DOES INFANCY MATTER? PREDICTING SOCIAL BEHAVIOR FROM INFANT TEMPERAMENT

Nathan A. Fox
Heather A. Henderson
University of Maryland

In this essay we argue that infant temperament, defined as behavioral styles that appear early in life as a direct result of neurobiological factors, plays a significant role in the development and expression of social behavior. Temperament may be studied using a typological or dimensional approach and the relations between early temperament and later behavior can be examined in terms of homotypic or heterotypic continuity. The implication of each of these approaches for understanding the influence of infant temperament on social development is examined. As well, utilizing data from our laboratory, we suggest that under certain circumstances one can predict social behavior by identifying two temperament types in infancy. These types are high reactive/high negative infants and high reactive/high positive infants. A significant proportion of the high reactive/high negative infants display behavioral inhibition and social reticence through the preschool years, whereas a significant proportion of the high reactive/high positive infants display exuberance and positive social interaction through the preschool period.

As a culture and society we believe that experiences that occur in the early months and years of life will have a profound impact upon later psychological development (Kagan, 1996). This belief is bolstered by compelling data such as those that identify the importance of early verbal input for the development of language (Huttenlocher, 1998), or those that demonstrate the influence of early visual stimulation on perceptual development (Maurer, Lewis, Brent, & Levin, 1999). The belief in the power of early experience has also been influenced by the psychoanalytic literature and by the more recent writings on attachment. Attachment theory, the current predominant theory of social development, emphasizes the importance of the first year of life in the development of social relationships. At the core of attachment theory is the belief that secure and trusting parent-infant relationships begin

• **Nathan A. Fox**, Department of Human Development, 3304 Benjamin Building, University of Maryland, College Park, MD 20742; Tel: (301) 405-2816; Fax: (301) 405-2891; e-mail: nf4@umail.umd.edu.

INFANT BEHAVIOR & DEVELOPMENT 22 (4), 1999, 445–455 ISSN 0163-6383

in the first year of life (Ainsworth, Blehar, Waters, & Wall, 1978; Bowlby, 1969). The formation of an infant's first and primary social bond is thought to be dependent upon the experience of sensitive and responsive caregiving. Across all these domains—language, perception, and attachment—the infancy period is a critical time during which experiences lay the foundation for later competencies.

A different yet complimentary approach to the study of development is one in which emphasis is placed upon the contributions of individual differences in infant characteristics. These characteristics set the tone and create the conditions around which social interaction and development occur. Infants who smile and vocalize in response to social stimulation create an environment quite different from infants who are likely to fuss or cry in response to the same type of stimulation. Similarly, infants differ in their threshold for visual and auditory stimulation such that one infant may enjoy a certain level of stimulation while another might find it aversive. Characteristics such as affective disposition and sensory threshold serve as a filter through which sensory and perceptual stimuli are processed and therefore create the environments that infants experience. They are the individual differences around which infant cognition and personality develop. As such, infancy is an important time in which these differences first appear and in which developmental trajectories begin to be set.

In this essay we argue for the importance of understanding individual differences in infant behavioral style or temperament as a means for approaching the study of the origins of social development. We address the issue of continuity and change in infant temperament and provide evidence for the utility of an individual difference approach.

Temperament: Dimensions or Types?

What is temperament? Individual differences in infant temperament are thought to form the core of a child's personality. Temperamental differences refer to variations in behavioral styles, which appear early in life as a direct result of neurobiological factors, and represent predictable modes of response (Rutter, 1987; Thomas & Chess, 1977). These behavioral styles have been considered as reflecting a series of dimensions along which the behavior of an individual infant may be described. Using a dimensional approach, Thomas and Chess view temperament as the product of a child's position on each of nine dimensions (Thomas & Chess, 1977; Thomas, Chess, & Birch, 1968).

