# Temperament Concepts in Developmental Psychopathology

16

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The concept of temperament is useful for distinguishing between one child and another and between the child and the social environment. Temperament traits have been regarded as the core of personality and have been shown by research to have important associations with developmental psychopathology. For decades, developmental psychopathology research using temperament has been growing vigorously. We found 1,441 peer-reviewed articles on temperament published between 2009 and June of 2012. Seventy percent of these considered temperament in relation to concepts representing the broader domain of developmental psychopathology, such as behavior problems, externalizing, internalizing, and psychiatric diagnoses.[1] Consistent with the vigor of this area of research, numerous major reviews, edited volumes, and monographs on temperament's relations with developmental psychopathology have appeared in recent years, including Seifer (2000) in the previous edition of this handbook; Caspi and Shiner (2006), Degnan, Almas, and Fox (2010), De Pauw and Mervielde (2010), Kiff, Lengua, and Zalewski (2011), Rothbart (2011), Zentner and Shiner (2012), and Klein, Dyson, Kujawa, and Kotov (2012), just to cite a few of the more recent reviews. We have also contributed reviews (e.g., Bates & Pettit, 2007; Bates, Schermerhorn, & Goodnight, 2010; Bates, Schermerhorn, & Petersen, 2012; Rothbart & Bates, 2006; Wachs & Bates, 2010). This chapter explains our conceptual definition of temperament and how it contributes to the development of psychopathology. This chapter also considers a few measurement issues and some key findings about temperament's role in developmental psychopathology.

This chapter concerns the intersection of temperament, environment, and adjustment. Temperament and environment are overlapping but relatively distinct conceptual domains. The domain of adjustment is wholly embedded in the much larger domain of environment (i.e., only has meaning in relation to social relationships); and a substantial part of the overlap between temperament and environment includes the domain of adjustment.

Temperament concepts are as old as ancient Greek philosophy and as new as the current research on genetic and neural bases of human behavior (Rothbart, 2011). Temperament came into active use in developmental science only in the 1960s, dating especially to the New York Longitudinal Study (Thomas, Chess, & Birch, 1968). The surge in interest in temperament can

[1] The complete list of search terms entered into the search tool, PsycInfo: psychopathology, adaptation, adjustment, competence, externalizing, internalizing, antisocial, depression, anxiety, aggression, disorder, and of course, temperament. This may have missed studies of variables we would consider temperament that were given other names.

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be related to the field's shift toward more complex systems models of the development of psychopathology, which resulted partly from arguments such as Bell's (1968) landmark assertion that children influence their own socialization by affecting the parenting they receive. The surge can also be related to the growth of developmental research in general and technological advances, e.g., in multivariate statistical analysis. Temperament concepts came with references to biological processes in the child. They therefore added a dimension to the dominant mid-twentieth-century models of psychopathology, which tended to focus almost exclusively on social environment causes, especially the domain of parent effects (Bates, 1989b). In the first decades after temperament's scientific introduction, several different perspectives on how to define temperament were evident, and there was fairly vigorous discussion of the strengths and weaknesses of the perspectives (see Seifer, 2000, for a review of the definitional perspectives past and present). Definitions do make a difference and there is continued discussion about how best to define temperament concepts (e.g., Aron, Aron, & Jagiellowicz, 2012); however, conceptual differences between the perspectives at the present are relatively modest (Lemery, Goldsmith, Klinnert, & Mrazek, 1999; Rothbart & Bates, 2006). We find scientific questions about specific measures of temperament and their usefulness in describing development of the most interest and will focus on dimensions included in three- and five-factor models of temperament and personality.

We perceive a general convergence on a basic definition first promoted by Rothbart and her colleagues (e.g., Rothbart, 2011; Rothbart & Bates, 2006). Our operating definition is that temperament is a rubric covering traits in negative and positive emotional reactivity and cognitively higher order self-regulation. These reactivity and regulation dimensions can summarize a wide swath of individual differences in human (and animal) behavior. For example, Big 3 and Big 5 models of temperament and personality typically involve high vs. low positive emotionality, high vs. low negative emotionality (often subdivided as fearful vs. angry emotion), and impulsivity vs. self-regulation and constraint. These models have provided a relatively simple but comprehensive dimensional structure for basic behavioral differences, traits that appear relatively early and are relatively stable across development (Rothbart & Bates, 2006). Temperament traits are based in individual differences in biological structures and processes, such as genes for dopamine, and neural functions, such as amygdala response to threat stimuli and greater right vs. left EEG activation as a marker of negative vs. positive emotionality. However, it is apparent that the phenotypes of temperament behavior patterns are far from simply mapped onto biological markers. We think of the reactivity and self-regulation differences as based in neural systems that are intricately balanced. For example, effortful self-regulation allows management and redirection of both approach- and avoidance-producing emotions, while emotional responses inscribe learning events with meaning and ultimately shape cognitive regulation habits (Barkley, 2012; Lewis & Todd, 2007).

Processes involving child characteristics could influence both the child's environment, such as good self-regulation producing increased parental acceptance (Lengua, 2006), and how the child responds to experiences, such as how genes for serotonin interact with family stress and developmental stages in forecasting anxiety and depression (Petersen et al., 2012). Conversely, processes involving environmental influences could influence child biological functioning, such as when chaotic and threatening environments are associated with abnormal brain processing of social stimuli (Pollak, Klorman, Thatcher, & Cicchetti, 2001), abnormal diurnal patterns of cortisol (Dettling, Parker, Lane, Sebanc, & Gunnar, 2000), or even epigenetic methylation of genes controlling cortisol responses (Champagne et al., 2004). The focus of this chapter is, of course, on the effects of children's biologically based traits rather than on how environment shapes biology. However, the latter findings remind us that any phenotypical measure of temperament could reflect a developmental product of both relatively inborn and experientially developed biological traits. The

measurement of temperament is not as simple as the concept of temperament. Measurement issues will be considered after consideration of developmental psychopathology questions.

