Through the Looking Glass: Temperament and Emotion as Separate and Interwoven Constructs

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Abstract

The current chapter reviews the theoretical and empirical forces that have shaped the study of emotional development from the perspective of temperament research. Despite variations in the theoretical perspective used to approach the link between temperament and emotion, the necessary limits in available methodologies have drawn the literature to a fairly close empirical consensus. To organize the discussion, the chapter examines four factors that have both led empirical research and have colored subsequent theoretical interpretations: Person, Context, Time, and Experience. Assessing permutations in each of the factors can help the field better understand the complex patterns of emotion development that reflect, and are embedded in, variations in temperament over time. The systematic inclusion of individual differences in each of the four factors also moves the field away from the difficult task of trying to capture the elusive "average child." This strategy may improve our understanding of temperament and emotion development and advance our overarching goal of improving the robustness of our science.

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There are three hard truths in the study of emotion and emotion development. First, the emotions we feel are often more complex than the emotions we express. Second, the form and function of an emotion can shift dramatically across development (time) and space (context). Third, the very nature of what we call an emotion can shift as we shuffle through the operational definition of interest from behavior (e.g., facial expression) to language (e.g., self-report), to activity (e.g., withdrawal), and to biology (e.g., neural circuitry activation). Much of the "core" emotion literature has grappled with how best to deal with this inherent complexity and diversity. It is no surprise, then, that the struggle also spills over to the temperament literature.

Studying temperament in the context of emotion is both a daily occurrence for temperament researchers and a seemingly unattainable goal. That is, 30 years of theory and research has intertwined temperament and emotion, binding the two together at the conceptual, empirical, and methodological level. This entanglement then triggers several questions: When does emotion end and temperament begin? Or, is it that temperament helps define emotion? Or, is it that emotion is the foundation of temperament? Or, yet again, is it that emotion plays no fundamental role in temperament, but is only an ancillary marker of temperament?

Although there are ongoing arguments as to whether temperament and emotion are

theoretically separable (Bowman & Fox, 2018), they are practically intertwined (Bates, Goodnight, & Fite, 2008). This is partially driven by an overlap in definition, methodology, and construct of interest. In addition, the literature has tended to focus on aspects of temperament most closely aligned with emotional expression. Broadly, the most basic, and agreed upon, definition of temperament is that it encompasses a constellation of traits that are (1) early emerging, (2) biologically based, and (3) multidimensional (Fu & Pérez-Edgar, 2015; Goldsmith et al., 1987; Shiner et al., 2012). Thus, temperament can encompass a wide range of socioemotional and behavioral profiles. Yet, we see many more temperament papers attempting to capture variation in negative affect (Braungart & Stifter, 1991) versus, for example, variation in activity level (Saudino & Eaton, 1991). This is especially true for research traditions that focus on the frequency and intensity of specific basic emotions as the definitional marker of temperamental variation (Goldsmith & Campos, 1986).

The current chapter examines the role temperament may play in helping understand variation in emotion development. As already noted, this question is complicated by our definitional debates on how to best distinguish the constructs—assuming of course that we can or should make this distinction. To provide some structure, the main parts of the chapter are organized around four constructs that reflect the developmental reach of temperament and emotion: Person, Context, Time, and Experience. With a nod to Bronfenbrenner (Bronfenbrenner & Morris, 1998), each construct allows us to examine multiple levels of analysis in understanding the emotional life of a child, in light of evident temperamental variation. First, the chapter addresses some of the broader issues that shape specific constructs of interest.

The Problem at Hand

Decades of research has puzzled with how to best define the emergence and evolution of emotion, beginning in infancy. Much of this work has focused on outlining theoretical and empirical operations of emotion and emotion regulation, striving to describe universal axioms (Pérez-Edgar & Hastings, 2018). However, variations in emotional reactivity, often temperament-linked, are patently evident in the first months of life. Within a relatively short period of time, self-directed attempts to regulate emotion also emerge, and variations in the deployment and efficacy of regulatory mechanisms are also temperament-linked. Adding another layer of complexity is the fact that early on in life outside forces, often caregivers act as external regulators of the child, shaping emotion and behavior to reflect both the caregiver's ideals and broader cultural norms.

What Are We Studying?

Ostensibly, the goal of temperament research is to characterize the dynamic child, in context, as they actively engage in their own development to support change over time across multiple levels of functioning (Overton & Molenaar, 2015). However, if we define temperament research not by the goal, but by the actual approaches taken, the picture shifts a bit. Temperament research, as a science, tends to take static snapshots at a moment in the child's life. With accompanying measures, researchers hope to approach an accurate portrayal of the child's traits and tendencies across a wide range of environments. If researchers are lucky, they will be engaged in a longitudinal study, so that they may follow up the same children over the course of development. However, even here, researchers rely on a series of static snapshots that can be strung together to create an approximation of change over time—much like the old-fashioned kinetoscope before the advent of modern film technology (Dickson & Dickson, 2000). This is not to say that these herky-jerky pictures of development are not important. Indeed, the sections that follow argue that the element of time is pivotal to allowing for a more dimensional view of emotion in the context of early temperament.

Traditionally, the broader field has strived to capture and describe nomothetic rules for emotion development, creating universal laws that can be widely applied without regard to the four constructs of interest (MacNeill & Pérez-Edgar, in press). In this way, psychology has strived to emulate the "hard sciences" with algorithms, laws, and unifying theories (Pérez-Edgar & Hastings, 2018). However, attempts to impose this approach on development have rarely been successful, except in the case of very basic and hard-wired mechanisms (e.g., vision). However, even in this case, we see that variation in time and experience can alter even early emerging sensory mechanisms (Greenough, Black, & Wallace, 1987).

In the case of emotion and temperament, this approach is even less successful. Indeed, the very study of temperament is a rejection of the notion that nomothetic or universal laws can capture variation in children's subjective responses to seemingly stable objective circumstances. Thus, temperament embraces an idiographic approach, tasked with describing, accounting for, and predicting variation within and across individuals and the environment (Overton & Molenaar, 2015). This approach cuts across the multiple components of temperament (e.g., activity), although here we focus on emotion and emotion regulation.

A temperament approach distinguishes itself from other associated fields, focusing more specifically on emotional or social development, by placing emotion within a constellation of complex traits and events. For example, Calkins and Fox (2002) noted that frustration in the laboratory at 6 months is coupled with decreases in attention, increases in activity levels, and poor physiological regulation. From another temperament tradition, the difficult baby shows increased activity, increased negative affect, decreased adaptability, and decreased soothability (Degnan, 2017). Researchers can then layer on individual differences in the form and efficiency of competing strategies that children bring to bear on their initial emotional response (Davis, Levine, Lench, & Quas, 2010).

What Is the Relation Between Temperament and Emotion?

In large part, this question is central to the entire discussion in this chapter. However, to begin, this subsection touches on some of the central points of view which, in turn, implicitly shapes the research and data noted below. Other chapters in the current handbook more directly and thoroughly examine the theoretical approaches to emotion development (see Buss, Cole, & Zhou, Chap. 2, this volume).

An initial starting point is to view emotion as a self-organizing mental system that reflects and regulates the motivation-related aspects of our actions (Holodynski & Friedlmeier, 2006). Since emotion is a continuous, ongoing stance in dealing with the world, emotions will change in relation to actual or perceived significance for well-being or the goal at hand (Cole, Lougheed, & Ram, 2018). Emotions also provide our primary appraisals of the world. As such, they are highly conserved (Bates et al., 2008) and create a foundation of basic emotions (e.g., fear, anger) that can be studied across animal and human models (Capitanio, 2018; Cavigelli, 2018).

Initially, emotional displays, which researchers *assume* reflect the experience of emotion, are triggered by discrete and acute stimuli, both internal and external to the child. Typical development then produces a dissociation between emotion expression and emotion feeling, such that emotions can function as both phenomenological experiences and communicative tools (Holodynski & Friedlmeier, 2006). Temperament researchers are interested in each component of emotional functioning.

One temperament-linked approach to emotion explicitly ties temperament, by definition, to operationalizations of emotion. That is, temperament is defined and delineated by individual differences in the expression and intensity of emotion. As such, temperament is studied in contexts designed to elicit a specific profile of emotions (Goldsmith & Campos, 1982, 1990). This perspective can be characterized by the assumption that temperament is latent and behavior, in

this case, emotion, is the observed expression of the underlying trait. Ironically, this perspective buts up against the view of emotion researchers that emotion itself is latent, and emotion researchers use the physical embodiment as the observed markers. Thus, the same behaviors are used to examine two different constructs, as if the researchers were standing on opposite sides of a plate of glass.

In contrast to the approach binding temperament to emotion, Bowman and Fox (2018) made the clear declaration that "emotion is not a core feature of temperament." Their argument is that tying temperament to a specific emotion is too constricting. For example, one can focus on the temperament trait Behavioral Inhibition (BI, discussed below, Kagan, 2016, 2018b). Central to BI is an early appearing sensitivity to threat, novelty, and reward, as well as the strategy children use to regulate this reactivity. If you focus on these behaviors, you need not *necessarily* invoke emotion to characterize the child's temperamental profile. Rather, you may examine motor activity, patterns of attention, and higher order patterns of approach and withdrawal (Bowman & Fox, 2018). Under this formulation, affect in isolation is not a clear index of temperament.

