Child-Parent Attachment and Response to Threat:

A Move from the Level of Representation

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“We are here concerned with nothing less than the nature of love and its origins in the attachment of a baby to his mother. According to this viewpoint, attachment originates in a few specific patterns of behavior, some of which are manifest at birth and some of which develop shortly afterward. Attachment is not present at birth, however; it emerges gradually through a course of development, and it is perhaps a matter of more or less arbitrary definition to identify the point at which it could be said to have finally emerged. Attachment is manifested through these patterns of behavior but the patterns do not themselves constitute the attachment. Attachment is internal. We can conceive of attachment as somehow being built into the nervous system, in the course of and as a result of the infant’s experience of his transactions with his mother and with other people. This internalized something that we call attachment has aspects of feelings, memories, wishes, expectancies, and intentions, all of which constitute an inner program acquired through experience and somehow built into a flexible yet retentive inner mechanism (which we identify with central nervous system functions) which serves as a kind of filter for the reception and interpretation of interpersonal experience and as a kind of template shaping the nature of outwardly observable response.”

Mary Ainsworth, 1967

*Infancy in Uganda*

During the past 30 years, the study of individual differences in the quality of infant-parent attachment has focused on the representations that infants form during their first year of their caregivers, of themselves, and of relationships. John Bowlby, the developer of attachment theory, sometimes called these “representational models” (Bowlby, 1973) and sometimes “internal working models” (the latter to emphasize the active nature of these representations; Bowlby, 1973, 1988). These representational models are thought to center on the extent to which the parent serves as a secure base from which the infant can explore and a safe haven to which the infant can return when distressed or threatened. The pioneering empirical work of Mary
Ainsworth (e.g., Ainsworth, Blehar, Waters, & Wall, 1978), and later of Mary Main (e.g., Main, Kaplan, & Cassidy, 1985), led to an explosion of research related to these representations (see also Bretherton & Munholland, 2008). Above all else, the notion that representations derive from experiences (as opposed to Freud’s, 1905/1953, 1917/1953, claim that representations were based on fantasy and drives) was central to Bowlby’s conceptualizations.

Yet at the same time that these experiences with caregivers are contributing to the formation of infant representations, these experiences are also likely to set into motion a variety of non-representational, physiological regulatory processes that have important links to children’s developing attachment systems. The fact that Bowlby paid relatively little attention to these physiological processes is surprising given that Bowlby had begun his studies as a biologist, and that the education about ethology that he had received largely from Robert Hinde was so central to his early theorizing about why humans become attached to their caregivers. Yet Bowlby’s focus on representations may be understood considering that he was initially writing during a time when many branches of science were focused on the “cognitive revolution.” Importantly, most of the research related to physiology within the mother-infant relationship was not then available.

In this chapter, the aspect of infant and child functioning on which we focus is response to threat. Understanding children’s response to threat is fundamental to understanding virtually all aspects of children’s well being, including social, emotional, cognitive, and physiological functioning, as well as the development of psychopathology and physical disease. One of the core propositions of attachment theory is that attachment serves to reduce fearfulness in the face of possible or actual threat, and that a central mechanism explaining this link is children’s experience-based representations of the availability of the attachment figure. Moreover, it is individual differences in the nature of these representations that are thought to predict individual
differences in children’s response to threat. Yet in species that do not possess the representational capacities that humans possess, the link between attachment and response to threat nonetheless clearly exists. The goal of this chapter is to consider what is known about this link that does not involve representational processes.

We begin this chapter with Bowlby’s (1969/1982, 1973) thinking about the link between attachment and response to threat, which is best understood within the context of what Bowlby referred to as the secure base/safe haven construct. Bowlby drew on the research available at the time to focus on behavioral response to threat. We then describe briefly the nature of attachment-related representations and how they are thought to mediate the link between child-parent attachment and child behavioral response to threat in humans. We then focus on the ways in which the same experiences with caregivers that contribute to infant representations are also likely to contribute to non-representational, physiological regulatory processes that reflect response to threat at the biological level. In this way, we discuss how early experiences within the attachment relationship can contribute directly to infant and child response to threat, without involving representational processes, as is surely the case in some nonhuman mammals. Next, we discuss the ways in which representational and nonrepresentational processes may interact to influence development in humans. We conclude with a brief summary and consideration of additional topics that could be examined within a broader model.

The Secure Base/Safe Haven Construct:

Understanding the Link between Attachment and Children’s Response to Threat

Attachment theory contains key propositions about the link between attachment and children’s response to threat. In fact, much of the early development of attachment theory grew from observations that children appeared to view separations from their mothers as threats to which they responded with considerable distress (see Kobak & Madsen, 2008). Bowlby (1988),
along with his colleague Mary Ainsworth (1963), proposed what has come to be known as the secure base/safe haven construct, and it is this thinking that is at the center of understanding the link between attachment and response to threat.