Concepts of developmental psychopathology or adjustment provide an essential context for the study of temperamental differences between children. We can see evidence of interest in the origins of children's behavioral adjustment growing with the fields of psychology and psychiatry and the areas of clinical and developmental psychology across the nineteenth and twentieth centuries, but the earliest instance we have seen of use of the term *developmental psychopathology* as a comprehensive summary of previous research and a clear, developmental systems vision of future directions was Achenbach's classic 1974 text. By now, the term developmental psychopathology has come to represent a dominant perspective (Cicchetti, 2006; Sroufe & Rutter, 1984). Developmental psychopathology is a field of immense breadth and complexity. It is an approach to research that embraces cross-disciplinary, multilevel, and dynamic concepts, from the fundamental biological processes to the psychological and sociological systems. It is concerned with elucidating processes in both adaptive and maladaptive development. In the service of achieving a dynamic and systemic understanding of development, it integrates the emerging findings and methods of so many basic and applied areas of research that it is nearly impossible to draw boundaries around the field (Cicchetti, 2006). Developmental psychopathology models, even ones most creatively and authoritatively focused on parenting and other environmental variables (e.g., Patterson, Reid, & Dishion, 1992), almost invariably touch on biological levels of child differences.

Developmental psychopathology, just like temperament, contains some differences of perspective, and just as a temperament construct coming from one perspective can have somewhat different meanings than one coming from another perspective, so can developmental psychopathology constructs. Our interest is primarily in developmental psychopathology constructs coming from a dimensional perspective, in which distinctions between individuals are relatively continuous and ordered, as in a spectrum. Categorical, more molar, and configural concepts of psychopathology, such as conduct disorder vs. depression, are quite relevant to questions about temperamental roots (Loeber & Burke, 2011), but we have focused on the more general dimensions of externalizing and internalizing behavior problems. These dimensions have provided convenient summaries of complex growth patterns of the individual children's adjustment in samples representing a broad range of risks and adaptations. Externalizing and internalizing problems tend to be correlated, but they can be analytically separated in their growth parameters and in their temperament antecedents (Keiley, Lofthouse, Bates, Dodge, & Pettit, 2003). The externalizing and internalizing dimensions, despite not being fully independent, can be used to summarize the largest portion of cases of psychopathology at all ages of development. There may be a need, however, for a third dimension, as foreseen in Eysenck's (1992) personality inventory. Eysenck's three dimensions were extraversion-introversion, neuroticism, and psychoticism. Perhaps the hypothetical third dimension involves exceptionally disordered thought processes, such as what happens in autism spectrum disorders, in psychotic disorders, and to perhaps a lesser degree in extreme hostility and cruelty. Autism spectrum and psychotic disorders have externalizing and internalizing elements but appear at this point to be less well accounted for by externalizing and internalizing and less well accounted for by temperament variables than the disruptive behavior disorders and anxiety and mood disorders.[2]

To summarize our points so far about temperament and developmental psychopathology, in the domain of temperament, the key trait dimensions found so far include (1) positive emotionality, which covers variability in approach motivation, activity, and joy; (2) negative

[2] Because developmental exploration of a third dimension of psychopathology in relation to temperament is not highly developed, it is not a focus of this chapter. For similar reasons, the chapter also does not focus on temperament origins of positive adjustment dimensions that might be independent of the pathology dimensions.

emotionality, which appears to begin as one dimension and with development becomes two—fearfulness and frustration/anger; and (3) self-regulation, a complex dimension we see as centered on effortful attention, which allows situation-appropriate modification of emotional/motivational responses and inhibition of both approach and avoidance actions (Rothbart & Bates, 2006). And in the domain of developmental psychopathology, the key trait dimensions found so far include (1) externalizing behavior problems, which involve overassertive, aggressive, oppositional, and attention-demanding behaviors as well as rule-breaking, stealing, and everyday cruel behaviors, and (2) internalizing behavior problems, which involve fearful, tense, anxious, and depressed behaviors. We do not consider here, because they have been of little interest in temperament studies so far, thought disorders, which might include psychotic problems and extreme cruelty.

## A Social Process Model of Temperament in Developmental Psychopathology

As important as specifying particular dimensions of behavioral adjustment is specifying social-development processes in the emergence, continuity, and change of adjustment. We tend to think of psychopathology vs. competent adjustment of children as arising from a combination of initial child traits (assuming strong biological roots even if child behaviors are responsive to the environment from the beginning), initial parent traits (which reflect the parent's personality and also respond to the child from the beginning), and broader social context as it influences the child's experience, such as deviant peers or marital and economic stress (which reflect the parents' personalities and may in some part respond to the child's needs and personality). From this rough framework, we aim to identify particular interfaces or correspondences between traits and environments and ineffectually resolved conflicts between children and their environments.

Temperament traits are inherently defined in relation to particular incentive situations (Bates, 1989b; Rothbart & Bates, 1998), and so are psychopathology traits. For example, the trait of fearfulness, based in Gray's (1991) conceptual brain network, the Behavioral Inhibition System, is described not only in terms of frequency and extent of an individual's fearful affect and inhibition and withdrawal but also in terms of the environmental situation's degree of threat of punishment (or non-reward). If a situation, for example, is highly threatening, almost all children would seek protection, so temperament differences in fearfulness would be hard to see. However, if it is only mildly or moderately threatening, temperamental differences in fearfulness would be more apparent (Buss, 2011). Correspondingly, psychopathology dimensions are also framed by situations. Anxiety disorders, for example, are noted in relation to actual level of threat.

