CHAPTER 1

Advances in Temperament

History, Concepts, and Measures

Mary K. Rothbart

This new *Handbook of Temperament*, organized and edited by Marcel Zentner and Rebecca L. Shiner, reflects the rapid growth of temperament research and application during the last 40 years (see Zentner & Shiner, Chapter 32, this volume). The influence of temperament concepts and research on related areas has also expanded to include general development, education, personality, psychopathology, and the neurosciences (Caspi & Shiner, 2006; Kagan & Fox, 2006; Posner & Rothbart, 2007a; Rothbart & Bates, 2006). For psychologists, clinicians, and teachers, temperament provides an introduction to individual differences in the infant and young child. Concepts of temperament also introduce us to basic processes of social and personality development, psychopathology, and adjustment. Finally, temperament provides links between our understanding of infants and young children and our understanding of older children and adults, including ourselves (Rothbart, 2011).

Temperament and Personality

Temperamental tendencies form building blocks that underlie development of individual differences in personality (see Shiner & Caspi, Chapter 24, this volume). Allport (1937) defined *personality* as the organization of the "systems that determine [the person's] unique adjustment to his environment" (p. 48). One level of personality organization is the *trait*, defined as a pattern of thoughts, emotions, and behavior that show consistency over situations and stability over time. Temperament traits, a subset of personality traits, include the emotional, motor, and attentional reactive tendencies and regulative capacities seen early in development. These tend to show consistency across situations and stability over time, although they also may be altered in development (Rothbart & Bates, 2006) and applied in different ways to specific persons and situations (Rothbart, 2011).

In infancy, temperament is the predominant influence on the child's reactions and adjustments to a given environment. In adulthood, there remain close links between the broad factors used to describe personality (the Big Five, the Five-Factor Model [FFM]) and the broad factors found within the temperament domain in children and adults (Evans & Rothbart, 2007; McCrae et al., 2000). The most recently discovered of these are the links between temperamental

perceptual sensitivity and Big Five Openness. These links suggest that temperament dispositions developing early in life may form the basis of the adult structure of broad personality traits (Rothbart, 2011; Zentner & Bates, 2008).

It is important to remember, however, that the personality domain extends considerably beyond traits. In addition to temperament and personality traits, personality includes one's interpretations, attitudes, identifications, goals, specific adaptations, defenses, values, and ideas about general and more specific events and situations, including concepts of the self and others (Rothbart, 2011). Because personality includes cognitive as well as behavioral adjustments, and because some of the most important aspects of our adjustment include ideas and behaviors specific to a particular person or situation, a trait-limited view is inadequate to describe the developing personality (also see Zentner & Bates, 2008). General context and indeed specific situations and people also need to be taken into account (see chapters in Part V, this volume).

Temperament, Evolution, and Development

We all inherit adaptations that are general to our species, genetically based processes geared to the "environment of evolutionary adaptiveness" in Bowlby's (1971) terms. These processes support the basic emotions and related motivations, such as approach and fear, and individuals differ in their propensities toward these reactions. Our genetic inheritance also supports the individual's response to change via shifting and focusing attention and the development of expectations. Allport (1937) would call these "nomothetic" processes, general to humans. When we consider the individual person, however, we see adaptations to a specific life history and to specific others that can be applied uniquely to the person through "idiographic" processes, and ultimately describe the development of a single person. The person adapts to other people and situations but can also select a range of environments and persons with whom to interact, and can influence the physical and social environment. Thus, both change and an inflexibility of thought and behavior are possible consequences of the person's history.

Temperament reflects individual information processing through the emotions, motivation, and attention networks. By identifying the basic dimensions of temperament, we can study temperament's influence on the development of behavioral strategies and cognition (Rothbart, 2011). We can also clarify the role of life experiences, recent events, identifications, and other influences on individual development. We share a number of temperamental processes with nonhuman animals; others, such as propositional concepts of self and others, we do not (see Barr, Chapter 13, and MacDonald, Chapter 14, this volume). The child's developing concepts of the self and the social and physical environment go beyond temperament to provide another level of information processing that influences the expression of temperament, and vice versa.

This volume provides detailed reviews of the field, offering support for future research and applications of temperament as a science of development. It lets us build a model of the developing person based on children's temperament and their adaptations to environmental challenges. At the same time it links temperament to our understanding of biology and the neurosciences. This handbook thus provides a unique basis for studying the development of human coping, psychopathology, and competence, including an exploration of the range of individual differences that the child brings to school and the adult brings to the workplace and family settings. As neuroscience methods and findings proliferate, our understanding of temperament processes will be further extended and clarified.

In this introductory chapter, I offer a brief historical introduction to temperament concepts. I then put forward a definition of temperament that we and others have found useful, noting that alternative definitions are to be found in later chapters of the book. I then describe a hierarchical model of development first proposed by Robert Hinde (1998) and discussed in greater depth in Rothbart (2011). Hinde's model gives us a systematic way to think about contributions to this volume and to develop new directions for research and strategies for intervention.

Throughout this chapter, suggestions are offered as to how this handbook can be used to generate ideas and research.

Ancient Historical Roots

Temperament concepts have a truly ancient past—as early as the Hindu Rig Vedas (approximately 1500–1000 B.C.E.) and the Bhagavad Gita (500–200 B.C.E.). For example, concepts of the *gunas* described basic qualities of the material world, including the human body, that were seen to contribute to mind and behavior (Larson, 1979; Needham, 1973). The *gunas* were seen as supporting the experience of pleasure, pain, and related approach and inhibition, as well as cognitively based detachment from the sources of pleasure and pain. They included *rajas* (desire and the anger and other suffering that result when we do not get what we want), related to approach and reactivity to incentives; *tamas* (restraint and inertia), related to behavioral inhibition; and *sattwa* (clear thinking and detachment), related to attention and self-regulation. These were seen as processes of nature that could activate or support each other, dominate or interact with each other (Larson, 1979). *Rajas*, as evidenced in the desire for clarity, for example, helps to support *sattwa*, clear thinking, although desire and clear thinking may at times conflict. *Tamas* may also follow the loss of *rajasic* desired objects. The *gunas* were reflected in the emotions and related motivations, and in the qualities of attention and regulation. They were also represented in the moods that could vary within a day.

Ancient Chinese approaches to what we would call temperament were based on the concept of energy, or *chi* (Yosida, 1973). The movement and fluctuation of *chi* was seen as the basis for individual differences in emotion and behavior, with the more active force of *yang* and the more passive force of *yin* acting to oppose and to complement each other, just as the *gunas* opposed and complemented each other in the Hindu model. Neither the Hindu nor the Chinese tradition put forward typologies but rather described dynamic interactions of human qualities or tendencies.

In the Western tradition, Galen (second century C.E.) is usually given credit for putting forward the fourfold typology of temperament (e.g., Carey, 1997; Kagan, 1994). However, parts of the typology were anticipated in Hellenistic medicine and cosmology, and the fourfold typology itself did not emerge until the fourth century C.E. with Vindician (Diamond, 1974). The word *temperament* was derived from the Latin *temperamentum*, meaning to "mingle in due proportion." The typology was thus based on the relative strength of temperament components we all share.

The Greco-Roman physicians foreshadowed modern research by linking temperament to physiology. In present-day research, we investigate the genetics and biochemistry of individual differences in temperament, a currently flourishing area of research. In the Greco-Roman fourfold typology, temperament was linked to the bodily humors, so that the *melancholic* person was seen as moody, with a tendency to fear and sadness, and a predominance of black bile (Diamond, 1974). The *choleric* person was touchy, aggressive and active, with a predominance of yellow bile. The *sanguine* person, sociable and easygoing, was seen to have a predominance of blood; the *phlegmatic* individual was calm, even-tempered, and slow to emotion, with a predominance of phlegm. The typology was further linked to aspects of psychopathology, with the choleric person likely to show problems with aggression, and the melancholic person to show problems with sadness and depression. The typology was applied throughout the Middle Ages, and into the 18th to 20th centuries.

In his 18th-century treatise titled *Anthropology from a Pragmatic Point of View*, for example, Immanuel Kant (1789/2006) discussed the ancient typology with the aim of distinguishing temperament from character or moral action. He described *temperament* as "what nature makes of the human being" (p. 192), whereas *character* refers to "what the person makes of himself" (p. 192) through willful thought and action and the application of virtue. While virtues themselves represented moral ideals, character referred to moral behavior and thought as expressed and observed in the person. Kant's argument relates in interesting ways to recent progress in the study of temperament, and I return to it later in this chapter.

