimate of the partner's affect at moment *i*) from the individual's own self-reported affect at moment *i* (centered around the individual's own within-person mean), the partner's self-reported affect at moment *i* (centered around his or her within-person mean), and whether the discussion topic at that moment was "positive event" (coded −.5) or "conflict" (coded .5). Hence, the Level 2 model contains the following two equations.

$$\pi_1 \textit{Adolescent's Estimate of Mother's Affect}_{\textit{moment i,dyad j}} = \beta_{10ij} + \beta_{11}\textit{Discussion Topic}_{ij} + \beta_{12}\textit{Mother's Self-Reported Affect}_{ij} + \beta_{13}\textit{Adolescent's Self-Reported Affect}_{ij} + r1_{ij}$$

$$\pi_2 \textit{Mother's Estimate of Adolescent's Affect}_{\textit{moment i,dyad j}} = \beta_{20ij} + \beta_{21}\textit{Discussion Topic}_{ij} + \beta_{22}\textit{Adolescent's Self-Reported Affect}_{ij} + \beta_{23}\textit{Mother's Self-Reported Affect}_{ij} + r1_{ij}$$

The β_{10} and β_{20} coefficients are the intercepts of the model. The β_{12} and β_{22} coefficients represent the "empathic sensitivity" effects (i.e., slopes representing the degree of association between the individual's estimate of the partner's affect and the partner's corresponding self-reported affect). Although these slopes represent moment-by-moment associations (as opposed to associations between aggregated ratings of affect across the entire discussion), the Level 2 equation does not preserve information about the specific sequence of ratings (as would be found in a growth model). The β_{13} and β_{23} coefficients represent "perceived concordance" (i.e., slopes representing the degree of association between the individual's estimate of the partner's affect and the individual's own corresponding affect). Level 3 tests for moderation of the Level 2 slopes by between-person characteristics (specifically, adolescent attachment anxiety, avoidance, and vagal tone, all of which were centered at the sample mean). So, for example, the test for a moderating effect of adolescent attachment avoidance on coefficient β_{12} tests whether adolescents with high levels of avoidance show less empathic sensitivity to their mothers' affective states (i.e., showing a weaker association between their estimate of the mother's affect and the mother's own self-reported affect). As noted earlier, we also tested for moderating effects of gender (coded −.5 for boys and .5 for girls), as well as interactions between anxiety and avoidance. Nonsignificant effects were not retained in final models.

We used the multiple imputation procedures available in SPSS 17 to impute missing data (approximately 4% of data were missing, and analyses revealed no systematic differences between respondents with and without missing data on any demographic or study variables). For continuous variables, these techniques are identical to those described and validated by Schafer and Graham (Graham & Hofer, 2000; Schafer, 2001; Schafer & Graham, 2002). Following standard procedures, we created multiple imputed data sets (five in all) to approximate the type of measurement error that is represented in real, but not imputed data. We then conducted all of our analyses with each set, and the final coefficients we present are averages of the coefficients that were generated by each of the five runs. This technique has been shown to perform well when data are missing at random and even acceptably under some cases of nonrandom missingness (Schafer & Graham, 2002). As an additional check, we repeated our analyses after eliminating any cases with missing data, and found that the magnitude, direction, and significance of our effects were nearly identical.

Before proceeding with our planned analyses, we examined the correlations between participants' affective ratings across the two discussion types to determine whether it was reasonable to analyze both positive and negative event discussion in a single model. We found high correlations between both mothers' and adolescents' affect ratings across the two discussion types: $r_{\text{youths' positive and negative affect}} = .68$ and .45; $r_{\text{youths' estimates of mothers' positive and negative affect}} = .74$ and .50; $r_{\text{mothers' estimates of youths' positive and negative affect}} = .53$ and .51; and $r_{\text{mothers' self-reported positive and negative affect}} = .59$ and .42. We then tested whether any of our hypothesized effects significantly interacted with discussion type. We did this by entering two separate cross-product terms into the Level 2 equation: Discussion Topic x Partner A's affect and Discussion Topic x Partner B's affect. Both terms were non-significant. We then tested whether either of these interaction terms was moderated by the Level 3 variables (attachment style, gender, and vagal tone) to test whether any of our hypothesized effects varied as a function of discussion type. Again, all of these tests were nonsignificant. Based on these results,

all of the analyses below represent the entire mother–adolescent discussion, while controlling for Discussion Topic in the Level 2 equation.