The secure base/safe haven construct contains the notion that the two principle roles of an attachment figure are serving as a secure base from which the child can explore, and as a haven of safety to which the child can return in times of threat or distress (haven of safety is a term originally used by Harlow, 1958). As such, this thinking rests on the conceptualization of the interrelations among three behavioral systems: the attachment, exploration, and fear systems. Bowlby (1969/1982) borrowed the behavioral system concept from ethologists to describe a species-specific system of behaviors that leads to certain predictable outcomes, at least one of which contributes to reproductive fitness.

When formulating attachment theory, one of Bowlby’s (1958) initial observations was that infants engage in a series of behaviors, which he called attachment behaviors (e.g., crying, following, signaling), that have the predictable outcome of gaining or maintaining proximity to caregivers. Bowlby (1969/1982) argued that attachment behaviors are organized into an attachment behavioral system that evolved because it enhanced the child’s survival to reproductive age by reducing the threat of predators and other dangers. According to Bowlby, the exploratory system gives survival advantage to the child in a different way – by providing important information about the workings of the environment. Yet unbridled exploration with no attention to potential hazards can be dangerous. The complementary yet mutually inhibiting nature of the exploratory and attachment systems is thought to have evolved to ensure that while the child is protected by maintaining proximity to attachment figures, he or she nonetheless gradually learns about the environment through exploration. According to Ainsworth (1972),
“the dynamic equilibrium between these two behavioral systems is even more significant for
development (and for survival) than either in isolation” (p. 118).

The fear behavioral system, with its close links to both exploration and attachment, is
another behavioral system particularly important to understanding children’s responses to threat.
For Bowlby (1973), the biological function of the fear system, like that of the attachment system,
is protection. The evolutionary advantage of the fear system stems from the fact that it is
biologically adaptive for children to be frightened of certain stimuli. Without such fear, survival
and reproduction would be reduced. Bowlby described “natural clues to danger” — stimuli that
are not inherently dangerous but that increase the likelihood of danger; these include darkness,
loud noises, aloneness, and sudden looming movements. Because the attachment and fear
systems are intertwined so that frightened infants increase their attachment behavior, infants who
find these stimuli frightening are considered more likely to seek protection from caregivers and
thus to survive to pass on their genes.

Most infants balance these three behavioral systems, responding flexibly to a specific
situation after assessing both the environment’s characteristics and the caregiver’s availability
and likely behavior. For the purposes of this chapter, it is most important to note that experiences
related to the attachment figure’s availability and responsiveness are thought to play an important
role in the activation of an infant’s fear system, such that an available and responsive attachment
figure makes the infant much less susceptible to fear. According to Bowlby (1973), “the degree
to which each of us is susceptible to fear turns in great part on whether our attachment figures are
present or absent” (p. 201). Bowlby (1973) described as important not only the physical presence
of an attachment figure, but also the infant’s confidence that the attachment figure will be
available if needed. The evolutionary advantage derived from this linkage is that it is at times
when the child is under threat and therefore most vulnerable that the child has most to gain from
contact with and protection from the attachment figure. A converging body of empirical work, in which maternal physical or psychological presence was experimentally manipulated, has provided compelling evidence of the theoretically predicted associations among maternal availability, infant exploration, and infant fear/wariness (Ainsworth & Wittig, 1969; Carr, Dabbs, & Carr, 1975; Sorce & Emde, 1981). In sum, for Bowlby (1988), the secure base/safe haven concept was at the heart of attachment theory: “No concept within the attachment framework is more central to developmental psychiatry than that of the secure base” (p. 163–164).

**Internal Representational Models and their Role as a Mediating Mechanism of the Link between Attachment and Response to Threat**

In addition to the normative links between attachment and response to threat, individual differences in the *quality* of attachment relate in important ways to variation in children’s response to threat. Although virtually all children become attached to their primary caregivers (yet see Dozier & Rutter, 2008, and Zeanah, Smyke, Koga, & Carlson, 2005, for descriptions of extreme circumstances), the quality of the attachment varies as a function of the nature of the specific infant-caregiver relationship. Some infants – labeled securely attached – are able to effectively use their caregivers as a secure base from which to explore and a safe haven to return to in times of need, as described above, whereas other infants – labeled insecurely attached – are unable to do so effectively (Ainsworth et al., 1978; for reviews, see Cassidy & Shaver, 2008).

Several studies of infants and young children have reported links between attachment quality and behavioral response to threat, with children securely attached to their mothers showing less fearfulness than insecurely attached children (e.g., Kochanska, 2001; Shamir-Essakow, Ungerer, & Rapee, 2005; Stevenson-Hinde & Shouldice, 1990).

Attempts to explain how attachment and early attachment-related caregiving experiences are linked to behavioral response to threat have centered in large part on infant representations as
the causal mechanism. In order to understand how representational models mediate this link, we
begin this section by describing these models. Next, we explain the formation of representational
models, focusing on the centrality of early experiences. Then, we describe how these models are
thought to influence response to threat.