On a practical level, the approach to characterizing temperament is quite similar across the two perspectives. That is, the typical empirical study of temperament couples emotion systems (affect and its regulation) with motivation systems (the tendency to approach or withdrawal) in the context of a putative trigger. Thus, anger would be characterized as the tendency to show negative affect and approach in the face of goal blockage. In contrast, fear would be characterized as the tendency to show negative affect and withdrawal in the face of a potential threat. Researchers are also equally (sometimes more so) interested in the atypical patterns in which sadness is shown during an anger episode, or fear is shown during a joy episode. These atypicalities suggest individual variation in how infants are interpreting and responding to the individual episodes that are at odds with the "objective" valuation of the events from the researcher's perspective. In addition, profiles of responses across episodes (a vari-

ation of time) can help draw out previously unidentified temperamental profiles (Buss, 2011).

For example, the typical BI paradigm refined by Kagan (García Coll, Kagan, & Reznick, 1984) and Fox (Fox, Henderson, Rubin, Calkins, & Schmidt, 2001) averages across emotion- and behavior-eliciting episodes designed. These episodes are quite similar to the procedures created from the Goldsmith approach to the temperament-emotion link (Buss & Goldsmith, 2000). In particular, they both share a structure of individual episodes meant to elicit specific responses. In the case of BI, the focus is on negative affect and behavioral withdrawal in the face of social and nonsocial novelty. Typically, these variables are measured across episodes, and individual scores are averaged. Children who score high in the composite (top 15%–20%) are designated as BI.

Building on this foundation, Buss and colleagues (Buss et al., 2013) instead examined profiles of response across episodes. In doing so, they extracted a subgroup of children that show yet another temperamental profile, dysregulated fear (DF). The BI child may show a relatively similar pattern of response to the episodes (more withdrawal particularly scary episodes, less withdrawal when threat is low) but have overall higher means due to the intensity and frequency of the response. In comparison, the DF child will show high levels of fear and withdrawal even in low-threat episodes.

Which Emotions Do We Study?

Developmental mechanisms, both internal to the child and provided by the caregiving environment, are thought to work in tandem to support adaptive emotional development. The working assumption for "good" development is that you will see a decrease in the frequency and intensity of emotional reactions over time (Holodynski & Friedlmeier, 2006). This is particularly true for negative emotions (e.g., anger and sadness) that are viewed as personally and socially disruptive. At the same time, we expect, and foster, the emergence of new, pro-social emotions, such as empathy.

The specific constellation of emotions that predominate in the temperament literature, as opposed to associated research traditions also interested in emotions, arises from the fact that researchers are interested in an emotion not simply for the sake of understanding its form or function in isolation but as a marker and mechanism for downstream consequences that permeate a host of socioemotional and cognitive domains. In addition, temperament research is often predicated on capturing individual differences evident in the first months of life (Fox, Snidman, Haas, Degnan, & Kagan, 2015). The infant's limited behavioral repertoire effectively guarantees that researchers will focus on basic active states and gross motor patterns. Hence, the practical constraints bring temperament studies closer together in practice, even if they differ in theoretical foundation (Bowman & Fox, 2018; Kagan, 2016). Thus, methodologies typically used in temperament research cut across theoretical considerations.

First, there is a focus on identifying change and continuity over time. Researchers must rely on measures that can be used across a wide developmental window that are both age-appropriate and target the construct of interest. This can greatly limit the scope of potential measures and tasks. As a result, although the target behaviors are similar across studies (e. g., smiling, crying, self-soothing), the interpretation of the behavior is influenced by the researcher's theoretical orientation.

Second, temperament research has drawn from a cognitive and neuroscientific tradition that looks to processes, such as attention (Nozadi et al., 2016; Pérez-Edgar, Taber-Thomas, Auday, & Morales, 2014), tied to neural regions, such as the amygdala (Blackford, Clauss, & Benningfield, 2018; Jarcho & Guyer, 2018), to highlight pathways that support emotion processing. This reflects the core agreement that temperament traits are biologically based and often reflect variation in mechanisms reflecting reactivity and regulation (Rothbart, Ellis, & Posner, 2004). Again, the requirements of task (e.g., computerized stimulus presentation) and measure (e.g., magnetic resonance imaging, MRI) constrains

how researchers approach questions of interest. A core concern in this line of work is whether these measures capture processes associated with emotion processing, as opposed to the subjective experience of emotion. Both are vital to emotion development, but they are not interchangeable.

Third, temperament research has drawn from behavioral neuroscience and psychobiology traditions that focus on animal research, often with the direct manipulation of potential circuits. Most often, these studies focus on rodent (Cavigelli, 2018) and nonhuman primate models (Capitanio, 2018; Fox & Kalin, 2014). When building on this literature, researchers interested in human development will by virtue of the underlying models take away evidence targeting discrete emotion patterns that are evolutionarily conserved and typically thought to impact survival value. Ironically, until recently, there was little focus on *development* within the animal literature (Capitanio, 2018).

Building on a foundation of animal studies tends to push the field toward studies of fear, distress, and anger (Rothbart et al., 2001). Negative emotions are typically examined at a relatively granular level in which discrete stimuli are linked to a circumscribed emotional response. For example, the presence of a snake is linked to withdrawal and a fear response in naive monkeys (Nelson, Shelton, & Kalin, 2003). In contrast, many of our prototypes for positive emotion, such as joy or pleasure, are difficult to operationalize in nonhuman models. In addition, positive emotions are often interwoven with complex social processes, such as affiliation and attachment, which may be even more difficult to translate. As a further complication, these constructs are inferred in the ability to engage in socially competent interactions, creating the risk for circularity (Cavigelli, 2018).

Thus, although the varying temperament traditions described below vary in their approach to, and definition of, the temperament-emotion relation, practical forces often blur theoretical distinctions. The desire to capture processes that are (1) identifiable early in life; (2) trackable over time; (3) reflected in biology, thought, and behavior; and (4) traceable to evolutionarily conserved

forces binds these traditions together, by necessity, to a relatively constrained set of measures that best fit some, but by no means all, of our targets. As a result, the review of the literature noted below will reflect a great deal of overlap in outcome, if not in motivation. In the end, the source of information available to us will constrain how we characterize and capture stability and change (Brownell, Lemerise, Pelphrey, & Roisman, 2015). The data generated by the temperament literature is also bound by a common "enemy": attempting to disentangle the form and function of emotion from the embedded mechanisms of emotion regulation.

Are We Studying Emotion or Emotion Regulation?

First, researchers need to ask if this is even a legitimate question. For example, Campos, Frankel, and Camras (2004) argue that emotion and emotion regulation are functionally inseparable. That is, we may phenomenologically sense the initial feeling of an emotion (e.g., fear in the face of a furry spider), followed by subsequent regulation (e.g., self-talk pointing out that the specimen is indeed harmless). However, this perspective argues that no emotion is ever "pure," existing in an unregulated state. In infancy, often a target of temperament research, researchers may have a better chance of seeing the initial reactive burst of emotion to a stimulus trigger. Even here, however, unconscious mechanisms of regulation may be automatically triggered with the very experience of emotion (Campos et al., 2004).

It may be that humans are pre-wired to engage in regulatory, if unconscious, processes, particularly when embedded in a social context. For example, the intraindividual stress contagion is evident in the earliest months of life (Wass, Clackson, & Leong, 2018). You can see infants thumb-sucking in response to another infant's cry (Geangu, Benga, Stahl, & Striano, 2011), laying the foundation for socially mediated emotion and emotion regulation. Over time, more sophisticated emotion regulation is seen in a shift from

action to cognition, which reflects a broader underlying developmental progression (Perry & Calkins, 2018).

While most researchers agree with the practical difficulty in disentangling emotion from emotion regulation, strategies of attack have been formulated to help loosen some of these binding threads (Cole, Martin, & Dennis, 2004). Here, the focus is on temporally sensitive measures and repeated assessment of infants' emotional experiences (Cole & Hollenstein, 2018). Establishing the construct validity for emotion regulation strategies (e.g., based on behavioral and/or physiological correlates) relies on the assessment of consecutive changes in emotion-linked biological markers, behaviors, and expressions over time (Buss & Goldsmith, 1998; Cole et al., 2004; Fox, Kirwan, & Reeb-Sutherland, 2012). Multiple levels of analysis are needed as researchers cannot assume that they will all modulate in the same way over the course of assessment (Morris, Robinson, & Eisenberg, 2006).

Our ability to capture regulation is also tied to the child's ability to regulate with development. Capturing an elusive construct is all the more difficult when its presence is unstable, fleeting, and often ineffective. To outline the steps of emotional self-regulation, McClelland and colleagues (McClelland, Geldhof, Cameron, & Wanless, 2015) suggest researchers can look to see if the child is engaging in three orderly steps: (1) Take in information, (2) weigh choices and their consequences, and (3) make an adaptive choice in order to move closer to the goal. If we first look at infancy as the emergence of self-regulation (Sheese, Rothbart, Posner, White, & Fraundorf, 2008), researchers can often capture number 1 but are unlikely to see a systematic attempt at number 2. In addition, while researchers often see action and reaction on the part of the infant to a stimulus, they cannot necessarily infer the element of choice typically implicated in number 3. Over time, the expectation is that children will be better able to generate and sift through regulatory choices (Davis et al., 2010) and engage in active selection, making each individual step more easily discernible. These regulatory responses can then be assessed as a dynamic process that

monitors and evaluates emotion in light of the child's overarching goal (Perry & Calkins, 2018).