We find it most useful to think of temperament as a component in what becomes a dynamic process of transactions between the child and environment, gradually producing adjustment outcomes. Temperament only probabilistically influences a child's response to a situation, just as situations only probabilistically influence a child's response, but over many encounters, hour by hour, day by day, the child-environment system organizes itself. Outcomes follow patterns but are the products of dynamic, interactive processes, so they are not completely determined (Thelen & Smith, 1998). The causal processes can involve dramatically transformative events but most often involve myriad, subtle transactions (Sameroff, 2010) between the child and the social environment. Equilibria are attained in the child-environment relationship, with attractors in a state space (Granic & Patterson, 2006; Thelen & Smith, 1998), but habitual child–parent interaction patterns do sometimes change. Changes over time in maladaptive patterns of behavior appear more likely than changes in adaptive ones—the bias is toward amelioration, according to a relatively old literature (Kohlberg, LaCrosse, & Ricks, 1972), and the essence of psychopathol-

ogy is not simply the experience of conflict with the environment in development but also failure of the developmental system to right itself. Most young children have moments of heightened distress, tantrums, and aggression, but most of them learn, with the help of parents, teachers, siblings, and friends, effective ways to solve the problems and minimize the distress, tantrums, and aggression. Even in the middle-childhood era, parents often mount successful campaigns to solve problems with their children (Goodnight, Bates, Pettit, & Dodge, 2008), and both informal observations and emerging research suggest that children themselves often contribute to their families' resolution of issues and reductions of conflict (Eisenberg et al., 1999; Schermerhorn, Chow, & Cummings, 2010).

Social environment settings can be described in terms of prevalence of particular kinds of situations (Wachs, 2000). How prevalent a given incentive is may have implications for the emergence of particular qualities of the child. For example, twin research suggests that emotionally positive child behavior is significantly influenced by the environment (Goldsmith, Buss, & Lemery, 1997), which seems likely to be due to the prevalence of parental warmth. In the other direction, an emotionally positive child disposition may evoke increases in parents' warmth (Lengua & Kovacs, 2005). Social environment and child temperament tendencies can also relate in a more interactive way. The implications of the environment for child adjustment may depend on child temperament, and the reverse. As will be discussed in more detail later, parenting that works for one kind of child may not for another, and under some regimes of parenting, a child with a temperamental risk for psychopathology may avoid significant levels of pathology.

Situations start out fairly simple for a very young child—feeding, affection, soothing, stimulation, and small shares of autonomy—but gradually become more complex. In the complexity of human adaptation, there are multiple, often conflicting needs and ambiguous cues for action. For example, common situations include both reward and punishment cues and children learn how to detect the cues and balance their responses (Newman & Wallace, 1993). Situations also have cognitive meanings with complex norms for emotional and behavioral responses (Dodge, Coie, & Lynam, 2006; Lewis & Todd, 2007). In children's pursuit of the social and material events that meet their needs, there sometimes are conflicts with the environment. How these are resolved determines qualities of child adjustment. Poor resolutions with chronic distortions and inefficiencies in people meeting their social and psychological needs are the essence of psychopathology. The most salient needs are for protection, the feeling of security and belonging, and the needs for effective action, learning, and feelings of efficacy. The core developmental tasks (Sroufe & Rutter, 1984) involve meeting these needs. The initial, characteristic biases in a child involving needs for protection can be characterized in terms of temperamental fearfulness and irritability. The feeling of security and belonging appear to come from a sense of generally dependable response and support from caregivers, especially at times of distress (Ainsworth, Blehar, Waters, & Wall, 1979), and in general, as measured so far, these traits do not appear to have strong roots in temperament, although some aspects of attachment behavior, such as crying in the Strange Situation, may have such roots (Vaughn & Shin, 2011). Effective action, learning, and self-efficacy grow in importance with the child's physical and cognitive capacities, and ideal environments are supportive of growth in these areas—providing developmentally appropriate affordances for the child's practice of effective and smoothly regulated actions upon the world.

Accompanying the child's growth in competencies, perhaps even shaping some aspects of it, are child temperament and parent–child relationship variables. As mentioned, initial temperament biases involve positive and negative emotionality and early-appearing self-regulatory traits. Approach motivations and actions create many opportunities for basic learning and more advanced social learning. Tendencies in the environment relative to children's needs have been

extensively described, especially in terms of parenting—one of the longest and most vigorous research traditions in developmental science. Parenting traits have often been statistically summarized on two or three broad dimensions, including warmth and control, both supportive and negative, with sensitive responsiveness to the child's lead often linked to warmth but sometimes regarded as separate (Bugental & Grusec, 2006). Environmental differences in warmth and responsiveness would pertain to the child's needs for affection, soothing, protection, belonging, learning, and efficacy. Environmental positive and negative control would pertain to how children's needs for autonomy and self-regulation are negotiated.

Child temperament can be seen as reflecting differences between children in some of their psychological needs. These include not only the fear, distress, approach, joy, and frustration that we have already mentioned but also needs for loving, empathy, and caring. Also relevant is self-consciousness. Self-consciousness is viewed by Barkley (2012) as the most central of the executive functions, and individual differences in it relate to effortful self-regulation. Deriving from self-consciousness and effortful control, secondary needs with a more indirect connection to temperament include needs such as shame resolution and identity (Schore, 1994). Environmental qualities in the child's life—especially parenting—involve complementary and clashing emotions and behaviors. In response to fearfulness and distress, parents may feel and act protectively and provide confident soothing. In response to approach and joy, parents may feel love and joy and behave in affectionate, synchronously responsive ways, and when the situation is right (which they can partly engineer), they may encourage autonomous exploration. In response to tokens of the child's needs for connection, parents may feel responsible and act in conscientious (predictable, dependable) and attached ways. In response to the child's needs for self-regulation, parents may withhold protection when it is not really needed, and they may explicitly model and shape cognitive skills, e.g., by facilitating the internalization of language to guide behavior (Kopp, 1982).