According to attachment theory, infants develop experience-based mental models of their
develop early in life, begin as simple sensorimotor expectations and become more complex,
flexible, and extendable over time (Bretherton & Munholland, 2008; Thompson, 2008). These
models contain information about “how [an infant’s] mother and other significant persons may
be expected to behave, how he himself may be expected to behave, and how each interacts with
the other” (Bowlby, 1969/1982, p. 354). These models then operate like cognitive schemas and
scripts, allowing individuals to efficiently predict, interpret, and guide their interactions with
others (Bretherton & Munholland, 2008; Main et al., 1985; Waters & Waters, 2006). For
instance, securely attached infants have representations of their caregivers as effective secure
bases – as such, they may have predictive scripts such as, “If I’m upset, then my father will
comfort me,” whereas insecure infants may have a predictive scripts such as, “If I’m upset, then
my father will push me away.” These models also allow infants to interpret their caregivers’
behavior in new situations. Finally, these models guide how infants behave with caregivers.
Securely attached infants, as compared to insecurely attached infants, will be more likely to
approach their caregiver when distressed because they have an expectation that the caregiver will
respond and be an effective aid. Individual differences in infants’ representational models were
recently demonstrated in a quasi-experimental study: Securely attached infants’ cognitive
expectations for the behavior of caregivers and infants followed a secure base script (wherein a
distressed infant seeks and receives care), whereas insecurely attached infants’ expectations of
infant-caregiver interactions deviated from a secure base script (Johnson, Dweck, & Chen, 2007; Johnson et al., 2010).

What are the precursors of representational models? According to Bowlby, these representational models are experience-based – he viewed them as “tolerably accurate reflections of the experiences those individuals have actually had” with their caregivers, rather than projections of the child’s internal psyche as Freud had proposed (Bowlby, 1973, p. 202). Securely attached infants represent their caregiver as a secure base and safe haven because past experiences during attachment-related interactions provided information that their caregiver was available, responsive, and sensitive. This information is stored in the mental model and is used as the basis from which to create expectations for the caregiver’s future behavior. As such, individual differences in the content of these representations are based on the caregiver’s parenting behavior during day-to-day attachment-related interactions. To the extent that caregiving experiences remain stable, children’s attachment representations remain stable as well, and they become increasingly resistant to change (Bowlby, 1988; Bretherton & Munholland, 2008). If, however, caregiving experiences change, either for the better or for the worse, then children’s attachment representations will change accordingly (Vaughn, Egeland, Sroufe, & Waters, 1979; Weinfield, Sroufe, & Egeland, 2000).

That Bowlby viewed representations as playing an important role in predicting children’s response to threat is clear. In his discussion of representational models, Bowlby (1973) noted that “intimately linked to the type of [representational] forecast a person makes of the probable availability of his attachment figures, moreover, is his susceptibility to respond with fear whenever he meets any potentially alarming situation during the ordinary course of his life” (p. 203). It is the nature of secure and insecure children’s representations of the availability and responsiveness of their caregivers in times of threat that is thought to account for the variation in
the ways in which these children respond to threat. Specifically, it is because securely attached infants are more likely than insecurely attached infants to predict caregiver availability and responsiveness that they are able to interpret the threat as manageable and respond with less fear and anxiety.

**A Move from the Level of Representations: Back to Biology**

Two important and related advances since the time of Bowlby’s (1969, 1973) initial writings about infant attachment and response to separation have greatly extended scientists’ understanding of the link between attachment and response to threat. One important advance originated in the research of Myron Hofer that began to emerge during the 1970s. Hofer, a developmental psychobiologist, noticed defensive vocal protest responses to maternal separation in infant rat pups, and asked what non-representational process could account for these responses. This work has facilitated researchers’ consideration of processes beyond the level of representation (see Main, 1999, for a call to examine these nonrepresentational processes in humans). A second and related advance has been an extensive examination of response to threat beyond the behavioral and emotional levels to an examination of response to threat at the physiological level. The explosion of research examining neuroendocrine systems and epigenetic processes, much of this work done by researchers examining what is called stress reactivity, has brought a greatly enriched understanding of the links between early attachment experiences and response to threat at multiple levels of analysis.

We begin this section with a review of Hofer’s seminal work on the physiological subsystems that become disrupted in response to maternal separation, as well as the work of Seymour Levine who examined the effects of maternal separation on rat pups’ physiological threat response system. Next, we discuss the important work of Michael Meaney and colleagues, who identified – at the level of the gene – how maternal caregiving experiences influence gene
expression and response to threat in rats. We then describe evidence from studies of primates, again showing how attachment experiences shape responses to threat in mammals without fully developed representational systems. We conclude this section with a brief review of caregiving influences on the threat response system in humans, highlighting recent evidence that suggests the presence of underlying physiological subsystems that serve regulatory functions early in development in response to threat.

