Temperament and Personality: Origins and Outcomes

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This article reviews how a temperament approach emphasizing biological and developmental processes can integrate constructs from subdisciplines of psychology to further the study of personality. Basic measurement strategies and findings in the investigation of temperament in infancy and childhood are reviewed. These include linkage of temperament dimensions with basic affective–motivational and attentional systems, including positive affect/approach, fear, frustration/anger, and effortful control. Contributions of biological models that may support these processes are then reviewed. Research indicating how a temperament approach can lead researchers of social and personality development to investigate important person–environment interactions is also discussed. Lastly, adult research suggesting links between temperament dispositions and the Big Five personality factors is described.

Temperament arises from our genetic endowment. It influences and is influenced by the experience of each individual, and one of its outcomes is the adult personality. An important goal of our research has been to specify processes at the levels of biology and social development that may link a child's early endowment to its later expression as an adult. In this article, we suggest that understanding temperament is central to understanding personality. Individual differences in temperament have implications for development in infancy and childhood, and they form the core of personality as it develops. Temperament also provides process-oriented models that are often lacking in trait theories of personality, by establishing links between individual differences in behavior and their psychological and biological substrates. Temperament also can be used to relate human individual differences, through evolutionary models, to individual differences in nonhuman animals.

The purpose of this article is to review our approach to temperament research, indicating ways in which thinking about temperament can illuminate the understanding of individual differences. Many of the guiding principles of this approach are already familiar to personality researchers, because they were laid out by those who helped to develop modern conceptions of personality. Other principles may be less familiar, because they derive more heavily

from developmental or biological psychology, but each represents tools by which personologists can more effectively understand personality processes.

In recent years there has been a major resurgence of interest and progress in personality research. This has been due in part to a general agreement among researchers about a set of higher order constructs describing personality traits of adults and school-age children (Digman, 1990, 1996; Goldberg, 1990). These constructs, alternatively called the "Big Five" and the "Five Factor Model" (FFM), have emerged from self- and peer-report factor analytic studies using rating scales and trait-descriptive adjectives, but they share a history that goes back to early factor analytic work (e.g., Cattell, 1933; Thurstone, 1934). It is interesting to note that Cattell identified his early factor analytic research as a study of temperament and that Thurstone set out to study temperament and personality, along with other "vectors of mind."

A major problem in the study of temperament, however, is one that has also affected personality research. This is a tendency of different researchers to rename temperament variables, even when the content of the previous and renamed constructs is quite similar. This produces an apparent lack of agreement about the subject matter of temperament that may not be justified (Rothbart, 1999). Variability in labels sometimes reflects real differences across studies, but we have also found substantial agreement in the content of constructs across a number of studies of temperament (Rothbart & Bates, 1998), and we and others have also noted significant similarities between temperamental dispositions and several of the Big Five trait factors (Ahadi & Rothbart, 1994; Martin, Wisenbaker, & Huttunen, 1994; Rothbart, 1989b; Rothbart & Ahadi, 1994). We urge the reader of temperament research to consider the content of temperament scales before deciding, on the basis of variable names, that there is lack of agreement in the field.

In our laboratory, we have studied dimensions of temperament in infancy (Rothbart, 1981, 1986), toddlerhood (Jones, Gartstein,

Rothbart, & Chasman, 1999), childhood (Goldsmith & Rothbart, 1991; Rothbart, Ahadi, Hershey, & Fisher, 1997), adolescence (Capaldi & Rothbart, 1992), and adulthood (Derryberry & Rothbart, 1988; Evans & Rothbart, 1999). We have also discussed possible links between temperament and biology (Rothbart, Derryberry, & Posner, 1994) and used a temperament approach to clarify our understanding of Big Five factors in studies of adults (Evans & Rothbart, 1999). In this article, we review this work along with related research on temperament and development. The article begins with definitions of personality and temperament, followed by a discussion of the nature of temperament as it has emerged from studies of infants and young children. We continue by describing research programs linking temperament and social and personality development, and conclude by relating temperamental variables to the Big Five.

Definitions

Allport (1937) defined *personality* as "the dynamic organization within the individual of those psychophysical systems that determine his unique adjustment to his environment" (p. 48). This definition supports the study of common traits, with *trait* defined by Allport (1961) as "a neuropsychic structure having the capacity to render many stimuli functionally equivalent and to initiate and guide equivalent (meaningfully consistent) forms of adaptive and expressive behavior" (p. 347). Allport (1937) further put forward two primary goals for personality research: the identification of individual differences and the explication of the psychological processes underlying those differences.

Several aspects of Allport's (1937, 1961) approach point to the centrality of temperament in understanding personality. One is his emphasis on process; another is his consideration of adaptive qualities that may be linked to evolution. A third is his concern with dynamic organization. Views of temperament since ancient times have stressed the balance among dispositions and their links to the individual constitution as it was understood at the time. Temperament, from the Roman "temperamentum," originally referred to a proportionate mixture of bodily humors, and it took the form of the fourfold typology among Greco-Roman physicians close to 2,000 years ago (Diamond, 1974). The choleric individual, with a predominance of yellow bile, is irritable and quick to anger; the melancholic individual, with predominant black bile, is sad and anxious; the sanguine individual, with predominant blood, is positive and outgoing; and the phlegmatic individual, with predominant phlegm, is slow rising in emotion and action. This fourfold typology was accepted up to recent times, and Eysenck (1967) and others have linked their theoretical models to it.

We have defined *temperament* as individual differences in reactivity and self-regulation assumed to have a constitutional basis (Rothbart & Derryberry, 1981). We (Rothbart & Derryberry, 1981) defined *constitutional* as "the relatively enduring biological makeup of the organism, influenced over time by heredity, maturation, and experience. *Reactivity* refers to the excitability, responsivity, or arousability of the behavioral and physiological systems of the organism, whereas *self-regulation* refers to neural and behavioral processes functioning to modulate this underlying reactivity" (p. 40, italics added). We developed this definition in an attempt to capture central notions of temperament and to provide umbrella terms for thinking about temperament that might be applied at multiple levels of analysis. For example, we proposed that reactivity could be measured in terms of five response characteristics: latency of response, rise time, peak intensity, overall intensity, and recovery from a peak of excitation (Rothbart & Derryberry, 1981). These parameters can be used to describe behavioral, autonomic, endocrine, and other forms of reactivity, and they allow for the study of the time course and intensity of different components of response (e.g., heart rate, motor activity). These characteristics have more recently been put forward and measured by Thompson (1990) and others. We also wished to stress that phasic responses are themselves a result of an interplay between reactive and regulatory processes.

The definition of temperament was also offered in part as an alternative to the "behavioral style" definition of Thomas and Chess (1977) and Buss and Plomin (1975). Thomas and Chess, in their pioneering work on infant temperament, defined temperament as the "how" of behavior, to be differentiated from ability, which they saw as the "what" and "how well" of behavior, and from motivation, which they saw as the "why" of behavior. We did not wish to identify temperament with style for at least three reasons. First, we did not want to suggest that dimensions of temperament would be reflected in all behaviors of the individual. Instead, temperamental characteristics must be studied in the context of stimuli appropriate to their elicitation. A disposition to fear will be shown in situations that are novel and unpredictable, but not when the situation is familiar and safe; the disposition to frustration will be seen in situations in which one has been blocked from reaching a goal, but not when goals have been satisfied. In temperament constructs, the "functional equivalence" of stimuli discussed by Allport (1961) is rendered by stimulus membership in an adaptive class (e.g., the classes of fear-eliciting or frustration-eliciting stimuli).

