16

Group Report: Early Social Attachment and Its Consequences

Dynamics of a Developing Relationship

R. A. THOMPSON, Rapporteur
K. BRAUN, K.E. GROSSMANN, M.R. GUNNAR, M. HEINRICHS,
H. KELLER, T.G. O'CONNOR, G. SPANGLER,
E. VOLAND, and S. WANG

ABSTRACT

The origins and consequences of early social attachments are longstanding interests of developmental scientists that have been enlivened through the integrative contributions of psychobiological research. Among the issues to emerge in this integrative work are:

- A better understanding of the behavioral and biological prerequisites for forming first attachments in infancy, and how these are reorganized when first attachments must develop later than is species-typical, or under atypical conditions.
- A better understanding of how attachment develops in different cultural settings within the context of the biologically adaptive requirements of inclusive fitness.
- A clearer conceptualization of the interaction between behavioral experience and psychobiological development with respect to how early caregiving shapes infant regulatory capacities, and how these influences become progressively updated through new caregiving experiences.
- Greater theoretical clarification of how attachment continues to develop beyond infancy, and the representations associated with this developmental process, in concert with the development of new measures and methods for assessing attachment at later ages.
- More systematic inquiry into the internal and external processes mediating continuity and change in attachment relationships over time, and what are the expectable consequences of early attachment relationships for both behavioral and psychobiological organization.
- The integration of biological and behavioral insights into the most compelling question of all: How does early experience influence later behavior?

INTRODUCTION

The origins and consequences of infant–mother attachment have consumed the interest of philosophers for centuries and of developmental scientists throughout psychology's short history. This is because the developmental dynamics of this primary relationship provide a forum for examining questions of enduring interest: How formative are early experiences for psychological development? what are the influences underlying continuity and change in early personality growth? How does the first relationship shape later relational experience? In addressing these questions, the formulations of developmental theory can be integrated with the findings of biobehavioral studies that examine attachment development from the perspective of the psychobiological systems in the infant and mother. Results of this integrative work form the basis for new insights and inquiry addressed in this chapter.

UNDERSTANDING EARLY ATTACHMENT

Forming relationships with primary caregivers is one of the most important developmental tasks of the early months in many species. These relationships are bidirectional; that is, characteristics of both infant and caregiver are important in forming and maintaining the relationship, and the relationship affects the development of both partners. A central facet of the relationship between an infant and primary caregiver is their "attachment." However, the diversity in how specific attachment relationships are formed for members of different species, and for humans of different cultures, requires a careful examination of what is meant by this term. Are there specific, unique defining features of attachment relationships (distinct from other kinds of social affiliations) that are shared across species and cultures? If we can identify common elements, then we can begin to explore their common (or shared) neurobiology, and this information can provide insights into the ontogeny of these behavioral patterns and their association with other adaptive systems. What makes an individual an attachment figure for another individual? What are the behavioral or physiological indices that reliably indicate that an attachment relationship exists for an infant or young animal? What are the functions served by attachment figures? In many species, and especially in humans, attachment figures serve many roles (e.g., protector, playmate, teacher), but these roles are also assumed by other individuals to whom a child may not be attached. Is it possible to identify the specific, unique functions that attachment figures alone provide the child and caregiver?

In addressing these questions, it is important to distinguish different facets of the term *attachment*. First, there is an *attachment system*, which may be conceived as a behavioral or motivational system (in attachment theory) or a module (in modularity theory) with specific information-processing functions serving attachment functioning. An attachment system evaluates and integrates

information, for example, concerning (a) the partner in the relationship, such as a baby or caregiver, (b) one's internal state relevant to relational activity (e.g., competing or complementary motives and needs), and (c) environmental conditions (e.g., social support, material and emotional resources). Second, there are *attachment behaviors*, which are the behavioral results of the functioning of the attachment system: how attachment figures act in relation to each other. Third, there is an *attachment relationship*, which is the interpersonal history and functioning of attachment behavior. Individual differences in the quality or security of attachment relationships have been of particular interest to students of human attachments in childhood. Because the term *attachment* is commonly used to refer to each of these facets, however, it is easy for developmental scientists to be needlessly confused about the use of the term.

Attachment and bonding are related concepts (Ainsworth 1985). *Bonding* typically refers to the establishment of an emotional connection of the mother to the infant, often shortly after birth, that is closely tied to the hormonal processes associated with birth. As we discuss below, the release of oxytocin and other hormones at parturition biologically primes many physical and behavioral aspects of caregiving in adults of many animal species, including humans. The process of bonding, especially of the mother to the baby, shortly after birth sets the stage for the development of attachment, which develops later in infancy as a mutual relationship shared by caregiver and offspring. Bonding is not essential to attachment (as studies of adoptive parents show) but typically leads to attachment in most mother–infant dyads.

Developmental scientists from different disciplines typically approach the phenomenon of attachment from various orientations. Scientists studying the neurobiological substrates of attachment or attachment relationships in nonhuman populations are interested in attachment as a normative phenomenon, and seek to clarify its origins and outcomes. Researchers studying humans more often focus on individual differences in attachment relationships and their consequences. In each case, conceptualizations of attachment permit analyses of how these relationships contribute to support, security, and the regulation of one or both partners. Ethological studies of pair bonding emphasize analyses of whether two animals have established a pair bond and the processes (behavioral and neurobiological) that contribute to the formation of the bond. Both behavioral and neurobiological approaches are required to understand the disturbances in relationship formation of individuals whose early environments and experiences deviate sufficiently from the expectable environment that they cannot form a normal attachment relationship at the species-typical time.

Attachment in Mothers

The formation of a specific, unique relationship between an infant and an adult begins before birth, and its bidirectional character is evident early. In mammals,

for example, there is a biological priming of the physical and behavioral aspects of becoming a mother. Progesterone levels are high during pregnancy and decrease toward the end of pregnancy; estrogen levels increase to promote the synthesis of oxytocin receptors (Keverne, this volume). Oxytocin[1] is critical for stimulating uterine contractions during labor and for the ejection of milk. During birth, there is a massive release of oxytocin, a hormone which has also been shown to facilitate maternal behavior (Pedersen and Prange 1979) and formation of selective social bonds in some mammals (Carter 1998).

A major factor in establishing maternal behavior in mammals appears to be the shift in motivational processes toward selective reinforcement of maternal behavior (e.g., nursing, infant grooming, infant retrieval, physical contact, and protection of the infant), which are relevant to the infant's early physiological regulation, well-being, and survival. Research on the endogenous opioid, dopamine, and oxytocin systems in relation to maternal behavior and the formation of social bonds indicates that these three systems are likely to be involved in the predisposition to bond, which is related to a dramatic change in the reinforcing properties of mother–infant interaction for the mother (e.g., Aragona et al. 2003). Blocking opioid receptors with naloxone in postpartum rhesus monkeys reduces maternal initiation of caregiving and protective behavior toward the infant, including grooming and infant retrieval (Martel et al. 1993). Blocking opioids in sheep also blocks oxytocin release (Keverne, this volume). Blocking oxytocin receptors has been shown to decrease maternal behavior in mammals, including decreasing the percentage of time a mother rat grooms her infant compared to the time she grooms herself (Pedersen and Boccia 2002). Dopamine–oxytocin interactions have been implicated in the formation of social bonds in some mammals, and it has been proposed (Insel 2003) that the rewarding effects of dopamine could be related to the strong positive emotional feelings associated with the formation of social bonds.

In primates, compared to smaller-brained animals, there may be less exclusive reliance on these hormonal systems and more reliance on experiential and cognitive influences to initiate a shift to preferential reinforcement of caregiver–infant interactions; this may also allow nonbiological mothers and other individuals to provide high-quality caregiving. However, pregnancy and birthing still supply significant biological priming in all primates to facilitate the mother–infant bonding process. But understanding better the nature of the interaction between neurohormonal systems and the influences of particular

[1] Oxytocin is synthesized in magnocellular neurons of the paraventricular and supraoptic nuclei of the hypothalamus (Swaab et al. 1975; Vandesande and Dierickx 1975). It is processed from precursor forms, together with carrier proteins, along the axonal projection to the posterior pituitary, from which the peptide is secreted into the systemic circulation (Brownstein et al. 1980). Oxytocin is widely distributed throughout the central nervous system from smaller parvocellular neurons and influences many neurobehavioral functions (de Wied et al. 1993; McCarthy and Altemus 1997).

experiences and related cognitions and attributions is an important task of research concerning the development of maternal behavior in humans. This is particularly so since experiential influences (e.g., the absence of social support) and cognitive factors (e.g., the self-attributions associated with maternal depression) may function contrarily to the biological primes that would ordinarily help to activate maternal behavior, resulting in more troubled early mother–child interactions and disruptions in the bonding process.

Attachment in Offspring

The development of an attachment relationship is an extended developmental process for offspring, and research in this area has focused more on behavioral than hormonal processes (for reviews, see Cassidy and Shaver 1999; Colin 1996; Lamb et al. 1985; Thompson 1998). The extended process of attachment owes not only to the child's physical and socio-emotional immaturity. If one of the distinctive features of attachment entails an individualized relationship from which the baby can predict and form expectations for the partner's behavior, cognitive advances are necessary before the child can generalize broader social expectations from specific event representations of a particular partner. Several achievements must occur: Cognitively, the infant must be capable of recognizing the adult's voice, face, and/or other features, integrate these features into a perceptual whole, and identify the attachment figure consistently across different contexts. Affectively, the infant must begin to associate the caregiver's presence with distress relief, heightened pleasure or joy, and/or other qualities that contribute to a preference for the attachment figure's stimulus characteristics. In this respect, the child must also develop an awareness of the contingencies that exist between the child's behavior and social responses from the adult. A history of shared experiences is required to enable infants to develop these cognitive capacities and affective expectancies, of course, but there is evidence that this begins to develop quite early. Between three and six months of age, for example, infants reveal a generalized expectancy that others will respond to their initiatives in the "still face" paradigm (in which infants respond positively to their mothers' interactive behavior but become withdrawn, more sober, and behaviorally provocative when their mothers are instructive to be impassive to them). During the second half of the first year, a distressed infant will sooth to the sound of the mother's distinctive footsteps as she approaches to provide comfort (Cohn et al. 1991; Gekoski et al. 1983; Lamb and Malkin 1986). In general, infants respond with positive emotion to their perception of social contingency from early in the first year (Watson 1972, 1979).

All of these prerequisites for developing attachment relationships are evident in the young infant's responses to attachment figures, but some of these responses are also displayed with familiar figures to whom the baby is not attached. There are other elements to attachment formation that are likely to be

more specific to the attachment figure. One is the adult's privileged influence over the infant's developing neurobiological regulatory systems, which arises through repeated shared interactions: feeding, soothing, play, and other experiences involving arousal and its regulation. Owing to the frequency with which the caregiver manages the baby's positive and negative arousal, the adult's responsiveness becomes a salient and important influence on the child's biobehavioral regulation and experience of well-being (Gunnar, this volume; Gunnar 2000; Gunnar and Donzella 2002). Together with the cognitive expectancies in the baby created by these recurrent (daily) experiences, this contributes to the qualities that may make attachment relationships distinct from others to the baby: they are individualized relationships from which the infant develops expectancies for the partner's behavior that help to define the affective quality of their relationship, afford security, and contribute to the child's self-regulation.