An alternative approach to the study of temperament is to view individual infants as representing different temperamental types or categories. As such, particular behavioral styles represent unique types of individuals. Thomas and Chess attempted to bridge the dimensional and typological approaches by proposing a set of temperamental types based upon various commonly occurring combinations of the nine factors. They proposed three such types: difficult, easy, and slow to warm up. Infants who are irregular in body functions, withdraw in response to novelty, react to stimulation with great intensity, express high levels of negative affect, and have difficulty adapting to changes in the environment are called "difficult" infants. Infants who are low in activity level, withdraw in response to novelty, are slow to adapt, and somewhat negative in mood are described as "slow to warm up." And, infants who are high in regularity, adaptability, and approaching towards novelty, are considered "easy" in temperament.

Researchers have used these temperamental types, particularly the difficult type, to predict behavioral outcomes in later childhood. For example, Guerin, Gottfried, and Thomas (1997) found that maternal reports of difficult temperament at 1.5 years were related to both parent and teacher reports of behavior problems, including attention and thought problems, in middle childhood.

Other research on infant temperament has utilized the typological approach for studying

continuity among a group of highly selected children. Kagan, Reznick, Clarke, Snidman, and Garcia Coll (1984) studied infants described as temperamentally fearful or inhibited. Following a typological approach, behaviorally inhibited infants are not simply higher on a dimension of fear or inhibition; they are qualitatively different than other infants. The "package" of their behavioral repertoire and physiological responses defines them as a type different from other infants.

Fox and colleagues also used a typological approach in order to identify a temperamental type of infant they call "exuberant" (Calkins, Fox, & Marshall, 1996; Fox, Henderson, Rubin, Calkins, & Schmidt, in press). Infants classified as exuberant displayed a common set of behavioral and physiological responses beginning early in the first year of life. Specifically, they displayed a high degree of positive affect, a high frequency of approach behaviors, low levels of fear, a high degree of sociability, and left frontal EEG asymmetry as early as the first year of life (Fox et al., in press).

The decision to study behavioral style or temperament from a dimensional or typological approach has implications for understanding continuity over development. The implications of a typological approach for explaining continuity may be illustrated by an analogy to medical conditions. Individuals may vary along a continuum in their blood sugar level. However, if an individual has a very high blood sugar level with a very low insulin level then that person has diabetes, which is a categorical condition. Although the patient may vary along certain parameters or dimensions the condition of diabetes is not dimensional. That is, individuals in a population are not more or less diabetic. The category provides the physician with a condition that can then be treated and controlled. Although that individual may use insulin to temporarily decrease the relative amount of blood sugar, they will continue as a diabetic. The underlying genotype is unchanged. The same applies to a typological approach to temperament. Individuals may vary along a certain dimension or may change over development on that dimension but they do not change type.

In contrast, dimensional approaches provide an index of an individual's standing relative to others in the population. For example, individuals vary in their level of systolic blood pressure and the level at which one is considered extreme (hypertensive) will vary as a function of population. Similarly, infants may vary along a dimension of temperament with extremes defined only as a function of population means and continuity defined as one's relative standing over time with respect to that population. A group of infants may reflect a type to the extent that there is homogeneity of a particular characteristic within the group as well as heterogeneity between that group and other children. Ideally, within group differences in the profile of behaviors of interest should be small relative to between group differences in the same profiles (Aksan et al., 1999; Caspi & Silva, 1995).

The choice of a typological or dimensional approach will also influence the manner in which data are analyzed. A typological approach would require examination of within group similarities and between group differences in relevant variables, while a dimensional approach would require the use of correlational analyses over time. With the former approach, groups of individuals are expected to differ from others on predicted variables while with the latter approach individuals may maintain relative ranks or levels on certain variables over time. A typological approach may also be more consistent with an extreme group analysis. Such analyses select arbitrary cut-off points for target variables and create groups based upon these cut-offs. Group differences are then examined. Note that the extreme group approach may be utilized with either a typological or dimensional approach to the study of temperament.