In the early years of psychology as a science, a shift was made from positing typologies to talking about dimensions of individual variability. Kant's (1789/2006) typology of temperament had been based on dimensions that included activity–passivity and emotionality, and Wundt (1903) proposed the temperament dimensions of strength and speed of change of emotions. Ebbinghaus (1911), on the other hand, proposed the dimensions of optimism–pessimism and emotionality (H. J. Eysenck & M. Eysenck, 1985). Each of these sets of two dimensions could be used to generate four quadrants corresponding to the fourfold typology. Although typological approaches to temperament continue to play a role in the field (see Kagan, Chapter 4, this volume), most research today focuses on temperament dimensions rather than types.

Constitutional Psychology

An early approach to temperament called *constitutional psychology* is little studied today. This approach linked body types first identified by Hippocrates and linked to health (fifth century B.C.E.) and later to mental illness (Kretschmer, 1925). Kretschmer's work was followed by applications of his constitutional approach to the study of temperament and behavior in children, but these developments were hardly noted outside German-speaking countries (see Zentner, 1998). Sheldon and Stevens (1942) measured *endomorphic* (soft, rounded), *mesomorphic* (hard, rectangular), and *ectomorphic* (linear, fragile) components of five different body areas (measures were refined by Sheldon, Lewis, & Tenney, 1969). These components were then linked to temperament clusters of *viscerotonia* (sociable, gluttonous, appreciative of comfort and affection, even tempered, slow, relaxed, tolerant), *somatotonia* (need for vigorous activity, risk taking and adventure seeking, courage, aggression and callousness toward others), and *cerebretonia* (restraint, inhibition, fearfulness, self-consciousness, need to be alone, secretiveness), respectively.

In applications to children, moderate correlations were found between somatotype and teachers' ratings of 2- to 4-year-olds' behavior patterns (Hanley, 1951; Walker, 1962), and adolescents' self-reports (Cortes & Gatti, 1965). These findings may be influenced by the child's activity level and by the strong stereotypes that raters have of body types (Lerner, 1969), but studies have also linked delinquency to greater mesomorphy and lower ectomorphy (Cortes & Gatti, 1972; Glueck & Glueck, 1950, 1956). Greater longitudinal stability has been found for mesomorphy and ectomorphy than for endomorphy (Walker & Tennes, 1980), but recent increases in obesity in children may influence the stability of endomorphy. Although constitutional psychology appears to have died out, the connections between temperament and health continue to be exciting ones, as described by Hampson and Vollrath (Chapter 28, this volume).

Pavlov and the Eastern to Middle European Schools

Pavlov's model of temperament was based on his observations of dogs during conditioning, and linked to his ideas about the nervous system (Gray, 1979; Rothbart, 2011; Strelau, 1983). Russian temperament research was originally based in the laboratory, where properties such as nervous system strength of excitation were assessed. Individuals who continued to function under high-intensity or prolonged exposure to stimulation before the onset of inhibition of responses were described as having "strong" nervous systems, and those with low thresholds for inhibition as having "weak" nervous systems. Additional nervous system properties were labeled *strength of inhibition*, *balance between excitation and inhibition*, and *mobility* (speed of responding to changes in the signal value of a stimulus). Later, *lability* and *dynamism* were added to this list (see review by Strelau, 1983; Teplov, 1964).

Nebylitsyn (1972) and his followers reported that individuals with weak nervous systems demonstrated lower sensory thresholds. However, problems developed for the Russian School when the laboratory measures of general nervous system properties proved to be highly dependent on the nature of the stimulus and the modality of the response. Thus, sensitivity varied from one sensory system to another, for example, from audition to vision, and the properties did not appear to be general ones (a phe-

nomenon called *partiality*; Strelau, 1983). One result of partiality was that researchers moved out of the laboratory and into the development of questionnaire measures (Rusalov, 1987; Rusalov & Trofimova, 2007; Strelau, Angleitner, & Newberry, 1999; see also Strelau & Zawadzki, Chapter 5, this volume, for more recent developments).

Temperament in Western Europe

During the early 20th century, the Dutch researchers Heymans and Wiersma (1906) began a pioneering psychometric study by collecting questionnaire data from doctors concerning their patients, including both parents and children. They then applied an early form of factor analysis to the data, yielding three broad factors: (1) *Activity*, the tendency to express or act out what is thought or desired; (2) *Emotionality*, the tendency to show body symptoms and to be fearful and shy; and (3) *Primary vs. Secondary Function*, the tendency to react immediately rather than in a postponed and more organized way. These factors foreshadowed three of the broad factors of temperament we study today: Extraversion, Negative Emotionality, and Effortful Control (Rothbart, 2011). Heymans and Wiersma also crossed each of these three factors with interpretable cells seen as forming eight types, labeled Passionate, Choleric, Phlegmatic, Apathetic, Sentimental, Nervous, Sanguine, and Amorphous, that were particularly influential in the French school of *caractérologie* (Le Senne, 1945). A manual written for teachers and parents explained childrearing practices that would work best for each of the types (Le Gall, 1950).

Other French researchers (Wallon, 1925, 1934) carried out longitudinal studies of infant characteristics and their role in later development (see review by Balleyguier, 1989). Beginning in 1950, Meili in Switzerland studied 3- to 4-month-old infants' responses to unfamiliar stimuli, such as a black ball descending into the infant's visual field. Meili was among the first to code infants' reactions from filmed recordings that have just recently been digitized and catalogued. The authors found that the 3- to 4-month-old infants' muscle tension and emotional distress in response to the unfamiliar objects predicted later behavioral inhibition or shyness at 7 and 14 years (Meili-Dworetzki & Meili, 1972). The Swiss work and findings showed a number of similarities to the more recent work of Kagan and his colleagues (Zentner, 2008; also see Kagan, Chapter 4, this volume).

The British Psychometric Tradition

Whereas in Eastern Europe research moved from the laboratory to questionnaires, in Great Britain the order was reversed. There, temperament and personality factors were derived from self-report measures and only later related to the nervous system. Webb (1915), a student of Spearman, and Cyril Burt (1915) each carried out factor analyses of temperament-related items early in the 20th century. Webb analyzed items assessing emotionality, activity, self-qualities, and intellect, identifying a factor defined as "consistency of action resulting from deliberate volition or will" (p. 34).

Burt (1915) identified a factor he labeled Emotionality or Emotional Stability–Instability, which was later called Neuroticism by Eysenck (1947). (This habit of renaming constructs has been widely used in the field). Burt also identified the factor of Introversion–Extraversion and generated the fourfold typology by crossing the dimensions of Emotionality (Neuroticism) and Introversion–Extraversion. In addition, he discovered secondary dimensions of negative emotionality: "a general trait or tendency which, when positive, predisposes people towards assertive angry, sociable and inquisitive behavior, in short towards active or aggressive conduct, and when negative towards submissiveness, fear, sorrow, tenderness and disgust, in a word, towards repressive or inhibitive emotions" (Burt, 1937, p. 182). This factor foreshadows later externalizing and internalizing factors in behavior problems (see Lengua & Wachs, Chapter 25; Klein, Dyson, Kujawa, & Kotov, Chapter 26; Tackett, Martel, & Kushner, Chapter 27, this volume), and the two kinds of negative emotionality found in temperament in adults (Evans & Rothbart, 2007) and children (Rothbart, 2011).

Eysenck (1967) and later Gray (1971, 1982) posited biological bases for temperament

dimensions. Eysenck's theory was based on cortical arousal, whereas Gray rotated the axes of Eysenck's model 45 degrees, making anxiety the behavioral inhibition system (or BIS) and impulsivity the behavioral activation system (or BAS) the basic dimensions of temperament. Eysenck (1947) also identified the dimension of Psychoticism, associated with hostile and aggressive behavior. The 20th century showed extensive development of psychobiological models of adult temperament by Eysenck and Gray in Britain, and Cloninger, Zuckerman, Depue, Panksepp, and others in the United States (see Zuckerman, Chapter 3, this volume).

U.S. Research on Temperament in Childhood

The influential normative child psychologists in the 1920s and 1930s observed children in order to establish the normal sequences of motor and mental development, using both large samples and more intensively studied small samples of children. In doing so, they noted striking temperamental variability among the children they observed (Gesell, 1928, as cited in Kessen, 1965; Shirley, 1933). Mary Shirley's intensive longitudinal study of motor development during the first 2 years of life led her to observe the infant's "core of personality." She noted that, developmentally, "both constancy and change characterize the personality of the baby. Traits are constant enough to make it plausible that a nucleus of personality exists at birth and that this nucleus persists and grows and determines to a certain degree the relative importance of (other) traits" (Shirley, 1933, p. 56). She devoted a full volume to these traits, even though she had originally intended to study only motor and intellectual development.

