

Temperament and coping: Advantages of an individual differences perspective

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Abstract

This paper examines the advantages that arise from an individual differences approach to children's coping and vulnerabilities. It suggests that the basic motivational and attentional systems involved in temperament constitute relatively primitive coping mechanisms. With development, these primitive coping skills are aided by representational and other cortical functions, allowing the coping process to begin before a stressful event and thereby increasing the child's capacity to plan an effective coping option and to enhance self-control. Such an emphasis on motivational and attentional differences allows us to take advantage of children's diverse personalities as "experiments of nature" and to better understand the temperamental patterns that contribute to adaptive and maladaptive outcomes.

The idea of "experiments in nature" has a rich history in psychology. For over a century, researchers in neuropsychology have studied the effects of localized brain damage on cognitive functions. By investigating the consequences of these unfortunate accidents, neuropsychologists have revealed some of the basic principles underlying brain function and have generated models of specific processes ranging from simple reflexes to perception to the most complex thought (Rapp, 2001). Similarly, researchers in psychiatry and clinical psychology have taken advantage of the natural experiments afforded to them by patients with emotional disorders, enabling "manipulations" impossible to accomplish in a laboratory. Again, the findings have been far-reaching, providing general frameworks and specific mechanisms for understanding emotion and its role within the human personality (Davidson, Scherer, & Goldsmith, 2003).

The value of these approaches should not be too surprising; after all, much of the early understanding of physiology was based on medical disorders. However, the utility of such natural experiments need not be limited to disorders. Human individuality is salient in virtually all domains, and this diversity provides a valuable tool for revealing underlying processes and mechanisms. Even within the "normal" range, researchers can compare individuals whose differences are subtle or profound and through these differences gain a better understanding of the underlying processes and their development.

In this paper, we discuss the usefulness of experiments of nature as viewed within a temperament framework. Like most approaches to personality, temperament models attempt to understand the underlying dimensions along which people differ. The dimensions on which we focus are positive emotionality (e.g., extraversion, impulsivity) and negative emotionality (e.g., neuroticism, anxiety, depression), as well as other dimensions involving self-regulatory capacity (e.g., effortful control, attentional control). What makes the tempera-

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ment approach unique is its underlying assumption that these dimensions have a physiological basis (i.e., a person's location along the dimension depends on the strengths of underlying neural systems). It is assumed that these neural systems carry out specific functions crucial to survival, in particular those related to basic motivational needs. In short, temperament approaches are biologically based, functional frameworks that attempt to explain individual differences (Rothbart & Bates, 1998).

We begin by describing the general neural systems and their relation to personality dimensions. We suggest that the temperamental systems can be viewed as coping mechanisms, with personality differences arising from the diverse ways people try to cope and the efficiency of that coping. This view of coping is broader than that used by some researchers. We include both voluntary and involuntary responses to stressful situations where either fear or frustration are the sources of stress. In the second section, we extend the individual differences analysis to childhood psychopathology by focusing on symptoms that arise from systems that are underreactive or overreactive. An underlying theme is that vulnerability arises from inefficiencies in coping functions, which in most cases involve the interplay of multiple temperament systems. In the final section, we move beyond the primitive coping mechanisms and consider some of the cognitive processes that extend their capacity during later childhood and adolescence. We focus on a specific coping strategy, planning, and consider its consequences for different children. In each of these sections, our general emphases will be on how individual differences impact/inform vulnerability and coping, but we try to point out the other advantages of an individual differences approach.

Personality Organization and Functioning

To understand personality differences, temperament theorists focus on the relatively enduring "reactivity" or "responsivity" of specific neural systems. Such reactivity is thought to arise from each system's physiological parameters, such as the amount of neurotransmitter released, the number of receptors, and the extent of dendritic branching. The systems

are organized to regulate one another, such that tonic and phasic activity depend on the system's underlying reactivity and the converging regulatory influences. Although it is possible to specify a number of relevant systems, we will limit the present discussion to three: an appetitive system, a defensive system, and an attentional system.

Temperament systems and personality dimensions

The appetitive system is involved in seeking and approaching rewards. Alternative formulations of this system can be found in Gray's (1987b) *behavioral activation system*, Panksepp's (1998) *expectancy foraging system*, and Depue and Collins' (1999) *behavioral facilitation system*. In general, the neural circuitry involves evaluation of rewards within orbital frontal and limbic regions (e.g., amygdala and hypothalamus), connections to approach responses within the ventral striatum and brainstem, and a general facilitatory influence arising from midbrain dopaminergic neurons. As reactivity within this circuitry increases, the individual becomes more sensitive to rewards, more likely to experience emotional feelings such as desire and hope, and more likely to show approach behavior. The appetitive system is most commonly related to the adult personality dimension of extraversion, such that reward sensitivity and approach increase as one moves from introverted to more extraverted individuals (Eysenck & Eysenck, 1985; Gray, 1987a). In the case of young children, the relevant dimensions have been referred to as "positive emotionality" or "surgency" (Rothbart & Bates, 1998).