The Biological Basis for Temperament

Temperament is thought to describe those aspects of behavioral responding that are not due to interactions with caregivers or other environmental influences, but rather those aspects that are present from birth and biologically based. For example, in Rothbart's model of temperament the general factor of reactivity is seen as being directly related to the responsivity of the nervous system to sensory stimulation (Rothbart & Derryberry, 1981). Individual differences in the young infant's reactivity are a result of the excitability of the nervous system and can be measured using autonomic, endocrine, and central nervous system changes in response to stimulation. Similarly, in Kagan's model of temperamental inhibition, infants vary in the degree of their reactivity to novelty and mild stress as a function of the excitability of certain nuclei within the amygdala and surrounding regions such as the Central Gray (Kagan, Reznick, & Snidman, 1987). This model relies heavily on data from researchers such as Davis (1992; Davis, Hitchcock, & Rosen, 1987) and LeDoux (1987, 1989) who described the neural circuits and structures in the brain stem and mid-brain that are associated with animals' heightened fear responses as a result of conditioning. Davis et al. (1987) and LeDoux (1987, 1989) identified the neural systems involved in rats' fear responses during a classical conditioning paradigm involving a tone or light and shock. This system appears to underlie both the behavioral (e.g., startle, freezing, and negative vocalization) and physiological (e.g., increased heart rate and stress hormone) signs of fear demonstrated by the rats. LeDoux further argued that human fear reactions originate from the same neural system. This neural system centers around the amygdala and in particular the central nucleus of the amygdala which appears to function as a way station organizing sensory input and sending afferent information to other mid-brain nuclei including the Central Gray and lateral hypothalamus. Kagan considers individual differences in behavioral reactivity to novelty as indicators of differences in these underlying neural processes (Kagan et al., 1987).

Yet a third model of temperament is one that centers on individual differences in two independent systems of motivation that are present from birth (Fox & Davidson, 1984). These two systems, approach and withdrawal, are common to most organisms and underlie the expression of affect and basic exploratory behaviors. Infants differ in the degree to which they respond with either approach or withdrawal responses when presented with novel or mildly stressful stimuli. Included in these responses are the expression of certain emotions and motor behaviors associated with either approach or withdrawal. For example, infants with a predisposition to respond with approach behaviors are more likely to display positive affect and motor behaviors involving exploration. In comparison, infants with a predisposition toward withdrawal may be more likely to display negative affect and the motor behaviors associated with freezing or fleeing. The approach and withdrawal systems appear to be lateralized between the two hemispheres of the frontal cortex with left frontal regions being associated with approach-related behaviors and right frontal regions being associated with withdrawal. These lateralized differences and their relations to predispositions to respond to novelty have been identified in infants during the first year of life, in children who vary in temperamental style, and in adults who differ along specific personality dimensions. For example, Davidson and Fox (1989) found that 10-month-old infants who exhibited right frontal EEG asymmetry were more likely to cry to maternal separation than infants who exhibited left frontal EEG asymmetry. Davidson and colleagues found that adults with left frontal EEG asymmetry were more likely to rate videos in a positive fashion compared to those exhibiting right frontal EEG asymmetry (Tomarken, Davidson, & Henriques, 1990). The precise nature of the asymmetry is not known. However, there are data describing the inhibitory connections between prefrontal re-

gions and the central nucleus of the amygdala (McDonald, 1998; Morgan, Romanski, & LeDoux, 1995).

Temperament: Predicting Behavior Across Development

An additional aspect of the definition of temperament is that these behavioral styles represent predictable modes of response. This element of the definition refers to the notion of continuity of the response over time. In order to understand the influence of temperament it is important to define exactly what we mean by continuity and to specify the processes, whether endogenous (e.g., physiology) or exogenous (e.g., parent-child relationships), that might support or discourage continuity. Caspi (1998) discusses five different types of continuity: differential, absolute, structural, ipsitive, and coherence. These five forms of continuity can be contrasted with one another in at least three ways, including whether they describe: (1) absolute versus relative continuity; (2) the same versus different phenotypic expressions of a common genotype over time; and (3) continuity over time at the level of an individual versus a group of individuals. Briefly, differential continuity refers to the consistency of individual differences within a sample population over time and is generally indexed via a correlation coefficient. Absolute continuity refers to the degree of consistency in level or amount of a specific behavior for a group of individuals over time and is indexed by a comparison of group means on the same behavior or attribute over time. Structural continuity refers to the persistence of patterns of correlations among a set of variables or factors, within a population, over time, and is based on analytical methods such a structural equation modeling. The persistence of patterns of relations over time is interpreted as reflecting consistency in underlying or latent structures or processes. The fourth type of continuity described by Caspi is ipsitive, which refers to continuity in the configuration of variables within an individual over time. Essentially, ipsitive continuity is equivalent to structural continuity except it is considered at the level of the individual as opposed to a group or population. The fifth type of continuity described by Caspi is called coherence. Coherence refers to continuity in an underlying genotype or attribute despite changes in the phenotypic expression of the attribute. In Caspi's view, such an approach necessitates a theoretical model of development that allows for *a priori* predictions regarding the later behavioral outcomes associated with an early appearing trait.