Regulation reflects the tension between the child's probable response in the face of an event within a context and the strategies that the child will use to modulate that response, again in light of the event and its context (Cole, Bendezú, Ram, & Chow, 2017). If the emotions are not deemed to need regulation, regulatory mechanisms are likely to lie dormant. If the child's probable response does not match the needs of the moment, attempts at regulation are more likely to emerge. If the emotion is overwhelming and pressing, then any regulatory attempts may be difficult to capture, simply because they are woefully ineffective.

The tension between emotion and regulation generates within and between child variation in the pattern of coupling between the child's pre-potent emotional response and the regulatory processes, executive and automatic, that are then brought to bear. One can think of emotion regulation as a physical system with location, velocity, and acceleration (Morales et al., 2018). The system works to return to its homeostatic set point. Large variation from the set point will prompt the system to engage regulatory mechanisms. Over time, less dramatic deviations from the set point, coupled with more effective counter measures, produces the phenotypic presentation of greater stability in emotionality with development.

Temperament impacts the profile and context of emotion generated. For example, a temperamentally reactive child confronted with a threat may experience, and express, an acute fear response. This initial response then impacts the intensity and form of regulation needed by the child (Stifter, Dollar, & Cipriano, 2011). There may then be temperament-linked differences in the ways in which children regulate and the efficacy of the regulation strategy. For the youngest of children, regulation is socialized in that caregivers lead (e.g., distraction) or scaffold (e.g., coach the child) implemented strategies. Given that extreme temperaments (e.g., BI) are often marked by a relative inability to smoothly engage in social interactions, this may add an additional wrinkle in the child's ability to practice and inter-nalize socially mediated regulatory strategies (Zalewski, Lengua, Wilson, Trancik, & Bazinet, 2011).

These foundational issues highlight the complexity of examining temperament as biologically based variations in how children engage with their environments. Variations are marked by evident differences in emotion and emotion regulation, although there is disagreement regarding how to classify these constructs as antecedent, consequence, or proxy to temperament. As noted above, this chapter is organized to highlight four constructs that may help underscore our understanding to date and note evident gaps for future study: Person, Context, Time, and Experience. The first section, Person, will be the longest as it most directly reflects the focus on individual differences at the core of the temperament literature (Kagan, 2018b; Pérez-Edgar & Hastings, 2018). In addition, this section will briefly lay out the most prominent historical approaches to temperament and emotion (for an additional discussion, see Fu & Pérez-Edgar, 2015; MacNeill & Pérez-Edgar, in press).

Person

How do we capture temperament? Often, the focus is on the person, with little sense of other moderating factors. That is, both in and out of the laboratory, researchers tend to focus on the traits and behaviors "carried" by the individual child. First, there are natural observations of the child as they interact with the environment, caregivers, and peers. Sometimes, these are solitary observations—the child approaches and attempts to climb the highest slide in the playground. Researchers note if, and how long, it took to get the child up the stairs and down the slide. However, most of what researchers typically focus on is dyadic or social in nature (Henderson, Green, & Wick, 2018; Rubin, Barstead, Smith, & Bowker, 2018). The child may or may not receive bids to play from peers. The child may or may not have a caregiver that approves of his affective displays. One difficulty with this approach is that the researcher cannot assess the formal function

of an emotion in the absence of a clear signal of the emotion, or in the absence of a situational trigger likely to pull for a specific emotion. For example, researchers cannot capture variation in the emotional response to social exclusion if social exclusion does not actually occur during the observation window (Howarth, Guyer, & Pérez-Edgar, 2013; Morales, Vallorani, & Pérez-Edgar, 2019; Rubin, Hymel, Mills, & Rose-Krasnor, 2014).

In the alternative, researchers bring the child to the laboratory, so that they may tightly control the experiences of the child and our ability to capture the accompanying response. Thus, researchers can film the child and later code his behavior for direction (approach vs. withdrawal), intensity, speed, and valence. This type of research is often coupled with physiological measures in the moment (Buss, 2011; Lunkenheimer et al., 2015). As such, there is added insight into the biological mechanisms that accompany (and perhaps generate) observed emotion and behavior. Indeed, given the rapidity with which regulatory processes are called into play, researchers often rely on psychophysiology to reveal hidden threads of temperament that are not evident behaviorally. Of course, multiple methods often generate multiple time courses and multiple profiles of activity, each of which complicate our understanding of a child's temperament (Morris et al., 2006). This is not necessarily a bad thing, given that a static unidimensional view of temperament often fails to capture individual trajectories or help predict outcomes of interest.

Researchers then often ask outside observers to weigh in. Rothbart (2012), for example, has designed a series of questionnaires that can follow a child from the first months of life—the Infant Behavior Questionnaire (IBQ)—firmly into adulthood—the Adult Temperament Questionnaire (ATQ). Of course, as with any questionnaire, it must use observable behavior (physical or verbal) to characterize the child. As the child ages and presumably becomes both more verbal and self-reflective, self-report versions, such as the Early Adolescent Temperament Questionnaire (EATQ), are used. The shared

structure of the questionnaires also helps alleviate the concern that studies of temperament do not hold constant the item of measurement over time (see below).

Finally, temperament researchers turn to focus on biological markers as a central source of information. Biological measures are noted last since there are typically the least commonly used across the literature and limited to laboratory-based studies (Pérez-Edgar & Bar-Haim, 2010). Their relative lack of use is quite understandable at the practical level since many times the needed equipment is expensive and requires extensive training (e.g., MRI). From a theoretical level, however, this is a surprising imbalance in the empirical evidence since the very definition of temperament specifies that the traits of interest are biologically based (Fox, Henderson, Pérez-Edgar, & White, 2008). In addition, biologically based measures may help researchers disentangle socioemotional patterns based on temperament (e.g., dysregulated fear; Buss & Kiel, 2013) from phenotypically similar behaviors that may be acquired via other mechanisms (e.g., fear conditioning; Reynolds, Askew, & Field, 2018).

Thus, an inherent difficulty of the temperament literature is that researchers all tend to study temperament *backwards*. Researchers define the construct as biologically based tendencies that shape observed behavior but typically measure behavior, through either direct observation or questionnaire report, and then go in search of the biological basis. To date, none of the typically studied temperamental profiles or continuums are *defined* by the presence or absence of a specific biologically based measure.

Naturalistic observations, laboratory-controlled paradigms, questionnaires, and biological measures are the basic building blocks of temperament research. However, they have been used in unique ways to create individual models of temperament—each focused on the traits embodied by the individual child. These traits are then juxtaposed against the other developmental factors (e.g., Context, Time, and Experience) that are thought to shape long-term trajectories. Here is a brief summary of some of the leading models that have shaped temperament research to date.

The Thomas and Chess Approach

The New York Longitudinal Study (NYLS) stands as a landmark in the field of temperament research (Thomas & Chess, 1977), characterizing temperament across nine dimensions: activity level, regularity, approach-withdrawal, adaptability, threshold of responsiveness, intensity of reaction, quality of mood, attention span/persistence, and distractibility. Children are categorized as "difficult," "easy," and "slow to warm" types on the basis of their scores on each dimension. Moreover, Chess and Thomas introduced the concept of "goodness of fit" to describe the temperament-environment interplay and its link to adjustment. It is important to note that the characterization of difficult or easy was not solely born by the child but by his or her match with the environment. For example, Dennis (2006) showed that children demonstrated better emotion regulation, marked by low frustration and high persistence while waiting to open an attractive gift, only when children and their mothers both shared high levels of temperamental approach.

The Buss and Plomin Approach

Buss and Plomin (1975, 1986) proposed a behavior genetics-oriented model of temperament, proposing that temperament traits have an early onset and are inherited, evolutionary adaptive, present in nonhuman animals, relatively stable during development, and predictive of later behaviors in adulthood. They identified three core dimensions: (1) emotionality (E), the tendency to become upset easily and greatly (considered as equivalent to distress); (2) activity (A), which contains the components of tempo and vigor; and (3) sociability (S), defined as the preference for others' company and the tendency to engage in social interactions. In the model, temperament dimensions undergo quantitative changes in their mean levels over time, while the underlying structure of temperament remains stable.

The Goldsmith Approach

Goldsmith and Campos (1982, 1986) defined temperament as individual differences in the propensity to express and experience primary emotions (e.g., joy, anger, and fear, Goldsmith & Campos, 1982, 1986) restricted their definition to infant temperament, in order to obtain a relatively "pure" conceptualization of temperament expressions that are not mediated by socialization influences and cognitive processes. The initial definition is also behaviorally oriented, as behavioral expressions impact infants' interactions with their environments and can provide a starting point to understanding the biological underpinnings of temperament (Goldsmith & Campos, 1982). As noted above, Campos et al. (2004) argue that emotion expression and regulation might not be separable, as the observed emotion outputs are likely to have been processed by preexisting regulatory functions, even in infancy. This approach has had a strong empirical impact across theoretical approaches via the Toddler Behavior Assessment Questionnaire, TBAQ (Goldsmith, 1996), and the age-adapted Laboratory Temperament Assessment Battery (Lab-TAB; Buss & Goldsmith, 2000; Goldsmith & Gagne, 2012; Goldsmith & Rothbart, 1993).