Gesell (1928, as cited in Kessen, 1965) identified the critical importance of temperament in development and illustrated it with the example of CD, a child closely observed over early development who showed "a striking degree of amenability, sociality and good nature as early as the age of nine months. . . . In spite of a varied experience in boarding homes and institutions she has not lost these engaging characteristics" (p. 223). Gesell pointed out that there may be some stability of early temperament, but that "more than this cannot be predicted in the field of personality. For whether she (CD) becomes a delinquent, and she is potentially one, will depend upon her subsequent training, conditioning, and supervision. She is potentially also a willing, helpful, productive worker. Environment retains a critical role even though heredity sets metes and bounds" (p. 223).

Shirley (1933) and Gesell (1928, as cited in Kessen, 1965) argued that temperament traits are constitutionally based characteristics that provide the core of personality and influence directions for development. They also argued that although some stability is expected, outcomes also strongly depend on the child's experience in the social context. Finally, a given set of temperament characteristics will allow for multiple possible outcomes. Different trajectories and outcomes may occur for children with similar temperamental traits, and children differing in temperament may come to similar developmental outcomes via different pathways (Kochanska, 1997). In addition, specific life histories will influence the person's idiographic adaptations to life.

The next major line of research on temperament in childhood following the normative psychologists came from biologically oriented clinicians. Bergman and Escalona (1949) identified children who were particularly reactive to low intensities of stimulation in one or more sensory modalities. Escalona (1968) proposed the concept of *effective experience*, the idea that events in children's lives are experienced only as they are filtered through the individual child's nervous system. A given event will thus differ in its effects for children who differ in temperament. An adult's vigorous play, for example, may lead to pleasure in one child and distress in another.

Given individual differences in temperament, the objective coding of environmental events will not capture essential information about the individual child's reaction to that event, that is, the child's experience (see also Wachs, 2000). Research on temperament thus introduced the idea that in addition to individual differences in thoughts and motor patterns, individual differences in children's *emotional* processing could bias their reactions and representations of experience,

with important implications for their development. In other studies, Fries and Woolf (1954) identified and studied congenital activity type, Korner (1964) studied neonatal individuality and developed an extensive assessment schedule for the newborn, and Birns, Barten, and Bridger (1969) developed and implemented some of the earliest standardized assessments of temperament.

Among clinical investigators, Thomas, Chess, Birch, Hertzig, and Korn (1963) published the first of their volumes on the extremely influential New York Longitudinal Study (NYLS). Chess and Thomas studied individual differences in what they called "primary reaction patterns," collecting interviews from parents of infants on repeated occasions. Beginning when their initial sample of 22 infants was 3–6 months of age, parents were interviewed about their infants' behavior in varying contexts. Each infant reaction and its context was then typed on a separate sheet of paper, and Birch inductively sorted the descriptions into categories that came to represent the nine NYLS temperament dimensions (Chess & Thomas, personal communication, May 1992; Thomas et al., 1963): activity level, approach–withdrawal, adaptability, mood, threshold, intensity, distractibility, rhythmicity, and attention span/persistence. Later, Michael Rutter suggested the term *temperament* to describe their area of study, and this term was adopted by the NYLS group (Chess & Thomas, personal communication, May 1992). The NYLS is further discussed by Mervielde and De Pauw (Chapter 2, this volume).

In recent years, concepts of temperament and personality in adulthood and childhood have increasingly come together (Halverson, Kohnstamm, & Martin, 1994; Rothbart & Derryberry, 1981), and their joint influence is seen in many chapters of this volume. Nevertheless, more integrated work is needed. For example, one can compare and contrast concepts and methods in the two review chapters on adult temperament (see Zuckerman, Chapter 3, and Depue & Fu, Chapter 18, this volume) and the two chapters on child temperament (see Mervielde & De Pauw, Chapter 2, and White, Lamm, Helfinstein, & Fox, Chapter 17, this volume), leading to hypotheses for future integrative developmental research.

Defining Temperament

My coauthor and I (Rothbart & Derryberry, 1981) have defined *temperament* as constitutionally based individual differences in reactivity and self-regulation, influenced over time by genes, maturation, and experience. The term *constitutional* refers to the biological bases of temperament. By *reactivity*, we mean dispositions toward emotional, motor, and orienting reactions (these are sometimes referred to as the three A's: affect, activity, and attention). By temperamental *self-regulation*, we refer to processes that regulate our reactivity. Self-regulatory dispositions include our motivational tendencies to approach or withdraw from a stimulus, to direct our attention toward or away from it, and the effortful attentional control that serves to regulate our thoughts and emotions. These tendencies form the basis for early coping with challenges presented by others and the environment.

Temperamental reactivity can be measured by the latency, intensity, peak rise time, and recovery of the person's reaction (Rothbart & Derryberry, 1981). For example, how rapidly do we become fearful, inhibited, withdrawing, or self-protective in a potentially fear-inducing situation? How rapidly do we approach a novel or threatening object, or become frustrated when we are prevented from achieving our goals, and become sad when we experience loss? How intense are our reactions, and how long does it take to recover from the reaction? Reactivity can be measured broadly, as in Kagan's (1994; Chapter 4, this volume) observations of the development of behavioral inhibition, and it can be also be measured more specifically in terms of emotional systems and components of those systems (e.g., in links between behavioral inhibition and amygdala function; see, in this volume, Kagan, Chapter 4; White et al., Chapter 17, and Depue & Fu, Chapter 18; and Zentner & Shiner, Chapter 32).

Approach and inhibitory or withdrawal tendencies can oppose one another (Gray, 1971; Rothbart & Sheese, 2007), and regulatory tendencies can moderate reactive ones. Thus, approach and impulsivity are opposed by reactive fear, and by effortful self-regulatory control. Both reactivity and self-regulation are adaptive processes, and

they form the basis for the child's earliest patterns of evaluating and coping with the environment. Temperament supports individual differences in infancy and shapes the personality adaptations that develop out of our initial dispositions and our history of life experiences. Our life experiences also shape our reactivity by influencing our emotional evaluations, experience of stress, and strategies for coping with situations and people (Rothbart, 2011).

Temperament develops, as can be seen throughout this volume. Not all aspects of temperament are observable in the newborn, but rapid development occurs over the first years of life in both temperament and in the mental capacities that allow us to move beyond temperament traits to the wider domain of personality. Early in development, emotional reactivity and relatively unregulated approach (impulsivity) characterize the infant, but as motivational and attentional systems develop, greater individual control over emotion, thought, and action becomes available. In fact, the regulation of temperament tendencies can be seen as a major aim of the child's socialization into a society or culture (Olson & Sameroff, 2009; Vohs & Baumeister, 2011).

The Structure of Temperament

One of the major advances in temperament over the past four decades has been our increased understanding of the basic dimensions of temperament and their relation to each other. Factor-analytic work with parent-report and self-report questionnaires has strongly contributed to this effort (Rothbart & Bates, 2006). As mentioned earlier, Thomas and Chess (1977) originally offered nine dimensions of temperament based on a content analysis of infant reaction patterns in their NYLS. More recently, their list of dimensions has been revised and supplemented as research on temperament has progressed (Rothbart & Bates, 2006). This handbook reflects many of the dimensions of temperament studied today, including behavioral inhibition, activity, anger/irritability, positive emotionality, effortful control, and candidate dimensions of empathy/agreeableness and sensory sensitivity (see, in this volume, Kagan, Chapter 4; Strelau & Zawadzki, Chapter 5; Putnam, Chapter 6; Deater-Deckard & Wang, Chapter 7; Rueda, Chapter 8; Knafo & Israel, Chapter 9; see also Aron, Chapter 31).

Research reported in this handbook depends heavily on our understanding of temperamental dimensions and components. An understanding of the structure of temperament allows us to explore links between temperament in children and temperament in adults integrating the contributions to Part I. In addition, this understanding furthers improvement in measurement (Part II), allows us to make links between temperament and biology (Part IV), relate temperament to the development of psychopathology and physical health (Part VI), and study contextual influences on temperament (Part V). Part VII, on applications, is particularly dependent on the prior chapters and on how we see the structure of temperament. As McClowry and Collins argue in their chapter on prevention and intervention, in order to instruct children and parents about temperament, we need a solid understanding of temperament itself (Chapter 29, this volume).