One of the critical issues in assessing the predictive utility of infant temperament is the specification of exactly what behaviors one ought to predict to over the course of time. Clearly, this will influence the definition of continuity to be employed. The first four forms of continuity described by Caspi (differential, absolute, structural, and ipsitive) are similar in that they all describe homotypic continuity, whereas the fifth form, coherence, describes heterotypic continuity. Kagan and colleagues wrote of the distinction between homotypic and heterotypic continuity over thirty years ago based on an analysis of continuity and change in the Fels project (Kagan, 1969, 1971; Kagan & Moss, 1962). Homotypic continuity refers to the continuity of similar behaviors or phenotypic attributes over time. For example, one might predict that the same pattern of fear responses to novelty observed in infancy would be found in later childhood. In contrast, heterotypic continuity refers to the continuity of a genotype or common underlying trait despite changes in the phenotypic expression of the tendency. Therefore, heterotypic continuity refers to relations between earlier and later behavior that are based upon age-appropriate and logical associations rather than similarities in exact behaviors. For example, several reports describe the relation between a difficult temperament in infancy and externalizing behavior in childhood (e.g., Guerin et al., 1997; Sanson, Smart, Prior, & Oberklaid, 1993). Clearly, external-

izing behaviors can take many different forms and are not isomorphic with irritable behavior. However, the assumption being made in such studies is that there is a common underlying basis for both infant irritability and children's externalizing behavior such as a dysregulatory state that would affect a child's ability to control their emotions in both infancy and later in childhood.

Whether homotypic or heterotypic continuity will be the focus of any study of change over time depends on both the age-span under consideration and the nature of the behaviors being examined. Kagan (1969) suggested that heterotypic continuity was more likely to be found from infancy while homotypic continuity would be found later in adult life. His reasoning was that infants and children go through multiple contextual changes over the first years of life whereas, in general, adult life circumstances are more consistent. In addition, rapid changes in competence in areas including language, motor control, and higher-order cognition will allow for not only quantitative but also qualitative changes in the way in which temperamental tendencies will be expressed.

There are many complexities to the study of either type of continuity, particularly when continuity is being considered from infancy. Because of the focus on identical behaviors over time, the most precise manner to assess homotypic continuity would be to utilize identical eliciting conditions at different time points and measure similar behavioral responses. The assumption of such an approach is that the stimulus situations will be equally salient at different time points. Although this assumption will be met with most studies of adults, in the study of infants and children one must consider developmental changes in the nature of eliciting events. For example, stimulus situations that elicit fear responses in infancy will undoubtedly change in their salience as elicitors of fear for older children. Similarly, stimulus situations that would not elicit fear in infants may be potent elicitors of fear in older children.

Specifying heterotypic continuity is complex as well, especially when continuity is being assessed over periods of rapid development. The best-defined models of continuity require *a priori*, theoretically derived predictions relating certain types of infant temperament to specific behaviors in childhood. These predictions ought to be based upon theories of development that would allow one to predict age-appropriate changes in the phenotypic expression of a common genotype. For example, Kagan and colleagues (Kagan & Snidman, 1991) and Fox and colleagues (Calkins et al., 1996) selected infants who displayed a good deal of motor response and irritability in response to novel visual and auditory stimuli during the first year of life and predicted that these infants would display behavioral inhibition and shyness when they were older. This prediction was based upon data implicating the central nucleus of the amygdala and the Central Gray as the neural substrates of fear responses. Arousal of these areas would be expressed as motor reactivity and distress in infancy and anxiety and active social withdrawal in older children.