Other potentially important developmental influences also contribute to the initial creation of attachment relationships. Joint attention is probably central to the interactive experiences leading to attachment, especially as it relates to the child's growing capacity for intersubjectivity and developing understanding of the mother as a person (e.g., Harris 1996; Tomasello 1999). The role of self-produced locomotion, which has been shown to be an important influence on affective development and parent–child relations late in the first year, may also be relevant to the development of attachment as well as to the growth of security or insecurity within this relationship (Campos et al. 1992). In short, although attachment researchers have devoted considerable attention to the origins of individual differences in attachment, much more work is needed to elucidate how and why attachment develops initially and the ontogenetic processes in brain and behavior that cause infants to become attached to their caregivers.

What are the behavioral indicators of attachment in the young? It appears that behaviors such as recognizing the mother (her face, voice, and/or smell) and joint attention — and the experiences of intersubjectivity with which they are associated — may contribute to the development of an attachment relationship but are not, in themselves, definitive because they are also displayed with non-attachment figures. On the other hand, a large literature on attachment in infancy has developed during the past thirty years that enlists the 12-month-old baby's responses to separation and reunion with the mother (within the Strange Situation procedure) as an index of attachment (for reviews, see Cassidy and Shaver 1999; Lamb et al. 1985). The problem here is the variability in cultural child-rearing conditions that make short separations differentially stressful for one-year-olds (indeed, to mothers of some cultures, the extent of normative separation between mother and baby required in most Western societies might be regarded as abusive) (Thompson 1998). Other indices of attachment that are likely to be differential to the attachment figure include monitoring the physical location of the adult, developing strategies for reestablishing proximity and contact with that figure when needed (with "psychological access" substituting for

physical contact with increasing age), the reallocation of attention and effort from other interests to reestablishing contact or access when it is precluded, and preferentially seeking contact or access to the attachment figure under conditions of threat or stress. These reflect how the attachment figure functions as a "secure base" as well as a haven of safety for the child under stress. In addition, the child's "affective sharing" (i.e., making social contact for purposes of conveying pleasure in a discovery or achievement) may also be an important marker of the existence of an attachment relationship in infants and young children (Ainsworth et al. 1978).

It is clear that the behavioral markers of an attachment relationship will be developmentally flexible and somewhat different in the years from birth to adolescence based on the changing cognitive, social, and emotional capabilities of the child, but they are likely to share in common reliance on attachment figures as supportive havens for exploration, a secure base during stress, and assistance in developing self-regulation. Indeed, although attachment theorists vary in their underlying conceptions of the psychological qualities definitive of attachment relationships (e.g., the emphasis on secure base behavior of theorists like Waters and Cummings [2000] compared with the focus on the adult as a haven of safety by others; see Thompson and Raikes [2003]), children are likely to rely on attachment figures for all of these reasons. Candidate indices for the development of an attachment relationship in older children are important both for normative reasons (children often form new attachments to individuals like stepparents) and for clinical reasons (such as indexing attachment in children whose aberrant early experiences have precluded the creation of reliable adult relationships). Such behaviors might include: (a) monitoring the well-being of the attachment figure (e.g., concern over that person's health, injury or harm), (b) motivation to maintain the self as a valued figure to the adult (e.g., sharing accomplishments with that person and the salience of the adult's expressions of pride or disinterest in those accomplishments), and (c) competition for the attention of the attachment figure in preference to others of interest to the adult (such as other offspring or adult partners). Although we might colloquially call the latter "jealousy," the activation of attention-seeking behaviors in these circumstances probably reflects the development of a differentiated, exclusive emotional attachment to a specific, valued person.

Clearly, considerable theoretical and empirical work is needed to understand better the indicators that an attachment relationship has developed between a caregiver and a child. It is apparent, however, that there is no rich literature on the developing biological foundations of human attachment in the infant, comparable to the extensive understanding of the hormonal determinants of bonding in the mother. It would be especially desirable, therefore, to have greater knowledge of specific brain systems whose maturation is relevant to the unfolding of attachment relationships early in life, and which humans may share with other

primate species and, indeed, with other mammalian species. This constitutes a pressing research need for the future.

Development of a Bidirectional Relationship

Cross-culture research of humans instructs us that infants develop attachment relationships with multiple caregivers and that, in many cultures, caregivers other than the mother care for the young and elicit responses consistent with an attachment to them. The behavioral propensities that cause a caregiver to become an attachment figure vary across species and, within humans, cross-culturally because of the variety of ecological and cultural constraints and incentives that define caregiving. Among these influences are the availability of cooperative conspecifics who can function as alloparents (Hrdy, this volume), subsistence strategies and workload (Blurton Jones 1993; Hurtado et al. 1992; Panter-Brick 1995), and the condition and needs of the infant. All of these shape the environmental context in which care occurs. What remains unclear in many studies is the degree to which the childcare strategies found in different cultures represent adaptive choices or environmental constraints. To clarify this, detailed knowledge of the costs and benefits of various childcare options are necessary to determine more precisely parents' trade-off problems. This knowledge is necessary to recognize the outcomes of parenting favored by natural selection: maximization of production of offspring, of their survivorship, or of their social and material endowment (Blurton Jones 1993).

In the human attachment literature, particular attention has been devoted to variations in maternal responsiveness and sensitivity as a major proximate (or psychological) determinant of the formation of attachment relationships and, especially, of variations in the child's sense of security within those attachments (Ainsworth et al. 1978; De Wolff and van IJzendoorn 1997). Most recently, a cognitive construct called maternal "mind-mindedness" has been studied as a complement of maternal sensitivity (Meins et al. 2001). Although maternal sensitivity must itself be expressed in culturally specific ways, its importance reflects the safe haven/secure base/supporting self-regulation features of attachment relationships highlighted above.

Beyond this, it is apparent that the attachment system is robust or, in evolutionary terms, highly canalized. Even in aberrant and abusive conditions of care (e.g., those of Romanian orphanage children or others subjected to neglectful institutional care), the majority of children manage to create attachments to new caregivers after their rescue (indexed by criteria like those discussed above), often long after the normative developmental period for creating first attachments has passed, although many children still have lingering sequelae (O'Connor, this volume). This reflects a system that is both resilient and, in the context of cultural variability in normative conditions of child care, flexible.

EARLY ATTACHMENT AND INCLUSIVE FITNESS

Behavioral and neurobiological studies of attachment in mother and infant are theoretically framed by the assumption that attachment evolved as an adaptation to promote the inclusive fitness of each partner. It is thus important to inquire about how attachment processes relate to the reproductive success and inclusive fitness of mother and baby.

In the case of the infant, the answer seems clear. It is beneficial to remain close to, and to elicit the proximity of, mature conspecifics who are likely to provide protection, nurturance, developmental guidance, and other survival-related forms of assistance when nearby. It follows, therefore, that infants are likely to be biologically organized to strive to obtain maximal resources from the caregiver, assuming that the caregiver is both willing and capable of providing these resources for her offspring.

Fitness considerations for the mother in forming attachments to offspring are more complicated. Promoting the survival, health, and well-being of each child contributes to the mother's lifetime reproductive success. However, maternal energy and other resources to invest in reproduction are finite and must be divided between the demands of multiple offspring and the mother's own physical requirements, including her own future reproductive potential. Consequently, the determinants of maternal investment in any particular offspring are complex, based in part on characteristics of the child (health, intactness), the presence of other offspring, environmental resources (e.g., social support), and the mother herself.

Norms for infant care vary across cultures, but within populations, mothers may also vary in their commitment to offspring depending on their circumstances. In adversity, mothers may retrench their investment or even terminate it altogether by abandoning or even eliminating offspring through infanticide. Across traditional societies, rates of infanticide vary from a low of around 1 per 100 births in the nomadic hunting and gathering !Kung to rates as extreme as 40% or higher in groups like the Eipo of highland New Guinea, where there is a strong preference for sons that leads mothers to expose daughters (Schiefenhoevel 1989). The conditions and determinants of infanticide in these and other cultures merits further study, especially in relation to the theoretically predicted determinants of maternal investment outlined above. The occurrence of infanticide in the past (reviewed in Hrdy 1999) suggests that whenever other forms of birth control were not available, mothers who lacked what they needed to rear offspring resorted to infanticide. This suggests that infanticide as a means of birth spacing was likely to have been an option among our human ancestors in the Pleistocene environment of evolutionary adaptedness (EEA). Newborns were and are at high risk of not being accepted by their mothers. The contingent nature of maternal solicitude in our species has meant that infants are biologically selected to look appealing to mothers from birth onward and to act in ways

that demonstrate their health and vitality, including robust crying, limb movements, facial engagement, and visual gazing. Mothers are highly sensitive to these cues in the baby during the immediate postpartum period. Because of the time lag until the onset of lactation and full engagement of bonding, neonates may be especially vulnerable during the 72 hours or so immediately after birth, which is the period when most abandonment or infanticide committed by mothers occurs. Once breastfeeding has been established and the mother has begun to recognize her baby as an individual, the decision to terminate investment becomes much more difficult.

One lesson deriving from this discussion of maternal fitness considerations is that the mother's adaptive interests do not always coincide with those of the baby. In certain circumstances (perhaps commonly, if not always, associated with infanticide in traditional societies), it may be in the mother's lifetime reproductive success to withdraw care from an infant in order to invest in other (perhaps more healthy) offspring or in other ways that improve her chances of producing more offspring in the future. This, of course, is not in the adaptive interests of the baby. Divergence of fitness considerations means that maternal solicitude cannot always be expected and that maternal sensitivity is a highly contingent phenomenon when viewed within the context of biological adaptation. This is not only true during the postpartum period but in other developmental periods as well. Trivers (1974, 1985) states that weaning conflicts later in infancy reflect a divergence of the fitness interests of mother and baby. During weaning conflicts, the child's interests in maximizing and maintaining the mother's investment in feeding conflicts with the mother's interests in withdrawing resources for the sake, for example, of preparing for future offspring (Blurton Jones and Da Costa 1987). There are likely other developmental periods when the interests of mothers and offspring diverge to create conflict between them and, in another sense, constitute biologically adaptive forms of maternal insensitivity. The conclusion that maternal disinvestment, withdrawal, and/or insensitivity is, at times, biologically adaptive conflicts with the underlying assumption of many developmental theories, including attachment theory, that parental investment is biologically prepared and that departures from maternal sensitivity are adaptively anomalous. It remains for developmental theorists within psychology to explore more fully the implications of the fitness considerations of mother and baby, especially early in life, for understanding the conditions in which maternal solicitude can and should be expected, and when it should not, and the consequences of this for the mother–child relationship. It is especially important to understand and distinguish processes that may be biologically adaptive for the mother and baby from those that are psychologically adaptive for either partner.

Humans are reproductive strategists, and there are many other considerations that shape maternal investment decisions (for a review, see Voland 1998). These include the infant's health, gender, the type of birth (single vs. twin), maternal

age and previous reproductive history, and social support from others in the human community. Thus inter- and intraindividual variability in investment decisions can be expected and is fully consistent with an evolutionary perspective on attachment and bonding. Among these considerations, the importance of social support merits further examination, especially because of its associations with maternal retrenchment, infanticide (Hrdy 1994), and postnatal maternal depression (Hagen 1999). If it is true that human communities in the EEA involved cooperative caregiving (Hrdy, this volume), then judgments of the extent of social support available are probably another important source of information relevant to inter- and intra-individual variation in maternal investment and attachment.