The Rothbart Approach

The Rothbart model (Rothbart & Derryberry, 1981) provides a more inclusive conceptualization of temperament than the previously reviewed approaches. This model defines temperament as biologically rooted individual differences in reactivity and self-regulation in emotional, activational, and attentional processes. Taking a dimensional approach, each of the three higher-order dimensions is comprised of several lower-order temperament traits (Rothbart & Bates, 2007). Questionnaire measurements under this approach assume heterotypic continuity in temperament development. That is, phenotypic manifestations of a temperament trait may vary across time, but the underlying biological profile

is constant (Caspi, 1998). As presented in Rothbart and colleagues' age-specific questionnaires, the broad dimensions remain stable, but the specific traits indexing each dimension changes across age groups. For example, effortful control during early infancy is measured as a form of involuntary attention orienting. As more voluntary forms of control develop later in life, indices of effortful control come to also encompass attention shifting and focusing (Rueda, 2012).

The Rothbart model is unique among the reviewed approaches in prominently placing regulation as a core component of temperament. These capacities first emerge at the end of first year of life and continue to improve during late childhood (Rothbart & Bates, 2007). For example, the ability to detect errors is observable as early as 7 months of age (Berger, Tzur, & Posner, 2006). Toddlers begin to show good executive attention functions in a spatial conflict task at 2.5 years old, and their ability to resolve conflicts steadily improves between 4 and 7 years (Rueda, 2012).

In addition to maturational changes in biological processes subserving negative affect and surgency, observed changes are also directly associated with the growing influence of effortful control on behavior. As effortful control develops during toddlerhood, it facilitates voluntarily shifting attention away from distressful stimuli, inhibiting impulses, and increasing self-monitoring of behavior. As a result, it exerts "brakes" on unregulated negative emotionality and motor activities (Derryberry & Rothbart, 2002) and enhances children's coping strategies and abilities to adapt to environmental demands. Longitudinal data indicate that higher effortful control predicts fewer experiences of negative emotional arousal, and conversely, elevated negative emotionality predicts lower effortful control efficiency (Eisenberg, Spinrad, & Eggum, 2010). As such, it is the continued dynamic and reciprocal interactions between temperamental reactivity and regulation that contribute to observed instability of temperament expression over time (Rothbart & Bates, 2007).

The Kagan Approach

Distinct from approaches that hold a dimensional view of temperament, Kagan and colleagues defined behavioral inhibition (BI) as a temperamental *category* characterized by discrete biological dispositions marked by high psychophysiological reactivity coupled with hypervigilance and behavioral withdrawal upon encountering novel people, objects, and events (Kagan, Reznick, Clarke, Snidman, & García-Coll, 1984). Elevated negative reactivity toward novelty can be observed as early as 4 months (Kagan, 1994). Research on BI focuses on examining the stability of BI and the relation between BI and internalizing symptoms (especially anxiety problems) over time (Kagan et al., 2007).

Kagan's approach emphasizes the use of behavioral observations and biological measures, rather than parent-report questionnaires, to study temperament (Kagan, 2018b). Based on laboratory observations, 4-month-old infants who displayed elevated motor reactivity and distress toward novel visual and auditory stimuli were categorized as "high reactive" (Kagan & Snidman, 1991) or "high negative" (Fox et al., 2001). BI in young children (from 14 months to before 48 months of age) is examined by coding their latencies to approach and interact with unfamiliar people and objects and an experimenter. Assessment in older children (4 years to school age) focuses on how they play and interact with unfamiliar peers. Hence, Kagan's approach also focuses on heterotypic continuity of temperament development over time (Fox et al., 2001).

Grounded in cross-species research on the neurobiology of fear responses (LeDoux & Daw, 2018), Kagan's construct of BI (Kagan, 2016, 2018b) is the most explicit example of tying the phenotypic expression of a temperament trait with its presumed underlying psychobiological mechanism. He proposed that the neurobiological foundation of BI is rooted in a highly excitable amygdala, which predisposes children to become hypervigilant toward unfamiliar stimuli (Kagan, 2012; Kagan, Reznick, & Snidman, 1988), as well as contributes to the development and stability of BI (Fox, Henderson, Marshall,

Nichols, & Ghera, 2005; Kagan et al., 1988). A series of neuroimaging studies indicate that adults who were identified as "high reactive" at 4 months showed greater amygdala responses when presented with neutral unfamiliar faces compared to those who had been "low reactive" (Schwartz et al., 2012; Schwartz, Wright, Shin, Kagan, & Rauch, 2003). Moreover, Pérez-Edgar and colleagues (Pérez-Edgar et al., 2007) found that, compared to noninhibited adolescents, adolescents with sustained BI in childhood showed elevated amygdala response while rating how afraid they were of emotional and neutral faces. The behaviorally inhibited adolescents also showed greater amygdala activation in task conditions involving uncertainty (i.e., rating fearfulness to happy faces). The hyperresponsive amygdala is also likely to mediate the stability of BI, as the amygdala has extensive connections to cortical areas that contribute to behavioral avoidance and deficient safety learning observed in behaviorally inhibited individuals (Schwartz et al., 2012; Sylvester & Pine, 2018).

Stable BI across childhood is a risk factor for anxiety disorders, especially social anxiety disorder (SAD; Pérez-Edgar & Fox, 2005). BI and anxiety disorders have a range of overlapping behavioral, cognitive, and neurological features, including social withdrawal, attention bias to novelty and potential threats, high baseline cortisol levels, and amygdala hyper-reactivity (Degnan, Almas, & Fox, 2010). A recent meta-analysis of prospective longitudinal studies suggested that risk for SAD increases sevenfold for behaviorally inhibited children (Clauss & Blackford, 2012). However, BI is unlikely to simply be an early manifestation of anxiety disorders (Pérez-Edgar & Guyer, 2014). First, the functional impairments and hypersensitivity to social evaluations associated with SAD are not defining features of BI (Blackford et al., 2018; Clauss & Blackford, 2012). Second, there is only moderate continuity of BI from infancy through childhood, with correlations between testing waves in longitudinal studies ranging from 0.18 to 0.52. Clauss and Blackford (2012)'s meta-analysis revealed that only 43% of behaviorally inhibited children developed SAD. The considerable degree of dis-

continuity suggests that BI should be considered as a construct distinct from anxiety disorders.

The central tenet of Kagan's approach argues that early BI does not necessarily predict stability of temperament and later anxiety disorders (Pérez-Edgar & Fox, 2018). Rather, it constrains possible socioemotional development outcomes: The possibility of behaviorally inhibited children *not* becoming exuberant or developing externalizing problems is greater than the likelihood of those children staying behaviorally inhibited or developing anxiety problems (Kagan et al., 2007).

Across each of the summarized research traditions, the focus has initially been the child and his or her place on the spectrum of variation on any one construct of interest. This emphasis is understandable, as temperament research historically stood as a counterpoint to traditions that emphasized the environment, and experience, as the central catalyst for developmental trajectories (Pérez-Edgar & Hastings, 2018). At the most extreme, social learning theorists would argue that environmental inputs, often in the form of rewards and punishments, gradually shape the arc of an individual's life without strong regard to the child's unique constellation of tendencies and abilities (Bandura, 1978). Although these debates were often fierce (Goldsmith et al., 1987; Shiner et al., 2012), it would be just as incorrect to assert that temperamental traits, including the experience, expression, and regulation of emotion, are not sensitive to environmental variation. As such, the next section examines the child in the context of his or her environment.

Context

When researchers discuss the context of development, they can point to the literal place in time and space that that the child's experiences play out (Witherspoon, Daniels, Mason, & Smith, 2016). The context can increase or decrease the likelihood that a child will face specific experiences, modulating the type, intensity, and frequency of inputs that generate temperament-linked responses. For example, a child

born in an area of war and strife is more likely to experience parental loss. For the reactive child, who may show difficulty in creating strong attachment bonds (Fox & Calkins, 1993), this loss may place a greater strain on adaptive compensatory mechanisms, relative to the child deemed more resilient. In the same vein, a child born into an environment that is predictable, well-resourced, and supportive may look much like his or her peers because any underlying "deficiency" in adaptation is never truly tested. These two environments would radically shift both the child's ability to function and the observer's formulation of who that child is as a person. This is because we integrate meaning making for a person as embedded in a context, rather than as an individual in isolation in any one moment in time (Overton & Molenaar, 2015).

The experience-expectant and experience-dependent nature of emotion development suggests that child temperament may modulate both how emotion generation and regulation processes emerge and the extent to which extrinsic contextual and environmental influences shape their emergence. Thus, in addition their unique and independent contributions to emotional development, temperament and contextual forces may interact to determine emerging trajectories. The dynamic interactions between infants' temperament and contextual influences are at the center of diathesis-stress/dual-risk (Klein, Dyson, Kujawa, & Kotov, 2012; Nigg, Goldsmith, & Sachek, 2004) and differential susceptibility (Belsky, Bakermans-Kranenburg, & van IJzendoorn, 2007; Ellis, Boyce, Belsky, Bakermans-Kranenburg, & Van IJzendoorn, 2011) models. Both theoretical perspectives suggest that temperamentally negative children display an increased receptivity to environmental influences. Diathesis-stress/dual-risk models primarily focus on the increased vulnerability of temperamentally negative children in the face of environmental or contextual adversity, whereas differential susceptibility models extend the idea of greater sensitivity to supportive and positive contextual influences. These theories propose that temperamentally negative infants are not

only affected more by adverse environments, but they also benefit more from supportive environments. Thus, they are open to environmental influences both "for better and for worse" (Belsky et al., 2007).