Influences on Continuity

There are many potential processes that can either support or discourage continuity over time in the expression of temperament. These processes have been thought of as involving transactions between person and environment. Models of personality and social development differ in the emphasis placed upon the person versus the environment in the process of developmental change. Caspi (1998) describes three transactional processes that will influence the degree of continuity in behavior over time: reactive, evocative, and proactive transactions. These person-environment transactions may lead as often to discontinuities in personality as they do to continuities.

Reactive transactions emphasize individual characteristics that impact upon a person's experience of identical environmental condi-

tions. Applied to models of early temperament, temperamental traits will affect the ways in which environmental information is processed and therefore interpreted. These temperamentally based biases in responding to the environment may be a powerful force in maintaining and promoting early individual differences. Evocative transactions refer to the manner in which unique individual differences evoke particular responses from the environment. In turn, such responses influence the manner in which the individual will respond back to the environment, establishing a self-perpetuating cycle of interaction between an individual and the environment. For example, infants of different temperaments may evoke different caregiving behaviors from the same parent. Infants displaying inhibited behaviors in response to unfamiliarity may evoke over-protection and over-indulgence from parents, whereas infants who are novelty seeking and sociable may evoke a more balanced caregiving approach. Differences in caregiving style could serve to either maintain or diminish the expression of temperamental differences. The final process, proactive transactions, refers to the manner in which individuals move beyond the environments into which they are born and actively select and construct environments of their own. Much of the work on individual differences in the establishment of close friendships and peer group selection is based on the idea of proactive transactions. It appears that friendship patterns and peer networks are often the function of children with similar behavioral tendencies affiliating with one another, which may facilitate continuity in each of the individual's traits (Hartup, 1996; Kupersmidt, DeRosier, & Patterson, 1995; Rubin, Lynch, Coplan, Rose-Krasnor, & Booth, 1994). However, proactive selection of peers might also function to discourage continuity of traits. Children may not always seek out individuals of similar characteristics. They may instead attempt to ally themselves with other children with whom they stand the best chance of not being rejected. For example, Suomi (1979) found that low status juvenile Rhesus monkeys often allied themselves with higher status peers to gain acceptance and protection within the peer group.

Evidence for Continuity from Infancy

In our own work we are interested in the temperamental origins of social withdrawal. Research from a number of laboratories suggests that a significant portion of socially withdrawn children may have a common temperament. The temperamental profile includes high levels of motor reactivity and arousal and high levels of negative affect and crying, particularly in response to the presentation of novel sensory stimuli. We used a typological approach to examine the relation between temperament in infancy and later social behaviors. Specifically, we selected infants at 4 months who represented the extremes on dimensions of both motor arousal and negative affectivity. We wished to investigate continuities in behavior over time for these infants who we believed reflected a particular temperamental type. Details on the selection of the infants in our study may be found in Calkins et al. (1996) and in Fox et al. (in press).

During our initial screening of 4-month-old infants we noted a second group of infants who also responded with a great deal of motor reactivity to sensory stimulation. However, instead of displaying negative affect and distress in response to the novel visual and auditory stimuli, they displayed positive facial and vocal affect. These infants appeared unique, not simply because of their lack of fear to the stimuli, but because of their apparent joy and pleasure in response to novel stimuli. This group of highly positive infants was included in our longitudinal study because we thought they represented a unique temperamental type. A third group of infants who were simply non-reactive (i.e., displayed neither motor activity nor signs of either negative or positive affect during the presentation of the novel stimuli) were selected as a comparison group.