Second, a style definition also suggests that a given response characteristic may generalize to all modalities of expression, as in Thomas and Chess's (1977) temperament dimensions of Threshold and Intensity. We (Rothbart, 1981) and others (Martin et al., 1994) have not found evidence for this kind of generality. Instead, we have found variability both in specific systems related to adaptation, such as fear, frustration, and positive approach motivation, which we have called affective-motivational systems, and in attentional characteristics. This set of basic dimensions allows us to consider affect, attention, and action within what we (Rothbart & Derryberry, 1981) described as "an integrated system, consisting of a range of affective–motivational capabilities and limitations, together with a set of cognitive, behavioral, and social 'strategies' for fulfilling these requirements" (p. 38). When viewed in this way, temperament is concerned with the what and why, as well as the how of behavior.

Third, our approach to temperament was also positively influenced by Allport (1961), who defined temperament as "the characteristic phenomena of an individual's emotional nature, including his susceptibility to emotional stimulation, his customary strength and speed of response, and the quality of his prevailing mood, these phenomena being regarded as dependent upon constitutional make-up" (p. 34). We wished to go beyond mood and emotion, however, to include motor tendencies and attention, so that self-regulatory as well as reactive processes would be studied.

One of the most promising reasons for taking a temperament approach to individual differences is that it allows researchers to

study development. We originally thought that if we could identify the basic components of affect, attention, and action and study them in infants, then we would have identified the initial state of personality. When we began our work, we thought it might be relatively easy to specify the initial state by identifying the temperament dimensions of the newborn or very young infant. Events would then influence personality through the expressions of the child's dispositions and the child's related experiences with the social and physical world. Temperament would influence and set constraints on the development of other aspects of personality. Aspects of personality that go beyond temperament include the following, among others: (a) the individual's views of the self, of other people, and of the physical world; (b) links between the self and other entities in concepts, schemas, and life narratives; and (c) cognitive adaptations to the social world, including coping mechanisms and defenses.

This approach, however, did not take into account the fact that an infant is not born with a full complement of temperamental characteristics. Temperament itself develops, that is, emotions and components of emotions appear at different ages (Izard, 1977), as do aspects of motor functioning and arousal systems (for a review, see Rothbart, 1989b) and systems of attention (Posner & Raichle, 1994). As we discovered this, we at first proposed that the young infant is chiefly reactive, so that the story of early development would be the addition of self-regulatory capacities to this reactivity (Rothbart & Derryberry, 1981). One late-appearing system, called the executive attention system, did indeed seem to be largely self-regulatory, with very important implications for the developing personality (Kochanska, Murray, & Coy, 1997; Posner & Rothbart, 1998). Under closer scrutiny, however, not all reactive systems were present at birth (e.g., fear), and reactive emotional systems themselves proved to have self-regulatory components, as in the behavioral inhibition aspect of fear and the approach aspect of positive incentive motivation. Developmental processes thus required us to consider the structure of temperament at different ages, beginning with infancy (Rothbart, 1989b; Rothbart & Bates, 1998).

Temperament in Infancy

One of the first large-scale longitudinal studies of infant temperament was published by Thomas and Chess and their colleagues in 1963 (Thomas, Chess, Birch, Herzig, & Korn, 1963). They began their research on infants age 2 to 6 months in the New York Longitudinal Study (NYLS). Parent interviews were carried out, and interviewers obtained detailed information about infant patterns of reaction across a wide variety of situations. A content analysis of the reactions of the first 22 infants yielded nine dimensions of temperamental variability: Activity Level, Rhythmicity (of bowel habits, sleep, and eating), Approach-Withdrawal toward new situations, Adaptability, Threshold of response to stimulation, Intensity of response, predominant Mood, Distractibility, and Attention Span-Persistence.

In our research (Rothbart, 1981), we set out to develop a parent-report questionnaire that would assess Thomas and Chess and their colleagues' (Thomas et al., 1963) dimensions, along with characteristics reported by Diamond (1957) as showing temperamental variability in other animal species, characteristics studied in human behavioral genetics, and positive affect, which had been the

focus of our early research (Rothbart, 1973). We also developed a home observation measure and a laboratory-based assessment of infant temperament. In the following section, each of these methods is described, and convergence (and lack of convergence) across the methods is noted.

Parent Reports of Infant Temperament

We developed a parent-report instrument by asking over 450 parents to act as informants about their infant's reactions; the infants were age 3, 6, 9, and 12 months (Rothbart, 1981). We realized that there are biases associated with parent reports. There are, however, major benefits as well, and we have reviewed these previously (Rothbart & Bates, 1998). In the questionnaire, we tried to avoid asking parents to make global judgments about events that had happened some time ago. Instead we asked parents how frequently certain behaviors had occurred in specified contexts across the previous week or 2 weeks. For example, "When put in the bath water, how often did the baby kick and splash?" or "When meeting a stranger, how often did the baby cry?" Parents responded to these questions on 7-point scales ranging from *never* (1) to *always* (7).

One of the most interesting findings from our early questionnaire research was that items composing some of the NYLS dimensions of temperamental variability did not covary (Rothbart, 1981). For example, on the intensity dimension, a child who was intense in smiling and laughter was not necessarily intense in fear or frustration, and, on the rhythmicity dimension, a child rhythmic in bowel habits was not necessarily rhythmic in sleeping. In fact, covariation of item scores across response modalities proved to be so low that it was not possible to construct psychometrically sound scales for Intensity, Threshold, or Rhythmicity. Thus, these general measures are not represented in our measure of infant temperament. On the Adaptability scale, only soothability items clustered together. We were finally left with unipolar scales of three affective systems (fear, frustration, and positive affect), a soothability scale, and a duration of orienting scale that combined items based on Thomas and Chess and their colleagues' (Thomas et al., 1963) distractibility and attention span dimensions. The Infant Behavior Questionnaire (IBQ) thus aggregated item scores across a range of situations and eliciting conditions to yield scale scores with high internal reliability for Activity Level, Smiling and Laughter, Fear, Distress to Limitations (frustration), Soothability, and Duration of Orienting (attentional persistence).

When we later made a conceptual review of infant temperament questionnaire research, we found that the IBQ scales showed considerable similarity to lists of factors that had emerged from item-level factor analyses of NYLS-based scales (Rothbart & Mauro, 1990). A combination of dimensions from these two sources yielded a "short list" of temperament dimensions that include fear, anger or frustration, positive affect and approach, activity level, and attentional persistence or duration of orienting. These dimensions, along with perceptual sensitivity and soothability for which there is also some evidence, are a good beginning for considering early aspects of temperament.

Throughout our research program, we have attempted to adopt a construct-validation approach to the measurement of temperament dimensions. Studies designed to evaluate our measures have often led to suggestions for changes, but have also served to

change our conceptions about the nature of temperament. We now turn to our studies exploring the validity of infant measures and the structure of temperament in school-age children as well as predictions of 7-year parent-report temperament from laboratory measures in infancy.