Empathic Sensitivity

Means and SDs for all variables appear in Table 1, along with correlations among variables. Full model statistics for the multilevel models appear in Table 2. In the following section, effect sizes are indicated in parentheses after model coefficients. We utilized the Psuedo-R^2 method recommended by Raudenbush and Bryk (2002), which represents effect size as the proportion of reduction in residual slope or intercept variance attributable to the effect of interest. As all goodness-of-fit statistics for HLM models are not exact fit statistics, and there is no agreed upon measure of goodness-of-fit, such metrics should be interpreted with caution. For all figures, high and low attachment style and vagal tone groups are defined as 1SD above and below the sample mean (the percentages of participants in these high and low groups were, respectively, 18% and 20% for anxiety, 21% and 16% for avoidance, and 5% and 10% for vagal tone).

Our first hypothesis was that higher adolescent attachment anxiety or avoidance and lower adolescent vagal tone would be associated with *lower empathic sensitivity* (i.e., weaker association between the adolescent's estimate of the mother's affect and the mother's own self-reported affect). As predicted, adolescents with higher levels of attachment avoidance showed less empathic sensitivity for their mother's positive affect, $\beta = -.07$ (.18), although not for their mother's negative affect. The effect for positive affect is displayed in Figure 1, which presents slopes representing the degree of change in the adolescent's estimate of the mother's affect associated with change in the mother's own self-reported affect, stratified by the adolescent's attachment avoidance. Low and high levels of the mother's affect are represented as 1SD below and above her mean affect. Also, note that for all graphs, the DV (estimate of the partner's affect) is centered around the partners' mean affect. This method of coding allows the figures to provide additional, descriptive information: Specifically, the levels of the DV depict the degree to which the individual's estimate of their partner's affect is higher or lower than the partner's own average self-reported affect. Hence, this allows us to easily see the conditions under which the individual's estimate of the partner's affect is close to the partner's overall mean affect (DV = 0), higher than the partner's overall mean affect (DV > 0), or lower than the partner's overall mean affect (DV < 0).

TABLE 1
Correlations Among Study Variables

	1.	*2.*	*3.*	*4.*	*5.*	*6.*	*7.*	*8.*	*9.*	*10.*
1. Adolescent's attachment anxiety (M = 2.9, SD = 1.0)										
2. Adolescent's attachment avoidance (M = 3.3, SD = 1.3)	.02									
3. Adolescent's vagal tone (M = 5.3, SD = .5)	−.04	.17								
4. Adolescent's mean positive affect (M = 3.4, SD = .9)	.17	−.52***	−.14							
5. Adolescent's mean negative affect (M = 1.6, SD = .5)	.02	.33**	.11	−.49***						
6. Mother's mean positive affect (M = 3.6, SD = .7)	.07	−.16	−.21	.30**	−.40***					
7. Mother's mean negative affect (M = 1.5, SD = .5)	.11	.27**	.15	−.29**	.53***	−.40***				
8. Adolescent's mean estimate of mother's positive affect (M = 3.5, SD = .9)	.11	−.45***	−.19	.87***	−.33***	.31**	−.26**			
9. Adolescent's mean estimate of mother's negative affect (M = 1.6, SD = .6)	.11	.30**	.20	−.34***	.76***	−.35***	.46***	−.37***		
10. Mother's mean estimate of adolescent's positive affect (M = 3.4, SD = .7)	.02	−.22*	−.23*	.35**	−.36***	.83***	−.33***	.39***	−.28**	
11. Mother's mean estimate of adolescent's negative affect (M = 1.5, SD = .5)	.12	.25*	.11	.26**	.38***	−.38***	.76***	−.27**	.28**	−.44***