The approach of our longitudinal study was

to identify patterns of heterotypic continuity over a four-year period of time. Although we identified temperamentally reactive infants at 4 months based on discrete motor and affective behaviors in response to *sensory* stimuli, we assessed toddler and preschool children's responses to novel *social* situations. Although the nature of the eliciting stimuli clearly changed with age, we reasoned that the stimuli were age-appropriate in their abilities to activate the neural circuits associated with the fear system. Our hypothesis was that individual differences in the threshold for activation of these neural circuits would be expressed as differences in negative reactivity in early infancy and then as differences in social withdrawal at later ages. Therefore, despite phenotypic variation in the behavioral and affective expression of fear, we hypothesized that there would be continuity in the underlying genotype. Thus, the selected infants were assessed over a four-year period of time with both behavioral and psychophysiological measures designed to examine the child's responses to novelty and their autonomic and central physiological levels. At 14 and 24 months, the infants were observed in a paradigm designed to assess their reactions to unfamiliar objects and unfamiliar adults. At 48 months, the children were organized and observed in same gender play quartets. We expected to find continuity in children's response to novelty between 4 months and later ages such that high reactive/high negative infants would display social withdrawal both as toddlers and as preschool children.

Overall, we found that patterns of continuity in behavior over the first four years of life were related to the 4-month temperament groups (Fox et al., in press). Specifically, of the 44 infants selected based on their high levels of negative reactivity at 4-months, 12 (or 27%) were classified as continuously socially withdrawn over the 4-year period. In contrast, only one of the 32 infants (or 3%) selected based on high levels of positive reactivity was classified as continuously withdrawn. And only four of the 39 (or 10%) infants in the comparison group of infants who displayed low levels of motor and affective reactivity at 4 months were classified as continuously withdrawn.

Examination of patterns of continuity in the second temperament type identified (high positive reactivity) revealed an even stronger picture of continuity across age. Of the 32 high positive infants, 15 (or 47%) were classified as consistently exuberant over the first four years of life. In contrast, only four of the 23 infants selected based on their high levels of negative reactivity met the criteria for consistently exuberant behavior. That is, at 14, 24, and 48 months, infants selected at 4 months to fit the temperament profile of high motor and positive reactivity displayed a consistent pattern of novelty seeking, lack of fear of novelty, and sociability.

Together, the data we have reported on continuity of these two temperamental profiles across the first four years of life demonstrate that (a) there is as much discontinuity as there is continuity in the behavioral expression of these temperaments, and (b) the degree of continuity or change may depend on the specific temperamental characteristics under study.

There are obviously many reasons for discontinuity in temperament, or the modification of the expression of temperament, particularly among the group of infants we identified as high in negative reactivity. The most obvious, perhaps, is that environmental pressures within the social context in which children develop provide the structure around which temperamental dispositions will be modified. These pressures may occur at many different levels ranging from the day-to-day experiences and interactions children have with others to more widely held cultural values and beliefs.

We consider two pieces of evidence as supporting these ideas. First, in our own sample, high reactive/high negative infants who continued to display high levels of social withdrawal over the 4-year period of study were more likely to have been in the exclusive care

of their parents during the first two years of life. In contrast, infants who were equally high in negative reactivity in infancy but who did not continue to display signs of withdrawal over time were more likely to have been in out-of-home care with at least one non-sibling during the first two years of life (Fox et al., in press). Second, social withdrawal is not valued within North American culture and there may be pressures within the peer group and family to be more outgoing within social settings. There is evidence to support such a contention from cross-cultural work completed by Rubin and colleagues. Chen et al. (1998) asked parents in Mainland China and in a large city in Canada to rate the degree to which they felt shyness or inhibition was a positive or negative aspect of a child's personality. They found that Chinese parents saw inhibition as a positive aspect of a child's personality, while Canadian parents did not. The percentage of children exhibiting behavioral inhibition in China was significantly larger than it was in Canada. They argued that cultural belief systems support or modify a child's initial temperamental disposition. Together these findings suggest that initial temperamental dispositions may be susceptible to modification by cultural/environmental influences.