Home Observations of Infant Temperament

In our second approach (Rothbart, 1986), we used home observation, in which observers visited the children's homes and carried out moment-to-moment coding of infants' behavior and the eliciting context in which it occurred. We hoped to be able to use these data both to assess validity of the parent report and to formulate an observational technique that could be easily applied by other researchers to the study of temperament. We had moderate success with the validity goal but failed in the latter objective. Observations were made of 46 infants both in the home and through parent questionnaires at 3, 6, and 9 months. At each age, three separate home observations were made across a 2-week period; infants' emotional and motor reactions to bathing, feeding, and play were coded. Because of processing limitations of coders, we were unable to code direction and duration of the infants' visual orienting, and our measure of soothability in the home was not stable from one day to another. However, a vocal reactivity measure was developed in this study for the questionnaire and for home observation, allowing five variables to be assessed by both methods. These formed two clusters of scores from the IBQ, labeled *positive reactivity* (Smiling and Laughter, Activity Level, and Vocal Activity scales) and *negative reactivity* (Fear and Distress to Limitations scales; Soothability was deleted from this cluster because we could not reliably measure it in the home).

Reliable agreement between home observation and questionnaire measures was found at all ages for positive and negative reactivity, with the exception of positive reactivity at 3 months of age. Positive reactivity increased in both frequency and intensity with age, and fear also increased over the period from 3 to 9 months of age, but frustration (Distress to Limitations) did not. Greater longitudinal stability was found for positive reactivity than for negative reactivity, as we had found in our early longitudinal work with the IBQ (Rothbart, 1981). This would be in keeping with the later development of fear and its differentiation from anger. In our study it became clear, however, that home observation and questionnaire measures did not control for the physical intensity of stimuli the child experienced. When bathing their infants, for example, some parents introduced their infants slowly into water that had been carefully tested for temperature. Other parents put their infants into larger amounts of untested bathwater; one child had a pot of water poured over his head as he sat in an empty tub.

We were persuaded to believe that the use of a laboratory approach would allow for important controls of stimulus intensity in measures of infant reactivity, even though it would introduce problems of laboratory novelty for the infants (which can lead to fear) and possible carryover effects from one emotion or attention assay to another (for a review of methods and related biases, see Rothbart & Bates, 1998). Laboratory research also allowed us to capture on videotape for later coding the extremely rapid shifts in emotion and attentional orienting that often occurred. Once the reactions of the infants were captured on videotape, for example,

we noted that a high-intensity smile might be rapidly transformed into an expression of distress. We therefore developed standardized structured procedures, videotaped infants' reactions, and carefully coded the videotapes for latency, duration, and intensity of individual reactions. This laboratory work later formed the basis of the Laboratory Temperament Assessment Battery developed by Goldsmith and Rothbart (1991).

Laboratory Assessment of Infant Temperament

In the laboratory longitudinal study, we observed 62 infants twice in the laboratory at each age of 3, 6, 10, and 13 months (Rothbart, Derryberry, & Hershey, in press). For most of the laboratory experience, infants were seated in a high chair facing a three-sided gray enclosure. Windows allowed the presentation of stimuli, and a tabletop permitted the presentation of toys that could be grasped and manipulated. Conditions for eliciting smiling and laughter included presentation of novel small squeeze toys, mechanical toys, and visual and auditory stimuli with rapid rise time and sudden offset, such as the ringing of a bell and the rapid opening of a parasol. Social stimulation of positive affect was carried out at 13 months only and included the experimenter playing games such as "peek-a-boo" with the child. Fear was elicited by the use of mechanical toys that engaged in unpredictable movements, including a bear with cymbals and a dancing duck, and by an appearance from a stranger (the stranger appeared at one of the windows and gave a prepared speech to the child). For frustration, toys were placed out of the infant's reach or behind a Plexiglas screen. Attention was measured by the time spent looking at toys and visual displays; soothability was measured as the time it took to recover following distress. We induced soothing by blowing bubbles over the top of the enclosure. Infants repeatedly oriented themselves to the falling bubbles, and their distress would level off, more rapidly for some infants than for others.

Latency, intensity, and duration of positive and negative affect, in measures of smiling and laughter, of fear, and of frustration, were standardized within each episode and then averaged for a single reactivity score for each episode. Correlations across eliciting episodes were computed, and episodes were included in an aggregate score if they were positively related to scores in the other episodes. Agreement in correlations between laboratory and parent-report measures was then assessed. Convergence was not found for the 3-month questionnaire and laboratory measures, but for 6-, 10-, and 13-month measures reliable convergence was found for smiling and laughter, soothability, and fear (the latter at 6 and 10 months only). Two characteristics were measured only at 13 months: duration of orienting, for which reliable agreement was found between parent and laboratory measures, and activity level, for which agreement was not found. We also did not find convergence between mothers' reports and laboratory measures of frustration, and at 13 months the two measures were moderately negatively related. Thus, we found validation support for some, but by no means all, of our measures, and only for those made at 6 months of age and beyond.

With respect to longitudinal stability of these laboratory measures during infancy, reliable evidence for stability was found from 3 to 13 months of age both for smiling and laughter and for fear, and also for overall distress from 6 to 13 months (Rothbart et al., in press). However, frustration showed significant stability

from 3 to 13 months and from 10 to 13 months only. Finally, we wished to assess predictability from the time the infant measures were taken to middle childhood, but to accomplish this, we had to develop a parent-report temperament measure that could be used for the preschool to middle childhood period.

Temperament in Preschool and Middle Childhood

The Children's Behavior Questionnaire (CBQ) was designed to measure temperamental characteristics of preschool and early school-age children (Rothbart et al., 1997). Dimensions assessed by the CBQ were derived chiefly from those identified in our adult research (Derryberry & Rothbart, 1988). They were also derived from dimensions of temperament already measurable in infancy and toddlerhood (Goldsmith, 1996; Rothbart, 1981). The CBQ scales measured differentiated aspects of broad-based temperament characteristics, with a focus on potential hierarchical or vertical representations of traits rather than a purely horizontal approach to trait assessment.

The CBQ gives a more comprehensive assessment of childhood personality than do other available instruments, in that individual differences are assessed along 16 dimensions: Activity Level (gross motor activity), Anger/Frustration (negative affect related to the interruption of tasks or the blocking of goals), Positive Anticipation (excitement and positive affect to expected pleasurable activities), Attentional Focusing (capacity to maintain attention on tasks), Discomfort (negative affect from sensory qualities of stimulation), Falling Reactivity/Soothability (rate of recovery from peak distress, excitement, or general arousal), Fear (negative affect related to anticipated pain, distress, or potential threat), High-Intensity Pleasure (positive affect derived from situations involving high-intensity stimuli often involving risk), Impulsivity (speed of response initiation), Inhibitory Control (capacity to plan and to suppress inappropriate action), Low-Intensity Pleasure (pleasure derived from situations involving low-intensity stimuli), Perceptual Sensitivity (detection of slight or low-intensity stimuli from the external environment), Motor Activation (excess motor movement, such as finger tapping), Sadness (negative affect and/or diminished energy related to disappointment and object loss), Shyness (inhibited approach and/or discomfort in novel social situations), and Smiling and Laughter (positive affect in response to changes in stimulus intensity, rate, complexity, and incongruity).

The CBQ scales generally show adequate to good internal consistency reliability, with coefficient alphas ranging from .63 to .92 with a mean of .74 in one sample of 4- and 5-year-olds, and from .58 to .91 with a mean of .75 in one sample of 6- and 7-year-olds (Rothbart et al., 1997). For scales with lower reliabilities, analyses of item–total correlations and factor analyses of items within CBQ scales have identified poorly functioning items, and a revision of the CBQ designed to correct these problems is currently under way.

