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CROSS REF ID: **1026276348650001842**

LENDER: **DDF (Food and Drug Administration) :: Main Library**

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TYPE: Book Chapter

BOOK TITLE: Encyclopedia of Child and Adolescent Health

USER BOOK TITLE: Encyclopedia of Child and Adolescent Health

CHAPTER TITLE: Temperament

BOOK AUTHOR: Gartstein, Maria A

EDITION:

VOLUME:

PUBLISHER: Academic Press,

YEAR: 2023

PAGES: 195-207

ISBN: 9780128188736

LCCN:

OCLC #: 1369262647

Processed by RapidX: 10/24/2024 1:10:30 PM

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# Temperament

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## Abstract

Most recently, temperament has been defined as constitutionally based individual differences that incorporate reactivity along with self-regulation, both informed by one's biological makeup and impacted by maturation and environment. Over the lifespan, temperament remains fairly stable, but its expression can be impacted by a variety of factors, including biological changes, psychological well-being, socialization, parenting practices, and cultural values, just to name a few. Research on temperament has expanded over the past decades extending into genetics, neuroscience, and developmental and clinical psychology. Temperament can be construed as a complex intersection of biology, socialization, and other environmental factors that impact both an individual's internal and external experiences. Understanding these connections provides insight into adaptive and maladaptive temperament developmental trajectories. Additionally, temperament is strongly related to personality and its development, boding risk or protection with respect to clinical symptoms/disorders.

## Introduction

When asked to describe yourself, what comes to mind? Some people might describe themselves as funny, shy, outgoing, or quiet. When asked to describe yourself as a child, does your answer change? Thinking back to childhood, it may come as no surprise that these qualities that help make us unique individuals remain fairly stable—the babbling, excited baby turns into an active, talkative toddler and later into an outgoing, cheerful teenager. Temperament, and subsequently personality, offer great insight into how biology, psychology, and socialization interact to create the humans we are today.

## History of temperament

Understanding individual differences in character, personality, and behavior has been a common theme across the study of humanity. Dating back to ancient Greece, Hippocrates and Galen wrote on humors, the *tempore* (mixing), and their impact on illness and health, the course of life, and character (Stelmack & Stalikas, 1991; Kagan, 1998). Thus, the idea that biological foundations impact who we are and how we act over the lifespan is rather ancient. Galen defined the four humors as blood connected to being sanguine or cheerful, yellow bile linked to feeling choleric or angry, black bile to feeling melancholic or depressed, and phlegm connected to being phlegmatic or calm. It was thought that these humors come together to create the human experience. Balanced humors were thought to result in the optimal temperament with symmetry in both psychological and physical health. When the balance shifted, illness—both physical and psychological—were thought to occur. The four humors continued to dominate temperament conceptualizations during the Enlightenment, as Immanuel Kant, a German philosopher and a key figure during this era, identified each of the four temperaments as independent (i.e., not subject to combinations as originally

posited by Hippocrates and Galen; Kant, 1797). He wrote that temperament was manifested along two dimensions: feelings and activities, presenting a multi-dimensional, rather than a categorical conceptualization.

In the modern era, Hans Eysenck set out to define the main dimensions of temperament and personality. His work relied on adults' self-reports, yielding several factors, or broad dimensions, including introversion-extraversion, emotional stability-instability, later termed 'neuroticism,' (Eysenck, 1947), and volition or will. Eysenck claimed that these factors were inherited, biological in nature, and contributed to emotional and behavioral traits, such as being sociable, quiet, and impulsive (Eysenck and Eysenck, 1963; Eysenck, 1964). Gray (1970, 1973) revised this model, proposing individual differences in sensitivity/reactivity across three separate emotional systems: behavioral activation, behavioral inhibition, and the fight-flight system. Gray's model also introduced neurological systems as underlying these reactions.

Given this recognition that temperament is a product of neurological systems which mature over time, research addressing temperament in childhood represented the next logical step. The work of Thomas et al. (1963) in the New York Longitudinal Study (NYLS) formed the basis for much of the recent research on temperament in children. Thomas and Chess identified nine dimensions of temperament: activity, approach/withdrawal, threshold, mood, intensity, rhythmicity, adaptability, distractibility, and attention span/persistence. They also categorized temperament into three general types: 'difficult temperament,' 'easy temperament,' and 'slow-to-warm-up.' 'Difficult temperament' was defined as including low rhythmicity, high withdrawal, slow adaptation, high frequency of negative mood, and intense reactions. The 'easy temperament' category, on the other hand, was described as including regular eating, sleeping, elimination cycles, a positive approach response to new situations, along with frustration tolerance, whereas 'slow-to-warm-up children' were characterized as showing negative responses when exposed to new situations, but slowly accepting these with repeated exposure. This work also introduced the concept of goodness-of-fit, or the degree of match between the child's characteristics and the parent's demands and expectations (Thomas and Chess, 1977). A good fit between the parental approach and child characteristics was expected to result in a more positive adjustment, whereas a poor fit would lead to problematic outcomes. Thomas and Chess paved the way for subsequent research addressing early appearing individual differences, some of which led to significant revisions in the NYLS list of temperament dimensions, as well as modern theory and research.

### Temperament today

Today, there are four main theories of temperament that contribute to research in this area (Goldsmith et al., 1987). Buss and Plomin define temperament as inherited personality traits that are genetic in origin, appear in infancy, are adaptable, and found in other species (Buss and Plomin, 1975, 1984). Thomas and Chess (1977) conceptualize temperament as the *how, what, and why* of behavior, drawing on the fact that individuals have a personalized, or stylistic, approach to a behavior. For example, individuals might approach a similar situation with differing intensities, moods, and distractibility, all representations of temperamental components. Goldsmith and Campos describe temperament as individual differences in the probability of an individual experiencing and expressing the primary emotion and arousal (Goldsmith and Campos, 1982). Lastly, Rothbart proposed a theory of temperament focused mainly on reactivity and self-regulation (Rothbart & Derryberry, 1981).

