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Lisa M. Diamond and Christopher P. Fagundes

University of Utah, USA

ABSTRACT

Over the past decade, psychobiological research on adult attachment has increased dramatically. We review recent findings regarding associations between attachment style and patterns of reactivity in the hypothalamic–pituitary–adrenocortical axis and the autonomic nervous system. The overall pattern of results suggests that both anxiety and avoidance are associated with heightened hypothalamic–pituitary–adrenocortical and autonomic nervous system reactivity to stress, consistent with the notion that attachment insecurity is associated with deficits in emotion regulation. The finding of heightened physiological reactivity among avoidant individuals is particularly notable, given that avoidant individuals typically report dampened levels of subjective distress. Key directions for future study include greater investigation into *profiles* of physiological functioning across multiple systems and contexts and greater consideration of the relative importance of childhood versus adult patterns of attachment insecurity for adult physiological functioning.

KEY WORDS: attachment style • autonomic nervous system • emotion regulation • HPA axis • psychophysiology

One of the most important and provocative new directions taken by adult attachment researchers in recent years has been the devotion of increased attention to the biological underpinnings and correlates of attachment processes. A decade ago, the vast majority of psychobiologically oriented research on attachment had been conducted on infants and children, and few researchers (with some notable exceptions, such as Carpenter & Kirkpatrick,

All correspondence concerning this article should be addressed to Lisa M. Diamond, Department of Psychology, University of Utah, 380 South 1530 East, Room 502, Salt Lake City, UT 84112, USA [e-mail: lisa.diamond@psych.utah.edu].

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1996; Feeney & Kirkpatrick, 1996) had investigated links between *adult* attachment phenomena and physiological functioning (Diamond, 2001). Fortunately, this is no longer the case. In the present article we review findings from the emerging body of research on associations between attachment style and patterns of stress reactivity in two key stress-regulatory systems: the hypothalamic–pituitary–adrenocortical (HPA) axis and the autonomic nervous system (ANS). We also discuss two important directions for future study: (1) further investigation of *profiles* of physiological functioning across multiple systems and contexts, and (2) consideration of the relative importance of childhood versus adult patterns of attachment insecurity for adult HPA and ANS functioning.

Attachment style and the psychobiology of emotion regulation

Bowlby originally conceptualized the attachment system as a fundamentally psychobiological system undergirding individuals' basic capacities to respond adaptively to danger and threat (Bowlby, 1973). In line with this framework, individual differences in both infant and adult attachment style have been increasingly interpreted as indexing different capacities and strategies for emotion regulation (reviewed in Shaver & Mikulincer, 2007). Briefly, infants who did not receive adequate “external” help with emotion regulation from their caregivers are thought to sustain developmental deficits in their own self-regulatory capacities. Consequently, they come to rely on alternative, “secondary” or “conditional” (Main, 1990) – and sub-optimal – emotion regulation strategies. Specifically, individuals with high attachment *anxiety* tend to maximize experiences of negative affect and be hypervigilant to threat cues, whereas those who score high on *avoidant* attachment tend to minimize experiences of negative affect and direct attention away from threat cues.

Numerous recent studies have investigated whether these patterns are associated with distinct patterns of activity within physiological systems known to be involved in stress and emotion regulation, most commonly the HPA axis of the endocrine system, typically assessed via salivary cortisol, and the sympathetic and parasympathetic branches of the ANS, typically assessed via heart rate, blood pressure, respiratory sinus arrhythmia, and electrodermal activity. (For additional conceptual and methodological details related to these systems and their relevance to attachment processes, see Diamond & Hicks, 2004.)

Before launching into specific research findings, we want to highlight two key factors that differentiate kinds of studies. First, some studies focus on adult attachment styles in the context of romantic or marital relationships, whereas others focus on patterns of childhood attachment to caregivers (assessed retrospectively). Second, some studies examine patterns of physiological reactivity to *generalized* stress, such as performance of challenging laboratory tasks, whereas others focus on reactivity to attachment-specific

stressors, such as conflict with a current romantic partner. The significance of these methodological variations is not yet clear, but they warrant close attention when one is interpreting findings across studies and identifying directions for future research.

The overall pattern of results across studies provides strong evidence that individual differences in attachment anxiety and avoidance are characterized by heightened HPA and ANS reactivity to stress, consistent with the notion that attachment insecurity is associated with deficits in emotion regulation (see also Allen & Miga, 2010). For example, anxiously attached individuals have exhibited heightened HPA activation in response to a generalized laboratory stressor (Quirin, Pruessner, & Kuhl, 2008) as well as to a laboratory-based romantic conflict (Powers, Pietromonaco, Gunlicks, & Sayer, 2006). In the latter study, anxious men not only showed more rapid increases in cortisol in response to the conflict task; they also took longer to return to baseline following the conflict (Powers et al., 2006). Another study examined changes in day-to-day HPA activity prompted by a 4- to 7-day physical separation from a romantic partner (such as during a business trip) and found heightened HPA activity only among anxious individuals (Diamond, Hicks, & Otter-Henderson, 2008). Roisman (2007) found that adults who displayed hyperactivating strategies when talking about childhood attachments had elevated heart rates when trying to resolve a conflict with their romantic partners. Collectively, these findings suggest that anxious individuals' hypervigilance to threat cues and heightened negative affectivity are manifested in exaggerated patterns of stress-induced HPA and ANS activity.