In summary, in using a social process model of temperament in psychopathology, we aim to identify parallel correspondences between temperament and parenting, temperament and adjustment, and parenting and adjustment dimensions. The model would suggest that temperamental dispositions toward high levels of approach, reward-seeking, excessive efforts to control others, and frustrated emotion would be associated with externalizing problems; temperamental dispositions toward fearful emotion, safety-seeking, and behavioral inhibition would be associated with internalizing problems; and temperamental dispositions toward low levels of effortful self-regulation would be associated with both externalizing and internalizing problems. Low effortful control—perhaps expressed as low ability to direct attention away from a positive goal or a minor threat—would lead to conflicts between the child and environment, perhaps developmentally earlier in the case of failure to self-regulate impulsive action (an aggressive child would likely cause early difficulties for the family) and perhaps later in the case of failure to regulate fearfulness (parents can avoid conflict in the short term by overprotecting an over-fearful child but put the child at risk in later developmental tasks). However, these suggested processes assume an average environment. We recognize that the combination of the dimensions is not likely to be modeled in simple terms. Additive combinations have not been sufficient to explain outcomes to a satisfying degree, even allowing for our difficulties in operationalizing the dimensions of temperament, parenting, and adjustment. Some children experience severe environmental challenges and lack of support yet develop as well as others with better environments, and some children begin with difficult temperament traits and end up with no more problems than easier children. And even where there are additive combinations of the variables, there are likely complex cascades of influence across eras of development (Cox, Mills-Koonce, Propper, & Gariépy, 2010; Dodge et al., 2009) rather than

simple influences. In this social process model of temperament in developmental psychopathology, mechanisms involving both temperament and environment help explain the relative balance of poorly resolved conflict and positive support across development and ultimately, the growth of psychopathology.

## A Note on Measurement

Temperament measures are not the same as the temperament concepts, as much as we might strive for them to closely correspond. Methods for assessing temperament are crucial to their empirical meanings. Concepts of temperament refer to enduring dispositions, based in neurobiological systems, in responses to relevant situations. Measures, however, may reflect relatively momentary rather than enduring tendencies or tendencies that correspond to a specific situation more than to a general type of situation. For example, a young child's response to a novel stimulus in a laboratory task may reflect not only the hypothetical level of fearfulness of the child but also the child's general sense of being protected by their parent (Nachmias, Gunnar, Mangelsdorf, Parritz, & Buss, 1996) or being unable to cope on a particular day (e.g., due to an unresolved conflict with the parent or to deficient sleep). It may also reflect a trait that is associated with but not the same as fearfulness—sensitivity to the environment or tendency to deeply process new stimuli (Aron et al., 2012). Established measures are often interpreted in terms of a single dimension of temperament, such as negative emotionality, but any given behavior or set of behaviors in similar situations can actually represent multiple concepts of temperament. For example, the child's angry/frustrated emotionality can mark not only the tendency toward distress but also tendencies toward approach and mastery, as well as lagging growth in effortful self-regulation. In addition, a psychophysiological measure might map only approximately onto a behavioral dimension of temperament (Rothbart & Bates, 2006). Therefore, because we think of temperament variables as conceptual tools for describing natural phenomena rather than the phenomena themselves, our interpretations of measures are always provisional.

Each kind of measure has its own strengths and weaknesses—its own construct validational network of meanings. Caregiver ratings of child behavior across multiple modes of response in multiple incentive conditions are the most commonly used operationalization of temperament. Barkley (2012) has made a strong argument that caregiver ratings of child self-regulatory traits can have much greater validity than structured laboratory tasks, mainly because of the lack of ecological validity of the "cold cognitive" measures. Caregiver ratings are convenient, inexpensive, and psychometrically well understood. They do include components of subjectivity in the rater, but these are not greater than the components of objectivity, e.g., convergence with observer ratings (Bates et al., 2010; Bates & Bayles, 1984). So, especially concerning their advantages in the degree of ecological validity, caregiver ratings are useful in studies of development. Observational measures are often used, too, despite their greater expense. The most frequent observational approach is to measure child response to experimentally controlled situations, e.g., a room filled with a specified set of strange and noisy toys. Increasingly, there have also been biological measures of temperament-like constructs, such as sympathetic and parasympathetic responses, and cortisol reactions. Such measures are presumably more endophenotypical than overt behavior measures. There are even some reports of findings of genetic markers. A recent study (Raby et al., 2012), not explicitly about temperament, but nevertheless relevant, shows that serotonin transporter genotypes associated with lower transcriptional efficiency were associated with the infants' expressions of distress in the Strange Situation. Studies have sometimes found that distress in the Strange Situation is predicted by temperamental negative emotionality (Vaughn & Shin, 2011), so by analogy, serotonin transporter gene transcriptional efficiency could influence how an individual responds to other stressors and thus may explain why some individuals are particularly susceptible

to experience anxiety and depression in stressful environments (Petersen et al., 2012). No measure is unambiguous, not even the serotonin transporter gene, but a number of points of convergence have been found between different parent report scales, reports and observation, and bio-measures. The basic point here is that the concepts of temperament serve to organize a complex array of measures. Cross-measure generalizations can be drawn but should be viewed as provisional. Progress has been made, but construct development and validation (Cronbach & Meehl, 1955) are always ongoing.

## Associations Between Temperament and Developmental Psychopathology

This section considers two basic ways temperament could be developmentally related to adjustment—direct, linear connections and indirect and nonlinear ones. The most direct connections involve simple, linear processes, such as a psychopathology trait, e.g., social anxiety, representing a version of a similar temperament trait, such as distress in novel situations. Also linear, but more indirect, are influences that temperament might have upon the environment that then shape the development of child adjustment. Nonlinear processes involve interactions between different dimensions of temperament or between temperament and environmental variables in producing outcomes.