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

TABLE 2
Results of Multilevel Random Coefficient Models of Mothers' and Adolescents' Estimates of One Another's Positive and Negative Affect During Discussions of Positive and Negative Events

Dependent Variable	*Independent Variables*	*β*	*SE*	*95% CI*
Adolescent's estimation of mother's positive affect				
	Intercept	−.18*	.09	(−.35, −.01)
Empathic sensitivity	Mother's positive affect at moment *i*	.06	.03	(−.01, .13)
	Moderators: Adolescent's attachment avoidance	−.07**	.02	(−.11, −.04)
Perceived concordance	Adolescent's positive affect at moment *i*	.28***	.05	(.20, .37)
	Moderators: Adolescent's attachment anxiety	.10*	.04	(.02, .18)
	Discussion topic	−.32***	.06	(−.43, −.21)
Adolescent's estimation of mother's negative affect				
	Intercept	.19**	.05	(.08, .29)
Empathic sensitivity	Mother's negative affect at moment *i*	.07	.05	(−.02, .17)
	Moderators: Adolescent's attachment anxiety	−.09*	.04	(−.17, −.01)
	Adolescent's vagal tone	.05	.07	(−.08, .18)
	Attachment anxiety × vagal tone	−.18**	.06	(−.29, −.07)
Perceived concordance	Adolescent's negative affect at moment *i*	.30***	.03	(.24, .37)
	Moderators: Adolescent's attachment anxiety	.07*	.03	(.01, .12)
	Adolescent's vagal tone	−.18**	.04	(−.26, −.10)
	Discussion topic	.36***	.06	(.25, .48)
Mother's estimation of adolescent's positive affect				
	Intercept	−.04	.09	(−.2, .13)
Empathic sensitivity	Adolescent's positive affect at moment *i*	.09*	.04	(.02, .16)
Perceived concordance	Mother's positive affect at moment *i*	.38***	.04	(.30, .45)
	Moderators: Adolescent gender	−.19*	.07	(−.33, −.04)
	Adolescent's attachment anxiety	−.10**	.03	(−.16, −.04)
	Discussion topic	−.47**	.07	(−.60, −.34)
Mother's estimation of adolescent's negative affect				
	Intercept	−.05	.06	(−.16, .05)
Empathic sensitivity	Adolescent's negative affect at moment *i*	.07*	.04	(.01, .14)
Perceived concordance	Mother's negative affect at moment *i*	.35***	.04	(.27, .43)
	Moderators: Adolescent's attachment anxiety	−.13**	.03	(−.20, −.07)
	Discussion topic	.33***	.06	(.23, .44)

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

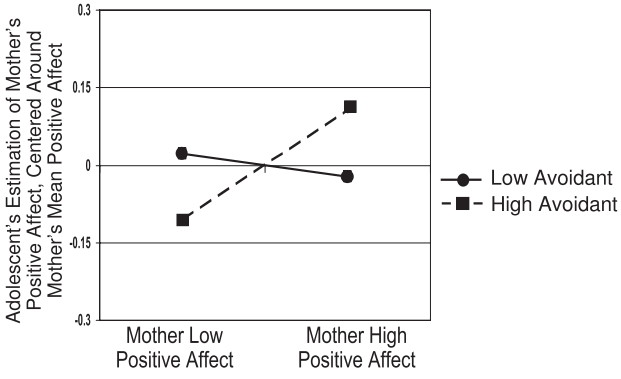

FIGURE 1 Slopes representing the association between adolescent's estimate of mother's positive affect and mother's own self-reported affect, stratified by adolescent's attachment avoidance.

For attachment anxiety, we found a significant effect for negative affect, but not positive affect. Specifically, adolescents with higher levels of attachment anxiety showed less empathic sensitivity for their mother's negative affect, β = −.09 (.18), and anxiety also interacted with vagal tone to predict youths' empathic sensitivity to their mother's negative affect, β = −.18 (.26). As vagal tone was centered, the lower-order coefficient for anxiety represents the significant anxiety effect for youths with average levels of vagal tone.