Yet interestingly, similar patterns of heightened HPA and ANS reactivity have also been consistently observed among *avoidant* individuals, directly contrary to their tendency to report lower levels of subjective distress. Avoidant individuals have been found to have heightened blood pressure and electrodermal reactivity in response to general stressors (Carpenter & Kirkpatrick, 1996; Diamond, Hicks, & Otter-Henderson, 2006; Feeney & Kirkpatrick, 1996; Kim, 2006) and heightened cortisol reactivity to romantic conflicts (Laurent & Powers, 2007; Powers et al., 2006). Similarly, studies assessing adults' recollections of childhood attachment experiences have found that individuals with dismissing and deactivating approaches (consistent with avoidance) show heightened cortisol reactivity to abandonment-related imagery (Rifkin-Graboi, 2008) and heightened electrodermal reactivity to romantic conflict (Roisman, 2007). None of these studies have found heightened *reports* of stress or negative affect among avoidant or dismissive adults, and hence the findings suggest a general pattern of *dissociation* between avoidant individuals' self-reported stress and their physiological reactivity to stressors.

Discrepancies between subjective and physiological responses to laboratory stressors are fairly common in the social psychophysiological literature, and their implications for interpreting emotion- and self-regulatory processes have received increasing attention in recent years (Dickerson & Kemeny, 2004; Mauss, Levenson, McCarter, Wilhelm, & Gross, 2005). With

respect to attachment, a central question is whether avoidant individuals' dampened reports of subjective distress suggest a failure to *experience* subjective distress or a failure to *report* it. Although avoidant individuals' heightened HPA and ANS stress reactivity might seem to suggest the latter explanation, such a conclusion is premature. Although it is tempting to assume that physiological responses provide a more direct window into an individual's psychological state than his/her own self-report, in actuality the relation between subjective and physiological responses is substantially more complex and inconsistent (Blascovich, Brennan, Tomaka, & Kelsey, 1992; Mauss, Wilhelm, & Gross, 2003). Hence, a key priority for future research should be closer investigation of the mechanisms underlying *both* correspondence and lack of correspondence between subjective and physiological responses to stress in anxious and avoidant individuals.

Profiles of response across multiple systems

Along the same lines, future research should be directed at more comprehensive *profiles* of physiological reactivity across multiple physiological systems and contexts. Most psychobiological research testing associations between attachment style and physiological reactivity focuses on one biological system at a time, in only one testing context (largely attributable to the considerable logistical challenges involved in assessing *multiple* systems across *multiple* contexts). Yet, if future research is to identify potential psychobiological "signatures" associated with attachment anxiety and avoidance, we must consider the potential relevance of certain *combinations* of reactivity, such as heightened HPA activity in the absence of sympathetic nervous system (SNS) response, or vice versa. Different combinations of reactivity in the SNS and parasympathetic nervous systems (PNS) are particularly important to consider, given the evidence that the coordinated functioning of these systems varies from situation to situation (Berntson, Cacioppo, & Fieldstone, 1996) as well as from person to person (Berntson et al., 1994).

Additionally, future research should also assess *tonic* physiological functioning. Overall, findings regarding attachment-related patterns of tonic HPA and ANS activity have proven less consistent than findings regarding reactivity. For example, Maunder (2006) found that avoidant individuals had tonically *lower* levels of heart rate variability during laboratory assessments, indicative of lower PNS cardiac control (sometimes called *vagal tone*), whereas Diamond and Hicks (2005) found lower levels of tonic PNS cardiac control (assessed in terms of resting levels of respiratory sinus arrhythmia) among young men with high attachment *anxiety*. Both findings are consistent with a large body of research suggesting that higher tonic PNS cardiac control is associated with adaptive emotion regulation over the life course (reviewed by Diamond & Fagundes, 2008), yet more research is needed before strong conclusions can be drawn regarding specific links between PNS activity and attachment style.

As for HPA functioning, both Quirin and colleagues (2008) and Adam and Gunnar (2001) found that high levels of adult attachment anxiety were associated with dampened levels of cortisol upon awakening (which is typically interpreted as an index of tonic HPA dysregulation). Yet Rifkin-Graboi (2008) found no associations between tonic HPA activity and adult men's recollected childhood attachment experiences with parents. As with PNS activity, more research is needed on these parameters. Ideally, we should strive to *integrate* findings regarding tonic functioning across multiple systems with findings regarding reactivity to major and minor stressors (both generalized and attachment-specific), with the eventual goal of developing a comprehensive portrait of the underlying psychobiology of attachment anxiety and avoidance.