Structurally, the scales of the CBQ reliably cluster into three large factors. The first factor is defined primarily by loadings for the scales of Impulsivity, High-Intensity Pleasure, Activity Level, and, loading negatively, Shyness. In addition, there are substantial loadings for both the Positive Anticipation and the Smiling and Laughter scales. We labeled this factor Extraversion/Surgency after the broad dimension of personality identified in many previ-

ous investigations of personality structure. The label is consistent with the responses identified, including rapid response initiation, high activity level, preference for situations characterized by high-intensity stimuli (risk taking), and relative lack of unease in new social situations. Although the Positive Anticipation scale loads on this factor as expected, it also consistently loads just as strongly on a second, Negative Affect factor. One interpretation of this finding is that positive anticipatory tendencies may result in negative affect through the frustration or sadness resulting when an expectation is not met.

Also, although the Smiling and Laughter dimension was designed to be a marker of positive affect and was therefore expected to load strongly on this first factor, Smiling and Laughter typically loads most strongly on a third, Effortful Control factor. It is interesting that we have found this same pattern of loadings for Smiling and Laughter in a sample of Japanese children, whereas in a very large sample of Chinese children, Smiling and Laughter loaded only on the first Extraversion/Surgency factor (Ahadi, Rothbart, & Ye, 1993). We speculated that in cultures where there are strong social prescriptions for presenting a pleasant or happy visage regardless of internal mood states, Smiling and Laughter may be a better marker of self-regulative processes underlying Effortful Control than of reactive positive affect, but other arousal-based interpretations are also possible if the finding from the Chinese sample does not prove replicable.

The second large factor, Negative Affectivity, is defined primarily by loadings for the scales of Sadness, Discomfort, Anger/Frustration, Fear, and, loading negatively, Falling Reactivity/Soothability. This pattern of loadings is consistent with the broad dimension of Negative Affectivity/Negative Emotionality/Neuroticism found in both adult and childhood investigations of personality structure. As previously noted, the Positive Anticipation scale tends to have substantial loadings on this factor.

The third factor reliably extracted from analyses of the CBQ scales is defined primarily by loadings for the scales of Low-Intensity Pleasure, Inhibitory Control, Attentional Focusing, and Perceptual Sensitivity. As previously noted, in samples of American and Japanese children, Smiling and Laughter also loaded quite highly on this factor, but this was not the case in a large sample of Chinese children (Ahadi et al., 1993). We labeled this constellation of trait characteristics Effortful Control because the traits appear to share in common the child's voluntary and willful regulation of attention and behavior, although this may be reflected more clearly for the latter three scales than for Low-Intensity Pleasure. In the following section, we also describe an attentional model that may underlie this dimension. Because Effortful Control appears to play a central role in the effective socialization of the child (Kochanska et al., 1997; Rothbart, Ahadi, & Hershey, 1994), we suggested that Effortful Control may be developmentally related to the broad dimension of Conscientiousness/Constraint/Superego Strength/Psychoticism identified in other structural models of personality (Ahadi & Rothbart, 1994). Results of a recent investigation to map these temperament dimensions onto Big Five personality dimensions are presented below.

The factor structure of the CBQ scales has been so reliably similar in parent-report samples from different sites in the U.S. and samples in China and Japan that we have become increasingly confident in the meaning of group differences on the scales and in

the existence of some differences in scale relationships between groups. The CBQ has also shown impressive levels of temporal stability across an almost 2-year period and moderate to high levels of parent agreement in multiple samples (Rothbart et al., 1997). As noted later in this article, the CBQ has shown strong relationships with many important social outcomes. In addition, CBQ scales have been instrumental in helping to explicate psychophysiological findings with respect to childhood stressors (Gunnar, 1994). In many ways, this measure has demonstrated utility as a measure of temperament in childhood.

It is important to note, however, that the CBQ does not purport to be a comprehensive measure of childhood personality. There are thus individual-difference dimensions that may be extremely important for understanding child behavior that are not assessed in the CBQ. Some of these characteristics may prove to be developmentally related to temperament characteristics and may need to be included in future assessments of childhood personality, especially for early school-age children for whom the Big Five is readily recoverable by means of teacher report (Digman, 1990; Digman & Takemoto-Chock, 1981). One interesting potential link between temperament constructs and personality involves effortful control and Block and Block's (1980) construct of Ego Resiliency. Executive attention skills may be a prerequisite to the flexible functioning described in this construct.

Longitudinal Stability and Predictions

A small number of infants studied in the laboratory were followed up at age 7 (Rothbart et al., in press). Predicting from the laboratory measures of temperament in infancy to CBQ parent-report measures of temperament at age 7, we found that some of the most strongly reliable relationships were between the rapidity of children's approach to small objects, as measured at 6, 10, and 13 months, and later Positive Anticipation scores. Fear assessed in the laboratory at 3, 6, and 13 months also reliably predicted Fear at 7 years, and laboratory anger at 6 and 10 months predicted 7-year anger/frustration. Smiling and laughter in the laboratory did not predict CBQ Smiling and Laughter scores, but activity level (measured only at 13 months) showed a trend toward predicting later CBQ Activity Level. In addition to these indications of developmental stability of systems, our study yielded findings that may provide interesting developmental links between infant temperament and child personality. We review some of the more interesting of these findings later in this article, but first we prepare for their possible meaning by briefly reviewing some of the major psychobiological models for temperament. These models have been most often based on animal models or research with adults.

Psychobiological Models

As previously noted, throughout the history of work on temperament, connections have been made between temperament dimensions and human biology. In recent years, these connections have been put forward by psychobiologists who have identified neural systems that might underlie variability in temperamental dispositions. In the following sections of this article, we refer briefly to their work, encouraging readers to investigate more thorough

reviews (e.g., Derryberry & Rothbart, 1997; Rothbart, Derryberry, et al., 1994) or the primary literature directly.

The work of these psychobiologists has chiefly focused on emotional–motivational aspects of temperament. This is not surprising because in classic approaches to temperament, self-regulation has been seen as driven by affect, arousal, or both. Thus, in Eysenck's (1967) early model, individual differences in arousability were seen as the major influence on whether individuals approached or avoided a situation, as depicted in an inverted-U relation of arousal, approach, and avoidance. More easily aroused introverts would experience positive affect and approach at lower levels of stimulus intensity than less easily aroused extraverts. Introverts would also become overaroused at lower levels of stimulation, so that when extraverts were still experiencing positive affect and approaching a highly stimulating situation, introverts would be experiencing distress and avoiding the event. Eysenck's model is similar to a number of other views of self-regulation in temperament (for a review, see Rothbart, 1989a). Strelau (1983), for example, posited a reactivity–activity model, in which high-reactive persons would undertake activities to decrease stimulation at a time when low-reactive individuals were continuing to engage in activities to enhance stimulative value.