Indeed, social support may be significant not only because of its relevance to inclusive fitness considerations but, more proximally, as it interacts with the neurohormonal priming of maternal behavior after birth. There is, of course, substantial evidence indicating that psychosocial risk factors (e.g., lack of social support) contribute to a wide spectrum of somatic, psychosomatic, and psychiatric disorders with major public health significance, such as depression (Bruce 2002; Kraemer et al. 2001; Rozanski et al. 1999). In animals, oxytocin has been shown to exert behavioral and physiological stress-attenuating effects and, as noted earlier, to promote positive social interaction and attachment (Carter 1998; Legros 2001; McCarthy and Altemus 1997; Pedersen 1997; Pedersen and Boccia 2002). The specific effects of oxytocin as a biological mechanism for the reduction of stress and anxiety as well as the promotion of positive social interactions are yet to be determined in humans. In one study, however, oxytocin appeared to enhance the efficacy of social support in coping with stress (Heinrichs et al. 2003). Here, 37 healthy men were subjected to a stress test: participants were randomly assigned to receive either intranasal oxytocin[2] or a placebo shortly before the test, and they received either social support from their best friend or no support during the preparation period. The findings revealed that the combination of oxytocin and social support was associated with the lowest subsequent cortisol concentrations as well as enhanced calmness and decreased anxiety during the stress test (social support was also directly associated with lower cortisol, and oxytocin was directly associated with reduced anxiety). In this sense, oxytocin seemed to enhance the buffering effects of social support on stress responsiveness. These results are in accord with data from animal research, which suggests an important role of oxytocin as an underlying biological mechanism for stress protective effects of positive social interactions.

There are thus significant biological, social, and cognitive contributions to the development of attachment consistent with species fitness requirements, and

[2] Some studies on the central effects of oxytocin and vasopressin in healthy humans and clinical patients have been conducted with exogenous stimulation using intranasal administration (Born et al. 1998; Bruins et al. 1992; Heinrichs 2000; Pitman et al. 1993). Neuropeptides have recently been shown to enter the cerebrospinal fluid directly following nasal administration (Born et al. 2002).

these multidetermined influences introduce considerable flexibility to the attachment system, especially in the context of substantial cultural variability in childcare practices. In this sense, cultural variability usually reflects adaptive phenotypic plasticity. This is important, especially in light of the differences between Eastern and Western prototypical conceptions of self (Greenfield et al. 2003; Markus and Kitiyama 1991) and the parenting strategies and child-rearing goals with which they are associated. Although attachment theory may primarily reflect Western approaches to parenting and child development (particularly emphasizing practices that contribute to the development of independent agency and self-respect in offspring), considerable variability in parenting practices and child-rearing goals can be accommodated within attachment formulations and broader biological models of the parent–child relationship. This is because a general species-typical repertoire of parenting practices can be activated in different compositions or styles in response to ecocultural demands (Keller 2000, 2002). As one illustration, a network of institutional and personal sources of social support and a broad variety of reproductive options (including birth control) may be one reason why rates of infanticide are much lower in Western industrialized nations compared to those observed in more traditional hunter–gatherer and horticulturalist societies. Although not all cultural systems are necessarily consistent with the adaptive requirements of infant care and well-being, it is clear that evaluating these cultural practices requires understanding the broader ecological and material circumstances affecting parenting practices within these niches.

BIOLOGY–BEHAVIOR MECHANISMS MEDIATING EARLY ATTACHMENT

Attachment is a biologically based behavioral system (Bowlby 1969, 1973). Within a systems view, such a behavioral system integrates biological substrates with behavioral control processes that exist within the child and the environment. Attachment theorists believe that the attachment system is one of several behavioral systems deeply rooted in our biological heritage. An exploratory system, for example, functions interactively with the attachment system such that exploratory interest decreases when children become concerned with reestablishing contact with an attachment figure (see Grossmann and Grossmann, this volume). A fear/wariness system is believed to have evolved to guide a child's reactions to circumstances of potential danger or threat. Importantly, morphologically similar behaviors may be motivated by different behavioral systems: a baby's cry may be a signal to a caregiver to reestablish proximity (attachment) or a distress response to an unexpected event (fear/wariness), and in many circumstances both systems may be activated simultaneously. The value of a behavioral systems perspective is that it permits developmental scientists to understand the complementary and conflicting motivational processes that exist from an early age, each of which has adaptive value.

The complexity of behavioral systems is based, in part, on the complex relations between biological functioning and behavioral responding within and across each system. For example, Spangler and Schieche (1998) recently showed that cortisol levels increased with distress in insecurely attached infants, but cortisol had no relation to crying for securely attached infants when each group was observed in standard stress procedures. Understanding these interrelations requires considering the behavioral systems that might be involved in each case (with fear/wariness perhaps evoked along with attachment for insecure infants), and the influence of attachment relationships on children's developing emotional self-regulatory skills. Concerning the latter, the attachment figure appears to contribute to modulating the functioning of the child's stress response in secure relationships, but this does not occur in insecure attachment relationships (Hertsgaard et al. 1995; Spangler and Grossmann 1993). This influence is especially prominent in infants who are behaviorally inhibited, for whom the internal resources for coping with stress may be more limited (Nachmias et al. 1996; Spangler and Schieche 1998).

Relations between biological functioning and behavioral development are thus complex and interesting. There is now abundant evidence from the animal literature of how early caregiving experiences tone the dynamics of stress response. The work of Michael Meaney, Seymour Levine, Paul Plotsky, and others shows, for example, that early maternal deprivation (and the reduction of maternal licking and grooming) during the preweaning period for rat pups has a number of significant consequences on the rat's subsequent physiological and behavioral functioning (Bredy et al. 2003; Francis et al. 2002; Rosenfield et al. 1992; Sanchez et al. 2001). These include heightened neophobia and fearfulness, increased corticotropin-releasing hormone (CRH) in the amygdala and locus coeruleus, a reduced number of glucocorticoid receptors, and increased and more prolonged corticoid and adrenocorticotropic hormone (ACTH) responses to psychosocial or progressive stressors. The continued sensitivity of these behavioral and physiological systems to further experience is revealed in subsequent research that shows considerable recovery in these functions when the rats were subsequently placed in cages affording complex social and physical stimulation (similar to a "complex environment"). When compared with preweaning-deprived rats who continued in deprived circumstances, those in the preweaning-deprived condition who subsequently lived in complex environments showed diminished neophobia and fearfulness, diminished corticoid and ACTH responses to stressors, and other indications of enhanced coping. Their outcome functioning was, indeed, more comparable to those of rat pups who had experienced early handling without maternal deprivation. Nonetheless, they still exhibited reduced numbers of corticoid receptors in regions of the brain involved in feedback regulation of the system.

Recent studies of rhesus monkeys and human infants reared in aberrant, species-atypical conditions tell a similar story: early experiences of deprivation and

neglect are associated with disturbances in the diurnal rhythm in cortisol[3] levels (Boyce et al. 1995; Carlson et al. 1995). The effect is most easily identified at the peak of the cycle, when deprived human infants frequently show a blunting of the peak and, for some, there may be relatively unvarying levels of cortisol throughout the day (Gunnar and Vazquez 2001). These atypical diurnal rhythms do not constitute, however, a fixed characteristic of the child: changing the caregiving context alters these patterns. In one study (P. Fisher, pers. comm.), children entering foster care were monitored for the first six months of their placements. Those children living in homes where their foster parents had been given special support and training to manage the needs of traumatized children tended to establish a robust diurnal cortisol rhythm over time, whereas those children in unsupported foster care placements did not improve and sometimes showed a worsening of the diurnal pattern.

One of the contemporary challenges of denoting biology–behavior connections in psychology that is relevant to the study of attachment concerns how we conceptually organize our understanding of physiological and behavioral systems. As research on the functional organization of the brain reveals, there is no direct connection between the complex psychological functions we seek to understand (e.g., categories of thoughts, feelings, and motives) and the functional development of specific brain regions. Indeed, there is no reason to expect that this would be so, given that the ways which scientists have classified psychological experience during the past century derive more from influences from

[3] The cortisol system is often interpreted as a simple physiological measure of stress, a view that leads to considerable confusion about the meaning of cortisol findings. Instead, it might be more accurately viewed as reflecting a dynamic balance between opposing arousal and anti-arousal mechanisms. Under conditions of threat and loss of control, elevated cortisol is related to loss of safety and the arousal of fear and anxiety, whereas low cortisol appears to be a compensatory defensive response to heightened arousal associated with emotional withdrawal, including emotional numbing, avoidance, and other disengagement strategies (Wolff et al. 1964; Mason et al. 2001). The latter may also be associated with diminished interpersonal sensitivity and compassion (Henry 1993). Under conditions of safety (from which social engagement and attachment behavior emerge), elevated cortisol is related to arousal and active engagement, but not fear, and has been associated with increased social competence (Hart et al. 1995) and sensitivity (Fleming et al. 1997). Lower cortisol under safe conditions is related to low arousal states and passive engagement (Handlon et al. 1962). This framework, which considers the perception of safety and level of engagement as important factors in determining the "meaning" of cortisol findings, may help us interpret apparently contradictory findings, such as high cortisol being related to fear and anxiety, on one hand, and increased competence and sensitivity, on the other, as well as low cortisol being associated with maladaptive behavior and also with increased relaxation and well-being in different circumstances. It also provides an orientation for understanding the response of individuals who have experienced early trauma or deprivation, which may create a bias toward heightened perception of threat and make it more difficult for them to engage in a mode of safety and relaxation associated with social engagement and attachment behavior (Henry and Wang 1998).

Western philosophy than from cognitive neuroscience.[4] Contrary to the tendency of popular psychology to denote specific brain regions as the centers for complex psychological motives, neuroscientists are increasingly emphasizing the complex interconnections between multiple brain areas related to ordinary as well as sophisticated psychological processes. This poses a challenge, however, to efforts to identify interconnections between biological and behavioral functioning in psychological development, and suggests that it may become necessary to reconsider conventional ways of conceptualizing psychological processes to accord better with the developmental organization of the brain. With respect to attachment, for example, it may be necessary to "unpack" conceptually the complex cognitive, affective, and motivational elements of attachment functioning (see above) before developmental associations with the functional emergence of specific brain processes can be revealed. Similarly, it may be necessary to reconsider early behavioral organization in terms of broad motivational systems (e.g., attachment, exploration, fear/wariness) when the neurobiological substrates are likely to be organized much differently. Such an effort is worthwhile, however, for the potential it affords to understand better the ontogeny of this important social phenomenon in a concertedly integrated biobehavioral manner.