Childhood attachment patterns, adult attachment styles, and adult "states of mind with respect to attachment"

As noted earlier, although most studies investigating attachment style and physiological reactivity have focused on adults' current romantic attachment styles, which are usually assessed with self-report measures (Diamond et al., 2006, 2008; Laurent & Powers, 2007; Powers et al., 2006; Quirin et al., 2008), some studies have focused on classifications of "state of mind with respect to attachment" assessed with the Adult Attachment Interview (AAI; Main, Kaplan, & Cassidy, 1985; see the recent review by Hesse, 2008) – an interview that focuses on narrative accounts of childhood experiences with attachment figures (Rifkin-Graboi, 2008; Roisman, 2007). This raises important questions of interpretation, as explained by Allen and Miga (2010). The AAI is sometimes assumed to be a measure of "adult attachment" that can be predicted by the interviewee's *childhood* attachment pattern, but it was created and evaluated primarily as a measure of *parental* "states of mind" intended to predict the attachment pattern of the interviewees' own children. In other words, it is not clear that the AAI measures attachment *per se*, as opposed to attachment-related mental states and communication patterns related to parenting behavior.

Neither the AAI nor typical self-report measures of attachment style are intended to measure retrospectively what a person was like as a child. Although a fundamental hypothesis based on attachment theory has been that childhood and adult patterns of attachment are meaningfully related, the degree of continuity between these patterns over the course of development shows substantial variation across studies (reviewed in Grossmann, Grossmann, & Waters, 2005). Furthermore, there are conceptual and methodological distinctions between the self-report measure commonly used to assess adult romantic attachment (the Experiences in Close Relationships Inventory (ECR); Brennan, Clark, & Shaver, 1998) and the AAI, which does not focus on adult romantic relationships, or adult relationships of any kind.

Future research aimed at comparing the psychobiological "signatures" of childhood attachment patterns (assessed by techniques such as the infant

Strange Situation test; Ainsworth, Blehar, Waters, & Wall, 1978) and adult attachment and caregiving patterns (assessed with measures such as the ECR and the AAI) would make groundbreaking contributions to our understanding of the basic mechanisms through which attachment and caregiving experiences at different stages of life shape emotional and physiological regulation.

Investigators hypothesizing links between attachment patterns, however measured, and patterns of physiological functioning generally rely on one of two different theoretical rationales (summarized in Diamond & Hicks, 2004). The first rationale emphasizes processes through which early experiences with non-optimal caregivers impair the basic “tuning” of stress-regulatory systems in infancy and childhood (see Glaser, 2000; Repetti, Taylor, & Seeman, 2002). The second rationale emphasizes linkages between attachment insecurity at a given stage in life and individuals’ concurrent, often negatively biased cognitive and affective appraisals of environmental demands, which should lead to higher and more sustained levels of psychological stress, negative affect, and corresponding reactivity in stress-responsive physiological systems. Although these two different rationales are not mutually exclusive, they yield different predictions regarding the relevance of childhood versus adult patterns of attachment security to physiological processes. The first rationale, for example, suggests a critical role for prior childhood attachment insecurity, and also suggests that we should observe links between attachment insecurity and *tonic* physiological functioning, as well as acute stress reactivity, in adulthood. The second rationale suggests that the relative importance of childhood versus adult patterns of attachment for physiological functioning depends on whichever pattern has a more consistent influence on current patterns of cognitive-affective stress appraisals (an open empirical question, which may have notably different answers for different individuals at different stages of life; this issue is also discussed by Simpson & Rholes, 2010.)

Clearly, these complexities underscore the importance of conducting research that specifically incorporates measures of *both* childhood and later adult attachment in order to directly contrast their relative influence on adult psychobiological processes. In addition, researchers should undertake longitudinal investigations of associations between attachment security and physiological functioning at different stages of development. Currently there are no published data speaking to the question of whether patterns of stability and change in stress-regulatory physiological systems are related to corresponding changes in the quality and security of attachment experiences from childhood to adulthood, or from one adult close relationship to another. Such investigations would make important contributions to developing a truly lifespan developmental approach to understanding the underlying psychobiology of attachment.

Conclusion

In recent years, researchers have increasingly adopted “biosocial” approaches to psychosocial development (Repetti et al., 2002), in which individuals are understood as products of ongoing reciprocal interactions among environmental, interpersonal, behavioral, psychological, and biological processes unfolding over time (Cairns, Gariepy, & Hood, 1990; Gottlieb, 1991). The emerging body of psychobiological research on attachment fits squarely within this important line of multidisciplinary inquiry. As researchers progress toward identifying the specific profiles of multi-system physiological functioning that characterize attachment anxiety and avoidance, we will make important strides toward mapping the basic psychobiological mechanisms through which attachment processes shape human health and well-being over the life course.

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