The interaction between anxiety and vagal tone is graphically depicted in Figure 2, which presents slopes representing the degree of change in adolescents' estimates of their mothers' negative affect associated with a change in the mother's own self-reported negative affect, stratified by the adolescent's attachment anxiety and vagal tone. Low and high levels of the mother's affect are represented as 1SD below and above her mean affect. Again, the DV is centered around the mother's average affect during the discussion, so that the levels of the DV represent deviations of the adolescent's estimate from that average. As shown in the figure, the highest levels of empathic sensitivity were found

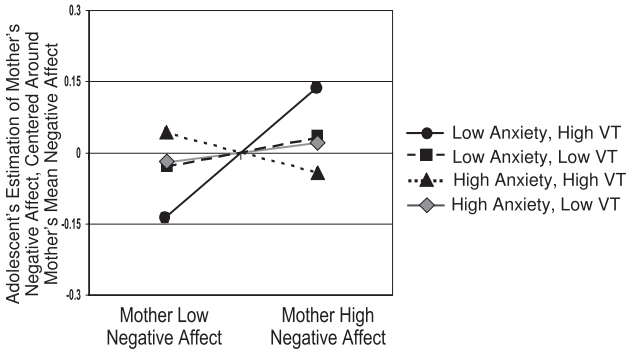

FIGURE 2 Slopes representing the association between adolescent's estimate of mother's negative affect and mother's own self-reported negative affect, stratified by adolescent's attachment anxiety and vagal tone.

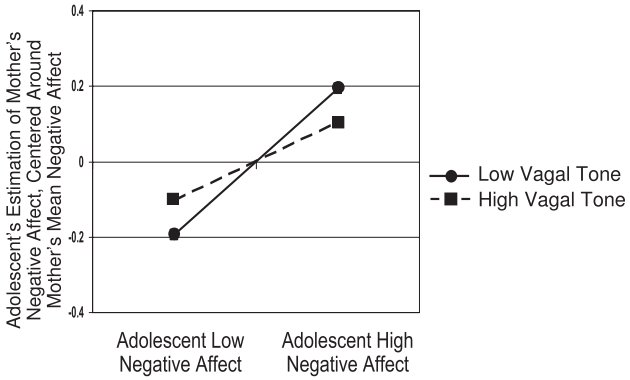

FIGURE 3 Slopes representing the association between adolescent's estimate of mother's negative affect and the adolescent's own self-reported negative affect, stratified by adolescent's vagal tone.

among youths with low attachment anxiety and high vagal tone, whereas the lowest levels of empathic sensitivity were found among youths with high attachment anxiety and high vagal tone. The fact that youths with a combination of high attachment anxiety and high vagal tone showed the lowest empathic sensitivity suggests that high vagal tone might only facilitate empathic sensitivity among youths with low attachment anxiety. Follow-up simple slope tests confirmed this interpretation: Vagal tone was significantly positively associated with empathic sensitivity among youths with *low* attachment anxiety, $\beta = .28$, $p < .05$, but among youths with *high* attachment anxiety it was actually slightly negatively associated with empathic sensitivity, $\beta = -.08$, $p < .05$. There were no effects involving gender and no interactions between anxiety and avoidance. Among mothers, contrary to Hypothesis 3, there was no association between mothers' empathic sensitivity and adolescent's attachment style.