### Processes to Account for Linkage

Accounts of temperament's role would ideally include developmental processes through which temperament contributes to psychopathology. At least ten possible processes have been envisioned (Rothbart & Bates, 2006), including multiple subtypes of *direct effects*, such as fearful temperament increasing odds of the conditioning that produces an anxiety disorder; of complexly *mediated effects*, such as early irritability shaping conflictual, coercive relationships with parents and others, which then shape disordered emotion and behavior; and of mechanisms involving *moderated effects*, such as early irritability predicting behavior problems mainly among children who also are low in temperamental effortful control or children who have parents low in effective discipline. The following section summarizes emerging findings on predictive linkages and where possible and on mechanisms by which temperament relates to adjustment outcomes. First, the section on differential linkage shows support for relatively direct models of transmission from temperament to psychopathology. Next, some findings with mediation models are highlighted, in which temperament influences social transactional patterns that, in turn, help create (or fail to suppress) emotional and behavioral problems. Mediated mechanisms are demanded by theory, but empirical demonstrations of them are relatively sparse. And finally, some of the relatively extensive research on moderator mechanisms is summarized.

### Linear Connections

#### Differential Linkage Model

There appears to be continuity of styles of temperamental reactivity and self-regulation that eventually support homologous styles of social adjustment. Based on the accumulation of temperament-adjustment links emerging through the 1980s, including a number of longitudinal studies, we proposed what we have called the differential linkage model, in which the various temperament traits predict conceptually related dimensions of psychopathology (Bates, 1989a; Bates & Bayles, 1984). This model is not fully differentiated yet, but it is more constrained than the most general models in which a multiplicity of temperament traits predicts adjustment as a unitary variable. The general pattern is for the fearful dimensions of temperament, especially discomfort in novelty, to predict later internalizing problems better than they predict externalizing problems, for the self-regulation dimensions of temperament to inversely predict later externalizing problems better than they predict internalizing problems (even though, theoretically, aspects of self-regulation should also predict

internalizing problems), and for dimensions of negative emotionality and "difficult" temperament to predict both internalizing and externalizing problems more or less equally. Although much further work is needed, e.g., for clarifying the aspects of temperamental self-regulation that might be more strongly related to internalizing problems than externalizing, the general outlines and some variants of the pattern have been noted by a number of reviewers (e.g., Bates et al., 2012; De Pauw & Mervielde, 2010; Saudino, 2005). The linkages cannot be simply attributed to having similar item contents in temperament and pathology measures, because several studies have shown that removal of content that is most clearly overlapping does not appreciably reduce the association between temperament and adjustment measures. The links are also beginning to show up in associations between laboratory measures of temperament and similar dimensions of adjustment, e.g., novelty fear predicting anxiety symptoms (Kagan & Fox, 2006). Similar patterns of differential association have been emerging in biomarkers of temperament-relevant traits, such as high sympathetic nervous system arousal predicting anxiety (Manassis & Bradley, 1994) and low resting sympathetic nervous system arousal and low vagal reactivity predicting externalizing problems (El-Sheikh et al., 2009).

The differential linkage of temperament and adjustment is paralleled by the general findings of differential linkages between adjustment variables across time—i.e., early internalizing predicting later internalizing better than later externalizing and vice versa (Keiley et al., 2003). It is reassuring that the different dimensions of adjustment have at least somewhat separable roots in temperament. Not all elements of the model are clearly differentiated yet. The main overlap is the fact that difficultness and negative emotionality dimensions of temperament predict both internalizing and externalizing problems. This overlap, however, is consistent with the substantial co-occurrence of internalizing and externalizing problems epidemiologically and the fact that both dimensions involve negative emotion expressions (Achenbach, 1991; Mikolajewski, Allan, Hart, Lonigan, & Taylor, 2013). Another possible overlap is that low levels of effortful control might be involved in both internalizing and externalizing problems. This possibility is based on theory—effortful control ability would allow children to avoid anxiety problems by redirecting attention and inhibiting dominant fear responses and performing nondominant, but counterphobic responses—and also based on a few findings (Gartstein, Putnam, & Rothbart, 2012), including fMRI findings of less activation of brain regions involved in attention and cognitive control in inhibited adults than in uninhibited adults (Clauss, Cowan, & Blackford, 2011). And, assuming the centrality of these abilities, they would also be useful for avoiding impulsive approach (Newman & Wallace, 1993) and aggression and performing socially appropriate forms of assertion. Finally, another partial overlap involves temperamental fearfulness, which is sometimes found to predict lower levels of subsequent externalizing behavior (Kochanska, Aksan, & Joy, 2007), and not just high levels of internalizing behavior.

Further studies are needed to put some detail into the picture of temperament roots of psychopathology. One recent example of findings generally consistent with the differential linkage pattern is the study of mothers' perceptions by Gartstein et al. (2012), relating infancy and toddlerhood temperament to preschool age internalizing and externalizing problems. This study's findings support the model and point to possible refinements. The study used a differentiated negative affectivity (NA) construct, with separate measures for six different kinds of NA. Four of the six kinds, including low soothing, fearfulness, and sadness (as would be expected) and also frustration (as might not have been expected), predicted internalizing problems at preschool age. A slightly different four, including frustration, motor activation, as well as sadness and low levels of soothing, predicted externalizing problems. Fear and discomfort did *not* predict externalizing (confirming our original model). From another perspective, the comparison of the size of correlations showed that frustration was more strongly predictive of externalizing than internalizing behavior. The surgency dimension, including activity level, impulsivity,

and several positive affectivity scales, did not predict internalizing problems, but by toddlerhood, it did predict externalizing problems. However, only one of the six scales, activity level, predicted as an individual scale. The self-regulation dimension's effortful control factor from toddlerhood predicted externalizing to a stronger degree than internalizing problems. Of the six orienting and self-regulation scales, attentional focusing and inhibitory control were inverse predictors of later preschool externalizing problems and the others—low pleasure in low-intensity events or affiliativeness, soothability by caregivers, or ability to shift attention were not. The basic conclusion, in summary, is that early temperament dimensions predict later adjustment problems, at least internalizing and externalizing problems, to a substantial degree and in a logical pattern. The differential linkage pattern of findings suggests something about the temperament core of adjustment, but this is only the beginning of an account of the temperament's role in developmental psychopathology. There may turn out to be meaningful sub-threads of the temperament-psychopathology linkage.