A General Model for Thinking about Temperament and Development

Recent advances in neuroscience, including research on brain imaging and the genome, and our progress in understanding temperament at multiple levels, has allowed us to study a number of bidirectional influences on the development of individual differences. Hinde's (1998) model of human development allows us to take these influences into account (see Figure 1.1). He argues that thought, emotion, and action will be influenced by both the dispositions of the individual and the influence of the environment at any point in development. At the same time, each person will see others and the physical environment based on his or her specific past history of experiences and goals for the future. As Hinde puts it, "Individuals respond selectively to the environment, assign meanings to it, change it, and are changed by it" (p. 166).

The point where the person and the perceived environment most dramatically come

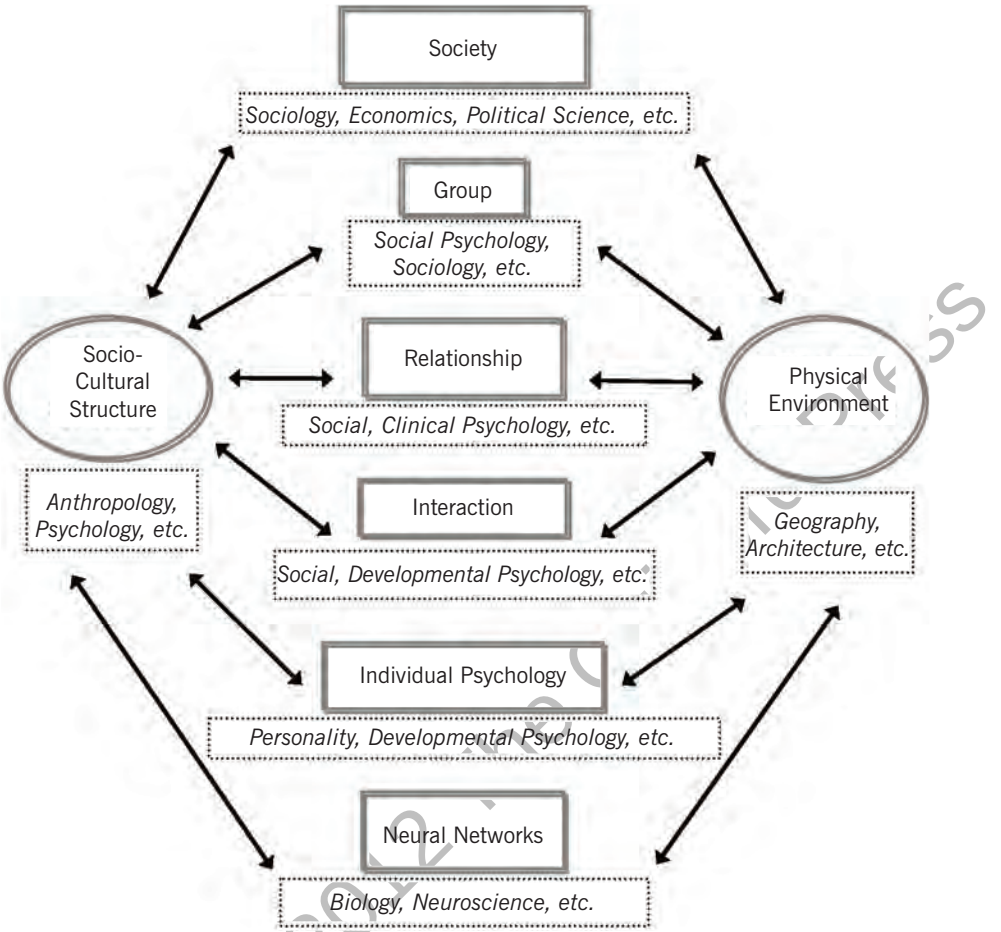

FIGURE 1.1. An adaptation of Hinde's (1998) framework for study in the human sciences. The levels of influence are listed within solid rectangles and circles; below, in dashed rectangles, are areas of study related to these influences.

together is in one's experiences with others over a life history, played out in social relationships. Temperament, especially early in life, makes basic contributions to the person's interpretations, actions, and relationships, while, at the same time, interpretations, actions, and relationships make basic contributions to the expressions of temperament (Rothbart, 2011).

To study multiple levels of influence, we need to explore biological, physical, social, and cultural influences on the individual and vice versa, along with the usual psychological level of analysis. This requires the study of "physiology, individual psychology, social psychology, sociology, anthropology, political science, and economics, among others" (Hinde, 1998, p. 166). Different explanatory concepts and methods apply at different levels of analysis, and a full understanding of development requires making connections between levels (Hinde, 1998; Figure 1.1). One level of the hierarchy can influence a quite distant level, and influences are bidirectional.

The downturn of an economy, for example, may create the threat or actuality of unemployment, increasing stress levels and marital conflict in parents. Marital conflict in turn affects the child's stress levels at the

biological and individual levels, and the child's social behavior (Cummings, Papp, & Kouros, 2009). The child also develops adaptive strategies for coping with parental conflict (e.g., playing the role of the peacemaker or the distracting troublemaker, or withdrawing from interaction), which can then feed back to influence marital conflict. These strategies can also be carried forward to other situations, interactions, and relationships, affecting the child's overall adjustment (Cummings et al., 2009). Throughout his analysis, Hinde (1998) emphasizes the importance of relationships in the home, the workplace, and the social world. Each partner to a relationship contributes to the experience of the other and to the constructions each partner comes to hold about the other and the self. The child's relationships in the family can easily be carried forward to influence other relationships, and vice versa. Each level of analysis is also related to what Hinde calls the *sociocultural structure*, that is, the norms, values, beliefs, and institutional roles of a culture.

Societal policies can have strong influences on the relationship, interaction, individual, and biological levels. The one-child policy in China, for example, instituted as a corrective for a high birthrate, affected individuals, family groups, interactions, and relationships. The policy in turn influenced not only the size of families but also the gender distribution of children, through a selection against girl babies (Hesketh, Liu, & Xing, 2005). The family unit is clearly affected by the policy, as is the child's relation to other family members. The differences in gender distribution are also related to the health of mothers and female children, and to the mental and physical health of young adults (Hesketh et al., 2005).

Numerous other applications of Hinde's (1998) framework are possible, and one of their major benefits is in thinking about the implications of change at the level of societies and economies, as well as the influences of roles, relationships, and individual psychology and biology on other levels of the hierarchy. For example, an economic factor closely related to many levels of bidirectional influence is whether the child is raised in poverty, and this is a worldwide problem subject to remediation at a number of levels (Lipina & Colombo, 2009).

Temperament, Socialization, and Culture

Many interactions within and between levels of analysis are observed as we study temperament "in context." This can be in the context of the neighborhood, the culture, the family, the parents' relationship with each other and with the child (see, in this volume, van IJzendoorn & Bakermans-Kranenburg, Chapter 19; Bates, Schermerhorn, & Petersen, Chapter 20; Coplan & Bullock, Chapter 21; Chen, Yang, & Fu, Chapter 22), and in the classroom (see, in this volume, Rueda, Chapter 8, and Duckworth & Allred, Chapter 30). In Hinde's (1998) framework, culture and the physical environment show a bidirectional influence across different levels of analysis, and in the study of temperament we have become increasingly concerned with issues of temperament and culture (Chen et al., Chapter 22, this volume).

Culture among humans is defined by Mascolo (2004) as "a dynamic distribution of meanings, practices, and artifacts throughout a linguistic community" (p. 83). Reasons for studying culture in relation to temperament are clear, although at times concerns about political correctness have led temperament researchers to avoid cultural issues. Research in differing cultures gives us a real-world laboratory for testing similarities in the structure of temperament even if childrearing strategies and cultural values vary (Rothbart, 2011). Because temperament includes emotional reactivity, and the primary emotions are similarly displayed and understood in different cultures (Ekman, Sorenson, & Friesen, 1969), we have had reason to expect that the structure of temperament would also be universal. This is not to say that levels of reactivity and self-regulation are identical across cultures, but that the dimensions of temperament are similar across cultures. The values of the culture can then act upon temperament to influence both how we act and how we think about ourselves and others.

It is likely that the brain's basic networks for attention are similar across cultures, with details depending on social and individual experience, including training (Rueda, Chapter 8, this volume; see also Diamond & Lee, 2011). Studies using the Children's Behavior Questionnaire (CBQ; Rothbart, Ahadi, Hershey, & Fisher, 2001) and other

temperament scales in the United States and other cultures have replicated the structure of temperament across cultural boundaries (Ahadi, Rothbart, & Ye, 1993; Rothbart, 2011). Finally, to the extent that the Big Five and FFM measures reflect the structure of temperament, they have also proven to be consistent across numerous cultures (McCrae et al., 2000).