The current section will first discuss two important markers of context that directly shape the development of emotional experience and regulation: parenting and culture. The third subsection then discusses how we can use context to help examine an important question in the temperament literature, namely, evident patterns in under-, over-, and adaptive regulation. Finally, the last subsection speculates on our ability to examine how the child, as marked by specific temperamental traits and vulnerabilities, acts as a unique context of development.

Parenting

Parenting is among the most extensively studied contextual factors in early development, and its links to children's later socioemotional development and well-being are well established (Kiff, Lengua, & Zalewski, 2011). Parents' positive emotional expressions, and their accompanying synchronous and sensitive responding to infants' emotional expressions, provide the main framework for both the early experience and regulation of emotion (Als, Tronick, & Brazelton, 1979; Cohn & Tronick, 1987; Tronick, 1989). In line with this idea, observational studies consistently find that young infants seem to instantly tune in to changes in their parents' expressions of emotion and their emotional expressions seem to mirror those of their parents during these interactions (Aktar, Bockstaele, Pérez-Edgar, Wiers, & Bögels, 2018; Aktar & Bögels, 2017). Thus, infants are more positive when parents express more positive affect. Additionally, infants express less positive and more negative affect when parents stop responding in these dyadic interactions, such as in the still-face paradigm (Mesman, van IJzendoorn, & Bakermans-Kranenburg, 2009).

Infants' self-regulatory capacity develops within early relationships with caregivers. At first, the parent steps in and *is* the regulatory

response. Thus, when an infant is frightened and cries in response, the parent will often swoop in to remove the offending object, soothe the child, and then turn the child's attention to an appetitive object or behavior (e.g., playing with a toy). Parents who are positive, sensitive, and responsive toward their infants in early interactions are thought to provide the optimal environment for supporting self-regulation. Therefore, the infancy literature typically focuses on parenting dimensions that relate to the early parent-child relationship, such as mutual responsivity, synchrony, attachment security, or to parents' interactive quality such as emotional synchrony, availability, and sensitivity (Kiel & Kalomiris, 2015; Kim, Stifter, Philbrook, & Teti, 2014). Synchrony between parent and infant emotion in early face-to-face interactions, captured in both behavior and physiology, is a key co-regulation process providing the foundation for infants' self-regulatory skills (Feldman, Magori-Cohen, Galili, Singer, & Louzoun, 2011).

Over time, the child will internalize these regulatory structures and move from co-regulation to self-regulation. Of course, the form of this shift will depend on the child's trait-level ability to regulate (person), the types of events they have been confronted with (experience), and the type of regulatory outcomes that are valued and reinforced by caregivers (context). As a result, "sensitive" parenting can only be characterized and defined in the context of the specific child, his or her traits, and the society in which the child must adaptively function in.

Positive aspects of parenting and mutual responsivity in early parent-child relationships seem to be especially beneficial for emotion regulation in children with temperamental difficulties. For example, children who experience more affective synchrony in their emotional expressions during face-to-face interactions with their mother at 3 months and 9 months were found to show better self-regulation at 2 years of age, especially if they have high levels of difficult temperament (Feldman, Greenbaum, & Yirmiya, 1999; Feldman, Greenbaum, Yirmiya, & Mayes, 1996). In a parallel vein, high levels of mother-child mutually responsive orientation at

15 months is related to better self-regulation at 25 months but only for children with high levels of temperamental negative affect (Kim & Kochanska, 2012).

The critical role of parenting in influencing socioemotional development continues from infancy into childhood and adolescence (McLeod, Wood, & Weisz, 2007). The parenting literature highlights the interplay between parenting behaviors and early child temperament (Kiff et al., 2011) to shape functioning over time. As a complex, multifaceted behavior, parenting has been conceptualized in different ways. The current review focuses on two types of parenting behaviors that have been commonly studied in the context of temperament, overprotection and intrusiveness (Rubin et al., 2018). To further constrain this discussion, the focus here is on BI, although parenting behaviors are equally important for other temperamental traits, such as exuberance (Tsotsi et al., 2019) and attention control (Eisenberg et al., 2005).

Overprotective parenting, sometimes labeled as oversolicitous parenting, is conceptualized as parental restrictions on their child's exploration in new environments. Oversolicitous parents often step in to provide excessive comfort to the child, particularly when not warranted (Ungar, 2009). In doing so, parents may inadvertently prevent the child from "practicing" how to experience, and then adaptively regulate, emotion. Inhibited toddlers and preschoolers of overprotective parents tend to show greater stability of behavioral inhibition, and a greater likelihood in showing anxious behaviors, than their equally inhibited peers with less protective parents (Hastings et al., 2008; Rubin, Burgess, & Hastings, 2002). Similar patterns were observed in other parenting behaviors marked by "overly" sensitive or high-warmth parenting. For instance, Mount and colleagues (Mount, Crockenberg, Jó, & Wagar, 2010) found that high levels of maternal sensitivity were correlated with more concurrent anxiety symptoms for inhibited toddlers, relative to their noninhibited peers. Parallel works (Park, Belsky, Putnam, & Crnic, 1997) found that for highly negative reactive infants only, more "supportive" parenting (i.e., higher

sensitivity and lower intrusiveness) during the second and third years of life was correlated with increased inhibited and anxious behaviors at age 3.

Intrusive parenting is defined as parental control over children that commands or constrains children's behaviors (Wood, 2006) and is sometimes been labeled as overcontrol or low autonomy granting (van der Bruggen, Stams, & Bögels, 2008). In the context of behavioral inhibition, intrusive parenting occurs when parents push their children to interact with an unfamiliar situation in a forceful way. Similar to the negative effect of overprotection, behaviorally inhibited children of intrusive parents show higher stability of inhibition and increased risks for later anxiety. For instance, toddlers' inhibited behaviors at age 2 significantly predicted their social reticence at age 4, but only when their mothers showed more intrusive behaviors at age 2 (Rubin et al., 2002).

The detrimental effect of intrusiveness and related parenting behaviors may be due to the fact that it overwhelms children's coping capacities when they are already stressed by the novel circumstances and thus enhances their feelings of being out of control (Chorpita and Barlow 1998). Intrusiveness may also induce in children heightened negative emotional arousal, which may further disrupt their ability to self-regulate (Nachmias et al. 1996). This line of studies suggests that the effects of early behavioral inhibition may be potentiated by variations in parenting behaviors, which color the emotional tone of the child's immediate environment. Interestingly, these two types of parenting behaviors, overprotection and intrusiveness, appear to be quite different from each other. Yet, they show similar effects, perhaps rooted in the fact that children are prevented from effectively facing, and adapting to, novelty across contexts.

In addition to the moderating effects of parenting on the link between behavioral inhibition and socioemotional outcomes, bidirectional relations are also observed between temperament and parenting. That is, while individuals are influenced by the environment, they also play an active role in shaping their environments (Sroufe & Rutter, 1984). These relations are evident in

the first months of life but can take on a larger role as children take on greater autonomy to choose and navigate their environments (Davies & Cicchetti, 2004).

In examining the impact of parenting on the child, longitudinal data report that overprotective parenting at age 2 predicted later increases in toddlers' fearful temperament at age 4, above and beyond the stability of children's behaviors over time (Rubin et al., 2002). Similar patterns were observed in studies of preschoolers, where protective parenting predicted children's fearful behaviors a year later, even when accounting for the stability of children's temperamental fearfulness (Edwards, Rapee, & Kennedy, 2010). In another study (Rubin, Nelson, Hastings, & Asendorpf, 1999), however, parents' self-reported overprotective behaviors at age 2 failed to predict parent-reported behavioral inhibition at age 4. Yet, another study with toddlers found that over and above the effect of early temperamental reactivity during infancy, certain "negative" parenting behaviors observed at 27 and 33 months, including lower sensitivity, less positive affect, and greater intrusiveness, predicted decreased inhibited behaviors in children when they were 36 to 37 months old (Park et al., 1997). These longitudinal patterns converge with findings from the interaction studies reviewed above. Overall, parental overprotection tends to worsen the negative impact of behavioral inhibition on mental health outcomes, either by conditioning the effects of behavioral inhibition or fearful temperament on later anxiety or directly leading to increased levels of behavioral inhibition, which in turn confer greater risks for anxiety.