## Mediator Models

Theoretically, as mentioned, early temperament could have its effect on the development of adjustment via impact on environmental factors. One example of a mediational model is the study of Kiel and Buss (2011), in which toddlers' fearful temperament predicted age-5 social withdrawal partly via mothers' protective behavior in toddlerhood. This mediated effect of maternal protectiveness was moderated by mothers' accuracy in predicting their toddlers' distress when exposed to standard novelty experiences. If mothers were accurate, their protectiveness explained a portion of the temperament-to-outcome linkage, but not if they were inaccurate. A second example is one in which low positive affectivity predicted low social support, which accounted for some of the linkage between low positive affectivity and depressive symptoms (Wetter & Hankin, 2009). Another example is provided by Zalewski, Lengua, Wilson, Trancik, and Bazinet (2011), who found that child self-regulation of frustration mediated between early temperamental effortful control and later depression and conduct problems. A pattern of low behavioral display of frustration in response to an experimenter repeatedly interrupting and changing a token sort task but normal levels of psychophysiological reactivity and subjective report of frustration predicted later symptoms of depression; and a more or less opposite pattern—high behavioral display of frustration and normal physiological and subjective frustration—predicted, to a trend degree, conduct problems. Finally, we mention a study by Zhou, Main, and Wang (2010), which suggests that child effortful control was associated with low levels of later externalizing problems via high academic achievement. Of the four studies mentioned, only one provided the classical 3-wave demonstration of mediation (predictor at the first measurement occasion, mediator at the second, and outcome at the third; Zalewski et al., 2011). We have seen very few other such studies, which is consistent with the relatively small numbers of such findings mentioned in previous reviews. Perhaps this is related to the methodological challenges in demonstrating mediation in longitudinal studies, as discussed by Cole and Maxwell (2003).

## Nonlinear Connections

Another kind of model of how temperament is related to later psychopathology is a moderator model—the implications of temperament for adjustment may depend on environmental differences or vice versa, or the implications of one temperament dimension may depend on an individual's level of a second temperament dimension. Despite studies on moderator effects having their own methodological challenges (McClelland & Judd, 1993), they have been published at a much faster rate than studies on mediation effects. Some patterns have been at least roughly replicated. Studies have considered how all three major dimensions of temperament, negative emotionality/inhibition, positive emotionality/

approach, and effortful control, interact with the major dimensions of parenting environment, warmth and control (both effective and harsh), as well as with a number of other qualities of children's environments (Bates et al., 2012; Bates & Pettit, 2007; Bush, Lengua, & Colder, 2010). This increasingly rich literature is not detailed here, but we do offer some theoretical remarks, some general summaries, and a few recent examples. There are almost no full replications across studies in the area, but there are beginning to be some converging findings, and the fact that similar patterns are found despite differences in measurement suggests some meaningful phenomena have been discovered.[3] We think of the different dimensions of temperament as reflecting particular sensitivities, e.g., fearful/inhibited temperament as sensitivity to threats or positive emotionality/approaching temperament as sensitivity to rewards (and perhaps comparative insensitivity to threats). The emerging literature suggests that the developmental implication of a temperament trait depends on the functionality of the trait in the child's environment. Specific generalizations are limited by the differences in measures and designs—e.g., comparisons across studies are often challenged by the key temperament measures representing relatively unique and complex mixtures of more basic temperament dimensions. However, some broad generalizations are still fair.

## Negative Emotionality X Environment

First, to consider interactions involving temperamental negative emotionality, children who are negatively emotional—especially if the emotion responds to novel people and places—are more likely than other children to develop adjustment problems if they are in either an overly supportive (Arcus, 2001; Kiff, Lengua, & Bush, 2011) or denigrating (Rubin, Burgess, & Hastings, 2002) environment. Subsequent studies have shown both kinds of moderated linkage between behavioral inhibition X challenging vs. harsh parenting and later anxiety problems, but the literature has not yet established the conditions under which the patterns do and do not hold (Kiff, Lengua, & Zalewski, 2011).

Another example of negative emotionality's prediction of later adjustment being moderated by environmental characteristics is the widely cited finding of Pluess and Belsky (2010): Children who were high on a composite of adverse temperament traits including negative emotionality showed a stronger predictive relation between the quality of parenting they received (sensitive, positively involved) and their social and academic adjustment than did the temperamentally easy children. That is, quality of the parent–child relationship mattered more for temperamentally difficult children than it did for easy ones. Difficult children with high-quality parenting even had slightly better outcomes than easy children with high-quality parenting. Mesman et al. (2009) provide a similar pattern of findings, in which children's linear slopes of externalizing problems were an interactive function of the child's adverse temperament and maternal sensitivity. In addition, the study by Kim and Kochanska (2012) is also relevant. In this study, self-regulation was not viewed as an antecedent for development, but rather as an outcome. Higher levels of mother–child "mutually responsive orientation," or harmonious, well-synchronized, positive involvement at 15 months predicted observed self-regulation (i.e., success in inhibitory control and compliance on "do" and "don't" tasks) at age 25 months, but only for children who were high in negative emotionality (anger in a frustrating situation and with parents) at age 7 months. Adding to the growing collection of crossover interactions involving negative emotionality, this study found that children who were high in negative emotionality and in high mutuality relationships with their mothers turned out to be more self-regulated at 25 months than

[3] Nevertheless, we keep in mind that the phenotypes we call temperament, whether caregiver ratings, observations of behavior, or observations of psychophysiological process, necessarily reflect a history of transactions with the social environment as well as inborn tendencies. At the same time, the phenotypes we call environment also reflect a history of transactions with the child as well as inborn tendencies (of the parents and children).

children who were low in negativity, whereas in low mutuality relationships, highly negative children turned out to have lower self-regulation than the low negative children. In a similar but not crossover interaction, Kochanska, Philibert, and Barry (2009) reported that children with the risk allele of the serotonin transporter gene, which we interpret as related to temperamental negative emotionality, showed low levels of self-regulation across early childhood if they had been insecurely attached to their mother, but showed levels of self-regulation that were as high as the children without the risk allele if they had been securely attached.