While these theories differ in details, there is considerable overlap in definitions. First, temperament refers to a set of traits; therefore, studies of temperament involve multiple dimensions (i.e., sadness, arousal level, activity level, etc.) rather than a single, all-encompassing construct. Additionally, temperament constructs provide a foundation for behavioral predispositions (not specific outcomes), meaning that temperament offers a framework within which observed tendencies are interpreted, which can serve to predict important outcomes (e.g., psychopathology/symptoms). Thus, temperament can be thought of as a lens to understand and predict emotional, social, and behavioral outcomes given the environmental context. Another set of commonalities lies in the biological basis of temperament, its stability over time and situations. Across theories, there has been an interest in identifying the biological underpinnings of temperament to understand how biology impacts temperament expression. Lastly, temperament is construed as individual differences, thus different temperamental predispositions can lead individuals to experience the same events/environments in different ways.

This chapter will focus on Rothbart's psychobiological theory of temperament because of its current prominence and widespread use. Her theory proposes that temperament is defined as constitutionally based individual differences that incorporate reactivity along with self-regulation, both informed by one's biological makeup and impacted by maturation and environment (Rothbart & Derryberry, 1981). Encompassing motivation, emotions, behavioral dispositions, and attention, reactivity can be defined as responsiveness and arousability of behavioral and physiological systems, and self-regulation can be defined as processes involved in modulating underlying reactivity.

Manifestations of temperament can be measured in terms of threshold, intensity, and temporal factors. Threshold reflects sensitivity to stimuli, with individual differences thought to impact later development of cognitive control (Rettew and McKee, 2005). Intensity, or response magnitude, is described as a pattern of "energy level of response" across activities or how strongly one engages with the environment (Thomas and Chess, 1977; Rothbart and Derryberry, 1981). In addition to threshold and intensity, it is also worth considering temporal aspects, including latency, rise time, and recovery time. For example, latency can reflect alertness when indicative of time taken to orient. Rise time, or time required to reach peak intensity, can lead to differences in reactions to stimuli and distress tolerance. Lastly, recovery time, or how long it takes to return to baseline, has implications for resiliency and an individual's ability to soothe. These parameters demonstrate the interplay between reactivity—how and in what ways an individual responds to a given situation—and regulation—how well one can manage these reactions.

Temperament is not a unitary construct, but rather a constellation of hierarchically organized traits which reflects the individual's unique temperament profile. Additionally, temperament attributes change over time, developing across the lifespan, and especially rapidly in early childhood (Putnam et al., 2001). Studies have identified higher-order temperament constructs, such as negative emotionality, positive emotionality/extraversion, and effortful control/regulatory capacity, which in turn consist of sets of more fine-grained temperament attributes (e.g., Capaldi and Rothbart, 1992; Rothbart et al., 2001). Negative emotionality typically consists of related dimensions of sadness, anger, irritability, and fear. Positive emotionality/extraversion consists of approach, smiling and laughter, activity level, and sociability. Early in life, regulatory capacity reflects orienting and self-soothing; later in life, effortful control reflects the ability to inhibit a dominant response in order to perform a subdominant response and includes perceptual sensitivity and attentional control (Rothbart et al., 2003). Studies addressing the structure of temperament and its development demonstrated marked shifts, especially at the fine-grained level, illuminating changes in the expression of reactivity and one's ability to self-regulate.

## Development of temperament

Although temperament is thought to remain fairly stable across the lifespan, many things can impact its expression. There are a multitude of changes in behavior and motivation that emerge between infancy and adolescence that impact the appearance of temperament. A clear example that emerges across the lifespan is reaction to novelty. In early infancy, babies can distinguish between familiar and unfamiliar objects and people, but approach both at similar rates; however, toward the latter half of the first year of life, infants show a hesitancy in approach to novel objects (Rothbart, 1988). Additionally, in toddlers, fear of the unfamiliar is easily recognizable by crying, pulling away, and safety seeking. In adolescents, fear is often induced by social rejection/evaluation and manifests more internally (Schwartz et al., 1999). Different emotions and attentional capacities "come online" throughout childhood and adolescence, with some related processes serving as precursors to effective regulation of other emotions and behaviors. Thus, timing of appearance for these attributes and the environment in which they emerge have important implications for later temperamental development.

### Infancy

Distress is evident at birth, whereas smiling and laughter emerge in early infancy as part of the positive affect constellation of reactivity. By 2 months, distress begins to differentiate, and infants are capable of demonstrating anger and frustration to restraint. Both of which are, perhaps counterintuitively, associated with approach, as anger and frustration are behaviorally exhibited when a desired approach is blocked, as evidenced when arm-restraint is applied (He et al., 2013). Motor activity also emerges during this time and is linked with both positive and negative affect displays. At about 4–6 months, fear and irritability are evident, along with behavioral inhibition to novel stimuli. Motor skills continue to develop with infants being better able to engage with the world around them by reaching for and grasping objects. In fact, rapid grasping of objects is positively related to smiling and laughter, suggesting that the neurobehavioral system underlying approach is "coming online." This emerging reactivity, in tandem with yet underdeveloped fear responses, allows researchers the opportunity to assess approach and attention as babies are interested in stimuli presented in the laboratory. Later in the first year of life, there is an increase in behavioral inhibition and other aspects of reactivity to novelty. Fear and avoidance could blunt infants' approach responses making it more difficult to examine approach tendencies especially when considering novelty of the laboratory setting. Given the immaturity of infant control over behavioral, emotional, and cognitive reactions, much of the infant's regulation and attention necessitates external involvement from the caregiver. However, as the child grows and engages with the world around them independently, more complex internal self-regulatory processes are required.