In tandem, there is evidence supporting the impact of temperament on parenting, demonstrating the evocative effects of child temperament in eliciting specific parenting behaviors. Much of this work has focused on the influence of early childhood behavioral inhibition on protective parenting. Specifically, it is conceptualized that inhibited children, compared with their noninhibited peers, may be more likely to elicit overprotection from parents, especially when they show fearful responses to novel and uncertain situations. Longitudinal data suggest that

parental report of toddler's inhibition predicted parents' future overprotection and discouragement of independence, when accounting for the stability of parenting behaviors (Hastings & Rubin, 1999; Rubin et al., 1999). Overprotection may in turn reinforce toddlers' inhibited behaviors and increase the likelihood of developing anxiety, playing a mediating role between early behavioral inhibition and anxious behaviors a year later (Kiel & Buss, 2011). Similarly, in older children, higher levels of fearful inhibition at age 9 predicted increased parental acceptance a year later and modest decreases in parental rejection over the next 2 years, even while controlling for stability of parenting (Lengua & Kovacs, 2005).

Culture

The manifestation and interpretation of emotion is intimately tied with the individual's cultural context. Wang (Chap. 22, this volume; Wang & Brockmeier, 2002) characterizes culture as a system manifested in customs and practices that works to direct and regulate individual and social behavior. In addition, culture provides individuals with communicative symbols, often in the form of specified patterns of emotion expression (Holodynski & Friedlmeier, 2006). Culture's impact on development is widespread, encompassing both expected socioemotional behavior and cognitive processes, such as autobiographical memories (Wang, 2013).

The developmental impact of temperamental openness on environmental input is magnified by the fact that emotions are often the target of parental socialization, with the intent to enhance or minimize specific forms of emotional displays (Denham, Bassett, & Wyatt, 2007). Within western cultures, this often means that parents try to increase the display of positive emotions while minimizing the displays of negative emotions (Chen, Rubin, & Li, 1995; Holodynski & Friedlmeier, 2006). These culturally mediated ideals build on two streams of co-regulation (Chen et al., 1995). One mechanism is often deliberate, as the parent hopes to shape the child's outward expression and experience of emotion to

reflect socially acceptable, and age-appropriate, emotional profiles (Sroufe, 1997). At the same time, infants and children may engage in unintended co-regulation, eliciting and triggering emotional responses within the parent which may need to be acted on through enhancement or downregulation, depending on the match with sociocultural expectations. Socialization practices also refine the communicative intent of emotions, supporting culture-specific transformations of expressive reactions into signs that can be used symbolically (Holodynski & Friedlmeier, 2006). These socialization practices begin early in life and are pervasive, such that by age 4.5 years, it is difficult to disentangle the effects of temperament and parenting (Kiel & Kalomiris, 2015; Root & Stifter, 2010).

Beginning as early as infancy, caregivers will shape and mirror acceptable emotions and reinforce preferred emotion regulation strategies (Holodynski & Friedlmeier, 2006). Although infants typically express a fairly standard array of emotional signals early in life, variation is initially introduced with the emergence of temperament-linked profiles of emotion and emotion regulation (Rothbart, Sheese, Rueda, & Posner, 2011). Quickly, however, we see culture-specific transformations of these expressions into socially embedded communicative signs (Holodynski & Friedlmeier, 2006). For children whose initial temperament does not match the cultural ideal, there is an additional pull on emerging regulatory mechanisms to align the individual with social partners. Thus, an open question in the developmental literature centers on the extent to which parents mirror the emotions of their children and then engage in culturally informed regulation of their emotions. Important, as well, is to ask how early in development cultural differences in emotion shaping emerge.

For example, western mothers tend to minimize signs of shyness in children, particularly in boys, but are unlikely to discourage boisterous exuberance (Degnan et al., 2011). In the United States, researchers often note decreases in the phenotypic expression of behavioral inhibition in children over time as parents and

teachers try to draw out the withdrawn child (Almas et al., 2011). In contrast, up until recently, one often saw increases in behavioral inhibition over time in mainland China. This reflects the traditional values of demure or reserved demeanor. Indeed, inhibited children were often held up as leaders in their school community (Chen et al., 1995; Chen, Rubin, Li, & Li, 1999). This pattern is still evident in rural, more traditional, areas of the country. In contrast, behaviorally inhibited children in rapidly urbanizing cities now show the same negative outcomes—shyness, withdrawal, loneliness— seen in the west (Chen, 2010). This shift in pattern suggests that socialization agents, namely, parents and teachers, are now evaluating patterns of emotion and emotion regulation in a more westernized manner and are responding accordingly.

Cultural norms and ideals also shape how we come to assess maternal sensitivity. As noted above, noncontingent, dismissing, and overly intrusive behaviors are linked to maladaptive socioemotional profiles, marked by increased negative affect and poor self-regulation skills (Kiel & Kalomiris, 2015). Cross-cultural work suggests that infant outcomes are not necessarily tied to specific emotional profiles and maternal behaviors. Rather, maternal sensitivity is evident in the match to cultural expectations (Friedlmeier & Trommsdorff, 1999). For example, in Germany, mothers focus on the cause of an emotion when helping the child regulate and meet the culturally approved target response. Mothers who scaffold independent and instrumental responses were deemed more sensitive. In contrast, Japanese mothers often targeted the child's emotional display in response to an affective elicitor. Here, sensitivity was embedded in the ability to mold emotion expressions that supported harmony within the social group. Thus, sensitive Japanese mothers focused on shaping and mirroring facial expressions.

There has been relatively less focus on culture as a context for temperamental variation relative to the parent-focused literature. Many cross-cultural studies rely on country of origin as the proxy for culture (McClelland et al., 2015). The few studies available examine cultural variation via variation in parenting practices. As such, we have a limited view of the mechanisms, beyond parenting, by which culture impacts emotional development. Indeed, another limitation is that once culture is introduced to a study, many of the other levels of analysis are not included as well. Thus, we have few studies examining psycho-physiological indices of temperament and emotion as a function of variation in cultural socialization practices (Hampton & Varnum, 2018; Soto, Lee, & Roberts, 2016). It is also difficult to bootstrap from other research traditions focused on cross-cultural considerations. For example, while personality psychology has traditionally focused on identifying "modal" personality traits (Chen & Schmidt, 2015), much of the developmental work has focused on individual differences.

Cultural considerations can also complicate how researchers go about comparing developmental processes across context. Take, for example, parental reports of emotion and temperament. Sociocultural considerations will alter the display and meaning of temperament traits (Chen & Schmidt, 2015). Expectations for a child's behavior may lead to nuanced shifts in ratings, changing the concordance between parental report of temperament and observed behavior in the laboratory (McClelland et al., 2015). Endorsing that your child is shy and reserved has a different meaning for a parent in rural China versus urban Los Angeles. Thus, the ratings must be coupled with adaptive and functional profiles to see if surface similarities in temperament-links emotion displays have the same developmental meanings (Chen et al., 1995; De Los Reyes & Kazdin, 2005).

Beyond the basic emotions, we can also see that some emotion categories are constrained at the level of definition by the culture (McClelland et al., 2015). For example, shame is a culturally embedded emotion tied to the norms of the culture or the group. In a similar vein, disgust is a socially meditated emotion building on low-level sensory processes. Temperamental variation in sensitivity to external assessments, and sensitivity to sensory input, may set the

foundations on which shame and disgust emerge (Aron et al., 2010).

Cultural forces will shape the socialization behavior and targets that caregivers use to shape and judge child behavior. However, if we tilt the view, then we can see that patterns of individual traits, both inherent and emergent, will then color the general tenor of the culture. A culture that pulls for reserved behavior may then be reinforced by individuals whose reserved traits are valued—these are the individuals that take on social leadership positions and model the cultural ideal. We see a systematic and successive alteration in the dynamic relation between the individual and the environment as children and their caregivers engage in the co-construction of both individual development and culture (Mistry & Dutta, 2015; Overton & Molenaar, 2015).

Regulation Across Context

Patterns of over- and under-regulation are often associated with variation in temperament traits. However, it is not always apparent where researchers should mark the border between adaptive regulation, under-regulation, and over-regulation. Overregulation may be particularly vexing since decreases in emotion have traditionally been used as the axiomatic marker of adaptive regulation. One potential signpost comes from noting functional outcomes of regulatory strategies across contexts. That is, the child perseverates in specific emotional behavioral and emotion regulation strategies across contexts even when they are not associated with goal attainment or competing "positive" alternatives relevant to that *place* in that *moment* (Martins, Soares, Martins, Tereno, & Osório, 2012).

Often the characterization of over- and under-regulation is not linear. For example, Cole (Cole, Dennis, Smith-Simon, & Cohen, 2009) presented children with an appetitive toy in a locked box, accompanied by the wrong key. The child who almost immediately gives up in anger, frustration, or disappointment is considered a classic marker of poor emotional regulation associated with impulsivity and poor inhibitory control.

However, at the other end of the spectrum, we could question the adaptiveness of the child who continues to work on the problem—even to the point of obsession—long past the point when most children rightly classify this as an impossible task. Overregulation can restrict the range of the child's emotional experience and is associated with a lack of openness to alternate strategies that can create emotional and behavioral flexibility (Pérez-Edgar, 2018). Overregulation also tends to rely on behaviors embedded in the self (self-soothing) at the expense of socially mediated regulatory strategies (Martins et al., 2012).