In keeping with this idea of emotion driving self-regulation, we had therefore expected positive correlations between children's fear and their behavioral control of action (sitting still, waiting, etc.). When in our research on children's temperament using the CBQ we found Fear and Inhibitory Control to be relatively independent, however, it suggested that another control system might also be involved in the ability to inhibit action. Correlations in the CBQ between Inhibitory Control and the attentional scales further suggested that this second self-regulatory system was related to attentional control. These were important findings because they indicated influences on self-regulation that were not driven by emotion. To identify neural systems that might support variability in these attentional capacities, we had to look beyond the psychobiology of emotion to psychobiological models of attention developed by Posner and his colleagues (Posner & Petersen, 1990; Posner & Raichle, 1994).

On the basis of the work of psychobiologists on emotion and attention, and our developmental research, we have now explored biological models supporting Approach/Positive Affect (extraversion), Fear, Irritability/Anger, reactive Orienting, and Effortful Control (Rothbart, Derryberry, et al., 1994). On the basis of Panksepp's (1986b, 1998) and others' work, a possible dimension of Affiliativeness also has been considered. We briefly describe some psychobiological models for temperament dimensions below. These models introduce important ideas about balance between emotional and attentional systems and have stimulated hypotheses about behavior that we have investigated in our behavioral work on temperament in adults and children. This behavioral work is discussed after the theory review.

Approach/Positive Affect (Extraversion)

Gray (1982) proposed an approach or Behavioral Activation System (BAS) and an anxiety or Behavioral Inhibition System (BIS). The BAS is sensitive to cues signaling reward, including those supporting active avoidance, is linked to structures including the medial forebrain bundle and lateral hypothalamus, and to

influences of the neurotransmitters dopamine and norepinephrine. Related approach systems include Depue and Iacono's (1989) Behavioral Facilitation System. Depue and Iacono suggested that when reward has been blocked or avoidance is impossible, the BFS may facilitate aggressive behavior toward the obstacle or threat. Panksepp's (1982, 1986a) Expectancy–Foraging system is also based on dopamine and includes appetitive actions as well as emotional states of desire and eagerness. Similar systems are also discussed by Zuckerman (1991) and Cloninger (1987), and limbic circuits that may underlie positive affect and approach have been reviewed by Rothbart, Derryberry, et al. (1994).

Fear/Behavioral Inhibition

As previously noted, Gray (1982) posited a BIS operating in situations of novelty, punishment, intense stimulation, and evolutionarily prepared fear. The BIS is involved in extinction and in passive but not active avoidance. In Gray's model, the Ascending Reticular Activating System responds to these stimulus events by activating the medial septal area, which is modulated by the orbital frontal cortex. The medial septal area influences hippocampal theta rhythm, inhibiting reticular activity and ongoing behavior. Gray's theory seems to particularly target attentional aspects of fear- or disappointment-related stimuli and the way in which they might act as a "stop mechanism" for action. Neurotransmitter substances involved in the BIS are norepinephrine and serotonin. The BIS and BAS described above are mutually inhibitory, and when in conflict, the occurrence of approach will depend on the balance between the strength of the two systems (for a review, see Fowles, 1988).

Psychobiological models for fear are also well developed in the neuroscience literature, and in this research the central nucleus of the amygdala has been found to be critically involved in the processing of fear-related information (Davis, 1992; LeDoux, 1987). Fear activation is a multilevel event, accompanied by inhibition of ongoing motor programs and preparation of response systems to sustain flight, fighting, or hiding. Fear projections support potentiated startle, fearful facial expression, and adjustments of the heart and respiratory systems (see Davis, Hitchcock, & Rosen, 1987, for a description of fear connectivity). These multiple systems can sustain considerable individual variability in the expression of fear, and their existence may have contributed to problems in establishing a standard terminology for this broad dimension (Rothbart, 1999).

Irritability/Anger

Gray (1982) described the Fight–Flight system as involving circuits connecting the ventromedial nucleus of the hypothalamus (central gray region of the midbrain) and somatic and motor effector nuclei of the lower brain stem in respect to painful or frustrating input. Panksepp (1982) put forward a similar circuitry for a "rage" system. He additionally suggested that the ventromedial hypothalamus is involved in the inhibition of aggressive behaviors controlled by the midbrain's central gray area, allowing for friendly, trusting, and helpful behaviors between species members. Panksepp (1986b) further suggested that prosocial behaviors are supported through opiate projections from higher limbic regions, including the amygdala and cingulate cortex to the ventro-

medial hypothalamus. He noted that brain opiates are related to social comfort and bonding, whereas opiate withdrawal promotes irritability and aggressiveness, suggesting a reciprocal relation between prosocial and aggressive behaviors and the likelihood of an Affiliative system that is open to social experience and linked to neural networks. Spoont (1992) also suggested that serotonergic projections from the midbrain's raphe nuclei may constrain processing in the aggression circuitry of the amygdala, hypothalamus, and brain stem. Here again, we see a balance between systems, indicating the importance of focusing on the interactions of several temperamental variables rather than focusing on only one at a time.

Orienting

Posner (1990) described the *posterior attention network*, including portions of the parietal cortex, the pulvinar and reticular nuclei, and parts of the midbrain's superior colliculus. These are involved in directing attention to relevant locations, binding information to a location so as to produce object perception, and selecting a scale for visual input. Although most of the information known about this network involves its relation to visual orienting, similar systems appear to be present for other modalities (Posner, 1990). Injury to the posterior attention system is closely related to specific deficits in the ability to select information contralateral to the lesion. The posterior system is heavily modulated by noradrenergic input and influenced by state of alertness. In our research on infants, we have chiefly focused on children's duration of orienting (Rothbart, 1981), and we discuss these findings below, but in older children and adults, we have been able to address parent-reported perceptual sensitivity (Rothbart et al., 1997) and adults' self-reported sensitivity to internal and external information (Derryberry & Rothbart, 1988; Evans & Rothbart, 1999). It is important to note that attention holding, as in measures of duration of orienting, differs from attention getting, or directing the receptors or attention to a significant location (Ruff & Rothbart, 1996).

Effortful Control

A second attention network, originally labeled the *anterior attention network*, involves areas of the midprefrontal cortex, including the anterior cingulate gyrus and parts of the supplementary motor cortex (Posner & Raichle, 1994; Posner & Rothbart, 1998). This network is related to executive functioning and is active in detection tasks, including the detection of errors, and in planning. The network is also active during conflict situations that require effortful control, including those in which a dominant response must be inhibited to perform a subdominant response, as in the conflict trials of the Stroop task. Not only does the anterior cingulate share input from many information sources, but it also has close relationships to the basal ganglia and motor systems. In addition, it has rich connections to areas of the lateral cortical surface important in holding information in temporary storage and to the hippocampus, which is involved in the formation of more permanent memories. It is interesting to note that attentional areas of the anterior cingulate gyrus are also proximal to areas involved in human pain and animal vocalization (Vogt, Finch, & Olson, 1992). Thus, it is a site that allows linkages between attention and emotion. In our research on infants, we have studied an orienting system developing in the first months of life (Johnson, Posner, &

Rothbart, 1991), in which the shifting of attention can be used to soothe the infant from a distressed state (Harman, Rothbart, & Posner, 1997).

Understanding Brain Functions Serves to Constrain Psychological Models

A neural level of analysis can be particularly important when competing psychological models are equally capable of accounting for observed behavior and thought. An example would be the choice of unipolar versus bipolar constructs of individual differences such as approach and inhibition. Biological models suggest separable systems for approach and inhibition and favor the use of unipolar constructs. Psychobiological models also give rise to important hypotheses about behavior that can then be tested behaviorally and studied developmentally, some examples of which we now discuss. In this way, converging evidence between the two levels of analysis can enhance the value of both.