### Childhood

In childhood, much of the temperamental individual differences emerging in infancy remain stable but are built upon as daily life begins to include more complex situations. Surgency, or trending toward higher levels of positive affect, in toddlers begins to manifest as impulsivity and seeking out intense experiences, which for those lagging in self-regulation development can lead to difficulties. Effortful control, closely linked with self-regulation, emerges in the toddlerhood/preschool period and includes focused attention, perceptual sensitivities, inhibitory control, and low intensity pleasure. Verbal communication begins to enter the picture and influence behavior. Many studies have examined the impact of verbal instructions on a child's self-control, finding that increases in verbal self-regulation (i.e., self-directed speech) begin in early childhood (Vaughn et al., 1984; Reed et al., 1984). Language development enhances the ability to anticipate and control a situation and has been implicated in individual differences in attention and delayed gratification (Kopp, 1982; Putnam et al., 2002). Language also involves both affective and cultural influences, resulting in more complex environmental inputs. Children are taught culturally expected emotional displays, shaping socialization efforts and emotional expression, also contributing to individual differences and cross-cultural variability.

## Adolescence

Biological, psychological, and social systems undergo much change during the period of adolescence (Feldman and Elliott, 1990; Spear, 2000). The age at which children transition to adolescence is marked by a search for independence, expanding peer relationships (including romantic relationships), and changes in executive and regulatory skills. Additionally, there are neurological and physiological changes that accompany puberty during this time. Taken together, this period of development is a crucial time often marked by major changes in socialization, biology, and psychology. It also marks a transition in measuring temperament, as there is a shift from parent- to self-reports relying on personal assessments of temperament, emotions, and behaviors. An additional factor that captures unique aspects of temperament during early adolescence has been labeled Affiliativeness, defined as the desire for warmth and closeness to others (Ellis and Rothbart, 1999; Latham et al., 2020). The emergence of this new dimension, in addition to Surgency, Negative Affectivity, and Effortful Control, reflects the importance of social interactions during this time, which exceedingly involves peers in addition to family members.

Overall, differences in expression of temperament across the first two decades of life are thought to be a result of developmental changes. Temperament development in infancy is primarily driven by reactivity, with various domains of emotionality “coming online”, later dominated by growth in self-regulation, especially as a child moves into adolescence. During infancy, temperament is manifested primarily in responses to stimuli and infants rely on caregivers to regulate their internal experiences. During childhood, self-awareness and other advanced cognitive skills (e.g., language, memory) come into play as children are able to interact with their environment in more complex, independent ways. During adolescence, socialization adds yet another layer through which adolescents interact with their environment as peers begin to impact the individual’s internal and external experiences. As developmental demands increase in complexity, there is less automaticity in responses to internal and external stimuli, with a shift toward more effective regulation of emotions and behaviors and volitional control of attention. Many changes across this developmental period in biology (i.e., puberty), socialization (i.e., peer interactions), and psychology (i.e., advanced cognitive skills) come into play, contributing to and interacting with individual differences in temperament.

## Biopsychosocial model of temperament

### Biology

Rothbart’s psychobiological temperament framework is based on a connection between biology and temperament. In fact, much of the current research on temperament is rooted in understanding how biology influences regulation and reactivity. As mentioned above, there is much interplay between reactivity and regulation, and this can be explored at multiple biological levels beginning with DNA and moving on to vast neural networks. The work of Cloninger and colleagues provide another major contribution to understanding the connection between biology and temperament (Cloninger, 1986, 1987; Cloninger et al., 1993). His theory focuses on learning and conditioning across evolution, and how these mechanisms are supported by brain structures/functions and are expressed outwardly through behavior. Cloninger identified four temperament dimensions that have been heavily examined in functional brain imaging: (1) harm avoidance, an indicator of negative emotionality, (2) novelty seeking, a measure of approach and impulsivity, (3) reward seeking, linked with sociability, and (4) persistence, ability to sustain and that to some extent overlaps with the Rothbart framework.

It should be noted that temperament has been studied across species. Much of this research has focused on understanding temperament in animals to increase our knowledge of the biological underpinnings in humans. Diamond (1957), focusing mainly on aggression and fearfulness, was one of the first to relate these traits in animals to human characteristics. In nonhuman primates, specifically rhesus macaques, two classifications emerged: “uptight” and “laid back” (Higley and Suomi, 1989). These “traits” also corresponded with social interaction and physiological differences. Studies in animals (e.g., rhesus monkeys) have provided insight into genetic underpinnings as well (e.g., Sullivan et al., 2011a, 2011b).