DEVELOPMENT OF ATTACHMENT EARLY IN LIFE

Attachment theorists have identified several stages in the development of attachment relationships during the first year of life that accord with the earlier discussion of the cognitive and affective origins of attachment in offspring (Ainsworth et al. 1978; Bowlby 1969; Lamb et al. 1985). During the initial months of life, a young infant typically responds in an undifferentiated social manner, with clear social discriminations later emerging at about 3–4 months of age as the child responds uniquely to familiar social partners. According to attachment theorists, another important transition occurs early in the second half of the first year, when infants begin to focus preferentially on specific partners, and this is reflected in the emergence of separation protest and, to a lesser extent, stranger wariness. As infants acquire locomotor skills, they begin to search for the caregiver when absent and follow the caregiver when present, which further reflect the baby's active engagement with a specific partner who is becoming an attachment figure for the child. This developmental sequence culminates by the end of the first year, when theorists believe a differentiated attachment relationship has fully developed.

[4] The same problem applies to the nosology of psychiatric diagnosis and efforts to denote connections between diagnostic categories and neurobiological processes. Indeed, the normative comorbidity among psychiatric diagnoses and the complexity of symptomatology together suggest that the diagnostic categories of clinical practice require considerable reexamination, hopefully informed by the emerging insights of the neurosciences.

Although there is evidence that infants identify familiar figures earlier than Bowlby and Ainsworth had hypothesized, and research on joint attention highlights the greater sophistication of young infants in inferring mental states in adults, this general developmental framework has held up well to the tests of time and empirical inquiry (Thompson 1998). Most research concerned with attachment in infancy has focused not on its normative development but rather on individual differences in the security of attachment, distinguishing infants who are securely attached from those who are insecurely attached. This research has been guided by a general theoretical expectation that secure attachment promotes more confident exploration in infants as mothers function as a secure base for the child and as a haven of safety when the baby is threatened or alarmed (Ainsworth et al. 1978).

Bowlby's (1969, 1973) developmental theory of attachment also posited another stage in the development of attachment relationships after the first birthday. In toddlerhood, he proposed, children become capable of engaging in a "goal-corrected partnership" with the attachment figure based on their growing comprehension of the caregiver as a psychological figure with needs, interests, and feelings of her own. At the same time, other aspects of mental representation become increasingly important in their relationship as attachment security changes from an exclusively behavioral system to a representational system in which security becomes mediated by the child's expectations and representations of the caregiver's behavior. These representations, or "internal working models" (IWMs), arise out of the simpler behavioral expectations that underlie attachment security in infancy, and become more elaborated and complex with increasing age and the growing sophistication of the child's representational skills (Bretherton and Munholland 1999). Indeed, according to one formulation (Grossmann and Grossmann, this volume), different forms of IWMs emerge developmentally as new representational capacities emerge and as children become capable of sharing and comparing their representations of experience with others through language (Thompson 1998, 2000). By adulthood, attachment is a fully representational system that has become associated with self-understanding, relational intimacy, and caregiving of offspring.

These developmental formulations are important and provocative, but they raise new problems for the study of early attachment and its consequences. One basic challenge is that there is little theoretical guidance concerning the development of attachment relationships beyond the phase of the "goal-corrected partnership." General developmental formulations exist, however, that have been broadly accepted by attachment researchers (Thompson and Raikes 2003). Attachment security increasingly becomes an attribute of the person rather than of a specific relationship with increasing age (e.g., as children's representations of relationships become generalized across different partners). The IWMs underlying security of attachment also become more complex and multidimensional but internally coherent over time, consistent with advances in intellectual

growth. Attachment theorists also tend to agree that parent–child relationships change over time with the child's psychological maturity and that the requirements of parental responsiveness evolve even as the adult's sensitivity has a continuing influence on the maintenance of a secure attachment. In adolescence, for example, the parent–child relationship must accommodate the concurrent psychological needs for relatedness and autonomy in young people and the dynamic balance between these needs shapes the security of attachment (Allen and Land 1999).

Beyond these general ideas, theory development is critically important to clarify, for example, how other changes in the relationship shared by a child with a caregiver occur as a consequence of the child's psychological growth, how IWMs evolve with the development of cognitive skills, and the bases for consistency and change in attachment representations over time. Understanding the development of IWMs in relation to concurrent growth in cognition is especially important. For example, from the perspective of current ideas about domain-specific conceptual skills (e.g., Hirschfeld and Gelman 1998), the IWM might be conceptualized as a "theory of attachment" (G. Spangler and A. Delius, pers. comm.) that includes representations, assumptions, and expectations concerning attachment, behavioral strategies, and attachment figures. Such a "theory" is based on early experiences with the attachment figure but would be expected to change and become more complex with later experiences and advances in conceptual growth, as do other intuitive "theories" of mind, biological kinds, and other conceptual domains in early childhood. Another approach describes the development of IWMs within a neo-Vygotskian framework in which implicit features of the conversations shared by parents with young children shape emergent representations of relationships, self, and psychological understanding, consistent with the literatures on event representation, autobiographical memory, and theory of mind (Thompson 1998, 2000; Thompson et al. 2003).

Further development of attachment formulations is also needed to elucidate the defining features of attachment relationships that exist in middle childhood, adolescence, and adulthood, and how they are associated with attachment relationships formed in infancy and early childhood (Raikes and Thompson 2004). Absent theoretical guidance, attachment researchers who have been interested in exploring these issues have had to work inductively, bootstrapping theoretical explanations onto empirical findings, and have had to develop methods and procedures that presuppose theoretical clarity that does not yet exist.

Theoretical development should be a guide to the development of measures and methods in the study of attachment, rather than the reverse. Thus another challenge raised by the developmental study of attachment is the need for theoretically based, valid, and reliable assessments of attachment after infancy (Thompson and Raikes 2003). There has been a proliferation of attachment assessments in recent years for research into attachment in middle childhood, adolescence, and adulthood. With the exception of the concerted validational work

on the Adult Attachment Interview (AAI), researchers have not tended to focus on their validation. There have been no efforts comparable to the careful validation of the Strange Situation for measures of attachment security in childhood or adolescence. This is unfortunate, because it means that there have been critical assumptions incorporated into the creation of attachment assessments that merit more careful examination.

For example, several widely used assessments of attachment after infancy rely on the quality of children's narrative discourse in response to incomplete story stems or doll-play prompts (Solomon and George 1999). Children's responses are often evaluated in terms of their coherence, in a manner similar to how narrative coherence is a central feature in assessing adult security from AAI responses. In adult studies using the AAI, lack of coherence is assumed to reflect the influence of defensive processes in adults' recollections of early childhood care (Hesse 1999). Where children are concerned, there are important questions concerning whether children's semiprojective story responses and the quality of their narrative stories can be comparably interpreted. Can "coherence" be similarly interpreted as reflecting unconscious defenses in a child's account compared to an adult's? Are children of age 5, 8, or 13 comparably capable of reflecting on the quality of their relationships with their attachment figures or of projecting onto story stems the affective features of their relationships with their caregivers? These are especially important questions in light of concerns, related to the AAI, that Grice's maxims of communicative coherence are a limited and culturally focused approach to discourse analysis. In the same way that individuals from dissimilar cultures have different narrative styles for which "coherence" must be interpreted distinctly, so too do children of different ages have various narrative skills to make "coherence" mean something particular for them. In the developmentally downward extension of the methodology of the AAI to research with children and adolescents, there may be important developmental differences in a variety of capabilities that require greater consideration in the interpretation of children's narrative discourse.

Another issue concerns how individual differences in attachment security should be characterized. It is remarkable that the adult attachment categories yielded by the AAI are so closely comparable to the fourfold classification categories of the Strange Situation, as though no further developmental changes in the organization of attachment from infancy to adulthood were expected. With few exceptions, researchers have devised attachment assessments for children of different ages that yield security delineations that are also quite similar to the Strange Situation classifications (Thompson and Raikes 2003). In the developmentally upward extension of the classifications of the Strange Situation to research with children and adults, important theoretical assumptions about the consistency of the organization of attachment security and insecurity are made that seem, in some respects, contrary to the wealth of psychological changes that occur from infancy to adulthood.

This is particularly surprising because in other ways, attachment in adults and infants is much differently conceptualized. In infancy, attachment security is relationship-specific, behaviorally oriented, and focused on current relational experience in which secure base behavior is a central index. For adults, attachment security is thought to be an attribute of the person rather than of specific relationships, representationally oriented, with assessments focusing on past relational experience (primarily in childhood) in which discourse coherence is a central index. There is a developmental account that is inherent in these differences in conceptualization and assessment that attachment theorists have yet to articulate and develop fully. Such an account would clarify how IWMs grow from infancy to adulthood, and how attachment transitions from a behavioral system early in life to a fully representational system in adolescence and adulthood. It would also articulate the dynamics of stability and change in the organization of the attachment system over life, and clarify expectations for whether early attachment security is expected to lead to security throughout life, or whether change is possible or likely.

How the development of attachment is theoretically conceptualized also has implications for expectations of stability or change in attachment relationships over the life course. In general, attachment theory has had strong claims, based on its object relations theory progenitors, that because attachment initially emerges during a formative early period of psychological development in infancy, its effects are likely to be long-lasting. Thus if the first and primary mother–infant relationship is secure, it is likely to remain so and will, furthermore, bias the infant to expect security and to elicit warmth and sensitivity from other relational partners, partly because of the influence of security on the child's developing IWMs (e.g., Sroufe and Fleeson 1986). In a sense, early developing attachment security becomes self-perpetuating because of how it shapes the internal representations that the child brings to new relationships and new opportunities for relational intimacy. The same is true, of course, of early attachments that are insecure.

Below, we discuss research evidence concerning this theoretical view. Theoretical expectations still need to be elaborated, however, to guide research as to the development of attachment. In a sense, attachment scientists have a valuable opportunity to extend systematically Bowlby's provocative formulations to the development of attachment in childhood, adolescence, and adulthood to give clarity and coherence to empirical efforts, and to do so in light of emerging findings in developmental neuroscience.

CONSEQUENCES OF EARLY ATTACHMENT FOR CHILD AND MOTHER

Studying continuity and change in psychological functioning presents developmental scientists with the formidable challenge of documenting heterotypic

continuity. When studying the consistency of psychological functioning in rapidly changing organisms over time, or the consequences of early functioning for later behavior, researchers must find ways to index psychological processes that are believed to remain continuous over time but are manifested in different, developmentally appropriate ways. In this sense, their search for continuity is "heterotypic": its manifestations will be different at various ages.

Consequences for the Child

This challenge is especially apparent when considering the consequences of attachment for the child. There are two senses in which one might be concerned with the consequences of attachment relationships for a child's development (Thompson 2001). First, one might ask: What are the consequences for the child *having become attached* to a caregiver? From an adaptive standpoint, the answer is likely to focus on the child's survival to maturity and reproductive success; from the perspective of psychological growth, an attachment relationship provides a child with a socio-emotional connection to another individual that influences self-understanding, social competence, and self-regulation. These are issues that merit further exploration. Second, attachment research has been concerned with a different question: What are the consequences for the child of *individual differences* in the security of attachment? Do securely attached children show different forms of self-understanding, emotional understanding, friendship and peer relationships compared with insecurely attached children? The challenges of heterotypic continuity are encountered in seeking to understand whether a secure attachment early in life leads to security in later years and to other sequelae (e.g., social competence, self confidence, emotional understanding) that might be expected from secure versus insecure attachment.