Behavioral Findings

Approach/Positive Affect (Extraversion)

We have found support for an approach system, including a positive relationship between infants' smiling and laughter and their speed of approach to objects (Rothbart, 1988) as well as positive relationships between infants' approach tendencies and their active avoidance (Rothbart, Ziaie, & O'Boyle, 1992), as predicted by Gray (1982). We also found reliable links between infants' rate of approach to objects in the laboratory and their later Impulsivity, lower Inhibitory Control, and higher Anger/Frustration and Aggression as measured by the CBQ (Rothbart et al., in press). Similar predictions were found for activity level, and smiling and laughter in the laboratory predicted later Positive Anticipation, Impulsivity, and lower Inhibitory Control (Rothbart, Derryberry, et al., 1994). Developmentally, the approach system is thus related to later aspects of extraversion, including positive anticipation and outgoing activity. However, it is also linked to later potential problems with control, including Impulsivity, Anger/Frustration, and lower Inhibitory Control. Kochanska (1993, 1997) has been concerned with important issues of how to socialize children high in approach and low in fear, and we consider her findings below.

Fear

Fear in infancy reliably predicted later lower Impulsivity, Activity, Positive Anticipation, and Aggression (Rothbart et al., in press) as well as later higher Fear and Sadness. As with approach, dispositions to fear have both costs and benefits. As Kochanska (1991) found, fear is an important control system for the development of conscience; we have also reviewed several additional instances of earlier fear as a protective factor for later-developing aggression (Rothbart & Bates, 1998). However, continuity in a disposition to fear and the prediction of later sadness from infant fear suggests that early fearfulness may be a predisposition to possible later internalizing disorders, and there is some evidence for this connection (Rothbart & Bates, 1998).

Behaviorally, models for reciprocal interactions between either approach and fear or the BAS and BIS have been very helpful in thinking about social development. For example, infants' speed of approach in the laboratory predicted not only childhood extraversion but also, negatively, childhood fear. Approach systems appear to be functional before the onset of behavioral inhibition late in the first year (Rothbart, 1988; Schaffer, 1974). Behavioral inhibition, a component of fear, represents an important control of behavior and can be used in socialization to support children's control of their actions through fear of punishment or disappointment (Kochanska, 1991). For children whose reactive inhibition system is not strong, control will be more difficult, and other forms of regulation such as attentional control appear to be more important (Kochanska, 1997). Problems can also develop with high levels of fear or ego control. As Block and Block (1980) pointed out, high levels of ego control are associated with inflexibility in functioning.

Irritability/Anger

In our laboratory research on irritability and frustration, early proneness to anger (at 10 months) reliably predicted later high Activity, Positive Anticipation, Anger/Frustration, Discomfort, High-Intensity Pleasure, Impulsivity, and Aggression (Rothbart et al., in press). It also negatively predicted Sadness. Our laboratory measure did not predict as reliably at 13 months, when it was also negatively related to parent reports of distress to limitations. This may have been in part because our anger–frustration measures were assays of distress and did not get at other later-developing signs of frustration, such as vocal communications, that were evident at 13 months. Nevertheless, frustration reactivity seems to be a factor that is predisposing to later externalizing negative affect but not to fear. How others react to these tendencies toward anger and frustrative distress, especially in the development of mutually coercive cycles, is also important in the development of later externalizing outcomes (for a review, see Rothbart & Bates, 1998).

Duration of Orienting

In the laboratory, mean fixation time toward small manipulable toys was relatively stable from 10 to 13 months (Rothbart et al., in press). Surprisingly, this measure predicted later Fear, Sadness, and Shyness and was negatively related to High-Intensity Pleasure. We had not expected early duration of orienting to predict later effortful control because of developmental changes in controls over sustained orienting in connection with the development of the executive attention system, and it did not (see Ruff & Rothbart, 1996). However, we did not expect this measure to be related to later internalizing negative affect. Our only post hoc account suggests that more fearful children were more wary and constrained in the laboratory and were not looking around for excitement and social stimulation. Concurrent relationships with fear are congruent with this interpretation. If this finding proves replicable, it would suggest the importance, even early in life, of the control negative affect can have over duration of orienting.

Effortful Control

We have posited that functioning of the anterior attention network is related to the Effortful Control dimension we have measured in childhood and adulthood. Evidence from our question-

naire data indicates that children in the United States who are high in effortful control tend to be low in negative affectivity (Ahadi et al., 1993) and that adults high in self-reported attentional control are likely to be low in negative affect (Derryberry & Rothbart, 1988; Evans & Rothbart, 1999). Again, we see reciprocal relationships between two of the major temperament dimensions. We did not attempt to create an effortful control measure for our laboratory research in the 1st year. However, we found that later inhibitory control and attentional capacities were predicted by infants' slow speed of approach to small objects. We do not know the degree to which the strength of approach tendencies might oppose later-developing attentional control, nor do we know whether attentional control is already reflected in infants' slower approach to objects. However, one post hoc interpretation is that the initial strength of action "acceleration" creates difficulties for any "braking" effects of effortful control or fear control. We hope that presenting some of our developmental findings has indicated the importance we place on making connections between behavioral and biological research. We now turn to another integrative aspect of temperament: links between temperament and social interaction.

Temperament and Social Development

As previously noted, behavior can be regulated through reactive emotional systems such as fear or through self-regulative attention systems such as effortful control. Both fear and attentional control are related to the regulation of social behavior, as has been demonstrated in a number of ways. Here we describe two approaches to this issue. In one study of 6- to 7-year-olds (Rothbart, Ahadi, et al., 1994), mothers of 80 children were administered the CBQ along with a set of scales designed to measure aspects of social behavior. The measures of social behavior included scales measuring prosocial behavior patterns of empathy and guilt/shame, as well as scales measuring behavior patterns of aggression, negativity, and help-seeking. The CBQ scales were aggregated to form composite factor-based measures. The prosocial traits of empathy and guilt/shame were both related to Negative Affectivity. This finding was expected, especially for guilt/shame, given the strong conceptual relationship between guilt/shame and fear proneness. Perhaps less obviously, both empathy and guilt/shame were also strongly and positively predicted by Effortful Control, indicating that these traits may include both attentional and emotional components.

Temperamental regulative processes are also proving to be important factors in the effective socialization of children (Kochanska, 1991, 1993; Rothbart, Ahadi, et al., 1994). Kochanska (1993) developed a model of conscience development that posits two important regulatory processes in the development of conscience: one more reactive and passive (fear) and the other more attentional and active (inhibitory or effortful control; cf. Rothbart, 1989b, for a similar analysis). Fearfulness also appears to be important in the development of the affective-discomfort component of moral behavior. Individuals high in temperamental anxiety or fear will be relatively more sensitive to cues of punishment (Gray, 1982) and more easily conditioned to inhibit transgressions of moral behavior associated with punishment (Dienstbier, 1984).

In addition, Kochanska (1997) posited and found individual differences in inhibitory control to have important implications for

active inhibition of antisocial behavior and acquisition of prosocial behavior. Children who can effectively use attention to regulate behavior will be better able to inhibit prepotent responses (e.g., striking out, stealing) in order to consider the effect of their actions on others, facilitating internalization of standards for prosocial behavior. In our research with 6- and 7-year-old children, internalizing components of Negative Affectivity were related to prosocial characteristics such as the tendency to experience guilt or shame (i.e., affective discomfort), and Effortful Control was related to children's characteristic levels of empathy (active moral regulation) and guilt/shame (Rothbart, Ahadi, et al., 1994).