**Hidden Regulators in Mother-Infant Interactions: The Case of the Rat**

Hofer’s (1970) observations that rat pups responded with significant distress when separated from their mothers – similar to distress signals in humans – led him to wonder about the mechanisms of separation distress in nonhuman mammals. After all, rat pups lack the capacity for mental representations and these signals of distress could not, therefore, be rooted in representational processes. To explore this question, Hofer and colleagues conducted a series of tightly controlled experiments to identify what physiological subsystems might be disrupted when mothers were removed from their pups (for reviews, see Hofer, 1994, 2002, 2006). These studies revealed a number of “hidden regulators” that no longer function properly if rat pups are separated from their mothers. These regulators are “hidden” because they are not immediately visible, but operate “under the skin.” Hofer and colleagues found that when rat pups were removed from their mothers, they showed a dramatic decline in multiple physiological and behavioral systems, such as those controlling heart rate, body temperature, food intake, movement, and exploratory behavior. Hofer argued that maternal separation resulted in the removal of the important regulatory functions that the mother serves for her offspring, and the absence of these regulatory components resulted in rat pups’ visible behavioral distress. Interestingly, these studies demonstrated that the underlying physiological regulatory systems are
interconnected in complex ways. For example, replacing heat that is lost in the mother’s absence led to a slower rate of decline in rat pups’ activity levels. Similarly, rat pup heart rate could be maintained by artificially regulating food intake (Hofer, 1970). These studies led Hofer to conclude that mother-infant interactions have embedded within them a number of vital physiological regulatory functions that are negatively affected by separation from maternal care and that do not require cognitive representations in order to influence infants’ responses to maternal separation.

But how do mother-infant interactions have such a profound impact on rat pup stress physiology? What is it about maternal behavior that “gets under the skin?” The work of Meaney and colleagues sheds light on this question. Meaney found that certain caregiving experiences early in infancy were associated with long-term changes in rats’ stress response physiology (Liu et al., 1997). Specifically, rat pups that received high levels of maternal licking and grooming and arched-back nursing positions showed attenuated responses to threat and increased exploratory behavior – effects that lasted into adulthood (Caldji et al., 1998; Liu et al., 1997; see Meaney, 2001, for a review). Meaney and his colleagues further identified that these individual differences in maternal behavior led to differences in gene expression for the glucocorticoid receptor gene promoter (Weaver et al., 2004). Although the genes themselves did not differ between rats, the ways in which the genes operated differed as a function of maternal behavior (see Weaver et al., 2004, for a more detailed account of the DNA methylation process).

Levine’s (1957) groundbreaking recognition that the environment can exert an influence over the infant’s developing stress response system represented a paradigm shift for the field. This new understanding led to investigations into the influence of maternal care on rat pups’ developing physiology that identified ways in which mothers serve as regulators of infants’
pituitary-adrenal stress response system (see Levine, 2001, 2005, for reviews; Stanton, Gutierrez, & Levine, 1988; Stanton, Wallstrom, & Levine, 1987). In one study, for example, rat pups were separated from their mothers and later exposed to a novel experience. Rat pups’ physiological stress response, characterized by the increased release of corticosterone, was related to the length of time that the pups had been separated from their mothers (Stanton et al., 1988). In other words, early caregiving experience (in this case, maternal separation) contributed to dysregulation in endocrine system functioning. Interestingly, findings from another study showed that the corticosterone response to maternal separation could be buffered by feeding rats during mothers' absence. These findings suggest that one hidden regulator of the rats' stress response system is mothers' regulation of infant feeding (Suchecki, Rosenfeld, & Levine, 1993). Levine’s large body of research taught researchers about the important role that mothers play as regulators of their infants' fragile and developing stress response systems.

Attachment and Response to Threat in Nonhuman Primates

Just as rodent mothers serve as regulators of their pups’ physiology, so too do nonhuman primate mothers serve as regulators of their infants’ biological functioning (Boyce, Champoux, Suomi, & Gunnar, 1995; Levine & Wiener, 1988; see Suomi, 2008, for a review). For example, following an initial state of hyperarousal, infant pig-tail macaque monkeys who were separated from their mothers showed declines in heart rate and body temperature (Reite, Kaufman, Pauley, & Stynes, 1974). Similarly, infant behaviors changed as a result of maternal separation: The youngest infants exhibited characteristic depressed behaviors (e.g., slouched posture and motor coordination problems) and the older infants showed decreased play behavior. These findings suggest that mothers’ absence is a threatening experience, and the lack of maternal availability leads to the dysregulation of behavioral and physiological systems.
Additional evidence for maternal regulation of infant physiological systems comes from studies of nonhuman primates’ endocrine dysregulation in response to separation (e.g., Sanchez et al., 2005). Rhesus macaque infants who were separated physically from their mothers, but who could still see, hear, and smell their mothers, showed a lower cortisol stress response, in comparison to infants who were completely isolated from their mothers (Levine, Johnson, & Gonzalez, 1985). Similarly, when infant rhesus macaques were separated from their mothers for four days, they showed elevations in plasma cortisol (Bayart, Hayashi, Faull, Barchas, & Levine, 1990). This effect was attenuated, however, when infants were able to see their mothers. In another study, infant rhesus monkeys who had been repeatedly separated from their mothers between three and six months of age exhibited long-term changes in cortisol stress reactivity during an acoustic startle paradigm (Sanchez et al., 2005). These effects of regulation of infant biology appear to be specific to contact with the mother, as evidenced by findings that infant monkeys who accidentally sought contact from another monkey experienced increases, rather than decreases, in physiological arousal (Suomi, 1979).