As considered earlier, one expected outcome of a secure parent–child attachment is that the parent–child relationship will remain secure in years to come. This concerns the stability of individual differences in attachment over the life course. Belsky (this volume) reviewed research evidence and concluded that attachment security exhibits modest but significant stability from infancy to adulthood, and that there are theoretical reasons to expect that attachments will be stable over time for some individuals, but not for others. In light of the remarkable variability in research findings on this issue, with some studies indicating that a high proportion of children are consistent in remaining secure or insecure for many years and others showing that infants and young children change dramatically in the security of attachment over a matter of months (Thompson 1998, 2000), the proper question is perhaps not to inquire about the average consistency of individual differences in the security of attachment over time. Rather, the better question might be: *Under what conditions is attachment security likely to remain stable, and under what conditions is it likely to change?*

Research evidence (Thompson 1998) on this issue suggests two provisional conclusions. First, children with secure attachments and (perhaps) those with the disorganized classification are more likely to remain consistent in their attachment status over time than are children with the two insecure classifications (avoidant and resistant). This is likely to be true for different reasons (e.g., secure relationships are stable because they are mutually rewarding; disorganized relationships are stable because their atypicality becomes self-perpetuating in the responses children and their caregivers elicit and provoke). Second, children and parents in more stable living circumstances are likely to enjoy more stable relationships, while those who experience disruptive family events are more likely to change because of the impact of those events on their relationship.

Research support for the importance of stability in living circumstances is suggestive but not conclusive (Thompson 1998, 2000). It remains for researchers to identify clearly the kinds of events that are likely to provoke change in attachment security over time. In their taxonomy of attachment-altering experiences, for example, most researchers would include manifestly traumatic events (e.g., death or loss of a parent). Many would also include stressors such as parental separation or divorce (see Grossmann and Grossmann, this volume), which is an important consideration in light of the high proportion of children in countries like the U.S. who have experienced parental separation or divorce by middle childhood. There is evidence that the birth of a sibling can provoke alterations in the security of attachment between firstborns and the mother, and some suggestions that events like parental employment changes or family difficulty may also be influential (Teti et al. 1996; Thompson et al. 1982; Vaughn et al. 1979). Surprisingly, little systematic research has been devoted to elucidate the origins of change (and consistency) in attachment relationships over time (cf. Belsky et al. 1991). This is a topic meriting further inquiry because of its relevance to understanding the dynamic influences on parent–child relationships over time. For example, although family experiences are likely to be most influential, outside events might also affect the security of parent–child attachments if they impose stress on either partner that the other cannot accommodate. Conversely, extrafamilial sources of social support might buffer difficulties in the parent–child relationships and can thus provide avenues to the development of greater security. There are also many provocative new hypotheses warranting exploration. For example, to what extent do normative developmental transitions in a child's life create opportunities for the renegotiation of parent–child relationships, leading to enhanced security for some and diminished security for others because of the challenges these transitions present to the adult? To what extent are culturally normative practices that alter children's relational experiences (e.g., changes in childcare providers or the transition to school) influential in changing parent–child attachment because of the challenges and new relational experiences afforded the child? To what extent is the impact of changing circumstances and stressors contingent on the maturity of the brain at the time

they occur (e.g., the vulnerability of developing psychobiological systems relevant to attachment or stress)? In a sense, systematic study of the factors contributing to change and continuity in attachment relationships across the life course provides another window into the factors influencing attachment security.

Until relevant research is conducted, attachment researchers are left with the conclusion that attachments change for some children and remain consistent for others (Thompson 2000). Even so, this has important implications for understanding the consequences of early parent–child relationships. For example, developmental formulations that assume long-term influences from early attachment relationships must accommodate the fact that attachment relationships themselves often change over time, and thus the consequences of early attachment may also be malleable (see the evolutionary formulation of Belsky et al. 1991). Moreover, such a conclusion underscores the dynamic nature of parent–child relations, which is consistent with the cascade of developmental changes occurring in the child and the changing parent and family ecology that constitutes the child's home.

Attachment theory also predicts that early secure parent–child relationships will yield other beneficial consequences later in life and that an early insecure attachment inaugurates children on developmental pathways that are likely to be less successful in other ways. In a large, expanding empirical literature, attachment researchers have explored the relations between attachment security and a wide variety of expected outcomes, studied either in consequent or contemporaneous relations to the security of attachment. Predicted outcomes have included teacher–child relationships; cognitive and language development; frustration tolerance; self-recognition; behavioral problems; relations with peers, friends, and siblings; interactions with unfamiliar adults; exploration and play; competence in preschool and kindergarten; curiosity; psychopathology; ego resiliency; and math achievement. Although researchers in this field disagree over the scope of the theoretically predicted sequelae of attachment security, this is because attachment theory is not especially clear about the range of consequences that could reasonably be anticipated from early security. Consequently, researchers have been guided alternatively by broader or narrower views of the range of outcomes under the umbrella of a general expectation that a secure attachment should be related to more optimal later functioning than an insecure attachment. Greater theoretical clarity is thus needed to inform hypotheses and the design and interpretation of findings. How can the claims of attachment theory be properly evaluated if researchers are unclear about its central hypotheses concerning the consequences of early attachment?

A large empirical literature examining the contemporaneous and predictive correlates of attachment security in infancy and early childhood yields, however, several conclusions (Thompson 1998, 1999). First, a secure attachment seems to be associated with greater competence and success in close relationships. Most notably, a secure attachment in infancy foreshadows a more

harmonious parent–child relationship in the immediate years to come, which heightens the child's receptiveness to the parent's socialization incentives and fosters mutual cooperation and responsiveness (Waters et al. 1991). Securely attached young children are also more successful in other close relationships, such as with friends, teachers, and counselors, although it is unclear whether this is due to social skills, social expectations (such as IWMs of relationships), maternal support, or other reasons. Attachment security is not strongly associated with children's interactions with unfamiliar partners. Second, there is also evidence that securely attached young children have different ways of thinking about the social world, reflected in a more acute emotional understanding, more positive friendship conceptions, and advances in conscience development, although this evidence is limited. Third, there is little systematic evidence that attachment security is associated with personality characteristics, such as ego resiliency, or with behavioral problems and other potential precursors of clinical difficulties (although research indicates that the disorganized classification may be a risk factor for later clinical problems).

The strongest evidence for the broader influences of a secure or insecure attachment arises from contemporaneous assessments of attachment and other behaviors which do not permit unequivocal causal conclusions. In predictive studies, short-term associations between attachment and outcomes are stronger than longer-term predictive associations but, at best, the strength of the relation between attachment security and its psychological correlates is modest (although some studies show a small, enduring effect for some children; see e.g., Sroufe et al. 1990). There are many reasons for this (Thompson 1999). The sequelae with which attachment security is associated are themselves multidetermined and are likely to be affected by a variety of influences besides the parent–child relationship. Moreover, children typically experience multiple attachment relationships that may have complementary or conflicting influences on aspects of the child's later psychological growth. Parent–child relationships also change over time, such that later relational experience at home may confirm the influences of early attachment security or may alter earlier developmental influences. Taken together, therefore, the security of attachment is an important but modest influence on children's subsequent relational experience; its broader effects have yet to be systematically established.

The central hypothesized mediator between early attachment security and its expected outcomes is the IWM of attachment in the mind of the child. In most current research, scientists seek to evaluate hypothesized consequences in relation to the nature of the IWMs that are presumed to result from secure or insecure attachments. As earlier noted, there is considerable uncertainty about what an IWM really is, how it changes with development, and how it relates to other cognitive constructs that have also been studied by psychologists (e.g., schemas, attributions, autobiographical representations). Part of the confusion is attributable, again, to lack of clarity within attachment theory. In some regards,

the IWM is conceptualized in a manner resembling the dynamic unconscious, initially formed based on relational experiences through the perceptual- affective schemas of infancy, and remaining influential throughout life but largely inaccessible to subsequent linguistic-representational influences. In other respects, the IWM is conceptualized in a manner consistent with other conscious, representational models; it functions like a script or relational schema, incorporating motivational attributions, elements of event representation, and autobiographical memory. These alternative conceptualizations are not entirely inconsistent, of course, but the differences between them have significant implications for how IWMs might be thought to develop, how they would influence behavior, or how they might be measured (Spangler and Zimmermann 1999). Without greater clarity on these and other central theoretical issues, researchers have been enticed by the powerful heuristic value of the IWM construct to create hypotheses based on their own conceptualization of the IWM (Thompson and Raikes 2003). It is unlikely that a clear and coherent research literature on the consequences of early attachment will be possible without greater theoretical clarity on this and other central issues.

There are other conceptual challenges to studying the consequences of early attachment for the child. First, although researchers have commonly examined the direct effects of attachment on other aspects of psychological development, it is also likely that attachment has indirect and interactive consequences. For instance, attachment security may enhance the efficacy of other forms of social support for the child. Although insecure attachment is not generally a direct risk factor for later psychopathology (with the possible exception of the D classification), it is likely to be influential within a constellation of additional risks to early mental health. Second, because cultural systems vary so significantly in parental belief systems, child-rearing goals and parenting practices, the interaction of parental sensitivity, attachment security, and developmental sequelae is likely to vary somewhat in different societies. Several decades ago, attachment researchers engaged in cross-cultural research on the Strange Situation situation and found that they were required to understand indigenous child-rearing practices to interpret infant attachment classifications properly (van IJzendoorn and Sagi 1999); similar processes of cultural understanding (within the context of the biologically adaptive needs of the human species) will likely be necessary to design and interpret properly studies of the consequences of early attachment in non-Western cultures. Third, if the stability of attachment security is contingent on influences such as the consistency in living conditions for parent and child, the same factors may be important in understanding the conditions when later outcomes of early attachment may be evident, and the conditions in which later sequelae will be hard to find. Thus, children living in markedly changing circumstances may show fewer long-term correlates of early attachment security than children living in more stable conditions, when the initial tendencies fostered by a secure or insecure attachment are more likely to be maintained.

This brings us back to the central question: How important are early experiences for psychological development? There have been at least four broad models of the influence of early experiences on long-term development (O'Connor 2003; Thompson 2001):

1. The "programming" model argues that early experiences exert a lasting effect because of the early malleability of biological (or personality or conceptual) systems that become subsequently less plastic. Supportive evidence for such a model often derives from studies of animals or human infants exposed to antenatal or early postnatal stressors (e.g., Barker 1998; O'Connor, Heron et al. 2003).
2. The "developmental sensitivity" model argues that the effects of particular events or experiences depends on the developmental period in which they occur. Contrary to the programming model, early experiences are not necessarily formative, and influences occuring at later ages (such as parturition) can have a comparably profound developmental influence.
3. The "cumulative experience" model argues that both early and later influences are important, and early experiences have an enduring effect when they are maintained or supported by subsequent experiences. Conversely, early adversity does not necessarily impair healthy development if it is corrected and replaced by supportive care, which is consistent with the literature on psychological resiliency (Clarke and Clarke 2000).
4. The "cognitive/affective processing" model argues that effects of early experiences on long-term development depends on how these events are interpreted and/or internalized by the individual. Like the cumulative experience model, the relations between early influences and later development is not deterministic but probabilistic.