### Genetics

In humans, genetic contributions to temperament have been examined through twin studies. These studies have provided strong evidence of a genetic influence on temperament, finding that monozygotic (MZ) twins are consistently more similar across temperamental dimensions than dizygotic (DZ) twins and non-related individuals. These differences indicate an underlying genetic contribution that emerges with more similarities in the genome (Cyphers et al., 1990; Goldsmith et al., 1997; Saudino and Cherny, 2001; Stevenson and Fielding, 1985). This literature is somewhat nuanced, as negative emotionality aspects of temperament have shown more within twin pair similarities than positive aspects (Goldsmith et al., 1999). Research with candidate genes has led to a vast array of research questions, one being how genes impact higher order biological processes such as neurotransmitters and expression of temperament. The *DRD4* gene has been linked with novelty seeking (Benjamin et al., 1996; Epstein et al., 1996). Allelic variation of the *SLC6A4* gene was implicated in an individual’s proneness to emotionality (Lesch et al., 1994; Sen et al., 2004). Many of the candidate genes studied in terms of genetic contributions to temperament were found to be associated with neurotransmitter functioning in particular. As molecular and behavioral geneticists continue to seek answers to these questions surrounding temperament, our understanding of the underlying genetic contributions has become more complex, expanding to include the entire genome and mechanisms regulating gene expression.

A recent review by Cloninger et al. (2019) addressed established concepts of temperament through the lens of modern molecular findings. Through recent genome-wide association studies (GWAS), it has been shown that temperament is influenced by over 700 genes. These genes have been implicated in molecular processes contributing to neural plasticity, long-term memory, and learning, providing a potential new line of research in behavioral conditioning. Multiple cellular mechanisms (e.g., Ras-MEK-ERK cascade and PI3k-AKT-mTOR cascade) have been implicated in processing somatic, psychological, and social stressors in the brain (Zwir et al., 2019). The ability to perform genome-wide association studies has expanded the understanding of temperament and further exposed the complexity of genetic and biological impacts.

Further complicating the story of genetic contributions to temperament, epigenetic studies have added an additional layer, implicating environmental inputs in gene expression that provides the foundation for temperament development. Epigenetics refers to the changes in the outward expression of the gene without changes in the underlying sequence or code and is a function of molecules around the DNA. This epigenetic “programming” has been shown to impact temperamental development by transmitting effects of the prenatal environment, for example maternal stress during pregnancy (Gartstein and Skinner, 2018). Such stress exposure was found to increase speed of gestation (Glynn et al., 2001; Roseboom et al., 2006), impact the child’s cortisol reactivity (Yehuda et al., 2005), and compromise neurodevelopment (Antonelli et al., 2017; Fatima et al., 2017). In addition to epigenetic contributions to the phenotypic expression of genes in utero, there are some genetic innovations in phenotypic expression that occur during adolescence, specifically at 12–16 years-of-age (Gillespie et al., 2004), and could be activated by the epigenetic contributions from the onset of puberty (Ganiban et al., 2008).

### In the brain

The study of underlying structural and functional neural development has also contributed greatly to the understanding of temperament and its emergence across childhood. Stemming from candidate gene studies, neurotransmitters started to emerge as important factors in temperament development and stability. The neurotransmitter dopamine is thought to be involved in the approach to novel stimuli, activation, and intensity (Auerbach et al., 2001; Cloninger, 1987). When considering serotonin, there have been links to impulsivity and behavioral inhibition (Ebstein et al., 1998). Each of these neurotransmitters plays a large role in behavior and psychology. Dopamine is connected with positivity affect, attention abilities, and approach behaviors (Schinka et al., 2002; White et al., 2012). Lower levels of serotonin have been linked to negative affect, greater attention to perceived threat, and greater amygdala activity (Gonda et al., 2009; Pérez-Edgar et al., 2010, White et al., 2012). Given the connection between these neurotransmitters, their behavioral impacts, and outwardly expressed temperament, neurotransmitters and the underlying genetic contribution could provide an interesting, yet complex, starting point for future research.

Structurally, many areas of the brain are thought to contribute to temperamental components and individual differences. When considering reactivity, negative emotionality has been found to be associated with low thresholds of arousal in the limbic system (Kagan & Snidman, 1991). Additionally, the amygdala activity and related sympathetic nervous system arousal have been implicated in negative emotionality, including inhibition, fear responses, and anxiety (Kagan et al., 1987; LeDoux, 1996). A highly excitable amygdala, in particular, was associated with a predisposition for hypervigilance toward unfamiliar stimuli (Kagan et al., 1988; Kagan, 2012). Approach and reward sensitivity have been linked to the striatum, including the nucleus accumbens, caudate, and putamen (Yin and Knowlton, 2006). While structural differences offer insight into between-individual differences, they also offer insight into within-individual differences that emerge across development. During adolescence, the striatum undergoes changes that are thought to heighten sensation-seeking and risk-taking behaviors typical in adolescence (Galvan, 2010).

Functionally, neural networks provide an understanding of how whole brain processes contribute to temperament expression. For example, effortful control is thought to be a behavioral manifestation of executive attention, and the attentional network, involving the prefrontal cortex, anterior cingulate, and basal ganglia, is important for effective effortful control (Rothbart & Rueda, 2005). Emotional and behavioral regulation processes are thought to be driven by activation in the anterior cingulate cortex (ACC) and the prefrontal cortex (PFC; e.g., Botvinick, 2007). The ACC is thought to contribute to emotional regulation through monitoring emotional responses (e.g., Beauregard et al., 2001). Additionally, activation in the ACC mirrors emotional intensity of stimuli, with heightened activity corresponding with higher emotional salience (Blair et al., 1999). The PFC has an interesting relationship with emotion regulation and the amygdala. At the basic level, the amygdala is associated with crude emotional responses to stimuli, but when higher order cognitive processes must be used, there is a shift away from the amygdala and toward the PFC (Hariri et al., 2003). Perhaps this connection shows the neural underpinnings of shifting between reactivity and regulation.