As psychologists, we are interested in how the expression of temperament can be shaped by culture and how individuals shape their culture. Temperamental qualities seen as "difficult" in children, for example, have been found to vary across cultures (Super et al., 2008). If we adopt Mascolo's (2004) definition, we realize that each of us belongs to a number of different cultures, such as our family of origin, nuclear family, work group, religion, gender, and political party. These different cultures yield overlapping and sometimes conflicting meanings, practices, and artifacts, and our temperaments will influence our adaptations to both cultures and culture conflicts.

Goodenough (1981) has identified a number of ways in which culture affects personality that clearly go beyond traits to describe how individuals develop in context. In our family, school, neighborhood, or work setting, for example, we

1. Assimilate the language categories and explicit knowledge that we will use to represent events.
2. Develop *beliefs* (propositions for which we do not have satisfactory evidence, but which we believe to be true), values and goals, and awareness of cultural rules and values (including the aspects of temperament that are valued or not valued by the culture).
3. Are influenced by the scripts, routines, and standards of behavior we follow and the skills we practice.
4. Are influenced by the books, television, tools, Internet, and networking websites we use.

Culture also contributes to

5. The narratives we use to describe events and our role in them, including family stories.
6. The models of self and others and the relationships we develop. The individual and groups of individuals can in turn influence the culture, especially when a subgroup or individual holds power over others.

Temperament, as noted earlier, is seen in our patterns of reactivity and in the coping methods we use in adapting to situations and people. The reactivity we express and the coping measures we use will in turn be affected by the values that the culture places on a given temperament characteristic. Temperamental shyness is particularly interesting in this regard, in that it varies in acceptability not only from culture to culture (Kerr, 2001) but also from girls to boys within a culture (Chen et al., Chapter 22, and Else-Quest, Chapter 23, this volume). Culture will in turn be shaped by the temperament of the group members who share it, and as a group's membership and leadership change, the culture may also change, sometimes in dramatic ways.

Hinde's (1998) framework helps us to pose many additional cross-cultural research questions. Studies of shyness have identified links between shyness and the values of a culture (Kerr, 2001; see review by Rothbart, 2011), but how does culture influence the development of warm intimate relationships, security, argumentativeness, leadership qualities, and political values? Studies of genetic contributions to development will be important in investigating the effect of interactions between genes, environment, and sociocultural values on temperament and personality outcomes. As a final example of the application of multiple levels of analysis, and a way of returning to Kant's (1789/2006) argument, I now consider research that we and others have conducted at multiple levels of analysis.

Exploring Multiple Levels

Chapters by many of the contributors to this handbook show how temperament has been studied at multiple levels, and I present here a brief review of our work on effortful control and executive attention as an example. In our work at Oregon, we have studied the development of attentional self-regulation and effortful control at many

levels. We first identified Effortful Control (EC) in factor analyses of the CBQ (Ahadi et al., 1993; Rothbart et al., 2001). Analyses of scale scores in this research yielded commonly found broad factors of Surgency/Extraversion (Putnam, Chapter 6, this volume), Negative Affectivity (Deater-Deckard & Wang, Chapter 7, this volume), Behavioral Inhibition (Kagan, Chapter 4, this volume), and Effortful Control (Rueda, Chapter 8, this volume). In research ranging from parent's report of toddlers' behavior to adults' self-report of temperament, we have reliably extracted an EC factor that includes some combination of attentional focusing, attentional shifting, and inhibitory and activational control (Derryberry & Rothbart, 1988; Ellis, Rothbart, & Posner, 2004; Evans & Rothbart, 2007; Putnam, Ellis, & Rothbart, 2001; Putnam, Gartstein, & Rothbart, 2006). Persons high in EC also tend to be low in negative emotionality, in agreement with the idea that attention can be used to regulate emotion, and vice versa (Rothbart & Sheese, 2007).

EC falls under the umbrella constructs of self-control, willpower, self-regulation, and executive functions. These general constructs have been used to designate processes that do not seem to be externally driven, and include, but are not limited to, working memory, planning, problem solving, and future-oriented activities The construct of EC refers more specifically to the ability to resolve conflict by inhibiting a dominant response in order to perform a nondominant response. The EC measure has been related to a brain network of executive attention involving the anterior cingulate, anterior insula, and basal ganglia (Posner, 2012; Posner & Rothbart, 2007a, 2009; Rothbart, Sheese, Rueda, & Posner, 2011). Correlations between EC and the ability to resolve conflict in cognitive tasks such as the Attention Network Test or Stroop effect have been shown from ages 3–4 to adulthood (Rothbart, 2011).

EC questionnaire measures are also directly linked to the activation of the executive attention brain areas involved in self-regulation (Kanske, 2008; Whittle et al., 2008). Individual differences in the function of this brain network have been related to genetic polymorphisms in the dopamine and serotonin system (Posner, Rothbart, & Sheese, 2007). In this way EC has become more than a measure of parent-reported differences in behavior and is a way of understanding the dramatic changes in self-control that occur early in childhood. Together EC and the underlying executive attention network allow connecting societal influences (Moffitt et al., 2011) to brain networks, genetic and experiential influences (Rothbart, 2011).

The Interaction of Genes and Experience to Predict Outcomes

In recent years, measurement of the genome has allowed us to study interactions between the genome and environmental factors in development. In a longitudinal study, we found that the 7-repeat allele of the dopamine D4 receptor (*DRD4*) gene interacted with quality of parenting to influence surgent temperamental variables of activity level, sensation seeking, and impulsivity (Sheese, Voelker, Rothbart, & Posner, 2007). With high-quality parenting, 18- to 20-month-old children with the 7-repeat allele showed average levels of these sensation-seeking scales, and those with poorer quality parenting showed much higher levels; children without the 7-repeat allele were not influenced by parenting. We also found that, at 3–4 years, the *DRD4* 7-repeat allele interacted with parenting to influence parent-reported EC (Sheese, Voelker, Rothbart, & Posner, in press), with higher-quality parenting related to greater EC for children with the 7-repeat allele, but not for those without the 7-repeat variation. In accord with these findings, a recent study showed that only those children with the 7-repeat variant of the *DRD4* gene showed the influence of a parent training intervention (Bakermans-Kranenburg, van IJzendoorn, Pijlman, Mesman, & Juffer, 2008; see also Depue & Fu, Chapter 18, and van IJzendoorn & Bakermans-Kranenburg, Chapter 19). Extensive reviews of interactions among genes, temperament, and the environment are provided in this volume (Saudino & Wang, Chapter 16; White et al., Chapter 17; Depue & Fu, Chapter 18; van IJzendoorn & Bakermans-Kranenburg, Chapter 19; Bates et al., Chapter 20).

EC and Moral Development

In our laboratory and others, EC has been found to undergo rapid development in chil-

dren between the ages of 2 and 7 years, especially during the preschool years (Gerardi-Caulton, 2000; Kochanska, Murray, & Harlan, 2000; Rothbart, Ellis, Rueda, & Posner, 2003). Kochanska and her colleagues studied the development of EC in two studies that followed children from ages 2 to 5 years and from 9 to 45 months of age (Kochanska, Murray, & Coy, 1997; Kochanska et al., 2000; Kochanska, Murray, Jacques, Koenig, & Vandegeest, 1996). They behaviorally measured five skills involving the ability to suppress a dominant response in order to perform a subdominant response, including both delay and conflict tasks. Beginning at age 2½ years (30 months), children's performance became highly consistent across these tasks, suggesting that an underlying quality of EC was developing. Children were also remarkably stable across age in their performance on the behavioral EC tasks, and stability correlations were consistently high, as high as those for the stability of intelligence (Kochanska et al., 2000). Guerin, Gottfried, Oliver, and Thomas (2003) have also reported that toddler persistence, an aspect of EC, predicts adolescent task orientation in parent-reports.

The construct of EC has important theoretical implications. Early theoretical models of temperament stressed how our actions are driven by our level of arousal, or by our positive and negative emotions. The control of approach by fear and the control of fear by strong approach or impulsivity tendencies fit with this kind of model (Gray, 1982). EC, however, means we are not always at the mercy of emotion. With EC, we can choose to approach situations we fear and inhibit actions we desire, giving a strong self-regulatory basis for socialized action, conscience, and self-control (Eisenberg, Smith, Sadovsky, & Spinrad, 2004).