There are at least three explanations for the greater continuity within the high reactive positive group compared to the high reactive/negative group. First, this group may reflect a more 'pure' temperamental type beginning in infancy. That is, there may have been less heterogeneity within that group compared to the group of highly reactive yet negative children. Second, the culture within which the children in our longitudinal study develop appears biased toward sociable, high approach motivated children as would be suggested by the findings of Chen et al. (1998) discussed above. Infants and young children exhibiting these traits are more likely to be reinforced by parents and the environment around them, making it more likely that continuity would be the norm. Third, it is possible that the underlying neural or biological substrates associated with the high positive reactivity temperament are less amenable to change whereas the system involved in fear may be more malleable. As a motivational system, the neural circuits involved in the expression of fear must be linked to discrimination of safe versus dangerous stimuli. As the infant matures these links must be updated to identify new sources of danger and at the same time to modify certain sources that were once thought novel but are no longer. The approach system involved in the behaviors of social interaction, novelty seeking, and behavioral exuberance may not rely on such revision and updating. Hence, the approach system may be less susceptible to environmental influences.

There appears to be significant continuity from infancy when identifying particular temperamental types of infants who reflect the extremes in behavioral patterns. The key to continuity within these temperament types is the homogeneity within the group in behavioral reactions in the infancy period. In the absence of selection of extreme groups and consistency in response it is doubtful that this significant degree of continuity would appear.

REFERENCES

Ainsworth, M. D. S., Blehar, M. C., Waters, E., & Wall, S. (1978). *Patterns of attachment: A psychological study of the strange situation*. Hillsdale, NJ: Erlbaum.

Aksan, N., Goldsmith, H. H., Smider, N. A., Essex, M. J., Clark, R., Hyde, J. S., Klein, M. H., & Vandell, D. L. (1999). Derivation and prediction of temperamental types among preschoolers. *Developmental Psychology*, *35*, 958–971.

Bowlby, J. (1969). *Attachment and loss (Vol. 1). Attachment*. New York, NY: Basic Books.

Calkins, S. D., Fox, N. A., & Marshall, T. R. (1996). Behavioral and physiological antecedents of inhibition in infancy. *Child Development*, *67*, 523–540.

Caspi, A. (1998). Personality development across the life course. In W. Damon (Ser. Ed.) & N. Eisenberg (Vol. Ed.), *Handbook of child psychology, Vol. 3: Social, emotional, and person-*

ality development (pp. 311–388). New York, NY: Wiley.

Caspi, A., & Silva, P. A. (1995). Temperamental qualities at age three predict personality traits in young adulthood: Longitudinal evidence from a birth cohort. *Child Development*, *66*, 486–498.

Chen, X., Hastings, P. D., Rubin, K. H., Chen, H., Cen, G., & Stewart, S. L. (1998). Child-rearing attitudes and behavioral inhibition in Chinese and Canadian toddlers: A cross-cultural study. *Developmental Psychology*, *34*, 677–686.

Davidson, R. J., & Fox, N. A. (1989). Frontal brain asymmetry predicts infants' response to maternal separation. *Journal of Abnormal Psychology*, *98*, 127–131.

Davis, M. (1992). The role of the amygdala in fear and anxiety. *Annual Review of Neuroscience*, *15*, 353–375.

Davis, M., Hitchcock, J. M., & Rosen, J. B. (1987). Anxiety and the amygdala: Pharmacological and anatomical analysis of the fear-potentiated startle paradigm. In G. Bower (Ed.), *The psychology of learning and motivation* (Vol. 21, pp. 263–305). San Diego, CA: Academic Press.

Fox, N. A., & Davidson, R. J. (1984). Hemispheric substrates of affect:A developmental model. In N. A. Fox & R. J. Davidson (Eds.), *The psychobiology of affective development* (pp. 353–382). Hillside, NJ: Erlbaum Press.

Fox, N. A., Henderson, H. A., Rubin, K. H., Calkins, S. D., & Schmidt, L. A. (in press). Continuity and discontinuity of behavioral inhibition and exuberance: Psychophysiological and behavioral influences across the first four years of life. *Child Development*.

Guerin, D. W., Gottfried, A. W., & Thomas, C. W. (1997). Difficult temperament and behavior problems: A longitudinal study from 1.5 to 12 years. *International Journal of Behavioral Development*, *21*(1), 71–90.