Moreover, a number of studies have documented connections between the quality of maternal care and infants’ biological and behavioral responses to threat (Coplan et al., 1996; McCormack, Sanchez, Bardi, & Maestripieri, 2006). Coplan and colleagues (1996) created a stressful caregiving environment for a sample of bonnet macaque infants and their mothers by varying the stability of available food. Monkeys who had been raised by mothers in the variable food condition had elevated corticotropin-releasing factor (CRF) in cerebrospinal fluid in adulthood. In comparison, monkeys who were raised in consistent, predictable environments – characterized by either low or high levels of effort required to obtain food – had lower CRF levels. Thus, these long-term changes in the biological stress system were not due simply to the
availability of food, but rather to the stress of uncertainty in the caregiving environment.

Similarly, monkeys who had been abused by their mothers showed dysregulation in hypothalamic-pituitary-adrenal (HPA) axis functioning (see Suomi, 2008, for a review). In summary, it is clear that variations in early caregiving experiences play an important role in regulating nonhuman primates’ physiological responses to threat.

**Early Attachment-Related Experiences and Human Infant Biological Response to Stress**

As discussed earlier, the infant’s experiences with an attachment figure contribute to the development of representations about the availability of support when needed. These same experiences also contribute to the development of a number of biologically based regulatory processes. Our focus is on evidence of connections between infants’ interactions with their mothers and HPA axis physiology, but we note that caregiving interactions also influence other physiological systems, such as cardiac activity (e.g., Moore et al., 2009) and electrical activity in the brain (e.g., Hane, Henderson, Reeb-Sutherland, & Fox, 2010).

A fully developed human stress response system is present at birth (see Adam, Klimes-Dougan, & Gunnar, 2007). This system becomes activated in response to stressful events by releasing a dynamic cascade of chemicals, ultimately leading to the production of cortisol. In response to stress, the hypothalamus releases corticotropin-releasing hormone and vasopressin. These hormones, in turn, stimulate the anterior pituitary, which releases adrenocorticotropic hormone, stimulating the adrenal glands to produce and release cortisol. Under normal conditions, this system exhibits a diurnal rhythm, with higher levels of cortisol in the morning and near zero levels by evening (Kirschbaum & Hellhammer, 1989; Watamura, Donzella, Kertes, & Gunnar, 2004).
The HPA axis is sensitive to environmental and contextual perturbations in humans as it is in rats and some nonhuman primates, and a growing body of research suggests that differences in the quality of early caregiving experiences contribute to important variations in the initial calibration and continued regulation of this system. Disruptions to normative caregiving experiences can lead to a variety of dysregulated stress response patterns, including overactive responses to stress and disruptions to the diurnal rhythm of cortisol production (see Adam et al., 2007, and Gunnar & Donzella, 2002, for reviews). The regulation of the HPA axis in turn plays an important role in shaping behavioral responses to threat (Jessop & Turner-Cobb, 2008; Shirtcliff & Essex, 2008).

Researchers have examined the connections between caregiving experiences and infant stress physiology by comparing infants’ cortisol levels before and after a stressful task (e.g., the laboratory Strange Situation paradigm that contains two brief episodes of infant-mother separation; Ainsworth et al., 1978). For example, Luijk and colleagues (2010) examined the contributions of maternal depression and infant attachment security to infants’ cortisol stress responses and found that insecure infants who also had depressed mothers showed the largest stress response during the Strange Situation. Similarly, Nachmias, Gunnar, Mangelsdorf, Parritz, and Buss (1996) found that inhibited toddlers who were insecurely attached to their caregivers exhibited elevated cortisol following exposure to novel stimuli. In another study, Feldman and colleagues (2009) found that low maternal sensitivity was associated with elevated infant cortisol reactivity in response to fearful stimuli, and this effect was independent of maternal depressive and anxiety symptoms. Additional evidence for the role of maternal influence in shaping the infant’s stress response comes from experimental evidence showing that mothers’ touch buffered infants’ cortisol stress response typically associated with a stressful experience (in this case,
during the *still-face* laboratory procedure in which mothers are asked to cease interaction with their infants; Feldman, Singer, & Zagoory, 2010). Similar evidence that sensitive maternal care can buffer stress reactivity comes from a study in which secure infants, relative to insecure infants, had a lower cortisol response during the transition to a new daycare environment (Ahnert, Gunnar, Lamb, & Barthel, 2004).

Children living in violent families endure particularly stressful caregiving environments, and such exposure is extremely dysregulating for children. The constant uncertainty and turmoil of these environments has consequences for children’s stress reactivity (Taylor, Repetti, & Seeman, 1997). A number of studies have documented the disrupted stress response of maltreated children (e.g., Davies, Sturge-Apple, Cicchetti, & Cummings, 2007, 2008). Even living in a family in which the violence does not involve them directly has negative consequences for children, and some evidence suggests that the quality of caregiving in these hostile environments plays an important role in modifying the stress response. For example, in a longitudinal study of intimate partner violence (IPV) and children’s adrenocortical responses to stress, Hibel and colleagues found that children who were exposed to IPV but whose mothers demonstrated high levels of sensitivity were buffered from heightened cortisol reactivity, compared to children who were exposed to IPV and low maternal sensitivity (Hibel, Granger, Blair, Cox, & The FLP Investigators, 2011).