EC also brings with it the possibility of the person changing his or her own thoughts and behavior. With the development of executive attention and EC, we can observe our own actions and select other actions based on our values and goals. Although the effectiveness of EC depends on the strength of the emotional and motivational processes against which it is exerted, it provides the possibility for true flexibility of thought, emotion, and action, and the volitional development of virtue.

This provides a link to Kant's (1789/2006) ideas about how we can influence ourselves through willed action. EC allows us to use self-regulatory attention systems to shape our own character. While our character reflects our use of attention in conflict situations, as well as other self-regulative functions, the development of moral character also reflects our motivation to do the right thing. EC measured in both questionnaires and in the laboratory predicts the development of conscience (Kochanska, 1997; Kochanska & Aksan, 2007), but EC, as expressed in daily life, is also linked to social and moral motivation. I suspect that children's affiliative tendencies and desire to please others (and perhaps gender; see Else-Quest, Chapter 23, this volume) are also involved in whether a child desires to comply with an adult's requests or orders.

Measurement of Temperament and Future Directions

How then do we measure temperament? It should be clear that there are many approaches to the measurement of temperament and related variables, depending on the question of interest and our level, or levels, of analysis (in this volume, see Gartstein, Bridgett, & Low, Chapter 10; Goldsmith & Gagne, Chapter 11; Calkins & Swingler, Chapter 12; see also Strelau & Zawadzki, Chapter 5; Huizink, Chapter 15; Saudino & Wang, Chapter 16). Aspects of temperament in the individual can be measured at the molecular genetic (genome) level, as well as at levels of everyday interaction. In the past, our view of the measurement of temperament was much more limited, including chiefly questionnaires, laboratory observations, measures, and behavioral home observations (reviewed by Rothbart & Goldsmith, 1985). Our review noted that each measure is associated with both advantages and potential sources of error (see also Rothbart & Bates, 2006). Because each method has both advantages and disadvantages, it is preferable to look for convergence of findings across measures, or to compare and combine measures of the same construct, rather than to dismiss any one measure (see, in this volume, Gartstein et al., Chapter 10; Goldsmith & Gagne, Chapter 11; Calkins & Swingler, Chapter 12).

We have also argued that contributions of questionnaires to our understanding of both temperament and personality have been substantial (Rothbart & Bates, 2006), as can be seen in a number of contributions to this volume beginning with Mervielde and De Pauw (Chapter 2). Although Kagan (1994, 1998) earlier argued against the use of questionnaire measures, there is also evidence for convergence of questionnaire, observational, and laboratory measures of temperament (Rothbart & Bates, 2006). Questionnaire scores are also directly linked to measures of brain structure and function (Kanske, 2008; Whittle et al., 2008).

There are now measures at the molecular genetic, genetic imaging, neurochemical, neuroimaging, and behavioral levels that allow us to study relations within and between different levels of temperament-related variables. Two important issues for future behavioral measurement arise. The first concerns the identification of narrower individual differences contributing to broader assessments, and their study within and across levels. The second concerns the relation of temperament to broader biological tendencies that can be studied in the laboratory and with nonhuman animals. Expanding the possibilities of temperament measurement allows us to study temperament in a way that is appropriate to the question we are addressing. We have already learned that fear and anger tendencies (subconstructs of Negative Affectivity) are likely to set up different routes or trajectories for the development of behavior problems (see Rothbart, 2011; Rothbart & Bates, 2006; see also, in this volume, Lengua & Wachs, Chapter 25, and Klein et al., Chapter 26). Furthermore, greater differentiation within both negative and positive emotions, and within different reward- and punishment-related sensitivities, will likely be possible in the future.

How, for example, does a broad temperament dimension, such as Surgency/Extraversion or Positive Emotionality break down into component processes such as reward sensitivity and pleasure, and how are these related to individual biology (see Putnam, Chapter 6, this volume)? What are the links between social fear (shyness), nonsocial fear, and cognition at different points in development (see Kagan, Chapter 4, this volume)? To what degree can EC be broken down into components of executive attention and motivation? How do children's structures of meaning, especially cognitions about the self and others, affect the expression of temperament, and how does temperament affect children's structures of meaning? How are both broad and differentiated measures of temperament related to genetic structure, and how do environmental events interact with effects of genes to predict developmental outcomes (see Saudino & Wang, Chapter 16, this volume)? As temperament is increasingly linked to brain structure and function, our understanding of both temperament and neuroscience will be enriched.

Another important research question is how social and nonsocial temperament reactions can be differentiated at different ages. When, for example, is social fear (shyness) first differentiated from fear of objects? How does the developing concept of self affect social and nonsocial fear? Aksan and Kochanska (2004) have distinguished between the joy expressed toward objects and toward people in infancy, and more differentiated measures related to surgency and affiliation will be helpful in addressing these research questions in the future.

In summary, our understanding of temperament has progressed rapidly (Rothbart, 2011), making use of new methods and linking genes to environments. These methods allow us to take a much broader view of temperament, and studies of molecular and imaging genetics of temperament are currently being published at an explosive rate (e.g., Hariri & Weinberger, 2003). At the same time, research using our earlier methods has continued to yield fruitful results. This recent rapid growth allows for greater understanding at the multiple levels proposed by psychobiological researchers and Robert Hinde (1998), as well as Posner and Rothbart (2007b). In the future, this handbook will provide the basis for a multilevel perspective on the study and application of temperament concepts and measures. There will clearly be many questions to for us to address and answer.

Acknowledgment

I am very appreciative of the contributions to this chapter by Michael I. Posner.

Further Reading

Hinde, R. A. (1998). Integrating across levels of complexity. In D. M. Hann, L. C. Huffman, I. I. Lederhendler, & D. Meineke (Eds.), *Advancing research on developmental plasticity* (pp. 165–173). Bethesda, MD: National Institute of Mental Health.

Kochanska, G., Murray, K. T., & Harlan, E. T. (2000). Effortful control in early childhood: Continuity and change, antecedents, and implications for social development. *Developmental Psychology, 36*(2), 220–232.

Rothbart, M. K. (2011). *Becoming who we are: Temperament and personality in development*. New York: Guilford Press.

Rothbart, M. K., & Bates, J. E. (2006). Temperament. In W. Damon, R. Lerner, & N. Eisenberg (Eds.), *Handbook of child psychology, Vol. 3: Social, emotional, and personality development* (6th ed., pp. 99–106). New York: Wiley.

References

Ahadi, S. A., Rothbart, M. K., & Ye, R. (1993). Children's temperament in the U.S. and China: Similarities and differences. *European Journal of Personality*, *7*, 359–378.

Aksan, N., & Kochanska, G. (2004). Links between systems of inhibition from infancy to preschool years. *Child Development*, *75*, 1477–1490.

Allport, G. W. (1937). *Personality: A psychological interpretation*. New York: Holt.

Bakermans-Kranenburg, M. J., van IJzendoorn, M. H., Pijlman, F. T. A., Mesman, J., & Juffer, F. (2008). Differential susceptibility to intervention: Dopamine D4 receptor polymorphism (DRD4 VNTR) moderates effects on toddlers' externalizing behavior in a randomized control trial. *Developmental Psychology*, *44*, 293–300.

Balleyguier, G. (1989). Temperament and character: The French school. In G. A. Kohnstamm, J. E. Bates, & M. K. Rothbart (Eds.), *Temperament in childhood* (pp. 597–606). Chichester, UK: Wiley.

Bergman, D., & Escalona, S. K. (1949). Unusual sensitivities in very young children. *Psychoanalytic Study of the Child*, *3/4*, 333–352.

Birns, B., Barten, S., & Bridger, W. (1969). Individual differences in temperamental characteristics of infants. *Transactions of the New York Academy of Sciences*, *31*, 1071–1082.

Bowlby, J. (1971). *Attachment and loss: Vol. 1. Attachment*. New York: Basic Books.

Burt, C. L. (1915). General and specific factors underlying the primary emotions. *British Association Annual Report*, *84*, 694–696.

Burt, C. L. (1937). The analysis of temperament. *British Journal of Medical Psychology*, *17*, 158–188.

Carey, W. B. (1997). *Understanding your child's temperament*. New York: Macmillan.

Caspi, A., & Shiner, R. L. (2006). Personality development. In W. Damon & R. Lerner (Series Eds.) & N. Eisenberg (Vol. Ed.), *Handbook of child psychology: Vol. 3. Social, emotional, and personality development* (6th ed., pp. 300–365). New York: Wiley.