Hartup, W. W. (1996). The company they keep: Friendships and their developmental significance. *Child Development*, *67*, 1–13.

Huttenlocher, J. (1998). Language input and language growth. *Preventative Medicine*, *27*, 195–199.

Kagan, J. (1969). The three faces of continuity in human development. In D. A. Goslin (Ed.), *Handbook of socialization theory and research* (pp. 983–1002). Chicago, IL: Rand McNally.

Kagan, J. (1971). *Change and continuity in infancy*. New York, NY: Wiley.

Kagan, J. (1996). Three pleasing ideas. *American Psychologist*, *51*(9), 901–908.

Kagan, J., & Moss, H. A. (1962). *Birth to maturity*. New York, NY: Wiley.

Kagan, J., Reznick, J. S., Clarke, C., Snidman, N., & Garcia Coll, C. (1984). Behavioral inhibition to the unfamiliar. *Child Development*, *58*, 1459–1473.

Kagan, J., Reznick, J. S., & Snidman, N. (1987). The physiology and psychology of behavioral inhibition in children. *Child Development*, *58*, 1459–1473.

Kagan, J., & Snidman, N. (1991). Infant predictors of inhibited and uninhibited profiles. *Psychological Science*, *2*, 40–44.

Kupersmidt, J. B., DeRosier, M. W., & Patterson, C. P. (1995). Similarity as the basis for children's friendships: The roles of sociometric status, aggressive and withdrawn behavior, academic achievement and demographic characteristics. *Journal of Social and Personal Relationships*, *12*, 439–452.

LeDoux, J. E. (1987). Emotion. In F. Plum (Ed.), *Handbook of physiology. Section 1: The nervous system: Vol. 5. Higher functions of the brain. Part 1*. Bethesda, MD: American Physiological Society.

LeDoux, J. E. (1989). Cognitive-emotional interactions in the brain. *Cognition and Emotion*, *3*, 267–289.

Maurer, D., Lewis, T. L., Brent, H. P., & Levin, A. V. (1999). Rapid improvement in the acuity of infants after visual input. *Science*, *286*(5437), 108–110.

McDonald, A. J. (1998). Cortical pathways to the mammalian amygdala. *Progress in Neurobiology*, *55*, 257–332.

Morgan, M. A., Romanski, L. M., & LeDoux, J. E. (1995). Extinction of emotional learning: Contribution of medial prefrontal cortex. *Neuroscience Letters*, *163*, 109–113.

Rubin, K. H., Lynch, D., Coplan, R., Rose-Krasnor, L., & Booth, C. L. (1994). "Birds of a feather. . .": Behavioral concordances and preferential personal attraction in children. *Child Development*, *65*, 1778–1785.

Rothbart, M. K., & Derryberry, D. (1981). Development of individual differences in temperament. In M. E. Lamb & A. L. Brown (Eds.),

Advances in developmental psychology (Vol. 1, pp. 37–86). Hillsdale, NJ: Erlbaum.

Rutter, M. (1987). Temperament, personality, and personality disorder. *British Journal of Psychiatry, 150*, 443–458.

Sanson, A., Smart, D., Prior, M., & Oberklaid, F. (1993). Precursors of hyperactivity and aggression. *Journal of the American Academy of Child and Adolescent Psychiatry, 32*, 1207–1216.

Suomi, S. J. (1979). Differential development of various social relationships by rhesus monkey infants. In M. Lewis & L. A. Rosenblum (Eds.), *The child and its family: Vol. 2. Genesis of behavior* (pp. 219–244). New York, NY: Plenum Press.

Thomas, A., & Chess, S. (1977). *Temperament and development*. New York, NY: Bruner/Mazel.

Thomas, A., Chess, S., & Birch, H. G. (1968). *Temperament and behavior disorders in children*. New York, NY: New York University Press.

Tomarken, A. J., Davidson, R. J., & Henriques, J. B. (1990). Resting frontal brain asymmetry predicts affective responses to films. *Journal of Personality and Social Psychology, 59*, 791–801.