**Attachment as a Regulator/Calibrator of Infant Stress Reactivity: Evolutionary Underpinnings**

In the species discussed in this chapter, the stress reactivity system serves to help the organism mobilize protective resources in times of threat, and, in the absence of threat, to devote metabolic and psychological resources elsewhere (e.g., food gathering, exploration). It seems
reasonable, therefore, that the most evolutionarily adaptive stress reactivity system would include a component that can extract information about the organism’s environment, gauge the level of environmental threat, and prompt an appropriate response. With high environmental threat, greatest adaptation means a stress reactivity system that is calibrated to recognize, attend to, and respond to threat quickly. Importantly, one central factor that demarks the extent of environmental threat is the presence or absence of a reliably responsive caregiver; an environment lacking a protective attachment figure is an environment of increased risk. Thus, for an infant without a responsive attachment figure, adaptation means being vigilant to threat and ready for a quick response.

Just as infants are thought to have evolved with the capacity to use experience-based information about the availability of a protective caregiver to calibrate their attachment behavioral system (Main, 1990), and given the close intertwining of the attachment and fear systems as described above, it is likely that infants evolved with the capacity to use information about the availability of an attachment figure to calibrate their threat response system at both the behavioral and physiological levels (Cassidy, 2009). This thinking about the role of attachment in the calibration of the infant’s stress reactivity emerges directly from Bowlby’s (1969/1982, 1973) theories of attachment and fear (see also Kobak & Madsen, 2008; Mikulincer & Shaver, 2007), Hinde’s (1986) evolutionary thinking about parental signaling about the state of the environment, and Main’s (1990) ideas of attachment strategies, as well as from the thinking of contemporary evolutionary biologists (e.g., West-Eberhard, 2003). This thinking also is compatible with the thinking of Flinn, Nepomnaschy, Muehlenbein, and Ponzi (2011) and Meaney (2010), and with much of the empirical work described above (e.g., the link between maternal behavior and infant
DNA methylation in rats [Weaver et al., 2004] may have evolved because maternal licking and grooming of rat pups signals the availability of an invested mother).

The Interaction of Representational and Non-representational Processes in Predicting Children’s Response to Threat

Just as the study of the correlates of attachment security at multiple levels of analysis is important, so too will examination of how cognitive processes interact with physiological processes to influence child outcomes constitute a significant extension of attachment theory and research. An important set of questions emerges: How are representational and physiological processes linked and how do they influence each other? How do these two sets of processes work together to predict child functioning? Does the nature of the interaction vary across particular aspects of child functioning, and across developmental periods? How do these processes interact during the initial attachment formation versus during maintenance of an attachment? How can we understand these interactions in relation to both normative development and individual differences? The growth of scientific knowledge since the time of Bowlby’s initial writings, including findings from the studies described here, has brought many scientists to a working assumption: Anything that influences representations influences many parts of the body and brain.

The most fundamental question relates to how representational and non-representational processes are linked. In humans, each process is thought to initiate the other in ways unlikely to be the case in other species. Sapolsky (2004) noted that in humans, representational processes – the anticipation of threat when none currently exists – can launch a stress response: “A stressor can also be the anticipation of that happening. Sometimes we are smart enough to see things [threats] coming and, based only on anticipation, can turn on a stress-response as robust as if the
event had actually occurred” (p. 6). Relatedly, Bowlby (1973), focusing on the link between attachment and fear, specified representational “forecasts of availability or unavailability” of the attachment figure as “a major variable that determines whether a person is or is not alarmed by any potentially alarming situation” (p. 204). Thus, the representations that others will be unavailable or rejecting when needed that characterize insecure attachment could contribute to chronic activation of physiological stress response systems, as could the associated representations of others as having hostile intent (see Dykas & Cassidy, 2011, for a review of the social information processing patterns associated with secure and insecure attachment). Just as representational processes are useful in the anticipation of threat, so are they useful in the anticipation of protective resources that will dampen the stress reactivity system. Thus, in times of both anticipated and actual threat, the capacity to represent a responsive attachment figure can reduce physiological responses associated with threatening or painful experiences (for evidence of reduced neural responses to painful stimuli when participants viewed pictures of their attachment figure, see Eisenberger et al., 2011). Consideration of the linkage between representational and non-representational processes must also contain a recognition that not only can representations lead to both increases and decreases in physiological stress reactivity, but that pathways of influence also can run in the opposite direction: Physiological stress responses can lead an individual to engage in higher level cognitive process to understand, justify, or change the stress (Festinger, 1957; Schacter & Singer, 1962).