Perceived Concordance

Our second hypothesis was that adolescents with higher attachment anxiety or lower vagal tone would show *greater* perceived concordance with their mother's affect. Confirming this prediction, adolescents with higher attachment anxiety showed stronger perceived concordance with their mother's positive affect, $\beta = .10$ (.09), and negative affect, $\beta = .09$ (.14). For negative affect, we also found the predicted effect of vagal tone, $\beta = -.18$ (.30), such that youths with higher vagal tone perceived less concordance with their mother's negative affect. This effect is presented in Figure 3, which presents slopes representing the degree of change in adolescents' estimates of their mothers' negative affect associated with change in the adolescent's own corresponding negative affect, stratified by vagal tone. Low and high levels of the adolescent's own affect are represented as 1SD below and above his or her mean affect. Again, the DV is centered around the mother's average affect during the discussion, so that the levels of the DV represent deviations of the adolescent's estimate from that average. Among mothers, consistent with Hypothesis 3, we found that mothers who perceived greater concordance between their own and their adolescent's affect had adolescents with lower levels of attachment anxiety, $\beta = -.09$ $(.19)_{\text{positive}}$, $\beta = -.13$ $(.38)_{\text{negative}}$. This effect is presented in Figure 4, which displays slopes representing the degree of change in mothers' estimates of their adolescents' negative affect associated with change in the mother's own self-reported affect, stratified by the adolescent's attachment anxiety.

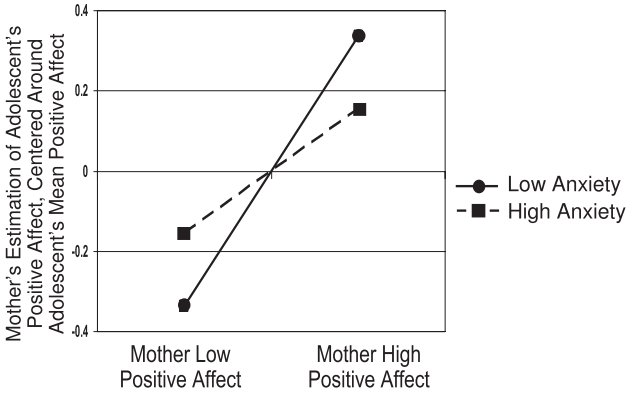

FIGURE 4 Slopes representing the association between mother's estimate of adolescent's positive affect and mother's own self-reported positive affect, stratified by adolescent's attachment anxiety.

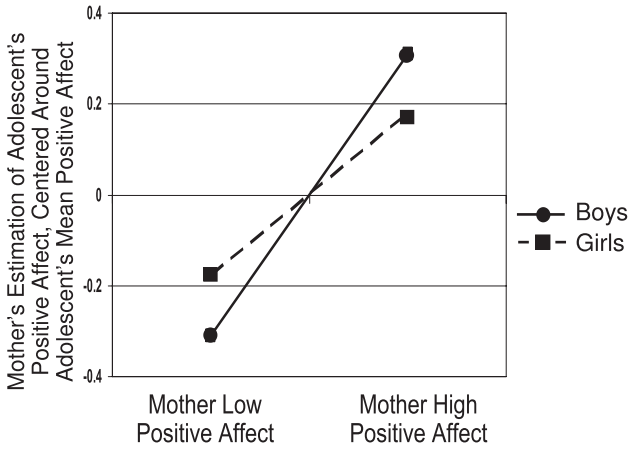

FIGURE 5 Slopes representing the association between mother's estimate of adolescent's positive affect and mother's own self-reported positive affect, stratified by adolescent's gender.

Low and high levels of the mother's affect are represented as 1SD below and above her mean affect. The DV is centered around the adolescent's average affect during the discussion, so that the levels of the DV represent deviations of the mother's estimate from that average. There was also an effect of child's gender for positive affect: Mothers perceived less concordance with the adolescent's positive affect if they had daughters, $\beta = -.18$ (.2). This effect is presented in Figure 5, which displays slopes representing the degree of change in mothers' estimates of their adolescents' negative affect associated with change in the mother's own self-reported affect, stratified by the adolescent's gender. Low and high levels of the mother's affect are represented as 1SD below and above her mean affect. Again, the DV is centered around the adolescent's average affect during the discussion, so that the levels of the DV represent deviations of the mother's estimate from that average. As with the analyses of empathic sensitivity, there was no significant interaction between adolescent anxiety and avoidance.