### Physiological measures

Physiological measures can also provide useful insight into how biology plays into temperament. Vagal tone and heart rate variability, cortisol levels, and hemispheric asymmetry have been correlated with temperament measures of caregiver reports and behavioral observations of temperament. Baseline respiratory sinus arrhythmia (RSA) is a measure of heart rate variability naturally occurring in each breathing cycle. It is conceptualized as a trait-like measure of an individual’s tendency to respond to their environment and is considered an indicator of arousal and reactivity (Blandon et al., 2010). Negative emotionality has been linked to higher RSA in infancy (Stifter and Fox, 1990; Calkins et al., 2002). Cortisol levels represent a response of the hypothalamic-pituitary-adrenal (HPA) axis and are thought to reflect stress hormones. Heightened levels were linked to fear, negative affect and withdrawal behaviors (Fortunato et al., 2008).

Electroencephalography (EEG) offers a unique psychophysiological measure of temperament, providing a marker of associated brain activity. Frontal symmetry, measured through EEG, has been a prominent area of research in temperament development. Greater relative left frontal EEG activation has been linked to approach motivation and emotions while greater right frontal activation has been associated with avoidance and negative affect (Fox, 1991). Smith and Bell (2010) found that greater left frontal activation between 10 and 24 months was associated with externalizing problems (e.g., aggression) and right frontal activation with internalizing symptoms (e.g., anxiety/depression) at 30 months old. Additionally, event-related potentials (ERPs) have offered insight into stimulus-specific responses, as well as changes across the lifespan. One example is the N2 amplitude ERP which is thought to be associated with activation of the ACC. It has been implicated in responses to emotionally salient stimuli, showing differences in amplitude and latency across different emotional stimuli. Lewis et al. (2007) found that children have higher amplitudes and shorter latencies when exposed to an angry face, suggesting that children quickly and heavily recruit regulatory processes when presented with threatening stimuli. Overall, children show longer latencies and N2 amplitudes when compared to adults, suggesting underdeveloped regulatory systems (Rueda et al., 2004). This difference in N2 amplitudes has also shown to decrease across adolescence and into adulthood as regulatory systems are consolidating and becoming more developed (Lewis et al., 2006). Although EEG has its limitations, it is a noninvasive technique that can be utilized across the lifespan, providing unique access from infancy onward.

## Social

Although temperament is genetically based and relatively stable, there is considerable evidence that experience and context play a role in shaping the expression of temperament (Rothbart and Bates, 2006). Interestingly, some of the socialization research also comes from genetic studies. It has been found that 20–60% of variability in temperament comes from genetics, leaving 40–80% to be explained by environmental factors (Saudino, 2005). Through behavioral genetics research, it became clear that environmental mechanisms are also complex in nature. It was found that shared family environments explain only a small fraction of temperament outcomes, with non-shared environments (i.e., experiences that differ among siblings) playing a bigger role (Robinson et al., 1992; Saudino and Cherny, 2001). This research suggests the need to further consider different experiences within families to better understand individual differences in temperament (Saudino, 2005). Whereas home environment appears to play a role in shaping temperament, it could be how an individual fits into that environment that provides the most impact.

Like many other aspects that contribute to the expression of temperament, socialization begins early in infancy and continues across the lifespan. Thomas and Chess (1977) emphasized the concept of “goodness of fit” for individuals, arguing that behavior was determined by the match between the environment and temperament, meaning that the demands of a certain environment can have impacts on temperamental expression. Taking this idea a step further, Wachs and colleagues coined the term “organismic specificity” to draw attention to the idea that there are differential effects of a similar environment on individuals with different temperaments (Wachs and Gandour, 1983; Wachs and Gruen, 1982). Belsky’s work in differential susceptibility highlighted the importance of considering environmental exposure through the lens of individual differences, as certain environments can be more detrimental or beneficial for individuals who show greater openness to contextual effects (Belsky and Pluess, 2009). Moreover, there are many ways in which the environment and temperament interact. As noted, environmental inputs can drive temperament development, and children can have an impact on their environment (so called “child effects”), so reciprocal effects need to be studied further. It is also important to consider how environments shape the contribution of temperament to later psychosocial adjustment.

In infancy, temperament regulates and is regulated by others’ actions. The caregiver-infant dyad typically provides the earliest and most consistent interaction for an infant. From these early days of life, it becomes evident that temperament serves a transactional role. That is, individual differences in temperament impact the interaction between caregivers and infants, and parental regulation impacts the infant’s behavioral expression of temperament. For example, caregivers use infant distress to guide their soothing behaviors, and these behaviors subsequently impact the infant’s regulation and reactivity. As the infant continues to grow and develop, caregivers remain important socialization agents, as peers and teachers get involved.

Parenting influences continue to play an important role as children get older. Children with higher temperamental attributes of negative affectivity are more likely to experience ineffective parenting practices (e.g., harsh and inconsistent discipline), which in turn has been linked to children’s development of behavior problems in the preschool period and beyond. Children’s temperament also affects the development of coercive family processes, interactions characterized by escalating aversive behaviors, in which children and parents engage in progressively more and more harmful actions directed toward each other. The child’s refusal to follow the parents’ requests and their tendencies toward frustration and aggression are also more likely to occur when the child has lower regulatory capacity. In turn, this contributes to ineffective discipline practices (e.g., harsh punishment, inconsistent enforcement of rules), which subsequently lead to child conduct difficulties. Moreover, male infants with increased fearlessness were shown to develop callous-unemotional traits, characterized by diminished empathy, guilt, emotionality, and a lack of concern for performance (Frick et al., 2014), in the presence of low positive parenting. Positive parenting may enable infants high in fearlessness to more effectively internalize socialization messages and consequently develop empathy, thus reducing their risk for the later expression of callous-unemotional traits. Without exposure to these types of parenting practices, however, infants with heightened fearlessness may later face an increased risk for conduct disorder and antisocial personality disorder, associated with callous-unemotional traits (Waller et al., 2017). Even infants with an optimal temperament profile may be susceptible to the adverse effects

of ineffective parenting. Beaver et al. (2015) demonstrated that even infants with an 'easy' temperament displayed increased psychopathic traits during adolescence in the context of low parental sensitivity.