It is difficult, of course, to design empirical tests that would set one model against another because of the difficulties of distinguishing the effects of early experience from later experience. The best opportunities to compare these alternative formulations arise from studies of the long-term effects of early deprivation, in which depriving conditions are followed by adequate, supportive care. One such study is the English and Romanian Adoptees (ERA) study (O'Connor et al. 2000; O'Connor, Marvin et al. 2003; Rutter et al. 2001, 2004), which examined long-term effects of early institutional deprivation for a sample of Romanian orphanage children who were subsequently adopted into well-functioning homes in the U.K.

The ERA study has yielded several conclusions concerning the effects of early deprivation. First, a number of disadvantageous outcomes were reliably associated with institutional deprivation, including cognitive delay, attachment problems, and difficulties with inattention and hyperactivity. These problems developed in a dose-response manner: prolonged early institutional experience was associated with severe outcomes. Other common behavioral problems (e.g.,

conduct disturbances) were not found, at least in the earlier follow-up assessments. Second, there was evidence of substantial recovery in some developmental domains, most notably increases in weight and height. Third, and most interestingly, where later outcomes of institutionalization were identified, the strength of the effect was as marked at age 11 years as at earlier assessments at four and six years of age; that is, the relative impact of institutional deprivation did not dissipate with time, even though children improved after adoption and were continuing to live in supportive, developmentally appropriate care settings. Finally, there were marked individual differences in outcome that were not easily explained either by characteristics of the adoptive placements or by other factors. Simply, some children showed severe impairment while other children showed relatively few disturbances in developmental functioning.

Findings such as these are not easily accommodated within any of the developmental models outlined above. The persistence of disturbance in the context of recovery but in the absence of continuing adversity, the wide range of individual differences in outcomes, and the dose-response association of early adversity with later outcomes are not fully consistent with any of the current formulations of the effects of early experiences. This suggests that newer, more complex models — or combinations of models — may be necessary to comprehend more adequately the effects of early experiences on children's development. Such a conclusion is also consistent with the larger literature on the outcomes of attachment security in early childhood, which reveals sequelae in some developmental domains but not others, multidetermined developmental outcomes, and influences from early experiences that wane but, for some, leave a lingering legacy.

Such a conclusion is also consistent with research into the psychobiological foundations of early attachment, which provides a view of plasticity as well as consistency in the biobehavioral systems related to attachment. Limbic system structures related to social reward, for example, are early-maturing but are also modified by experience throughout most of life, with some limbic structures maturing into the third decade of life. In a manner consistent with psychobiological studies reviewed earlier, it is clear that early experiences of marked abuse, neglect, and other chronic stressors can meaningfully alter the functioning of this reward system. In work with rodents, for example, repeated parental separation experiences transiently elevated dopaminergic receptors and serotonergic receptors in the prefrontal cortex, hippocampus, and amygdala (Ziabreva, Schnabel et al. 2003; Ziabreva, Poeggel et al. 2003). Long-term alterations of the limbic system deriving from chronic social isolation include reduced dopaminergic innervation in the anterior cingulate and orbitofrontal cortex (Braun et al. 2000; Poeggel, Nowicki et al. 2003), which are each related to social reward. Serotonin, which during early brain development also has a neurotrophic function to stimulate synaptic development, is also altered in these cortical regions as well as the amygdala (Braun et al. 2000; Poeggel, Helmeke et

al. 2003). Thus early experiences can significantly alter limbic-mediated social reward systems, albeit interventions that are species-atypical. Experiential "training" or "imprinting" of the limbic system's development in early years, however, involves continuous "updating" in light of current experience (e.g., during vocal communication between the mother and offspring; see Poeggel and Braun 1996; Braun and Poeggel 2001; Braun et al. 2003), and this is mediated by dopaminergic reward mechanisms. Human and rodent studies (Bredy et al. 2003; Francis et al. 2002) document this story by showing how subsequent caregiving can alter effects of earlier influences of care on psychobiological systems related to stress and coping. In a sense, early experiences (especially with a primary caregiver) help create a "grammar of emotion" that may be enduring, even though the language of emotion continues to unfold in the years to come.

Attachment is more than the limbic system, of course, and the multiple brain regions and behavioral regulators related to attachment confer additional flexibility to this developing system. There are limits to this flexibility, as continuing research into the developmental outcomes of Romanian orphanage children adopted into well-functioning British families thoughtfully documents. In the end, the conclusion that early experiences are important but not determinative, that later experiences are also influential, and that individual differences in outcomes are a significant consideration, probably constitutes a useful general working hypothesis to guide further inquiry.[5]

Consequences for the Mother

In contrast to the rich literature on the consequences of early attachment for the child's psychological development, theory and research concerning consequences for the mother are more sparse. It is apparent that as a counterpart to her enormous investment in infant care (energic costs, vulnerability, and inability to invest resources alternatively), mothers derive rewards from caregiving. Aside

[5] At this Dahlem Workshop, we had the opportunity to ponder issues of early attachment and its long-term consequences with the artistic catalysts provided by a delightful evening of viewing Prokofiev's ballet, "Romeo and Juliet" at the Deutsche Oper. It raised many questions concerning the developmental dynamics of the young, central figures in this drama. How much, for example, was Juliet's sudden infatuation with a boy from the other side of town named Romeo anticipated by her uncertain attachment to her mother (about whom very little is said in Shakespeare's play or the ballet)? To what extent was her current troubled relationship with her father, characterized by his coercive overcontrol, prognostic of a potentially troubled marriage to Romeo (assuming, of course, that both had managed to live long enough to share a married life together)? What does it mean that the nurse who cares for Juliet in Shakespeare's play became transformed into a priest in Prokofiev's staging, and what does this reflect about Prokofiev (or, for that matter, Shakespeare)? How were the somewhat disturbing peer relational dynamics of the adolescent subculture related to the interfamilial conflict of the Montagues and Capulets, and the possibility of insecure attachments within each family? We leave these questions for the reader to ponder.

from the well-known role of breast milk for infant health, breastfeeding seems to have protective effects for the mother and directly promotes attachment behavior. During lactation, the sucking stimulus of the newborn increases both oxytocin and prolactin release and decreases basal plasma levels of ACTH and cortisol, suggesting an inhibitory influence of both peptides on stress-responsive neurohormonal systems (Amico et al. 1994; Russell et al. 2001). As earlier indicated, data from several species implicate oxytocin in social attachment and related prosocial behaviors (Carter 1998; Insel and Young 2001; Pedersen 1997). Together, the inhibitory effect of intracerebral oxytocin on stress-induced activity of the hypothalamic–pituitary–adrenocortical (HPA) axis responsiveness points to its key role in social behavior and stress management.

Consistent with these animal findings, pituitary–adrenal reactivity to psychosocial stress is attenuated after endogenous stimulation of oxytocin following breastfeeding in postpartum lactating mothers (Heinrichs et al. 2001). Moreover, lactating women had reduced plasma ACTH, cortisol, and glucose responses to physical stress in comparison with postpartum nonlactating women (Altemus et al. 1995). In addition to physiological measurements, psychometric measures were also assessed in some studies. Both breastfeeding and holding the infant for a 15-minute period, for example, led to decreased state anxiety in lactating women (Heinrichs et al. 2001).

There may also be broader consequences of the lactating mother's short-term hyporesponsiveness to stress that facilitate attachment to the infant, including (a) lower cortisol levels that could conserve energy required for lactation, (b) suppression of the secretion of stress-responsive hormones that could inhibit lactation, (c) lower glucocorticoid levels to facilitate enhanced immune functioning for the mother, (d) enhanced sensitivity and responsiveness to the infant owing to fewer competing responses (Heinrichs et al. 2002). Beyond these psychobiological concomitants, breastfeeding in many cultures is regarded by mothers as a primary avenue to bonding with the baby and, for some, as a way of creating cultural identity.

Breastfeeding constitutes one exemplary illustration of the bidirectional influences that promote mutual attachment by mother and baby. Although maternal and offspring interests are not always concordant in an ultimate sense, especially in families with siblings close in age, it is striking how often the behavioral systems guiding attachment processes yield shared benefits for the mother and baby who are finding each other in a developing relationship.

CONCLUSION

At present, the integration of behavioral and psychobiological perspectives to early attachment and its consequences is more promise than realization. Our discussion has highlighted discoveries that are emerging in this integrative work and, more important, avenues for essential further exploration. Among the latter identified in this discussion are:

- Understanding better the behavioral and biological prerequisites for forming first attachments in infancy, and how these are reorganized when first attachments must develop later than is species-typical, or in circumstances that are atypical. More concerted research attention to attachment *development* will integrate attachment and bonding processes with other normative psychobiological growth processes and yield greater insights into the causes of attachment dysfunction.
- Understanding better how attachment develops in different cultural settings within the context of the biologically adaptive requirements of inclusive fitness. Attachment is both biologically imperative and context sensitive.
- Conceptualizing more clearly the interaction of behavioral experience and psychobiological development with respect to how early caregiving shapes infant regulatory capacities, and how these influences become progressively updated through new caregiving experiences. Current research shows that prevailing models of the effects of early experience on long-term development are inadequate to the complexity of psychobiological growth.
- Greater theoretical clarification of how attachment continues to develop beyond infancy, and the representations associated with this developmental process, in concert with the development of new measures and methods for assessing attachment at later ages. In this manner, the development of attachment can be better understood in the context of concurrent advances in cognition, relationships, social skills, personality, and the growth of self-understanding.
- More systematic inquiry into the internal and external processes mediating continuity and change in attachment relationships over time, and what are the expectable consequences of early attachment relationships for both behavioral and psychobiological organization, and the role of IWMs in the regulation of attachment functioning.
- Integration of biological and behavioral insights into the most compelling question of all: How does early experience influence later behavior?

REFERENCES

Ainsworth, M.D.S. 1985. Attachment across the life span. *Bull. NY Acad. Med*. **61**: 792–812.

Ainsworth, M.D.S., M.C. Blehar, E. Waters, and S. Wall. 1978. Patterns of Attachment. Hillsdale, NJ: Erlbaum.

Allen, J.P., and D. Land. 1999. Attachment in adolescence. In: Handbook of Attachment: Theory, Research, and Clinical Applications, ed. J. Cassidy and P.R. Shaver, pp. 319–335. New York: Guilford.

Altemus, M., P.A. Deuster, E. Galliven, C.S. Carter, and P.W. Gold. 1995. Suppression of hypothalamic–pituitary–adrenal axis responses to stress in lactating women. *J. Clin. Endocrinol. Metab*. **80**:2954–2959.

Amico, J.A., J.M. Johnston, and A.H. Vagnucci. 1994. Suckling–induced attenuation of plasma cortisol concentrations in postpartum lactating women. *Endocr. Res*. **20**: 79–87.

Aragona, B.J., Y. Liu, J.T. Curtis, F.K. Stephan, and Z. Wang. 2003. A critical role for nucleus accumbens dopamine in partner preference formation in prairie voles. *J. Neurosci*. **23**:3483–3490.

Barker, D.J. 1998. *In utero* programming of chronic disease. *Clin. Sci.* **95**:115–128.

Belsky, J., S.B. Campbell, J.F. Cohn, and G. Moore. 1996. Instability of infant–parent attachment security. *Dev. Psychol*. **32**:921–924.

Belsky, J.L., L. Steinberg, and P. Draper. 1991. Childhood experience, interpersonal development and reproductive strategy: An evolutionary theory of socialization. *Child Dev.* **62**:647–670.