DISCUSSION

The ability to accurately perceive and respond to another person's affective state is a key social-developmental task that becomes increasingly important during adolescence. Secure attachment should facilitate empathy by providing individuals with foundational capacities to attend to social partners' affective states and interpret their affective cues. Accordingly, individuals with high attachment anxiety or avoidance should show deficits in these abilities, as should individuals with poor physiologic capacities for affect regulation (indexed by low vagal tone). The present study confirmed these predictions in mother–adolescent dyads who rated their own and one another's positive and negative affect immediately after a naturalistic interaction. We examined two dimensions of empathic responsiveness: Empathic sensitivity (representing the degree of association between the individual's estimate of the other person's affect and the other person's own self-reported affect), and perceived concordance (representing the degree of association between the individual's estimate of the other person's affect and the individual's *own* affect). Both dimensions were associated with the adolescent's attachment style and vagal tone, indicating that adolescents with high attachment insecurity or low vagal tone may possess compromised capacities for empathy, which may have implications for socioemotional functioning.

Attachment Anxiety and Avoidance

We expected that high-avoidant adolescents would show lower empathic sensitivity because of their disattention to affective cues (Becker-Stoll et al., 2001; Joireman et al., 2002; Mikulincer et al., 2003; Westmaas & Silver, 2001), whereas high-anxious adolescents' hypervigilance to their own affect state would lead them to "project" their state onto their mothers, impeding sensitivity to the mother's independent affective cues (consistent with previous research on attachment anxiety, projective identification, and self-other differentiation, Berant & Wald, 2009) Our results support this conceptualization. Specifically, avoidant adolescents showed less empathic sensitivity for mothers' positive affect (but not her negative affect), whereas anxious adolescents showed less empathic sensitivity for mothers' negative affect (but not positive affect). The difference between the patterns for positive versus negative affect is actually quite consistent with our expectation that anxiety and avoidance would influence empathic sensitivity through different mechanisms. Specifically, if high-anxious adolescents show poor empathic capacities because they have difficulty regulating—and tend to become preoccupied with and to project—their *own* distress, then their deficits in empathic capacities should be particularly pronounced for negative rather than positive affect, which is exactly what we found. The findings for perceived concordance are particularly interesting, given that previous research on attachment

anxiety has tended to emphasize anxious individuals' hypervigilance to *other* individuals' negative affect (reviewed in Shaver & Mikulincer, 2002). Our findings indicate the importance of investigating the degree to which anxious individuals' perceptions of other individuals' affective states is based on their *own* affective state, and has specific relevance for understanding the tendency of anxious individuals to seek to "merge" with the attachment figure as a means of coping with insecurity (Bartholomew & Horowitz, 1991).

Attachment avoidance, in contrast, appears to impair empathic sensitivity through lack of attention to affective cues. The fact that we only found this effect for positive affect was unexpected, given that prior research suggests that avoidant individuals are particularly motivated to distance themselves from negative affective cues (Becker-Stoll et al., 2001; Fraley, Garner, & Shaver, 2000a; Mikulincer et al., 2003), and suggests the importance of conducting future research on the implications of avoidance for both positive and negative affect (see also Mikulincer & Sheffi, 2000).

Vagal Tone

We had expected that youths with lower vagal tone would show lower empathic sensitivity and higher perceived concordance than youths with higher vagal tone. Consistent with this prediction, adolescents with low vagal tone showed significantly greater perceived concordance for their mother's negative affect than adolescents with high vagal tone, mirroring the pattern we observed among high-anxious individuals. However, in the case of empathic sensitivity, we detected an unexpected interaction between vagal tone and attachment anxiety, such that the highest levels of empathic sensitivity were found among youths with low attachment anxiety *and* high vagal tone (as shown in Figure 2). Furthermore, we found that high vagal tone only facilitates empathic sensitivity among youths with low attachment anxiety. This finding raises intriguing questions about the coordinated functioning and development of the emotion regulation capacities indexed by attachment anxiety versus vagal tone. One possibility is that among highly anxious youths who find their mother's negative affect threatening, high vagal tone might help them to regulate their attention in the service of avoiding distressing cues and managing their own arousal. This is consistent with the work of Ickes and Simpson (2004a) on *motivated inaccuracy*, in which individuals display low empathic sensitivity for a partner's negative affect to protect themselves from potential feelings of rejection. Such processes have notable clinical implications: Although much clinical work with distressed families seeks to facilitate family members' understanding of one another's feelings and perspectives, the present work suggests that youths with compromised capacities for regulating their own negative affect may find it difficult to be aware, sensitive, and responsive to other family members' distress without overly activating their own. A key topic for future research is to identify the specific conditions and contexts under which "motivated inaccuracy" appears to take place (for example, during interactions with depressed or hostile parents), and its implications for both adolescent and family functioning.