Regulation is not a state of neutral homeostatic mechanism. That is, increases in arousal are more likely to be maintained, and for longer, than equivalent decreases in arousal (Wass et al., 2018). Indeed, you can see "metastatic" processes in which the initial trigger grows larger over time and becomes self-sustaining. In this way, an emotional state, and the accompanying regulatory response, leaves an imprint long after the child has left the context triggering the acute emotional incident. The dual-systems model, for example, suggests that regulatory functions may be used by temperamentally at-risk children to reinforce and sustain early reactive tendencies, rather than modulate initial responses back to baseline (Henderson & Wilson, 2017).

The Child as a Context

As a final, more speculative, discussion of context, there is the endoenvironment. The endoenvironment approaches the child as the context of development in which markers of risk and resilience may behave in a unique manner (Chen & Schmidt, 2015). For example, the error-related negativity (ERN) is an event-related potential (ERP) generated following an incorrect behavioral response (McDermott et al., 2009). The ERN is thought to reflect either the general process of cognitive control and performance monitoring (Moser, 2017) or pattern of fear sensitivity (Meyer, 2017). Traditionally, the ERN was examined with children at risk for ADHD or

externalizing concerns (Banaschewski et al., 2003), and the consensus was that larger ERNs was associated with more adaptive outcomes. Thus, the ERN is typically seen as a resilience factor.

However, among temperamentally anxious or fearful children, the ERN has a less rosy predictive profile. Instead, high levels of anxiety or temperamental fearfulness, when coupled with a large ERN, are associated with more emotional reactivity and poorer adaptive functioning (Brooker & Buss, 2014b; Lahat et al., 2014; McDermott et al., 2009). This pattern is particularly acute when embedded in the larger context of harsh parenting (Brooker & Buss, 2014a). In this circumstance, cognitive control mechanisms may be called on to canalize and potentiate risk, in line with the dual-systems model (Henderson & Wilson, 2017).

In the same way, temperament shapes the child's understanding and representation of the social environment. For example, over development, theory of mind allows children to extract and understand the thoughts and intentions of others (Wellman, Cross, & Watson, 2001). A child's interpretation of another's goals and motivations are, in turn, colored by their own temperament traits. For children wary of social interactions, the interpretation may have negative overtones. As such, in the case of temperamental fearfulness, increases in theory of mind are actually associated with less social competence (Bowman & Fox, 2018).

Holodynski and Friedlmeier (2006) argue that development is the *desomatization* of emotion as the child builds a repertoire of emotion signs that are used as a means of communication, in addition to experiencing emotions as an internalized phenomenological state. This process of course involves the person, in context, taking on new skills and traits over time. The child, as a context, is particularly important to capturing emotional processes. Indeed, if the child is removed, how do you measure a construct which is built from multiple subcomponents, parts of which are inherently subjective? Unlike other behaviors, we cannot simply dismiss subjective report out of hand: "Actually, you did not feel angry—we were

unable to detect a significant increase in heart rate in conjunction with corrugator muscle contraction." While researchers can assess emotion across many levels of analysis, the subjective view is uniquely the one source of information that cannot be easily set aside or dismissed out of hand.

Time

Developmental psychology is focused on characterizing, and hopefully explaining, change across time. In addition to carefully choosing the construct and population of interest, researchers also assess the time scale of their observations. That is, for any one question, there are likely both macro and micro levels of change. We see change in both the moment, within a specific window of behavior, cognition, or feeling, and across development, typically bound to markers of maturation or age. Thus, there is a tension between focusing on the rapid succession of functions, a microlevel approach (Cole & Hollenstein, 2018), and setting aside some fine-grain data in order to marshal resources to examine larger arcs of development at the macro-level (Caspi et al., 2003).

In designing studies, researchers must also race the constructs' known rate of change. That is, to capture change in a construct, we need to test at a pace faster than the rates of developmental change (Brownell et al., 2015). For example, if we are interested in infants' ability to carry out the classic A-not-B task, it would be fruitless to test at 6, 12, and 18 months of age with the same form of the task since the participants would be at floor at 6 months, likely at ceiling by 12 months, and almost certainly by 18 months. The researcher would have missed the rapid onboarding of skill that occurs in the second half of the first year of life (MacNeill, Ram, Bell, Fox, & Pérez-Edgar, 2018). In general, more complex traits tend to emerge and evolve at a more gradual pace. For example, examining emotion-coping strategies in adolescence can often capture meaningful change on a yearly basis (Compas, Connor-Smith, & Jaser, 2004; Compas, Connor-Smith, Saltzman, Thomsen, & Wadsworth, 2001). Across

development, we see temperament-linked variation in emotion at both the micro- and macro-levels of analysis.

Micro-level Changes

In coupling temperament to emotion, researchers typically move beyond documenting the presence of an emotion and additionally observe the intensity, duration, and frequency of an emotion. That is, temperament research couples valence with volatility (Morales et al., 2018), making variation over time central to the work. As noted above, researchers examine multiple components of interest when characterizing the child's response to his or her environment. First, beyond a discrete emotion, they are typically interested in the behavioral (approach/withdrawal) and cognitive (interpretation of threat or reward) response. Second, there is the trigger to this response. For some children, the triggers may be rather narrow and infrequently encountered. For other children, they are amorphous and may be lurking around many a corner.

Third, there is the intensity of the response. Here, the assumption is that the pitch and extent of the response reflects the child's temperamental reactivity. Highly reactive children should show intense emotions. Of course, this assumption is often difficult to capture beyond infancy as regulatory mechanisms can quickly come into play (Cole et al., 2018; Perry & Calkins, 2018; Rothbart, Ziaie, & O'Boyle, 1992). Fourth, there is the speed of the response. For some children, the affective and behavioral response is slow building, needing multiple triggers or sustained exposure to draw out a response. For others, the first exposure, even if fleeting, is enough to cause the child to embrace or pull away. In both cases, however, biological markers may outpace outward behavioral signs, particularly in older children.

Finally, there is the question of malleability. Again, this pulls in the question of regulation, carried by either the external environment or the self. The argument is that temperament-linked responses are easily triggered, quick to emerge, and highly pitched and would be difficult to modulate. Thus, high levels of reactivity may set the stage for a relatively unmalleable socioemotional behavior. Microscopic changes in emotion amplification and attenuation lead to macroscopic changes, as the system moves from one orderly state to another (Cole & Hollenstein, 2018). Thus, the accumulations of small slice of emotional experience will "stack" together to build stable socioemotional profiles evident over larger time scales, and across contexts.

Macro-level Changes

Although a central component of most temperament theories is that emotional and behavioral profiles should be relatively stable across time and space, practical considerations often limit the extent to which researchers can directly observe and follow the ebbs and flows of temperament over long time frames. First, the phenotypic expression of temperament will change over time. Practically, this reflects emotion regulation strategies that are brought to bear, first by parents, and then the child themselves, to modulate emotions to match individual goals and cultural expectations. The aspects of daily life that are salient to the child, and thus worthy of an affective response, also change. This is a core developmental precept. Unfortunately, this developmental imperative often runs head first into traditional analytical barriers. That is, many analytic approaches are built on the presumption (if not insistence) that items of measurement or stimuli triggering responses must be invariant over time (Khoo, West, Wu, & Kwok, 2006). If not, you are not "truly" examining a repeated measure. However, one could not expect that a stranger dressed as a clown would elicit the same response from an individual at age 2, 12, and 22. Thus, it is up to the researcher to carefully define the latent construct of interest and then operationally define an age-appropriate probe for that construct. Thus, if we believe that temperament is fairly stable over time and we are examining rank order stability, then the phenotypic expression of emotion must change in order to adaptively meet the

evolving challenges of daily functioning (Fox et al., 2001).

When comparing rank order stability versus mean level continuity, it is also important to note that the universe of measures and ratings will also change over time (Brownell et al., 2015). That is, change in rank order may reflect a shuffling of individuals within a fairly stable distribution of traits. However, change in rank order may also reflect the expansion or contraction of a measure which then changes the relation within the population. For example, consider two items from the Child Behavior Questionnaire (CBQ, Putnam & Rothbart, 2006): "Has temper tantrums when s/he doesn't get what s/he wants" and "Cries sadly when a favorite toy gets lost or broken." A parent of a 4-year-old endorsing this item would elicit different interpretations from researchers than if the parent of a 14-year-old endorsed the item. At age 4, you may expect a broader distribution of endorsements and more "space" in which to order and slot children. At age 14, however, you may expect a large swath of children to be at floor, such that a relatively small shift in behavior would produce a large shift in order. This is why the CBQ is targeted for 3- to 7-year-olds, and these questions do not appear in the age-appropriate measure, the EATQ (Ellis & Rothbart, 2001). As such, a measure must have sufficient variability at each time point of interest in order to extract a true signal of stability or change. In addition, the most influential processes shaping emotional function may vary along a developmental pathway, such that you will see changes in the relative strength of explanatory processes (Cummings & Valentino, 2015).

Another important consideration is the need to carefully select the construct believed to drive change over time. As discussed earlier, Bowman and Fox (2018) argue that emotion is not central to temperament. Rather, questions of motivation may be more important. Thus, the core measure of temperament over time may not be in emotion displays but rather in the motivational forces that shape a child's response to the environment. For example, the teenager who declines to attend the school dance may be presenting with the same

withdrawal tendencies as the preschooler who sits quietly in the corner and observes other children in play (Henderson et al., 2018). Research in line with Goldsmith and Campos (1982, 1986) in contrast may systematically manipulate the environment in order to elicit their central marker of interest, such a clear behavioral fear response.