Blurton Jones, N.G. 1993. The lives of hunter–gatherer children: Effects of parental behavior and parental reproductive strategy. In: Juvenile Primates: Life History, Development, and Behavior, ed. M.E. Pereira and L.A. Fairbanks, pp. 309–326. New York: Oxford Univ. Press.

Blurton Jones, N.G., and E. Da Costa. 1987. A suggested adaptive value of toddler night waking: Delaying the birth of the next sibling. *Ethol. Sociobiol*. **8**:135–142.

Born, J., T. Lange, W. Kern et al. 2002. Sniffing neuropeptides: A transnasal approach to the human brain. *Nature Neurosci*. **5**:514–516.

Born, J., R. Pietrowsky, and H.L. Fehm. 1998. Neuropsychological effects of vasopressin in healthy humans. *Prog. Brain Res*. **119**:619–643.

Bowlby, J. 1969. Attachment. Attachment and Loss, vol. 1. New York: Basic.

Bowlby, J. 1973. Separation: Anxiety and Anger. Attachment and Loss, vol. 2. New York: Basic.

Boyce, W.T., M. Champoux, S.J. Suomi, and M.R. Gunnar. 1995. Salivary cortisol in nursery-reared rhesus monkeys: Reactivity to peer interactions and altered circadian activity. *Dev. Psychobiol*. **28**:257–267.

Braun, K., P. Kremz, W. Wetzel, T. Wagner, and G. Poeggel. 2003. Influence of parental deprivation on the behavioral development in Octodon degus: Modulation by maternal vocalizations. *Dev. Psychobiol*. **42**:237–245.

Braun, K., E. Lange, M. Metzger, and G. Poeggel. 2000. Maternal separation followed by early social isolation affects the development of monoaminergic fiber systems in the medial prefrontal cortex of *Octodon degus. Neuroscience* **95**:309–318.

Braun, K., and G. Poeggel. 2001. Recognition of mother's voice evokes metabolic activation in the medial prefrontal cortex and thalamus of *Octodon degus* pups. *Neuroscience* **103**:861–864.

Bredy, T.W., R.A. Humpartzoomian, D.P. Cain, and M.J. Meaney. 2003. Partial reversal of the effect of maternal care on cognitive function through environmental enrichment. *Neuroscience* **118**:571–576.

Bretherton, I., and K.A. Munholland. 1999. Internal working models in attachment relationships: A construct revisited. In: Handbook of Attachment: Theory, Research, and Clinical Applications, ed. J. Cassidy and P. Shaver, pp. 89–111. New York: Guilford.

Brownstein, M.J., J.T. Russell, and H. Gainer. 1980. Synthesis, transport, and release of posterior pituitary hormones. *Science* **207**:373–378.

Bruce, M.L. 2002. Psychosocial risk factors for depressive disorders in late life. *Biol. Psych.* **52**:175–184.

Bruins, J., R. Hijman, and J.M. Van Ree. 1992. Effect of a single dose of des-glycinamide-[Arg8]vasopressin or oxytocin on cognitive processes in young healthy subjects. *Peptides* **13**:461–468.

Campos, J.J., R. Kermoian, and M.R. Zumbahlen. 1992. Socioemotional transformations in the family system following infant crawling onset. In: Emotion and Its Regulation in Early Development, ed. N. Eisenberg and R. Fabes, pp. 25–40. San Francisco: Jossey-Bass.

Carlson, M., C. Dragomir, F. Earls et al. 1995. Effects of social deprivation on cortisol regulation in institutionalized Romanian infants. *Soc. Neurosci. Abst*. **21**:524.

Carter, C.S. 1998. Neuroendocrine perspectives on social attachment and love. *Psychoneuroend.* **23**:779–818.

Cassidy, J., and P.R. Shaver, eds. 1999. Handbook of Attachment: Theory, Research, and Clinical Applications. New York: Guilford.

Clarke, A.M., and A.D.B. Clarke. 2000. Early Experience and the Life Path. London: Kingsley.

Cohn, J.F., S.B. Campbell, and S. Ross. 1991. Infant response in the still-face paradigm at 6 months predicts avoidant and secure attachment at 12 months. *Dev. Psychopathol.* **3**:367–376.

Colin, V.L. 1996. Human Attachment. New York: McGraw-Hill.

de Wied, D., M. Diamant, and M. Fodor. 1993. Central nervous system effects of neurohypophyseal hormones and related peptides. *Front. Neuroendocrinol*. **14**:251–302.

de Wolff, M.S., and M.H. van IJzendoorn. 1997. Sensitivity and attachment: A meta-analysis on parental antecedents of infant attachment. *Child Dev.* **68**:571–591.

Fleming, A., M. Steiner, and C. Corter. 1997. Cortisol, hedonics, and maternal responsiveness in human mothers. *Horm. Behav.* **32**:85–98.

Francis, D.D., J. Diorio, P.M. Plotsky, and M.J. Meaney. 2002. Environmental enrichment reverses the effects of maternal separation on stress reactivity. *J. Neurosci*. **22**: 7840–7843.

Gekoski, M.J., C.K. Rovee-Collier, and V. Carulli-Rabinowitz. 1983. A longitudinal analysis of inhibition of infant distress: The origins of social expectations? *Infant Behav. Dev.* **6**:339–351.

Greenfield, P.M., H. Keller, A. Fuligni, and A. Maynard. 2003. Cultural pathways through universal development. *Ann. Rev. Psychol.* **54**:461–490.

Gunnar, M.R. 2000. Early adversity and the development of stress reactivity and regulation. In: The Effects of Adversity on Neurobehavioral Development, ed. C.A. Nelson, pp. 163–200. Minnesota Symposia on Child Psychology 31. Mahwah, NJ: Erlbaum.

Gunnar, M.R., and B. Donzella. 2002. Social regulation of the LHPA axis in early human development. *Psychoneuroend.* **27**:199–220.

Gunnar, M., and D.M. Vazquez. 2001. Low cortisol and a flattening of the expected daytime rhythm: Potential indices of risk in human development. *Dev. Psychopathol.* **13**:516–538.

Hagen, E.H. 1999. The functions of postpartum depression. *Evol. Hum. Behav.* **20**:325–359.

Handlon, J.H., R.W. Wadeson, J.R. Fishman et al. 1962. Psychological factors lowering plasma 17-hydroxycorticosteroid concentration. *Psychosom. Med.* **24**:535–542.

Harris, P.L. 1996. Between Strange Situation and false beliefs: Working models and theories of mind. In: Early Mother–child Interaction and Attachment: Old and New Approaches, ed. W. Koops, J. Hoeksma, and D. van den Boom, pp. 187–199. Amsterdam: Elsevier.

Hart, J., M. Gunnar, and D. Cicchetti. 1995. Salivary cortisol in maltreated children: Evidence of relations between neuroendocrine activity and social competence. *Dev. Psychopathol.* **7**:11–26.

Heinrichs, M. 2000. Oxytocin and Behavior: Psychobiological Effects of Oxytocin on Human Cognitive Performance and Stress Reactivity. Gottingen: Cuvillier.
Heinrichs, M., T. Baumgartner, C. Kirschbaum, and U. Ehlert. 2003. Social support and oxytocin interact to suppress cortisol and subjective responses to psychosocial stress. *Biol. Psych.* **54**:1389–1398.
Heinrichs, M., G. Meinlschmidt, I. Neumann et al. 2001. Effects of suckling on hypothalamic–pituitary–adrenal axis responses to psychosocial stress in postpartum lactating women. *J. Clin. Endocrinol. Metab.* **86**:4798–4804.
Heinrichs, M., I. Neumann, and U. Ehlert. 2002. Lactation and stress: Protective effects of breast-feeding in humans. *Stress* **5**:195–203.
Henry, J.P. 1993. Psychological and physiological responses to stress: The right hemisphere and the hypothalamo–pituitary axis, an inquiry into problems of human bonding. *Integ. Physiol. Behav. Sci.* **28**:368–386.
Henry, J.P., and S. Wang. 1998. Effects of early stress on adult affiliative behavior. *Psychoneuroend.* **23**:863–875.
Hertsgaard, L., M. Gunnar, M.F. Erickson, and M. Nachmias. 1995. Adrenocortical responses to the strange situation in infants with disorganized/disoriented attachment relationships. *Child Dev.* **66**:1100–1106.
Hesse, E. 1999. The Adult Attachment Interview: Historical and current perspectives. In: Handbook of Attachment: Theory, Research, and Clinical Applications, ed. J. Cassidy and P.R. Shaver, pp. 395–433. New York: Guilford.
Hirschfeld, L.A., and S.A. Gelman. 1998. Toward a topography of mind: An introduction to domain specificity. In: Mapping the Mind: Domain Specificity in Cognition and Culture, ed. L.A. Hirschfeld and S.A. Gelman, pp. 3–35. Cambridge: Cambridge Univ. Press.
Hrdy, S.B. 1994. Fitness tradeoffs in the history and evolution of delegated mothering with special reference to wet-nursing, abandonment and infanticide. In: Infanticide and Parental Care, ed. S. Parmigiani and F. S. Vom Saal, pp. 3–41. Chur: Harwood.
Hrdy, S.B. 1999. Mother Nature: Maternal Instincts and How They Shape the Human Species. New York: Ballantine.
Hurtado, A.M., K. Hill, H. Kaplan, and I. Hurtado. 1992. Trade-offs between female food acquisition and child care among Hiwi and Ache foragers. *Hum. Nat.* **3**:185–216.
Insel, T. 2003. Is social attachment an addictive process? *Physiol. Behav.* **79**:351–357.
Insel, T.R., and L.J. Young. 2001. The neurobiology of attachment. *Nat. Rev. Neurosci.* **2**:129–136.
Keller, H. 2000. Human parent–child relationships from an evolutionary perspective. *Am. Behav. Sci.* **43**:957–969.
Keller, H. 2002. The role of development for understanding the biological basis of cultural learning. In: Between Culture and Biology, ed. H. Keller, Y. Poortinga, and A. Schoelmerich, pp. 215–240. Cambridge: Cambridge Univ. Press.
Kraemer, H.C., E. Stice, A. Kazdin, D. Offord, and D. Kupfer. 2001. How do risk factors work together? Mediators, moderators, and independent, overlapping, and proxy risk factors. *Am. J. Psych.* **158**:848–856.
Lamb, M.E., and C.M. Malkin. 1986. The development of social expectations in distress-relief sequences: A longitudinal study. *Intl. J. Behav. Dev.* **9**:235–249.
Lamb, M.E., R.A. Thompson, W.P. Gardner, and E. Charnov. 1985. Infant–mother Attachment. Hillsdale, NJ: Erlbaum.
Legros, J.J. 2001. Inhibitory effect of oxytocin on corticotrope function in humans: Are vasopressin & oxytocin ying-yang neurohormones? *Psychoneuroend.* **26**:649–655.

Markus, H.R., and S. Kitiyama. 1991. Culture and the self: Implications for cognition, emotion and motivation. *Psychol. Rev.* **98**:224–253.

Martel, F.L., C.M. Nevison, M.D.A. Simpson, and E.B. Keverne. 1993. Opioid receptor blockade reduces maternal affect and social grooming in rhesus monkeys. *Psychoneuroend.* **18**:307–321.