Mother's Empathic Responsiveness

We had predicted that mothers with greater empathic responsiveness would have adolescents with lower levels of anxiety and avoidance, but this was not the case. This prediction was based on theory and research suggesting that inconsistent and unresponsive caregiving (which is likely to be associated with low empathic responsiveness) plays a role in the initial development of attachment insecurity. However, of course mothers' empathic capacities might undergo considerable change over time, such that mothers' empathic responsiveness to their adolescent children may not accurately represent the levels of maternal empathic responsiveness they showed during their children's early development. Longitudinal data on changes in maternal empathy over time, and their relation to changes in children's attachment security, are necessary to discern the relationship between these two phenomena. Another possibility is that during the adolescent years, *perceptions* of the mother's empathic responsiveness may be more strongly related to adolescent attachment security than the mother's *actual* empathic responsiveness. For example, one recent study found that anxious adolescents recollected a laboroatory-based interaction with their mothers as significantly more negative than was reported by objective raters (Dykas, Woodhouse, Ehrlich, & Cassidy, 2010). Investigating the development and maintenance of such potential perceptual gaps, and their role in parent–adolescent interpersonal functioning, is a promising direction for future research.

With respect to perceived concordance, we expected that adolescents with high anxiety or

avoidance would have mothers who perceived less concordance between their own affect and their child's affect. This was confirmed with respect to anxiety. The fact that adolescent anxiety was associated with lower perceived concordance on the part of the mother, but higher perceived concordance on the part of the adolescent, confirms our expectation that perceived concordance has different dynamics and implications for each "side" of the mother–adolescent dyad. Specifically, we expected that perceived concordance on the part of adolescents probably reflects an empathy-hindering focus on one's *own* affective experience, and a tendency to project the adolescent's own state onto the mother, whereas perceived concordance on the part of mothers might reflect empathy-promoting attempts to adopt the perspective of the adolescent. Although our correlational data are incapable of identifying causal direction—whether perceptions of the partner's affect influence or are influenced by one's own affective state—the difference between our findings for mothers' vs. adolescents' perceived concordance support this general framework. We also unexpectedly found that mothers of sons showed greater perceived concordance (for positive affect) than mothers of daughters. One possible explanation is that mothers might make greater efforts to perceive their daughters as differentiated and independent from them to counteract tendencies toward assumed similarity that might easily arise from their shared gender (Choderow, 1978) and to facilitate autonomy and differentiation (Steinberg, 1990b). The degree that these are conscious versus non-conscious processes, and their potential implications for the affective quality of mother–child interactions from adolescence to emerging adulthood, is a fascinating question for future research that has important clinical implications. In particular, understanding the range of interpersonal processes through which mothers *and* adolescents may seek to amplify or attenutate a sense of emotional "connectedness" may inform our understanding of mother–child dyads that struggle with issues of differentiation and autonomy during the adolescent years.