As the child grows and begins interacting with peers, the child takes these familial socialization experiences in tandem with their temperamental profile into new settings and relationships. At this same time, self-regulation takes on a more complex role. Emotion-related self-regulation impacts behaviors, emotional experiences, and social interactions. This, in turn, impacts social competence, peers' perceptions of the individual, and later social and emotional adjustment. As an example, a child who is considered dysregulated might have emotional or behavioral outbursts that cause strain on peer interactions leading to rejection and less opportunity for learning socially competent behavior. As individuals get older moving into adolescence, these self-regulatory capacities expand, shifting away from compliance into more self-driven behaviors as a function of internalized social expectations and norms (La Guardia and Ryan, 2002). Eisenberg and colleagues outlined a linear model in which temperament impacts a child's behavior which impacts peer relationships and subsequent psychosocial functioning (Eisenberg et al., 2009). The main focus here is how temperamental traits influence outward behaviors and the quantity and quality of social interactions. For example, a child who is lower in effort control might exhibit outward behaviors of impulsivity, which in turn can cause peers to distance themselves. When considering interactional influences of temperament and socialization, a nuanced interpretation emerges, in which children with different temperamental profiles react differently to the environment, which in turn shapes future adjustment depending on responses to the child.

### Psychopathology

Given the ubiquity of temperament influences, it is no surprise that it has impacts on maladaptive behaviors and emotions, leading to psychological symptoms and disorders (i.e., psychopathology). Going back to the studies of humors and temperaments across history, there has been a conversation surrounding the connection between temperamental "imbalances" and psychopathology. Beginning with Hippocrates, it was believed that humoral imbalance led to physical illnesses, such as pneumonia and cholera. Galen claimed that this imbalance also led to mental illness, for example connecting the symptoms of anxiety and depression to an excess of black bile (Kagan, 1998). Psychopathology in childhood (e.g., depression, conduct problems, and Attention Deficit Hyperactivity Disorder) is associated with significant costs to society and frequently precedes psychological difficulties in adulthood. Identification of risk and protective factors (contributors linked with either escalation of difficulties or those associated with resilience in the face of stressors), especially those present early in life, could help in intervention and prevention efforts reducing such costs. Although considerable attention was originally given to risk factors including economic factors, parent psychopathology and parenting, recently contributions of child temperament started to receive more widespread attention.

There are three broad groups of theories that attempt to define the connection between temperament and psychopathology (Klein et al., 2012). The first group posits that there is an underlying connection between temperament and psychopathology but neither domain has a causal effect on the other. This group consists of three theories. The first of these theories proposes that temperament is a precursor to psychopathology, meaning that temperament and psychopathology stem from the same underlying mechanisms with temperament emerging first with psychopathology to follow. The second theory is focused on a common link between temperament and psychopathology but views the two as related only through another third variable. That is a third variable, such as genetic causes for depleted dopamine levels could cause both temperamental withdrawal and symptoms of depression. Lastly, is the theory of a spectrum with psychopathology representing the extreme, maladaptive version of temperament traits. The next group of theories posits a causal relationship between temperament and psychopathology with the idea that there is a direct causal effect of temperament on psychopathology, or an escalation from traits to disorder. The predisposition theory claims that temperament traits, in a detrimental environment, lead to psychopathology. The pathoplasty model asserts that temperament impacts the expression of the disorder rather than the onset. The final group of models theorizes that the relationship is reversed, with psychopathology leading to changes in temperament. The state-dependent theory states that temperament is distorted by psychopathology, implying that temperament is changed by psychiatric symptoms then returns to baseline once the illness episode is resolved. Lastly, the scar model examines the repercussion of psychopathology on temperament expression, or enduring changes of temperament after experiencing psychopathology.

Both internalizing and externalizing symptoms/disorders have been linked to temperament differences, with a number of traits shown to pose risk or affording protection with respect to psychopathology across development. Effortful control, in particular, has been implicated in the development of empathy, conscientiousness, widely viewed as protective factors, and lower levels of psychopathology (Eisenberg, 2000; Kochanska et al. 2000). Greater fear in childhood has been linked with greater conscientiousness later in childhood when compared to less fearful children (Rothbart, 2007; Kochanska et al. 2007). At the same time, higher levels of fear/behavioral inhibition have been shown to increase risk for anxiety (Fox et al., 2005). This temperament-psychopathology connection is also impacted by parenting practices. More fearful children develop more conscientiousness with less discipline and more gentleness, while more fearless children have greater development of conscientiousness from positive relationships with parents (Rothbart, 2007). Ormel et al. (2005) found that surgency has been linked to greater externalizing problems and fewer internalizing problems, while anger and frustration predict increases in both externalizing and internalizing. Affiliativeness in adolescence was connected to greater internalizing and fewer externalizing problems (Ormel et al., 2005). Overall, multiple links between temperament and psychopathology have been outlined. There is some evidence for a causal connection, with certain temperament traits contributing to later psychopathology. However, there is also research indicating a third variable (i.e., parenting style) could impact both temperamental expression and development of psychopathology. Because this chapter

focuses on development across childhood, the effects of psychopathology on temperament were not examined, but could provide an interesting insight into temperament in adulthood.