Temperament and the Social Environment

Just before his death, Eysenck (1997) reiterated Cronbach's (1957) call for psychologists in general, and personality psychologists in particular, to more widely implement Aptitude × Treatment (Person × Environment) interaction designs. There is now agreement that social behavior is influenced by characteristics of the individual and the environment, yet the study of person–environment interactions is still not a hallmark of personality research. One likely reason for this, as Eysenck suggested, is that purely descriptive models of personality do not readily lend themselves to making predictions about interactions. If anything, they tend to reinforce a simple trait-based model of personality. Temperament models, however, which focus on dynamic psychological and developmental processes, often lead to clear predictions of how the organism and environment interact. Perhaps more importantly, temperament approaches lead investigators to seek out such interactions.

Temperament can interact with the environment in a number of ways (Caspi, 1998; Rothbart, Ahadi, et al. 1994). Here we relate a few examples to illustrate the range of person–environment interactions. An elegant example of how temperament can interact with parenting behaviors was demonstrated by van den Boom (1989, 1994) in the Netherlands. In the first of two studies, van den Boom assessed infant irritability at 15 days of age and then measured infant attachment at 1 year of age using Ainsworth's (Ainsworth, Blehar, Waters, & Wall, 1978) Strange Situation. The results of this first study were unambiguous—temperamentally irritable children were far more likely to be classified as insecurely attached (particularly in the avoidant category), and temperamentally nonirritable children were more likely to be classified as securely attached (van den Boom, 1989). Little association was found between measures of parent sensitivity and attachment outcomes. The question therefore remained, by what mechanism might infant irritability affect the mother–infant attachment process?

In a second study, van den Boom (1994) again assessed temperamental irritability at 15 days of age. In this study, however, she retained only temperamentally irritable infants and assigned infant–mother pairs to one of two groups. The control group received no intervention and simply were followed up at 1 year for assessment in the Strange Situation, as in the first study. In the treatment group, experimenters visited each home and provided mothers (who were primarily from low socioeconomic status groups) with instruction on how to soothe their babies and how to play with them. These groups were then followed up at 1 year of age for assessment in the Strange Situation.

The results of this second study were also striking. Infants in the control group, as expected, were much more likely to be classified as insecurely attached (at about the same rate as irritable infants in the first study). In sharp contrast, however, infants in the treatment group were much more likely to be classified as securely attached. In fact, they were as likely to be rated as securely attached as were the nonirritable infants in the first study. The results of these two studies suggest that infant temperamental irritability may operate, in part, by affecting the quality of infant–mother interactions. Irritable and hard-to-soothe infants behave in a way that may push their mothers away, forcing the infants to learn to provide for their own comfort (Rothbart & Ahadi, 1994). Irritability may be an impediment to the development of a secure attachment, especially when mothers do not exercise the skills necessary to cope with their baby's discomfort.

The research program of Kochanska (1991, 1993) described above also illustrates the value of studying person–environment interactions. As noted by Kochanska and others (e.g., Dienstbier, 1984), fear represents an important pathway to child compliance and prosocial behavior. Because individual differences in fear reactivity refer to the individual's sensitivity to conditioned signals of punishment and to novelty, highly fearful children should be more sensitive to maternal requirements for compliance than should less fearful children. This is precisely what Kochanska found. For highly fearful children, maternal compliance strategies that deemphasize power are correlated with child compliance (Kochanska, 1991). Importantly, Kochanska has replicated this finding in a larger study both concurrently, when the children were 3.5 years old, and longitudinally, in a follow-up of the same children at 4.5 years of age (Kochanska, 1997). It is interesting that the same effect failed to replicate at a second follow-up when the children were 5.5 years old (Kochanska, 1997). This failure to replicate, however, may prove to be related to aspects of development, because when the child is between 3 to 5 years of age mothers might be expected to begin relying more heavily on voluntary and effortful self-regulation, which is associated with the rapidly developing executive attention system (Rothbart & Bates, 1998).

Cross-Cultural Research

The most extensive variability in treatment can be seen across cultures. By examining how cultural norms and practices interact with temperamental characteristics for developmental outcomes, one gains access to a natural quasi-experiment in which a wide range of environmental influences have been manipulated, from value systems to parenting practices. Much attention has been recently directed to the identification of cross-cultural differences in value orientations (Markus & Kitayama, 1991), academic achievement and achievement motivation (Stevenson & Stigler, 1992), and personality dimensions (Barrett & Eysenck, 1984). These studies remind us that our research questions and the inferences we draw from them occur within a value context that is not necessarily shared by others. The characterization of a trait dimension as neurotic or a constellation of trait qualities as describing a "difficult" infant may better serve to communicate our cultural valuations of these constructs than our substantive knowledge about psychological processes underlying the dimensions. As Allport (1966) noted, however, trait labels may reflect social or moral

value orientations, but the traits themselves are not value judgments. Cross-cultural research allows researchers to take advantage of the differential valuations that can be placed on a given temperamental disposition.

Cross-cultural research programs can be particularly beneficial when they not only advance our understanding of cultural value differences and similarities but also identify more clearly the processes by which individuals internalize those value systems. This strategy involves not only the identification of mean cross-cultural differences along value dimensions or traits but also the analysis of the psychological processes involved in these differences. In a large cross-cultural investigation of behavioral inhibition and child-rearing attitudes, Chen and colleagues (Chen et al., 1998) noted that although temperamental behavioral inhibition to novel stimuli is generally devalued among North Americans, behavioral inhibition or reserve is a valued characteristic within Chinese culture. Chen et al. expected and found mean differences between Chinese and Canadian children in their behavioral inhibition to novel stimuli, with Chinese children showing more inhibition. They also found substantial cross-cultural differences in child-rearing attitudes, with Chinese mothers scoring lower on the Child-Rearing Practices Report scale of acceptance (e.g., feeling intimate with child) and higher on rejection (e.g., feeling anger toward child), achievement (e.g., encouraging child to perform better than others), punishment orientation (e.g., belief in the effectiveness of physical punishment), and protection and concern (e.g., concern for child's physical safety).

Of great interest, however, are the relations Chen et al. (1998) found between child behavioral inhibition and maternal child-rearing attitudes. In almost every case, the direction of relationships were reversed for two samples. In the Canadian sample, children's behavioral inhibition was negatively correlated with their mothers' acceptance and encouragement of achievement and positively correlated both with punishment orientation and with protection and concern. In contrast, child behavioral inhibition in the Chinese sample was positively correlated both with the acceptance and encouragement of achievement and the encouragement of independence but was negatively correlated with rejection and punishment orientation. This leads us to consider that any negative social outcome of behavioral inhibition in research originating from Western and or industrialized nations might also reflect the social consequences for children who do not conform to cultural ideals.