To summarize, although the studies suggest that all children benefit from good quality care, more negatively reactive children appear to need and respond to good-quality care (or its absence or unpredictability) to a somewhat stronger degree than children lower on negative emotionality. There is some thinking that such findings imply that more is involved than simply the amount of negativity the child shows, suggesting an evolutionarily based alertness to the affordances of the social environment (e.g., Ellis, Boyce, Belsky, Bakermans-Kranenburg, & Van Ijzendoorn, 2011). Alertness is an interesting possible frame, but evidence for this interpretation is limited at this point. At the moment, there appears to be more support for an interpretation centered on the implications of temperamental negative emotionality. Studies have not provided a precise delineation of the core, endophenotypical temperament, or environmental features in such interactions. The pattern may or may not apply to all of the theoretical dimensions of temperament that could be represented in the negativity composites (e.g., high approach-related frustration, high sensitivity, high distress from novelty or sensory stimuli, low self-soothing). Already, a different pattern has emerged for more particularly fearful negative emotionality—in which temperamentally fearful children develop fewer anxiety problems when their parents are neither too undercutting nor too protective from social and other consequences.

## Positive Emotionality X environment

A second domain of temperament X environment interactions in the development of behavioral adjustment involves children's positive emotionality or extraversion (Rothbart & Bates, 2006). What parenting environment would be especially relevant for children high or low on positive emotionality in the development of behavioral adjustment? The important parent–child conflicts for children high on positive emotionality would pertain to the child's need for upper-limit control (Bell, 1968), involving excessive, poorly modulated actions (Newman & Wallace, 1993), as well as self-centered and dysregulated bids for control of others' attention and action (Spivack, Marcus, & Swift, 1986). An earlier study of ours considered the role of a temperament dimension of resistance to control (of approach behaviors), which we assume to pertain, in part, to children's strength of approach tendencies. Early resistant temperament predicted later externalizing adjustment, but more so if the early mother behavior pattern involved relatively low levels of control of the child (Bates, Pettit, Dodge, & Ridge, 1998). Of course, an alternative interpretation of the behaviors marked as resistance to control is a lack of effortful self-regulation, which itself could be a temperamental variation, especially in early childhood. Indeed, we think that as individual differences in effortful control emerge in year 2 and beyond, more and more of the phenotypes of positive and negative emotionality also reflect the child's regulatory dispositions and skills. A second, more recent example has used a dopamine gene (*DRD4*) measure, regarded as a possible root of temperament. This interpretation of *DRD4* is supported by the demonstrated approach and approach-regulation functions of dopamine (Bakermans-Kranenburg & van Ijzendoorn, 2007) (also see Ellis et al., 2011). Children with the risk allele for this gene show a stronger linkage between sensitive parenting and child non-aggressiveness than do children without the risk allele, who show little aggressiveness whether they get low or high sensitivity from their parents.

## Effortful Control X Environment

A third domain involves relatively early-appearing differences in child effortful self-regulation. This, like all temperament concepts, is not simple; it can be defined in terms of neurocognitive development, but it must also include neuroaffective development, because motivation is an important part of regulation (Barkley, 2012; Rothbart & Bates, 2006). There may be related but distinct endophenotypes within the domain of effortful control, including an ability to direct attention away from distressing stimuli, an ability to direct attention in response to abstract task demands, a working memory to keep goals and procedures in mind, a sense of self (Barkley, 2012), an ability to respond to another person's request or command (a major facet of our ICQ scale of resistance to control or unmanageability of approach behaviors; Bates et al., 1998), and eventually to be able to inhibit behaviors on the basis of internal representations (Barkley, 2012). It would be convenient if these all turned out to be part of an organized developmental sequence, but it is possible that they are not so tightly linked. The abilities may have separate threads of development, starting with their constellations of genes and psychophysiological signatures. However, despite many unresolved conceptual and methodological issues, we are especially encouraged by the literature on how early self-regulation interacts with environmental variables in forecasting later adjustment. It provides the promise of improved focus of prevention programs. Young children who are lagging in their ability to inhibit approach responses are at risk for developing externalizing behavior problems, but especially so if they experience below-average levels of parental management (Bates et al., 1998). A similar pattern, from another perspective, involves peer influences. Peer influences—whether toward deviant or nondeviant behavior—were the largest for youths who were low in ability to inhibit their own reward-seeking actions in a game with a mixture of rewarded and punished stimuli, according to findings of a study by Goodnight, Bates, Newman, Dodge, and Pettit (2006). Similarly, peer deviance was less associated with the delinquent behavior of youths who were temperamentally more regulated, responsive, and positive (Mrug, Madan, & Windle, 2012).

## Other Temperament Interactions

Temperament X temperament interactions are also of interest. Just as the meaning of a temperament trait should depend on its social-environmental context, so should the meaning of a temperament trait be framed by the individual's other temperament traits. So far, a solid handful of studies have emerged showing that negative emotionality matters more for the development of behavior problems when it is accompanied by low effortful control, for externalizing (Eisenberg et al., 2000), internalizing (Lonigan, Vasey, Phillips, & Hazen, 2004), and both internalizing and externalizing outcomes (Muris, Meesters, & Blijlevens, 2007).

Other temperament variables might also interact. A few examples of expanded interaction models are starting to emerge, too. One is the finding by Buss, Davis, and Kiel (2011) of a 3-way interaction between fearful temperament, a physiological stress composite (summing indexes of cortisol, sleep deficit, low birth weight, and cardiac vagal tone), and also a more purely environmental composite of parent personality and social class in predicting child anxiety problems at age 3 years. Children who had high temperamental fear and had a high-stress environment showed the strongest association between the physiological stress index and later levels of anxiety problems. Physiological stress was not much associated with later anxiety in a low-stress environment. And non-fearful children showed few anxiety problems whether they were high in physiological stress responses or in a high-stress environment or not. The Buss et al. (2011) study provides an example of a temperament X temperament X environment interaction effect. A second example is the finding of Schermerhorn et al. (2013) that children high in novelty distress who

were also high on resistance to control (unmanageability) were especially likely to develop later externalizing problems if they were in a high-stress environment. This was as predicted because it was assumed that chronic arousal due to family stress would amplify dysregulated, aggressive tendencies especially for the more fearful children.