### Taken together

Temperament effects permeate all domains of life, are driven by biological and social contributing factors, as well as different areas of functioning (e.g., cognitive and motor skills). Studying temperament and related processes has important implications for notions of equifinality and multi-finality, used to explain developmental psychopathology—how symptoms/disorders emerge in childhood (Cicchetti and Rogosch, 1996). Equifinality refers to the fact that many pathways can lead to the same outcome, while multi-finality is the idea that a contributing factor (e.g., temperament trait) can result in multiple different outcomes, dependent on the environment in which it operates. These concepts are key to understanding the roles of risk and protective factors, also helping explain the interplay between biology, socialization, and symptoms/disorders. Specifically, these concepts imply that a genetic predisposition to psychopathology (e.g., having a parent with a disorder) may not lead to a diagnosable condition, given a protective social environment. Temperament is involved in these pathways at all levels. A person's temperament might push them toward or away from a certain environment through social approach or withdrawal tendencies. Temperament could also intervene at the level of symptom emergence, driving a tendency toward internalizing or externalizing problems. Finally, the biological substrate of temperament could lead to hyper- or hypo-arousal of the sympathetic nervous system, making the individual more or less likely to outwardly express emotions through related behaviors.

### Gender differences in temperament

Gender differences in temperament have been examined across the lifespan and have provided an additional indicator of stability in temperament traits. While some of the distinctions may seem stereotypical and assumptive, research has shown that one's gender can shape temperament-related effects. However, there are important considerations to keep in mind. Informant reporting, especially parents, is a common source of information, which could be subject to sibling comparisons. It is also important to consider age, as socialization and maturation can influence temperament expression.

There is little evidence for gender differences emerging in infancy, with a few exceptions. Maccoby and Jacklin (1974), in one of the first literature reviews on gender differences in temperament, found more emotional instability and activity in boys, and that girls learn more emotional regulation, especially with respect to negative emotions, earlier than boys. When examining gender differences cross-sectionally during infancy, boys consistently exhibit higher activity levels as well as approach behaviors, whereas girls display greater hesitation in approaching novel objects (Campbell and Eaton, 1999; Cosentino-Rocha et al., 2014). Gender variations in temperament stability across infancy have also been identified, with girls displaying more consistent levels of positive affectivity compared to boys (Bornstein et al., 2015).

Else-Quest et al. (2006), conducted the most recent review of gender differences in temperament and had similar findings to Maccoby and Jacklin. They found differences in activity, with boys exhibiting higher levels than girls that grow in magnitude across childhood then become nonsignificant in preadolescence. Similarly, a difference emerged in high-intensity pleasure (enjoyment of more exuberant activities), with boys showing higher levels. Maccoby (1990) and Maccoby and Aitken (1999) suggested the latter may stem from high-intensity activities predominating in boys peer groups and leading to this perceived gender difference. Within Else-Quest and colleagues' meta-analysis, many of the gender differences in the domains for effortful control favored girls—evidence indicates that girls exhibit higher levels of regulation-related skills in early childhood than boys (2006). This difference seems to shrink when moving across development and into adulthood (Costa et al., 2001; Schmitt et al., 2008).

Given these differences, it should be noted that gender differences in temperament may vary according to assessment method and informant, with consistent results reported only for certain aspects of temperament in young children, such as increased fearfulness in girls (Olino et al., 2013). Additionally, there may be environmental aspects contributing to these differences, such as socialization, gender norms, and even culture.

### Cross-cultural differences in temperament

On the surface, individual differences in temperament may seem unrelated to culture, given the underlying biological basis. However, across this chapter and the field of temperamental research, it has become apparent that experience plays a role in the expression of temperament, making cultural difference an important aspect to explore. Development of reactivity and regulation is a function of contextual factors, culture critical among these (Rothbart, 2012). It has long been suggested that children are socialized to manifest behavioral phenotypes consistent with culturally-driven values, attitudes, and expectations (Kohnstamm et al., 1989). Moreover, parents in different cultural groups vary in parenting behaviors and attitudes that produce culturally specific outcomes in their children. While parents shape the expression of temperament, so too do teachers, peers, and society at large.

Cross-cultural studies have produced interesting results, for example suggesting that differences emerge across cultures for what temperamental traits might be adaptable given the societal pressures of the given culture. Ahadi et al. (1993) found that children in the People's Republic of China (PRC) and the U.S. differed on many aspects of temperament, with children in PRC demonstrating

greater Negative Affect relative to Surgency and Effortful Control, with results for children in the U.S. showing the opposite pattern. Ahadi and colleagues interpreted these differences as stemming from different socialization patterns across the PRC and U.S., emphasizing collectivistic values in the former and an individualistic orientation in the latter. The U.S. has been described as the “pinnacle of individualism,” prioritizing personal goals and traits associated with extraversion (e.g., expression of positive affect; [Kemmelmeyer et al. 2006](#); [Oyserman et al., 2002](#)). Collectivistic cultures orient more toward the needs and goals of a group rather than the self, seeing themselves as connected to others. One example from the Chinese culture involves the influence of Confucianism, which focuses on relational identity as the core of self-concept ([Lu and Yang, 2006](#); [Kolstad and Gjesvik, 2014](#)). This dynamic also plays out in the familial relationship: individualistic cultures focus more on the immediate family and collectivistic cultures focus more on the extended network ([Georgas et al., 1997](#)). Thus, children in the PRC likely adapt more effectively to cultural demands when they are somewhat lower in surgency and higher on negative affectivity, whereas children in the U.S. show greater adaptation with moderately high levels of surgency and low levels of negative affectivity ([Ahadi et al., 1993](#)). [Ahadi et al. \(1993\)](#) also found that smiling and laughter play a different role across Chinese and U.S. samples of children—smiling and laughter contributed to surgency for the PRC and to effortful control for the U.S. Perhaps the pressure to present with positive affect in the U.S. provides the link between smiling/laughter and regulation, casting these behaviors as a component of voluntary control rather than spontaneous expression.