If there is a recipe for temperament-linked emotional trajectories, the current chapter has touched on three ingredients so far. That is, emotional development is fueled by the child, embedded in specific contexts, displaying variations in emotion reactivity and regulation, as well as motivated behavior, over time. Implicit in the text has been the common catalyst that can point development toward one of the many potential trajectories—namely, experience.

Experience

One historical critique of the temperament literature has centered on the implication that the child's developmental trajectory is biologically driven, largely predetermined, and impervious to sociocultural forces. However, data emerging over the last three decades suggests quite the opposite. That is, temperamentally reactive infants and children are acutely sensitive to inputs from the environment (Ellis et al., 2011; Kiff et al., 2011; Lengua & Kovacs, 2005). As with time, there are both micro- and macro-level experiences that shape temperament development. For the micro, researchers can examine the acute experience that triggers a specific emotional state or motivated response. For the macro, researchers can focus on the patterns of individual and interpersonal events that shape the child's view of the self and the environment.

In the Plasticity for Affective Neurocircuitry model (Fox, Hane, & Pine, 2007), for example, early temperament shapes functioning over time and is modified by experience as caregiver behavior exposes children to varying levels of threat. As noted earlier, both the diathesis stress and differential susceptibility models suggest that temperamental variation increases the variability (multifinality) of early life experiences on devel-

opmental outcomes. It is the foundation for "adaptive phenotypic plasticity" (Ellis & Boyce, 2008).

Rather than minimizing the role of the environment, temperament research highlights how experience shapes fundamental individual traits. First, animal models and human emotion research has expanded our understanding of the bidirectional and interwoven relationship between individual traits and the environment. Indeed, this bidirectionality has expanded to even incorporate the level of genetics such that experience in the context of individual traits will modify the immediate and long-term pattern of gene expression (Diorio & Meaney, 2007; Francis, Diorio, Liu, & Meaney, 1999). Epigenetics reflect alterations in methylation and histone modification that are in response to environmental conditions but do not change the underlying DNA sequence (Edelman et al., 2012). As a result, the lived experiences of the child can amplify or mute gene expression.

The most extensive work has relied on animal models. For example, in rat models, lower levels of nurturing behavior in dams, such as licking and grooming, are associated with fewer glucocorticoid receptors in their pups (Cavigelli et al., 2007). As a result, these offspring will show increased sensitivity to stress (Hane & Fox, 2006, 2016). For an organism or child more open to environmental input, perhaps carried by variation at the epigenetic level, environmental experience may alter the developmental unspooling of initial temperamental traits. To start, this environmental input may be predominantly carried by parents. However, this process will broaden to incorporate other adults (e.g., teachers) and peers. It will broaden again as the child moves farther out from the familial unit and begins to experience (and often choose) varied environments (Pérez-Edgar, 2018).

At the micro level, the research illustrates how the interaction of temperament and experience can shape different trajectories and lead to observed emotional profiles. For example, BI is characterized by a withdrawal response to novelty in the environment. Exuberance, in contrast, is marked by a positive response to novelty. In the face of goal blockage, a common laboratory manipulation (Buss & Goldsmith, 2000), the differences in a child's response can be striking. A BI child may withdraw, appearing deflated and defeated. The exuberant child, in contrast, may show frustration (Dollar & Stifter, 2012; Stifter, Putnam, & Jahromi, 2008). When the response to a goal and its blocking becomes more diffuse, frustration may turn to low-level patterns of irritability for the child. Irritability, over time, may fuel poor self-regulation, particularly in nonsupportive environments that cannot help scaffold the child's regulatory response. The combination of reward sensitivity, goal blockage, and poor self-regulation may lead to an explosive negative response. In this way, the frequently observed temper tantrum can be conceptualized as an emergent property of the child responding to his daily experience (Roy et al., 2013).

If the environment is supportive, the child can learn to automate some adaptive behavioral and cognitive patterns. As such, the child can free up a great deal of cognitive resources that require active and effortful self-regulation (McClelland et al., 2015). Repeated or sustained negative experiences, in contrast, can increase levels of toxic stress, which, in turn can degrade the child's ability to automate self-regulation. However, it is important to note that self-regulation is and of itself is not static. Rather, adaptive and flexible traits can help the child take on (or leave behind) regulatory processes that do not match the challenges and goals at hand.

At a broader level, we can also see that temperament influences at higher order levels of functioning. Indeed, we can approach personality as the combination of temperament with life history (Anaya & Pérez-Edgar, 2019; Buss, Pérez-Edgar, Vallorani, & Anaya, 2019; Kagan, 2018a). The social interactions that work to shape the developmental progression of temperament to personality are interwoven with layers of individual expectation and cultural norms (Chen & Schmidt, 2015). Temperament can vary the individual's motivation of engage win these interactions and trigger variation in the environment's response depending on the extent to which they

reflect expected ideals. As such, the evolution of temperament into personality should be thought of as a developmental process, rather than the maturation of a static trait marker (Buss et al., 2019; Chen & Schmidt, 2015).

Conclusions

Temperament is embodied in *patterns* of emotion (Bates et al., 2008) that are distributed across a spectrum of elicitors (Buss, 2011) and emerge early (Kagan et al., 2007) but take time to stabilize (Fox et al., 2015). Emotion is often the target of parental socialization, attempting to both potentiate and minimize specific functional profiles. As a result, much of the impact of early temperament can be seen in emotional and socioemotional functioning (Root & Stifter, 2010). The form and function of temperament are embedded in our view of social adaptation. That is, the negative consequences of heightened reactivity, coupled with ineffective regulation, are codified in our clinical views of internalizing and externalizing difficulties (Bates et al., 2008) and "goodness-of-fit" matches to sociocultural expectations (Chen & Schmidt, 2015; Chess & Thomas, 2013).

The literature reviewed in the current chapter suggests several open gaps in our knowledge. Five are noted here:

First, it is not clear how to best characterize and interpret individual differences across multiple levels of analysis evident *within* a person and *across* individuals. Lamb (2015) points out that we have expanded our ability to explain patterns and variations in development while undermining the purity of discrete theoretical approaches. While evident that individual differences may have contributed to these blurred lines, the field could benefit from construct-level definitions that have greater specificity with respect to the source, context, and timing of the measure (Kagan, 2016).

Second, there is a need to better integrate advanced methods and analytics with more nuanced measures of the environment. Overton and Molenaar (2015) argue that we need complex systems to capture the "relative plasticity" of individuals across persons, space, and time. The question of "relative" is then shaped by both individual traits and the individual's interactions with the environment (McClelland et al., 2015). Environments that work to modulate a child's initial trait will of course provide data that supports greater plasticity. In contrast, a child with little pressure to change in order to adapt to environmental expectations may provide little evidence for plasticity.

Third, the field tends to define a construct based on outcome, as opposed to process. For example, is a negative response to a spider necessarily a temperamental response? A bad prior encounter with a spider may be the catalyst for fear learning, and, at the extreme, a phobia. This phobic response is not equivalent to fear responses that can be tied to sensitivity to novelty or perceived threat. Underlying both mechanisms is a near-universal perceptual response which may reflect a conserved bias to attend to spiderlike stimuli (LoBue, Rakison, & DeLoache, 2010). We know that "developmental systems allow for more than one way to reach a socially important outcome" (Bates et al., 2008). Thus, we must focus on factors that translate a tendency into actual behavior for an individual child.

Fourth, we need to independently measure both emotion and the proposed regulation strategy (Cole et al., 2004). If not, researchers fall into the trap of a circular confound. There is an inherent need for microlevel measures to capture temporal ordering. Traditionally, researcher look to see if a strategy is associated with a change in emotion, taking an observation that they follow each other close in time as evidence for regulation (Ekas, Braungart-Rieker, & Messinger, 2018). However, until recently, the field did not have the methods to see if the strategy *led* to the change in emotion (Cole & Hollenstein, 2018). Thus, there is the danger that we have inadvertently been alternating our dependent and independent variables based on the idiosyncrasies of any one study (Brownell et al., 2015).

Fifth, although there are some cross-cultural studies available, there is a dearth of non-WEIRD (western, educated, industrialized, rich, and

democratic) research (Henrich, Heine, & Norenzayan, 2010). Much of the published work in temperament focuses on US and western European middle-class families. Indeed, "there are virtually no studies of BI/SW [behaviorally inhibited/socially withdrawn] young children who are growing up in stressful, dangerous community and family settings" (p. 9; Chronis-Tuscano, Danko, Rubin, Coplan, & Novick, 2018). These gaps limit our understanding of culturally linked socialization practices and the unfolding of temperament across diverse contexts and experiences. When the field does engage with diversity, in the form of culture, the vast majority of the work has compared WEIRD populations to Asian populations, particularly in Japan and China, framing the comparison between collectivist vs. individualistic cultures (Chen, 2010).

The current chapter suggests that a core contribution of the temperament literature is its focus on the individual child interacting with his or her specific environment(s) over time. Variations across individuals within a context build to variations across individuals across time. The emergent properties of development suggest that relationships within and across individuals will not necessarily remain stable across time, modulating the rate and slope of change. In the end, the person-centered approach at the heart of temperament research brings together variables of interest to help reconstruct the child embedded in the data.

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