Mason, J.W., S. Wang, R. Yehuda et al. 2001. Psychogenic lowering of urinary cortisol levels linked to increased emotional numbing and a shame-depressive syndrome in combat-related posttraumatic stress disorder. *Psychosom. Med*. **63**:387–401.

McCarthy, M.M., and M. Altemus. 1997. Central nervous system actions of oxytocin and modulation of behavior in humans. *Molec. Med. Today* **3**:269–275.

Meins, E., C. Fernyhough, E. Fradley, and M. Tuckey. 2001. Rethinking maternal sensitivity: Mothers' comments on infants' mental processes predict security of attachment at 12 months. *J. Child Psychol. Psychiat.* **42**:637–648.

Nachmias, M., M. Gunnar, S. Mangelsdorf, et al.. 1996. Behavioral inhibition and stress reactivity: The moderating role of attachment security. *Child Dev.* **67**:508–522.

O'Connor, T.G. 2003. Early experiences and psychological development: Conceptual questions, empirical illustrations, and implications for intervention. *Dev. Psychopathol.* **15**:671–690.

O'Connor, T.G., J. Heron, J. Golding, V. Glover, and the ALSPAC study team. 2003. Maternal antenatal anxiety and behavioural/emotional problems in children: A test of a programming hypothesis. *J. Child Psychol. Psychiat.* **44**:1025–1036.

O'Connor, T.G., R.S. Marvin, M. Rutter, J. Olrick, P.A. Britner, and the English and Romanian Adoptees Study Team. 2003. Child–parent attachment following early institutional deprivation. *Dev. Psychopathol.* **15**:19–38.

O'Connor, T.G., M. Rutter, and the English and Romanian Adoptees Study Team. 2000. Attachment disorder behavior following early severe deprivation: Extension and longitudinal follow-up. *J. Am. Acad. Child Adoles. Psych.* **39**:703–712.

Panter-Brick, C. 1995. Child-care strategies in Nepal: Responses to ecology, demography, and society. In: Human Populations: Diversity and Adaptation, ed. A.J. Boyce and V. Reynolds, pp. 174–188. Oxford: Oxford Univ. Press.

Pedersen, C.A. 1997. Oxytocin control of maternal behavior: Regulation by sex steroids and offspring stimuli. *Ann. NY Acad. Sci.* **807**:126–145.

Pedersen, C.A., and M.L. Boccia. 2002. Oxytocin links mothering received, mothering bestowed and adult stress responses. *Stress* **5**:259–267.

Pedersen, C.A., and A.J. Prange. 1979. Induction of maternal behavior in virgin rats after intracerebroventricular administration of oxytocin. *PNAS* **76**:6661–6665.

Pitman, R.K., S.P. Orr, and N.B. Lasko. 1993. Effects of intranasal vasopressin and oxytocin on physiologic responding during personal combat imagery in Vietnam veterans with posttraumatic stress disorder. *Psychiatry Res.* **48**:107–117.

Poeggel, G., and K. Braun. 1996. Early auditory filial learning in degus (*Octodon degus*): Behavioral and autoradiographic studies. *Brain Res.* **743**:162–170.

Poeggel, G., C. Helmeke, T. Schwabe et al. 2003. Juvenile emotional experience alters synaptic composition in the rodent prefrontal cortex, hippocampus and lateral amygdala. *PNAS* **100**:16,137–16,142.

Poeggel, G., G. Nowicki, and K. Braun. 2003. Early social deprivation alters monoaminergic afferents in the orbital prefrontal cortex of *Octodon degus. Neuroscience* **116**:617–620.

Raikes, H.A., and R.A. Thompson. 2004. Attachment in middle childhood: Issues of theory and method. In: Attachment in Middle Childhood, ed. K.A. Kerns and R.A. Richardson. New York: Guilford, in press.

Rosenfield, P.D., S. Suchecki, and S. Levine. 1992. Multifactorial regulation of the hypothalamic–pituitary–adrenal axis during development. *Neurosci. Biobehav. Rev.* **16**:553–568.

Rozanski, A., J.A. Blumenthal, and J. Kaplan. 1999. Impact of psychological factors on the pathogenesis of cardiovascular disease and implications for therapy. *Circulation* **99**:2192–2217.

Russell, J.A., A.J. Douglas, and C.D. Ingram. 2001. Brain preparations for maternity: Adaptive changes in behavioral and neuroendocrine systems during pregnancy and lactation: An overview. *Prog. Brain Res*. **133**:1–38.

Rutter, M., J. Kreppner, T.G. O'Connor, and the English and Romanian Adoptees Study Team. 2001. Specificity and heterogeneity in children's responses to profound deprivation. *Brit. J. Psychiatry* **179**:97–103.

Rutter, M., T.G. O'Connor, and the English and Romanian Adoptees Study Team. 2004. Are there biological programming effects for psychological development? Findings from a study of Romanian adoptees. *Dev. Psychol.* **40**:81–94.

Sanchez, M.M., C.O. Ladd, and P. Plotsky. 2001. Early adverse experience as a developmental risk factor for later psychopathlogy: Evidence from rodent and primate models. *Dev. Psychopathol.* **13**:419–449.

Schiefenhoevel, W. 1989. Reproduction and sex-ratio manipulation through preferential female infanticide among the Eipo, in the highlands of west New Guinea. In: The Sociobiology of Sexual and Reproductive Strategies, ed. A.E. Rasa, C. Vogel, and E. Voland, pp. 170–193. London: Chapman and Hall.

Solomon, J., and C. George. 1999. The measurement of attachment security in infancy and childhood. In: Handbook of Attachment: Theory, Research, and Clinical Applications, ed. J. Cassidy and P.R. Shaver, pp. 287–316. New York: Guilford.

Spangler, G., and K.E. Grossmann. 1993. Biobehavioral organization in securely and insecurely attached infants. *Child Dev.* **64**:1439–1450.

Spangler, G., and M. Schieche. 1998. Emotional and adrenocortical responses of infants to the Strange Situation: The differential function of emotional expression. *Intl. J. Behav. Dev.* **22**:681–706.

Spangler, G., and P. Zimmermann. 1999. Attachment representation and emotion regulation in adolescents: A psychobiological perspective on internal working models. *Attach. Hum. Dev.* **1**:270–290.

Sroufe, L.A., B. Egeland, and T. Kreutzer. 1990. The fate of early experience following developmental change: Longitudinal approaches to individual adaptation in childhood. *Child Dev.* **61**:1363–1373.

Sroufe, L.A., and J. Fleeson. 1986. Attachment and the construction of relationships. In: Relationships and Development, ed. W. Hartup and Z. Rubin, pp. 51–71. Hillsdale, NJ: Erlbaum.

Swaab, D.F., C.W. Pool, and F. Nijveldt. 1975. Immunifluorescence of vasopressin and oxytocin in rat hypothalamo–neurohypophyseal system. *J. Neur. Trans.* **36**:195–215.

Teti, D.M., J.W. Sakin, E. Kucera, K.M. Corns, and R. Das Eiden. 1996. And baby makes four: Predictors of attachment security among preschool-age firstborns during the transition to siblinghood. *Child Dev.* **67**:579–596.

Thompson, R.A. 1998. Early sociopersonality development. In: Handbook of Child Psychology, ed. W. Damon, 5th ed., vol. 3. Social, Emotional, and Personality Development, ed. N. Eisenberg, pp. 25–104. New York: Wiley.

Thompson, R.A. 1999. Early attachment and later development. In: Handbook of Attachment: Theory, Research, and Clinical Applications, ed. J. Cassidy and P.R. Shaver, pp. 265–286. New York: Guilford.

Thompson, R.A. 2000. The legacy of early attachments. *Child Dev.* **71**:145–152.
Thompson, R.A. 2001. Sensitive periods in attachment? In: Critical Thinking about Critical Periods, ed. D.B. Bailey, J.T. Bruer, F.J. Symons, and J.W. Lichtman, pp. 83–106. Baltimore, MD: Brookes.
Thompson, R.A., D.J. Laible, and L.L Ontai. 2003. Early understanding of emotion, morality, and the self: Developing a working model. In: Advances in Child Development and Behavior, ed. R.V. Kail, vol. 31, pp.137–171. San Diego: Academic.
Thompson, R.A., M.E. Lamb, and D. Estes. 1982. Stability of infant–mother attachment and its relationship to changing life circumstances in an unselected middle-class sample. *Child Dev.* **53**:144–148.
Thompson, R.A., and H.A. Raikes. 2003. Toward the next quarter-century: Conceptual & methodological challenges for attachment theory. *Dev. Psychopathol*. **15**:691–718.
Tomasello, M. 1999. The Cultural Origins of Human Cognition. Cambridge, MA: Harvard Univ. Press.
Trivers, R.L. 1974. Parent–offspring conflict. *Am. Zoologist* **14**:249–264.
Trivers, R. 1985. Social Evolution. Menlo Park, CA: Benjamin Cummings.
Vandesande, F., and K. Dierickx. 1975. Identification of the vasopressin producing and of the oxytocin producing neurons in the hypothalamic magnocellular neurosecretory system of the rat. *Cell Tiss. Res*. **164**:153–162.
van IJzendoorn, M.H., and A. Sagi. 1999. Cross-cultural patterns of attachment: Universal and contextual dimensions. In: Handbook of Attachment: Theory, Research, and Clinical Applications, ed. J. Cassidy and P. Shaver, pp. 713-734. New York: Guilford.
Vaughn, B.E., B. Egeland, L.A. Sroufe, and E. Waters. 1979. Individual differences in infant–mother attachment at twelve and eighteen months: Stability and change in families under stress. *Child Dev.* **50**:971–975.
Voland, E. 1998. Evolutionary ecology of human reproduction. *Ann. Rev. Anthropology* **27**:347–374.
Waters, E., and E.M. Cummings. 2000. A secure base from which to explore close relationships. *Child Dev.* **71**:164–172.
Waters, E., K. Kondo–Ikemura, G. Posada, and J.E. Richters. 1991. Learning to love: Mechanisms and milestones. In: Self Processes and Development, ed. M.R. Gunnar and L.A. Sroufe, pp. 217–255. Minnesota Symposia on Child Psychology 23. Hillsdale, NJ: Erlbaum.
Watson, J.S. 1972. Smiling, cooing, and "the game." *Merrill-Palmer Qtly.* **18**:323–339.
Watson, J.S. 1979. Perception of contingency as a determinant of social responsiveness. In: Origins of the Infant's Social Responsiveness, ed. E.B. Thoman, pp. 33–64. Hillsdale, NJ: Erlbaum.
Wolff, C.T., S.B. Friedman, M.A. Hofer, and J.W. Mason. 1964. Relationship between psychological defenses and mean urinary 17-OHCS excretion rates: A predictive study of parents of fatally ill children. *Psychosom. Med*. **26**:576–591.
Ziabreva, I., G. Poeggel, R. Schnabel, and K. Braun. 2003. Separation–induced receptor changes in the hippocampus and amygdala of Octodon degus: Influence of maternal vocalizations. *J. Neurosci*. **23**:5329–5336.
Ziabreva, I., R. Schnabel, G. Poeggel, and K. Braun. 2003. Mother's voice "buffers" separation–induced receptor changes in the prefrontal cortex of Octodon degus. *Neuroscience* **119**:433–441.