Examining differences in temperament structure between Russia and the U.S. provides another example for exploring differences in collectivistic and individualistic societies. Russia provides an interesting examination of collectivism because as a society, they stress the importance of communal over individual values while still encouraging individual activities, competition, and assertiveness ([Triandis, 1995](#); [Gartstein et al., 2009](#)). Russian infants scored lower on regulatory functioning than their U.S. counterparts ([Gartstein et al., 2003a, 2003b](#)). Russian parents also rated their children higher on negative emotionality and lower on surgency compared to parents in the U.S. ([Gartstein et al., 2005](#)). Thus, cultural values translated into parenting practices can impact expression and development of temperament, providing yet another social aspect of the biopsychosocial model of temperament.

## Temperament and personality

Temperament and personality are difficult to untangle, as both represent constellations of individual differences, and this is reflected in the complexity of their relations in research. Some argue that temperament and personality are the same construct (e.g., [Caspi and Shiner, 2006](#)), or perhaps that temperament is what is identified in infancy and earlier childhood that transforms into personality with age and experiences ([McCrae et al., 2000](#); [Kohnstamm, et al., 1998](#); [Kagan, 1997](#)). Others view temperament as distinct from personality. Cloninger described personality as a combination of temperament and character, with temperament referring to emotional and behavioral predispositions and character as a part of self-concept—socially learned with intentional goals ([Cloninger et al., 1993](#)). According to [Rothbart and Ahadi \(1994\)](#), temperament is a component of personality, with personality representing a combination of temperament, cognitions, values, and goals as well as perceptions of the self, others, and events.

It is thought that over time temperament traits are consolidated, leading to cognitive and affective responses that become quickly and habitually utilized across scenarios. According to [Rothbart et al. \(2000\)](#), temperament provides the biologically-based foundation upon which personality develops. Several models of personality exist, but the most well-researched and widely accepted theoretical framework is the ‘Big Five’ model, which consists of openness to new experiences, conscientiousness, extraversion, agreeableness, and neuroticism ([McCrae and Costa, 1987](#)). Investigations of temperament frequently reveal dimensions that are consistent with the ‘Big Five’ factors in adult research, indicating a link between biologically-based temperament and later emergence of personality in adulthood. This connection is evident earlier, with infant temperament contributing to differences in personality in childhood. Surgency transforms into extraversion, taking on a new aspect of leadership in peer groups ([Shiner & DeYoung, 2013](#)). Negative emotionality begins to resemble neuroticism through greater awareness of the self and forward thinking (e.g., anticipatory anxiety; [Caspi and Shiner, 2006](#)). [Slobodskaya and Kozlova \(2016\)](#) found that more regulated infants exhibited higher levels of conscientiousness as children. Thus, temperament shaped by environment and socialization appears to transform into a personality that remains relatively stable across the lifespan.

While the distinction between temperament and personality might be blurred, there are important differences to consider. Temperament traits manifest through biological processes and are present during infancy and on, while personality is thought to emerge later in childhood. There are components of personality, such as self-concept, expectations, and coping strategies, that are not considered a part of temperament. Thus, personality is a broader concept, including temperament and other domains shaped by lived experience.

## Clinical implications and takeaways

Temperament can be construed as a complex intersection of biology, socialization, and other environmental factors. Biology is the foundation of temperament, and socialization provides the backdrop that molds related behaviors and internal experience and thus impacts future temperament expression. A variety of environmental factors, from prenatal exposures to peer relationships play a role

as well. These environmental factors and socialization can impact biology through epigenetic and neural functioning effects. Understanding these connections provides insight into adaptive and maladaptive temperament developmental trajectories.

Since the conception of temperament through humourism, it was thought that character or personality stemmed from a biological basis. Research in the area of biology, specifically genetics, is growing rapidly. There has been a surge in research to better understand how temperament is influenced by biology in terms of genes, neural structure and function, and physiological aspects, such as neurotransmitters and underlying brain connectivity. By better identifying these biological mechanisms, research applications will contribute to improved clinical trials with more homogenous subject groups and more consistent and generalizable results (Zwir et al., 2019). Additionally, better understanding the biological mechanisms can help with interventions and treatment of psychopathology.

Research addressing temperament and its underlying biological foundation provides immense insight into psychopathology. More specific phenotypes of underlying biology can be identified and classified by considering temperamental factors, such as regulation and emotional expression. Given the immense diversity of mental health conditions and their presentations, temperament, and its underlying biological contributors, could provide more comparable, homogenous subgroups within a diagnosis, facilitating research and treatment. Additionally, psychological interventions and outcomes can be more tailored by considering temperament. That is, children can be targeted for intervention based on a risky temperament profile, and related traits can be measured post-treatment to ensure effectiveness.

Humans are social creatures, and it comes as no surprise that these social interactions influence who we are and who we become across the lifespan. In early childhood, we are reliant on caregivers for our basic needs, but they provide much more. We learn from our caregivers how to engage with the world around us and how to regulate and react to that world. As we grow up, peer relationships also contribute to development. At the same time as this social network is emerging, we, too, impact the world around us. Into every social situation, we bring our unique temperament profiles that contribute to these interactions. A better understanding of the social impacts can help develop parenting and peer interventions targeted specifically to the child's/adolescent's needs.

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