Cortes, J. B., & Gatti, F. M. (1965). Physique and self-descriptions of temperament. *Journal of Consulting Psychology*, *29*, 432–439.

Cortes, J. B., & Gatti, F. M. (1972). *Delinquency and crime: A biopsychosocial approach*. New York: Seminar Press.

Cummings, E. M., Papp, L. M., & Kouros, C. D. (2009). Regulatory processes in children's coping with exposure to mental conflict. In S. L. Olson & A. J. Sameroff (Eds.), *Biopsychosocial regulatory processes in the development of childhood behavior problems* (pp. 212–237). New York: Cambridge University Press.

Derryberry, D., & Rothbart, M. K. (1988). Arousal, affect, and attention as components of temperament. *Journal of Personality and Social Psychology*, *55*(6), 958–966.

Diamond, A., & Lee, L. (2011). Interventions shown to aid executive function development in children 4 to 12 years old. *Science*, *33*, 959–964.

Diamond, S. (1974). *The roots of psychology: A sourcebook in the history of ideas*. New York: Basic Books.

Ebbinghaus, H. (1911). *Psychology: An elementary textbook*. Boston: Heath.

Eisenberg, N., Smith, C. L., Sadovsky, A., & Spinrad, T. (2004). Effortful control: Relations with emotion regulation, adjustment, and socialization in childhood. In R. F. Baumeister & K. D. Vohs (Eds.), *Handbook of self regulation: Research, theory, and applications* (pp. 259–282). New York: Guilford Press.

Ekman, P., Sorenson, E. R., & Friesen, W. V. (1969). Pan-cultural elements in facial displays of emotion. *Science*, *164*, 86–88.

Ellis, L. K., Rothbart, M. K., & Posner, M. I. (2004). Individual differences in executive attention predict self-regulation and adolescent psychosocial behaviors. *Annals of the New York Academy of Sciences*, *1021*, 337–340.

Escalona, S. (1968). *The roots of individuality: Normal patterns of development in infancy*. Chicago: Aldine.

Evans, D., & Rothbart, M. K. (2007). Developing a model for adult temperament. *Journal of Research in Personality*, *41*, 868–888.

Eysenck, H. J. (1947). *Dimensions of personality*. London: Routledge & Kegan Paul.

Eysenck, H. J. (1967). *The biological basis of personality*. Springfield, IL: Thomas.

Eysenck, H. J., & Eysenck, M. W. (1985). *Personality and individual differences: A natural science approach*. New York: Plenum Press.

Fries, M. E., & Woolf, P. (1954). Some hypotheses on the role of congenital activity type in personality development. *Psychoanalytic Study of the Child*, *8*, 48–64.

Gerardi-Caulton, G. (2000). Sensitivity to spatial conflict and the development of self-regulation in children 24–36 months of age. *Developmental Science*, *3*(4), 397–404.

Gesell, A. (1928). *Infancy and human growth*. New York: Macmillan.

Glueck, S., & Glueck, E. (1950). *Unraveling juvenile delinquency*. New York: Commonwealth Fund.

Glueck, S., & Glueck, E. (1956). *Physique and delinquency*. New York: Harper.

Goodenough, W. H. (1981). *Culture, language, and society*. Menlo Park, CA: Benjamin.

Gray, J. (1979). *Ivan Pavlov*. New York: Penguin.

Gray, J. A. (1971). *The psychology of fear and stress*. New York: McGraw-Hill.

Gray, J. A. (1982). *The neuropsychology of anxiety: An enquiry into the functions of the septo-hippocampal system*. London: Oxford University Press.

Guerin, C. W., Gottfried, A. W., Oliver, P. H., & Thomas, C. (2003). *Temperament: Infancy through adolescence*. New York: Kluwer Adademic/Plenum Press.

Halverson, C. F., Jr., Kohnstamm, G. A., & Martin, R. P. (1994). *The developing structure of temperament and personality from infancy to adulthood*. Hillsdale, NJ: Erlbaum.

Hanley, C. (1951). Physique and reputation of junior high school boys. *Child Development*, *22*, 247–260.

Hariri, A., & Weinberger, D. R. (2003). Imaging genomics. *British Medical Bulletin*, *65*, 259–270.

Hesketh, T., Liu, L., & Xing, Z. W. (2005). The effect of China's one-child family policy after 25 years. *New England Journal of Medicine*, *353*, 1171–1176.

Heymans, G., & Wiersma, E. D. (1906). Beiträge zur speziellen psychologie auf Grund einer Messenuntersuchungung. *Zeitschrift für Psychologie*, *42*, 81–127, 258–301.

Hinde, R. A. (1998). Integrating across levels of complexity. In D. M. Hann, L. C. Huffman, I. I. Lederhendler, & D. Meineke (Eds.), *Advancing research on developmental plasticity* (pp. 165–173). Bethesda, MD: National Institute of Mental Health.

Kagan, J. (1994). *Galen's prophecy: Temperament in human nature*. New York: Basic Books.

Kagan, J. (1998). Biology and the child. In W. S. E. Damon & N. V. E. Eisenberg (Eds.), *Handbook of child psychology: Vol. 3. Social, emotional and personality development* (5th ed., pp. 177–235). New York: Wiley.

Kagan, J., & Fox, N. (2006). Biology, culture, and temperamental biases. In W. Damon & R. Lerner (Series Eds.), & N. Eisenberg (Vol. Ed.), *Handbook of child psychology: Vol. 3. Social, emotional, and personality development* (6th ed., pp. 99–166). New York: Wiley.

Kanske, P. (2008). *Exploring executive attention in emotion: ERP and fMRI evidence. MPI series in human cognitive and brain sciences: Vol. 106*. Leipzig, Germany: Max Planck Institute for Human Cognitive and Brain Sciences, University of Leipzig.

Kant, I. (2006). *Anthropology from a pragmatic point of view* (R. B. Louden, Trans. & Ed.). Cambridge, UK: Cambridge University Press. (Original work published 1789)

Kerr, M. (2001). Culture as a context for temperament: Suggestion from the life courses of shy Swedes and Americans. In T. D. Wachs & G. A. Kohnstamm (Eds.), *Temperament in context* (pp. 139–152). Mahwah, NJ: Erlbaum.

Kessen, W. (1965). *The child*. New York: Wiley.

Kochanska, G. (1997). Multiple pathways to conscience for children with different temperaments: From toddlerhood to age 5. *Developmental Psychology*, *33*, 228–240.

Kochanska, G., & Aksan, N. (2007). Conscience in childhood: Past, present, and future. In G. W. Ladd (Ed.), *Appraising the human developmental sciences: Essays in honor of Merrill–Palmer Quarterly* (pp. 238–249). Detroit, MI: Wayne State University Press.

Kochanska, G., Murray, K. T., & Coy, K. C. (1997). Inhibitory control as a contributor to conscience in childhood: From toddler to early school age. *Child Development*, *68*, 263–277.

Kochanska, G., Murray, K. T., & Harlan, E. T. (2000). Effortful control in early childhood: Continuity and change, antecedents, and implications for social development. *Developmental Psychology*, *36*(2), 220–232.

Kochanska, G., Murray, K. T., Jacques, T. Y., Koenig, A. L., & Vandegeest, K. A. (1996). Inhibitory control in young children and its role in emerging internalization. *Child Development*, *67*, 490–507.