Limitations and Future Directions

One limitation of this study is that we assessed affect immediately after the interaction (rather than during the interaction) to preserve its naturalistic nature. This, of course, introduces potential memory distortion, even though the interval between the interaction and the rating was short. Another limitation is that we do not have objective observational ratings of each partner's degree of affective expression; future research would profit by investigating developmental changes in adolescents' capacities to identify affective and expressive cues more generally, and not simply with respect to a highly specific relationship. It is also important for future research to examine a more diverse range of interpersonal interactions. Although the present study used both a positive and negative event discussion, we found high correlations between participants' ratings of affect across the two discussions, and discussion type did not interact with any of the effects we tested. This may be largely attributable to the fact that the negative event discussion does not appear to have been experienced as extremely negative (ratings of participants' negative affect were extremely low across both discussions). Also, participants made their affect ratings for both discussions after the conflict discussion; hence, the conflict interaction may have subtly influenced the ratings given for both episodes, facilitating similarity between them. Hence, future research would profit by assessing empathic responsiveness across a broader range of interpersonal interactions involving more extreme positive and negative affective states. In addition, future research should investigate whether empathic sensitivity for highly specific affective states (such as anger versus sadness) shows different developmental trajectories, and is moderated by different individual difference dimensions.

Another limitation is that our questionnaire measure of adolescent attachment style (Miller & Hoicowitz, 2004) has not been the subject of formal reliability and validity analyses (nor, we should note, have any of the other questionnaire measures of adolescent attachment style widely used in current research, which represent adapted versions of the Experiences in Close Relationships Inventory (Fraley et al., 2000b) or Bartholomew and Horowitz's (1991) Relationship Questionnaire). Hence, future research on attachment and empathy would also benefit from the availability of adolescent-specific measures whose psychometric properties have been rigorously tested. To rule out the possibility that our attachment style effects were actually attributable to broader trait-like characteristics of our participants, such as tendencies to experience heightened negative affect or aggression, we conducted a number of ancillary analyses in which we controlled for adolescents' internalizing problems, externalizing problems, and the overall perceived quality of their relationship with their mother: None of the attachment effects were changed.

Sample homogeneity must also be taken into consideration. Replicating these findings with a more ethnically diverse sample, particularly including mother–adolescent dyads characterized by greater strife, is an important direction for future research. For example, observing dyads with greater interpersonal difficulties would allow us to examine how adolescents' attachment style and empathic responsiveness influence relationship repair. Previous research has found that individuals who are able to cognitively reframe social interactions, take the perspective of their partner, and modify rigid expectations of the partner's behavior, are better able to re-establish their relationships after conflict (Flanigan, 1998). Hence, one promising direction for future research is to examine whether mother–adolescent dyads with particularly frequent conflict or intense hostility appear to benefit from empathic sensitivity, perceived concordance between their affective states, and positive perceptual biases as their relationship weathers the increasingly complex challenges of late adolescence and young adulthood.

Finally, future research should investigate links between empathic responsiveness and a broader range of individual differences in autonomic functioning. Although our study focused on vagal tone, an increasing number of studies have examined children's and adults' individual differences in stress-induced changes in RSA (Beauchaine, 2001; Beauchaine et al., 2007; El-Sheikh & Whitson, 2006; Porges, 2001; Thayer & Lane, 2000). As noted earlier, there is currently no specific empirical or theoretic basis for expecting these individual differences to relate specifically to empathy; however, given how little research has examined such individual differences in adolescents, this is an important area for future study. In addition, future research should address individual differences in *combined* patterns of sympathetic and parasympathetic nervous system functioning, both at rest and during stress (El-Sheikh et al., 2009; Ottaviani, Shapiro, Davydov, & Goldstein, 2008; Salomon, Matthews, & Allen, 2000). The potential implications of these individual differences for adolescent *empathy* remain an underinvestigated topic that deserves more substantive theoretic and empirical attention.

CONCLUSION

Research on children has found that both attachment style and vagal tone are associated with multiple domains of socioemotional functioning that underlie the development of empathy; however, these associations have been underinvestigated among adolescents. The present research makes an important contribution to this body of research by demonstrating that both attachment style and vagal tone are associated with adolescents' perceptions and interpretations of their mothers' affective states during emotion-relevant interactions. Given the dearth of dyadic research on adolescent empathy as well as the dearth of research on the interpersonal implications of adolescents' vagal tone, the findings have important implications for understanding the psychobiological foundations of empathy during adolescence.

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