When and how do young children come to use attachment-related representations as regulators of stress? Both normative trajectories and individual differences in the developmental course of the use of representations to influence stress reactivity have been rarely examined. Evidence that stress dysregulation can lead to the conscious engagement of representational
processes comes from children as young as age four who are able to describe cognitive mechanisms for alleviating distress (e.g., deliberately changing thoughts or goals, reappraising the situation, mental distraction; Davis, Levine, Lench, & Quas, 2010; Sayfan & Lagattua, 2009). Younger children may possess these capacities without being able to verbalize them. Moreover, there is behavioral evidence of representations dampening distress in young children: Representations of their mothers (in the form of photographs) were calming to 24-month-olds experiencing a brief laboratory separation (inferred from greater engagement in play; Passman & Longeway, 1982), and to young children experiencing extended separations of several days (Robertson & Robertson, 1971, 1989).

Hofer (2008) and Suomi (2008) converge in their thinking about the biological advantages of the ways in which representational and non-representational processes work together in relation to human attachment. Hofer proposed that mechanisms wherein parents are early physiological regulators of infant stress reactivity (which prepare infants for the environment they are likely to face; he refers to this as the “predictive role of parenting;” see the initial thinking of Hinde, 1986) will be most effective when they allow a means for “corrective effects” (that is, input from later environments, some of which will involve representations) if the later environment differs substantially from that predicted by earlier parent-child interaction. Furthermore, Hofer (2006) called for future research to understand how specific components of mother-infant interaction, such as touch, voice, and imitation, link both to representational and to neural and hormonal processes, and how these processes interact to predict later functioning. Hofer’s proposition that hidden regulators constitute some of the “building blocks” of representations (1994, p. 205) has a compelling basis in the animal literature, and merits examination in humans.
Relatedly, Suomi’s (2008) speculations about how physiological mechanisms and cognitive representations interact contained the notion that advanced levels of cognition are not needed for the complex workings of the attachment system within most primates, and that humans have higher level cognitions superimposed on these other biological processes: “One might argue that working models are exclusively human constructions that are built upon a basic foundation that is essentially biological in nature and universal among the more advanced primate species. Cognitive constructions per se may not be necessary for long-term developmental or cross-generational continuities in attachment . . . That is, such continuities are essentially “programmed” to occur in the absence of major environmental disruption and are in fact the product of strictly biological processes that reflect the natural evolutionary history of advanced primate species, human and nonhuman alike” (p. 186).

Suomi further described representational processes and underlying biology in relation to both continuity and change: “Working models . . . may represent a luxury for humans that enables individuals to cognitively reinforce the postulated underlying biological foundation, in which case the predicted developmental continuity may actually be strengthened. On the other hand, the existence of a working model that has the potential to be altered by specific experiences (and/or insights) in late childhood, adolescence, or adulthood may provide a basis for breaking an otherwise likely continuity between one’s early attachment experiences and subsequent performance as a parent. These important issues deserve not only further theoretical consideration, but empirical investigation as well” (p. 186-187).

From a historical perspective, it is interesting to note that Bowlby’s early work (e.g., 1958), focusing on the evolutionary basis of the initial formation of the attachment bond, contained no mention of representational processes – an understandable state of affairs given
Bowlby’s initial reliance on Harlow’s studies of infant rhesus monkeys separated from their mothers (Harlow, 1958, 1960; see van der Horst, 2011). In fact, Bowlby clarified his “wish to distinguish [his theory about separation anxiety] from states of anxiety dependent on foresight [i.e., representations] (Bowlby, 1961, p. 267, cited in van der Horst, 2011, p. 120). It was only later, when Bowlby turned his attention to individual differences in the quality of attachment throughout the early years of human life, that the role of children’s representations as a mechanism linking attachment and functioning came to be highlighted.

**Summary and Additional Considerations**

In this chapter, we described the ways in which the same experiences with caregivers that contribute to infant attachment representations contribute to non-representational regulatory processes, some of which reflect response to threat at the physiological level; in this way, early caregiving experiences contribute to child response to threat directly, without involving representational processes. Since the time of Bowlby’s original writing, there has been an explosion of research examining these non-representational processes, and the idea that early caregiving experiences influence both immediate and long-term behavioral and physiological response to threat is well replicated and widely accepted with respect to some rodents, nonhuman primates, and humans (for reviews, see Adam et al., 2007; Champagne & Curley, 2009; Loman & Gunnar, 2010; Meaney, 2001; Polan & Hofer, 2008; Suomi, 2008).