## Summary

The studies described are just a sampling of the many noteworthy descriptions of temperament X environment interactions in the literature. Findings of temperament X environment interactions in the development of adjustment were expected theoretically, in a general sense, many years before advances in methods allowed the first converging findings on particular patterns of interaction (Bates et al., 1998). Close replications are much needed in this area (as well as other areas of developmental research—Duncan, Engel, Claessens, & Dowsett, 2012). However, there are enough converging patterns that we can hypothesize some specific temperament X environment interactions in shaping development. First, young children who are high on one aspect of general negative emotionality component, irritability, which might reflect, in part, sensitive awareness of environment, will be especially sensitive to family deficits in warmth and effective parental control and excesses in harsh control and therefore in such families be more likely to develop behavior problems. And they may also be especially advantaged when their family has the opposite parenting qualities. Second, children who are high on a particular kind of negative emotionality, fearfulness, would be especially sensitive to the environments' affordances of security and protection, and those with too little support or too few growth challenges are especially likely to develop anxiety problems. Third, young children whose effortful self-regulation abilities are slow in developing will be especially sensitive to properties of effective control. It appears likely that the higher the early self-regulation, the fewer the conflicts the child has with the environment and the fewer the chances to perfect skills of coercive control and the more chances the child is given to pursue rewarding prosocial and autonomous skills. However, with caregivers who effectively scaffold the slowly developing self-control of the child, even the child who is low in self-regulation can end up with a socially successful adjustment. Several other temperament X environment contours are emerging (Bates, 2012), but the three listed represent the three of most interest to us at this time. The patterns described are quite complex. However, none of the interaction effects described so far accounts for large amounts of variance. It will be interesting to see the extent to which models with multiple temperament and multiple environmental dimensions, extending beyond Buss et al. (2011) and Schermerhorn et al. (2013), ultimately provide more precise descriptions of adjustment outcomes.

## Conclusion

The evidence suggests that temperament traits are implicated in the development of psychopathology, at least the most common, internalizing and externalizing dimensions of adjustment. It is likely that the measured phenotypes of child temperament reflect some degree of experience, but it also appears likely that behavioral phenotypes are systematically associated with biological processes, including genes, neurotransmitters, and psychophysiological responses, and that these have comparable associations with behavioral adjustment. Biological processes are not, in theory, free of environmental influences, but they are regarded as more based in constitution than behavioral phenotypes. We have summarized evidence suggesting that particular temperament dimensions are differentially predictive of particular adjustment dimensions in ways that fit the concepts. For example, children's early fearful temperament predicts later anxiety problems better than it predicts later lack of aggression, and early impulsivity traits predict later aggressive problems better than anxious problems. Although such predictions are quite robust, they do not

predict so much of the variance or provide such a precise theoretical account that they can be considered of high practical value. Toward this, research has recently been testing models of how temperament might influence environment qualities that then account for the development of adjustment differences. A number of such mediational findings have been offered but too few for confident cross-study generalizations. The relative lack of such mediational findings may be due to methodological challenges (such as having the relevant measures at the right times across development), but it may also pertain to a more substantive possibility—that temperament does not have a consistent impact on parent–child relationships. Although there are a number of findings of associations between child temperament and parental behavior in aggregate, the effects are quite limited (Bates et al., 2012). This relative lack of findings could reflect a failure to include measures at the right level of individual or social processes. However, it is also possible that some of this relative lack of findings might mean that parents are adaptable—they can respond to children's temperament traits in more and less functional ways, thus influencing the likelihood of behavior problems developing out of the child's early personality. This possibility has recently acquired a relatively large number of empirical examples, with some converging findings on how child temperament traits matter more for future adjustment in some environments than others. Environments that compensate for child temperament risks—e.g., sensitive management for a negatively reactive child or effective control for an impulsive child or low stress for a child with both high unmanageability and high novelty distress—reduce the association between a temperament risk and later adjustment. In addition, with development, children are increasingly able to self-regulate, another way that adverse temperaments can be prevented from causing social conflicts and emotional and behavioral problems, as shown by the findings of interactions between negative emotionality or fearfulness X effortful control in predicting adjustment. Patterns such as these and others we have mentioned are particularly interesting to us because they raise testable intervention questions (Bates, 2012). For example, in parent behavioral therapy for children with early anxiety and negative emotionality problems, would it be helpful to emphasize, relative to the other elements of the intervention, the parents' finding ways to increase their power to withhold attention from anxious coercion and to promote child mastery efforts? Would it lead to more effective problem solving and ultimately better reductions of child anxious coercion?

The current directions of research are quite exciting. Studies are using more precisely described biological endophenotypes and genotypes that both map onto and extend concepts of temperament and developmental psychopathology. And studies are using more precisely described and theoretically grounded environment dimensions that are also advancing understanding of how transactional processes between child and environment shape development. Rich longitudinal studies, more frequent in recent years, are highly useful for evaluating the mediator, moderator, and mediated moderation processes that are theoretically involved in linking temperament and later adjustment. Finally, another trend, just gathering momentum (e.g., Scott & O'Connor, 2012) is for experimental—usually intervention—studies to evaluate treatment X temperament interactions. Such studies will not establish developmental process, but they will be an important complement to longitudinal studies. As the area of research proceeds, findings will begin to show practical usefulness for designing prevention and early intervention programs. Many behavior problems have a temperament core, but the reverse does not have to be true—temperament traits do not have to become behavior problems.

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