Finally, we note that in our research with 6- and 7-year-olds in Shanghai and in the United States, scores on the Effortful Control factor in China were negatively associated with Extraversion/Surgency factor scores; there was a zero relationship between these scores for the United States sample (Ahadi et al., 1993). Conversely, in the United States, Effortful Control scores were negatively associated with Negative Affectivity; there was a zero correlation between these scores for the China sample. Although these findings would need to be replicated, they are congruent with the idea that a flexible set of attentional controls can be programmed by a culture to promote the characteristics most valued in that culture. More research in this area can provide important links between the individual and environmental levels of analysis.

Temperament in Adulthood

In our view, it is possible to study temperament through self-report, and indeed much work on temperament has used this method (e.g., Eysenck, 1967; Strelau, 1983), but as with other approaches to the study of individual differences, there are advantages and limitations to this method. Limitations include biases similar to those affecting parent or peer report (for a review, see Rothbart & Bates, 1998); advantages include the individual's access to feelings and perceptions that may neither be available to the outside observer nor revealed in laboratory behavior. In our initial work on adult temperament, we used a bottom-up approach to its measurement, developing scales to assess multiple subconstructs of the positive and negative affects, arousal and sensitivity, and attention (Derryberry & Rothbart, 1988). Our goal was to decompose aspects of arousal, emotion, and self-regulation into subconstructs to study patterns of resulting relationships among scales.

In this research involving a sample of 231 college students, one of the most striking findings was the reciprocal relationship between negative affect and attentional control (attentional focusing and shifting capacities), as found in our work with children in the U.S. culture and as might be expected for a single control mechanism to which both attention and affect have access (Posner & Rothbart, 1998). This work with adults preceded our development of the CBQ (Rothbart et al., 1997) and inspired its highly differentiated subconstructs and bottom-up approach. In 1997, however, after completing the research on the CBQ and our review of the psychobiology of temperament, we revisited the area of adult temperament (Evans & Rothbart, 1999).

There were a number of reasons for doing so. First, in the initial work with adults we had taken care to eliminate items or scales that had social content, whereas in the child work we included a Shyness scale and items in the Frustration and Sadness scales that contained social frustrations and social loss. To make adult scales more comparable with the work with children, we therefore added a Sociability scale. We also added potential extraversion scales of Activity Level and a Pleasure Reactivity scale intended to assess positive affect independent of stimulus intensity. Given our increased understanding of the physiological architecture of emotions (Rothbart, Derryberry, et al., 1994), we also wished to remove those arousability scales that would be likely to cut across emotions. We also were interested in the first factor that had emerged from the Derryberry and Rothbart (1988) work, which seemed to be getting at an orienting sensitivity dimension, because this factor might address aspects of the posterior orienting system identified in Posner's psychobiological models of attention (Posner & Raichle, 1994; Rothbart, Derryberry, et al., 1994). We wished to investigate the generality of an orienting dimension by adding to the original scales of internal and external perceptual sensitivity, scales assessing affective sensitivity (emotionally valenced reactivity to low-intensity stimulation) and associative sensitivity (internal cognitive activity such as daydreams and images). We also included additional measures of attention shifting from reward and from punishment.

Using this revised set of temperament scales, we administered the Adult Temperament Questionnaire to 207 undergraduates at the University of Oregon (Evans & Rothbart, 1999). Results of a principal-axis factor analysis with oblique rotation are shown in

Table 1

Pattern Matrix for Factor Analysis of Adult Temperament Scales

Adult temperament scale	Factor loading			
	OS	EC	E	NA
Internal Perceptual Sensitivity	.83			
Affective Perceptual Sensitivity	.80			
External Perceptual Sensitivity	.80			
Associative Sensitivity	.64			
Attentional Shifting from Reward		.87		
Attentional Shifting from Punishment		.79		
Attentional Focusing		.78		
Attentional Shifting		.70		
High Intensity Pleasure			.80	
Sociability			.79	
Pleasure Reactivity			.63	
Activity Level			.40	
Fear				.75
Discomfort				.69
Reactive Sadness	.40			.49
Frustration				.35

Note. Variance accounted for = 54.1%. OS = Orienting Sensitivity; E = Extraversion; EC = Effortful Control; NA = Negative Affect. Only scale loadings greater than .25 are reported.

Table 1. This analysis yielded a clear four-factor structure, with factors labeled Orienting Sensitivity (defined by loadings for internal, external, and affective perceptual sensitivity, along with associative sensitivity), Extraversion (loadings for sociability, high-intensity pleasure, activity level, and pleasure reactivity), Effortful Attention (loadings for attentional shifting from reward and from punishment, attentional focusing, and attentional shifting), and Negative Affectivity (loadings for fear, frustration, discomfort, and sadness).

Three of these factors appeared to be quite similar to the broad factors that had emerged from our temperament work with children: Extraversion, Effortful Control, and Negative Affectivity. In an attempt to investigate the relationship between these adult temperament factors and the Big Five model of personality, we asked our participants to fill out the minimarkers for the Big Five developed by Saucier (1994), a scale consisting of 40 trait adjectives. The correlations between the temperament factors and the Big Five scales are shown in Table 2. These correlations indicate definite relationships between the temperament dimensions and measures of adult personality. As we expected (Rothbart & Ahadi, 1994), Extraversion was related across the two domains, Effortful Attention was related to Conscientiousness, and Negative Affectivity was related to Neuroticism. In a replication of our previous work (Derryberry & Rothbart, 1988), we also found a negative relation between (a) Effortful Attention and (b) Neuroticism and Negative Affect. A very interesting additional finding was the relationship between the Big Five factor variously referred to as Intellect, Imagination, or Openness, and the temperament Orienting Sensitivity factor. In addition to these relationships, the Orienting Sensitivity factor was related to Extraversion and the Effortful Attention factor was negatively related to Neuroticism. Agreeableness was predicted at lower levels by both Extraversion and Orienting Sensitivity.

Our findings thus suggest a strong relationship between temperament processes and four of the Big Five factors, with two of the

Table 2

*Correlations of Temperament Factor Scores
With Big Five Scales*

Temperament factor score	Big Five scale				
	I/O	C	E	N	A
Orienting Sensitivity	.54[a]	.15	.19	.19	.20
Effortful Attention	.21	.43[a]	.08	−.34	−.04
Extraversion	.40	.10	.59[a]	−.08	.30
Negative Affect	−.17	−.16	−.16	.49[a]	.03

Note. I/O = Intellect/Openness; C = Conscientiousness; E = Extraversion; N = Neuroticism; A = Agreeableness.
[a] Highest correlations between temperament factor scores and Big Five scales.

temperament processes being attentional in origin. These findings are intriguing in that together with the literature we have reviewed, they suggest considerable convergence of individual differences across ages, methods, and levels of analysis. We nevertheless argue that studies like the ones performed by van den Boom (1989, 1994) and Kochanska (1991, 1993, 1997) on the process of development, moving from specific temperament characteristics through trajectories of experience to social and personality outcomes, will be needed to further illuminate our understanding of these adult relationships.

Summary

In this article we have discussed basic temperamental processes observable in infancy or by early childhood and continuing throughout the life span. These processes are linked to psychobiological models and to characteristics seen in other nonhuman animals. They can be seen as the initial basis for dispositions and orientations toward others and the physical world and for shaping the person's adaptations to that world. The systems we have considered include positive affect and approach (extraversion), fear, anger/frustration, orienting, effortful control, and, to a lesser degree, affiliativeness. We are sure that other important processes will also be added to this list. We hope that continuing research will create firmer links between child temperament and adult personality and believe that the study of development will be critical to achieving this goal.

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