Several important topics are beyond the scope of this chapter; we mention a few of these here briefly. First, the focus of this chapter is on the early years of life. Bowlby, however, emphasized the fact that attachment characterizes humans “from the cradle to the grave” (1969/1982, p. 208). Relatedly, Hofer (1984) proposed that hidden regulators continue to function throughout life, and suggested that the withdrawal of hidden regulators may account for
bereavement processes in adulthood. We speculate that hidden regulators play a role not only in adult bereavement but also in more daily adult attachment processes (e.g., accounting for alterations in sleep/wake patterns when a long-term romantic partner is away on a business trip). Moreover, extensive evidence has emerged describing, for instance, the ways in which cortisol dysregulation is associated with both problematic precursors and negative sequelae in older children, adolescents, and adults (e.g., Ashman, Dawson, Panagiotides, Yamada, & Wilkinson, 2002; Barker, Greenberg, Seltzer, & Almeida, 2012; Marsman et al., 2008). Furthermore, if evolution has provided organisms with the capacity to extract information from their environments about the level of likely threat, it seems reasonable that this capacity would be present as early in development as possible, including during the prenatal period. A recent surge of theory and research has examined this phenomenon (called the fetal-programming model, fetal origins hypothesis, or developmental origins of health and disease, see Ellison, 2010; see also, Gluckman, Cutfield, Hofman, & Hanson, 2005, for the predictive-adaptive-response model). Numerous studies indicate that exposure to prenatal adversity can “program” a variety of biological systems in the offspring of both animals and humans (e.g., Clarke, Wittwer, Abbott, & Schneider, 1994; Ravelli et al., 1998; van den Hove et al., 2006; for reviews, see Ellison, 2010; Welberg & Seckl, 2001). One study of human newborns reported a link between prenatal maternal depression and infants’ elevated cortisol levels (Field et al., 2004). Another intriguing study in humans found that exposure to prenatal maternal depression led to epigenetic changes in infants’ gene expression that were associated with elevated stress reactivity in the HPA axis (Oberlander et al., 2008; see also Ponder et al., 2011). Relatedly, understanding of physiological processes related to the intergenerational transmission of stress reactivity in humans, which has been examined in rhesus monkeys (Suomi & Levine, 1998) and in rats (Francis, Diorio, Liu, &
Second, in this chapter, we focused on the ways in which maternal caregiving experiences contribute to the calibration and regulation of infant neuroendocrine responses to threat, but it is likely that these same caregiving experiences also manifest themselves in a number of other physiological changes. For example, variations in caregiving quality have been shown to be associated with telomere length attrition (Drury et al., 2011), inflammatory profiles (Chen, Miller, Kobor, & Cole, 2011) and sympathetic nervous system activity (Davis & Granger, 2009; Moore et al., 2009).

Third, Main noted that "[A]spects of the brain and/or brain chemistry particularly relevant to fear experiences may provide us with one starting point for increasing our understanding not only of the attachment system itself, but also of developmental differences originating in early experiences closely combining attachment and fright" (1999, p. 855). The research that Main calls for is particularly important given that the children most at risk for problematic development and psychopathology are children who are in the untenable situation wherein the person to whom they are biologically predisposed to turn to in times of threat (i.e., the attachment figure) is also the source of the threat (from whom the child is biologically predisposed to flee). Such a child is considered to face fright without solution (Hesse & Main, 2006, p. 310; see also Cassidy & Mohr, 2001, and Lyons-Ruth & Jacobvitz, 2008).

Fourth, this chapter discusses only the behavioral and physiological levels of response to threat; other levels should be considered. For instance, response to threat at the information-processing level (e.g., involving attention, memory) is likely to emerge from early attachment-related experiences (see Dykas & Cassidy, 2011, for a review). In addition, interconnections among the levels of response to threat (e.g., links between the behavioral and physiological levels
of response to threat) are important to understand.

Fifth, a rich set of questions about clinical implications emerges from consideration of the issues discussed in this chapter. Given the extent to which many forms of psychopathology reflect problems of self-regulation in the face of stress (e.g., internalizing problems, externalizing problems, substance abuse; Kring & Sloan, 2010), what can “hidden regulators” embedded within human infant-mother interactions tell us about the precursors of psychopathology? What about hidden regulators embedded within the relationship with the therapist (who, according to Bowlby [1988], comes to serve as an attachment figure within the context of long-term psychotherapy)? When change occurs following long-term therapy, does this change emerge through representational mechanisms, through physiological regulation, or both (see also Stern, 2004)? What are the neural and physiological mechanisms associated with change? Do therapeutic changes in representations contribute to these other neural and physiological changes? Or could it be that it is the other neural and physiological changes that drive the change in representations? (See Beebe, Knoblauch, Rustin, & Sorter, 2005, for a perspective wherein implicit, nonverbal, and nonconscious components of therapy are essential contributors to change; see also Pally, 2000). In relation to early parenting interventions designed to reduce the risk of insecure infant attachment, which have typically aimed to change maternal representations and/or behavior with little attention to hidden regulators (see Anisfeld, Casper, Nozyce, & Cunningham, 1990, for an exception): How should consideration of maternal regulators of infant physiology be included in the intervention? What child physiological changes are evident following parenting interventions (see Dozier, Peloso, Lewis, Laurenceau, & Levine, 2008, for evidence of children’s increased cortisol regulation following an intervention with foster parents)?
We end by noting that the theory and data reviewed here are fully compatible with the earliest thinking of Bowlby, whose scientific roots were in biology. Yet in Bowlby’s lifetime, tools for examining neural and physiological processes that scientists now possess were unavailable – as was even the concept of experiential effects on gene expression. We imagine that Bowlby would have found these newest developments enormously exciting.

Notes

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2. An important part of the secure base/safe haven construct is that during times of threat, not only is the fear system activated and attachment behavior increased, but exploratory behavior also decreases (Ainsworth et al., 1978).

References


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