Korner, A. (1964). Some hypotheses regarding the significance of individual differences at birth for

later development. *Psychoanalytic Study of the Child*, *19*, 58–72.
Kretschmer, E. (1925). *Physique and character*. New York: Harcourt Brace.
Larson, G. J. (1979). *Classical Samkhya*. Delhi: Motilal Banarsidass.
Le Gall, A. (1950). *Caractérologie des enfants et des adolescents, à l'usage des parents et des éducateurs*. Paris: PUF.
Lerner, R. (1969). The development of stereotyped expectancies of body build–behavior relations. *Child Development*, *40*, 137–141.
Le Senne, R. (1945). *Traité de Caractérologie*. Paris: PUF.
Lipina, S. J., & Colombo, J. A. (2009). *Poverty and brain development during childhood: An approach from cognitive psychology and neuroscience*. Washington, DC: American Psychological Association.
Mascolo, M. F. (2004). The coactive construction of selves in cultures. *New Directions for Child and Adolescent Development*, *104*, 79–90.
McCrae, R. R., Costa, P. T., Jr., Ostendorf, F., Angleitner, A., Hrebícková, M., Avia, M. D., et al. (2000). Nature over nurture: Temperament, personality, and life span development. *Journal of Personality and Social Psychology*, *78*(1), 173–186.
Meili-Dworetzki, G., & Meili, R. (1972). *Grundlagen individueller Persönlichkeitsunterschiede: Ergebnisse einer Längsschnittuntersuchung mit zwei Gruppen von der Geburt bis zum 8. und 16. Altersjahr* [*Foundations of individual personality differences: Results of a longitudinal study with two cohorts from birth to the 8th and 16th year of age*]. Berne: Huber.
Moffitt, T. E., Arsenault, L., Belsky, D., Dickson, N., Hancox, R. J., Harrington, H., et al. (2011). A gradient of childhood self-control predicts health, wealth and public safety. *Proceedings of the National Academy of Sciences USA*, *108*, 2693–2698.
Nebylitsyn, V. D. (1972). *Fundamental properties of the human nervous system*. New York: Plenum Press.
Needham, J. (1973). *Chinese science*. Cambridge, MA: MIT Press.
Olson, S. L., & Sameroff, A. J. (Eds.). (2009). *Regulatory processes in the development of behavior problems: Biological, behavioral, and social-ecological perspectives*. Cambridge, UK: Cambridge University Press.
Posner, M. I. (2012). *Attention in a social world*. New York: Oxford University Press.
Posner, M. I., & Rothbart, M. K. (2007a). *Educating the human brain*. Washington, DC: American Psychological Association.
Posner, M. I., & Rothbart, M. K. (2007b). Research on attention networks as a model for the integration of psychological science. *Annual Review of Psychology*, *58*, 1–23.
Posner, M. I., & Rothbart, M. K. (2009). Toward a physical basis of attention and self-regulation. *Physics of Life Reviews*, *6*/2, 103–120.
Posner, M. I., Rothbart, M. K., & Sheese, B. E. (2007). Attention genes. *Developmental Science*, *10*(1), 24–29.
Putnam, S. P., Ellis, L. K., & Rothbart, M. K. (2001). The structure of temperament from infancy through adolescence. In A. Eliasz & A. Angleitner (Eds.), *Advances in research on temperament* (pp. 165–182). Lengerich, Germany: Pabst Science.
Putnam, S. P., Gartstein, M. A., & Rothbart, M. K. (2006). Fine-grained assessment of toddler temperament. *Infant Behavior and Development*, *29*, 386–401.
Rothbart, M. K. (2011). *Becoming who we are: Temperament and personality in development*. New York: Guilford Press.
Rothbart, M. K., Ahadi, S. A., Hershey, K., & Fisher, P. (2001). Investigations of temperament at three to seven years: The Children's Behavior Questionnaire. *Child Development*, *72*(5), 1394–1408.
Rothbart, M. K., & Bates, J. E. (2006). Temperament. In W. Damon, R. Lerner, & N. Eisenberg (Eds.), *Handbook of child psychology: Social, emotional, and personality development* (6th ed., Vol. 3, pp. 99–106). New York: Wiley.
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.
Rothbart, M. K., Ellis, L. K., Rueda, M. R., & Posner, M. I. (2003). Developing mechanisms of temperamental effortful control. *Journal of Personality*, *71*, 1113–1143.
Rothbart, M. K., & Goldsmith, H. H. (1985). Three approaches to the study of infant temperament. *Developmental Review*, *5*, 237–260.
Rothbart, M. K., & Rueda, M. R. (2005). The development of effortful control. In U. Mayr, E. Awh, & S. W. Keele (Eds.), *Developing individuality in the human brain: A festschrift honoring Michael I. Posner—May 2003* (pp. 167–188). Washington, DC: American Psychological Association.
Rothbart, M. K., & Sheese, B. E. (2007). Temperament and emotion regulation. In J. J. Gross (Ed.), *Handbook of emotion regulation* (pp. 331–350). New York: Guilford Press.
Rothbart, M. K., Sheese, B., & Posner, M. I. (2007). Executive attention and effortful control: Linking temperament, brain networks, and genes. *Child Development Perspectives*, *1*(1), 2–7.
Rothbart, M. K., Sheese, B., Rueda, M. R., & Posner, M. I. (2011). Developing mechanisms of self regulation in early life. *Emotion Review*, *3*, 207–213.

Rusalov, V. M. (1987). *Questionnaire for the measurement of the structure of temperament (QST), short manual*. Moscow: Moscow University.

Rusalov, V. M., & Trofimova, I. (2007). *Structure of temperament and its measurement*. Toronto: Psychological Services Press.

Sheese, B. E., Voelker, P. M., Rothbart, M. K., & Posner, M. I. (2007). Parenting quality interacts with genetic variation in dopamine receptor *DRD4* to influence temperament in early childhood. *Development and Psychopathology*, *19*, 1039–1046.

Sheese, B. E., Voelker, P. M., Rothbart, M. K., & Posner, M. I. (in press). Parenting quality and DRD4: Attention and temperament at four years of age. *Child Development Research*.

Sheldon, W. H., Lewis, N. K. C., & Tenney, A. (1969). Psycholtic patterns and physical constitution. In D. V. Siva Sanker (Ed.), *Schizophrenia: Current concepts and research*. Hillsdale, NJ: PJD Publications.

Sheldon, W. H., & Stevens, S. S. (1942). *The varieties of human temperament*. New York: Harper & Row.

Shirley, M. (1933). *The first two years: Vol. III. Personality manifestations*. Minneapolis: University of Minnesota Press.

Strelau, J. (1983). *Temperament personality activity*. New York: Academic Press.

Strelau, J., Angleitner, A., & Newberry, B. H. (1999). *The Pavlovian Temperament Survey (PTS): An international handbook*. Göttingen, Germany: Hogrefe & Huber.

Super, C. M., Axia, G., Harkness, S., Welles-Nystrom, B., Zylicz, P. O., Parminder, P., et al. (2008). Culture, temperament, and the "difficult child": A study in seven Western cultures. *European Journal of Developmental Science*, *2*(1/2), 136–157.

Teplov, B. M. (1964). Problems in the study of general types of higher nervous activity in man and animals. In J. A. Gray (Ed.), *Pavlov's typology* (pp. 3–156). Oxford, UK: Pergamon Press.

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

Thomas, A., Chess, S., Birch, H. G., Hertzig, M. E., & Korn, S. (1963). *Behavioral individuality in early childhood*. New York: New York University.

Vohs, K. D., & Baumeister, R. F. (Eds.). (2011). *Handbook of self-regulation: Research, theory, and applications* (2nd ed.). New York: Guilford Press.

Wachs, T. D. (2000). *Necessary but not sufficient: The respective roles of single and multiple influences on individual development*. Washington, DC: American Psychological Association.

Walker, R. N. (1962). Body build and behavior in young children: I. Body build and nursery school teachers' ratings. *Monographs of the Society for Research in Child Development*, *27*(3, Serial No. 84).

Walker, R. N., & Tennes, J. M. (1980). Prediction of adult Sheldon somatotypes I and II from rankings and measurements at childhood ages. *Annals of Human Biology*, *7*, 1–8.

Wallon, H. (1925). *L'enfant turbulent*. Paris: Alcan.

Wallon, H. (1934). *Les origins du caractere chez l'enfant*. Paris: Boivin.

Webb, E. (1915). Character and intelligence. *British Journal of Psychology Monographs*, *1*(3), 1–99.

Whittle, S., Yücel, M., Fornito, A., Barrett, A., Wood, S., Lubman, D., et al. (2008). Neuroanatomical correlates of temperament in early adolescents. *Journal of the American Academy of Child and Adolescent Psychiatry*, *47*(6), 682–693.

Wundt, W. (1903). *Grundzuge der physiologischen psychologie* (5th ed., Vol. 3). Leipzig, Germany: W. Engelmann.

Yosida, M. (1973). The Chinese concept of nature. In S. Nakayama & N. Sivin (Eds.), *Chinese science* (pp. 71–90). Cambridge, MA: MIT Press.

Zentner, M. (1998). *Die Wiederentdeckung des Temperaments. Eine Einführung in die Kinder-Temperamentforschung [The rediscovery of temperament. An introduction to research on child temperament]*. Frankfurt: Fischer Verlag.

Zentner, M. (2008). Current trends in the study of child temperament (Editorial). *European Journal of Developmental Science*, *2*, 2–6.

Zentner, M., & Bates, J. E. (2008). Child temperament: An integrative review of concepts, research programs, and measures. *European Journal of Developmental Science*, *2*, 7–37.