In contrast, the defensive system is involved in detecting and avoiding dangers. Formulations include Gray's (1982) *behavioral inhibition system*, Panksepp's (1998) *fear system*, and Gilbert and Trower's (1990) *defense system*. Like the appetitive system, the defense pathways are primarily subcortical. Relevant circuitry again interconnects processing systems with the orbital frontal, limbic (amygdala and hypothalamus), and brainstem (periaqueductal gray) regions. As reactivity across these connections increases, individuals show greater sensitivity to punish-

ments, more fearful and anxious emotions, and behaviors favoring inhibition and avoidance. Relevant personality dimensions include neuroticism and negative emotionality (Eysenck & Eysenck, 1984) or more specific trait dimensions such as anxiety and shyness (Gray, 1982)

The attentional system most relevant to temperament is Posner's *anterior attentional system* (Posner & Raichle, 1994), although a similar formulation can be found in Shallice's *supervisory attentional system* (Stuss, Shallice, Alexander, & Picton, 1995). In Posner's model, the *posterior attentional system* is involved in orienting attention from one location to another and involves circuits interconnecting the parietal cortex, superior colliculus, and thalamus. This orienting system can be involuntarily recruited by the appetitive and defensive systems, for instance when attention is reflexively drawn to a potential reward (the smell of good food) or danger (a sudden loud noise). In contrast, the anterior attentional system is a higher level system that takes more highly processed information into account and allows for more voluntary control of processing. It involves a set of frontal circuits focused on the anterior cingulate region. Crucial functions of the anterior system include voluntary control over the posterior system's orienting, the inhibition of dominant response tendencies, the inhibition of dominant conceptual associations, and, more generally, the detection and control of errors (Posner & DiGirolamo, 1998). As the anterior system functioning increases, the individual shows increasing voluntary control over orienting, conceptual processing, and behavior, allowing greater flexibility and control over dominant tendencies. This capacity is best reflected in Rothbart's dimension of effortful control in the developmental literature (Rothbart, Derryberry, & Posner, 1994). We have used a similar measure of "attentional control" in studies of college students (Derryberry & Reed, 2002), and in the adult literature, dimensions of conscientious and openness are also related.

Our exposition of temperament systems is admittedly conservative and sidesteps a number of important issues. One involves the likely possibility that there are other neural systems relevant to temperament. For example, Mac-

Donald (1992, 1995) has suggested the importance of an *affectional system* related to nurturant behavior, which might be related to the personality dimension of agreeableness. Along similar lines, it could be argued that more than one defensive system is required. Gray and McNaughton (1996) distinguish between anxiety and fear systems, and both evolutionary (Marks & Neese, 1994) and clinical approaches (Zinbarg & Barlow, 1996) can be used to identify even more systems. Furthermore, rather than showing the one to one relation between neural systems and personality dimensions as described above, it can easily be argued that personality dimensions arise from the converging activity of multiple systems. For example, Gray (1987b) has suggested that extraverts possess strong appetitive systems and weak defensive systems, with the reverse being true of introverts.

The point we want to make here is that these issues cannot be readily solved through existing experimental techniques. We do not know enough yet about neuroanatomy or neurochemistry to dissect highly specific systems and trace their connections to personality-relevant behaviors. On the other hand, we can take advantage of an individual differences framework and make use of personalities as natural experiments. By looking at the structure of correlations for different types of motivation and emotion within individuals, we can test the utility of various models consisting of different sets of underlying systems. Correlations between seemingly different attentional and response processes (e.g., approach and avoidance) will also clarify the structure of the underlying systems. This will be a long-range task, but as we hope to show in the following sections, we can already see evidence of its usefulness. At the same time, an individual differences framework will always be able to accommodate physiological evidence as it becomes available.

Temperament systems as functional mechanisms

A major advantage of a temperament approach is that its focus on underlying neural systems provides a highly functional view of personality. The appetitive and defensive circuitry con-

stitute motivational systems that have evolved to detect and respond to stimuli that are crucial to the survival needs of our species. Depending on the person's experience, the stimuli that activate these systems can range from simple perceptual events (e.g., food, pain) to the most abstract forms of conceptualization (e.g., personal accomplishments, potential failures). It is important that the systems' response is twofold, involving both behavior and attention (Derryberry & Reed, 1994; Gray, 1982). At the behavioral level, the defensive system responds to danger by inhibiting ongoing behavior, preparing an avoidance response, and adjusting autonomic and endocrine functions. However, at the same time, the defensive system directs attention to important environmental information, such as the danger itself and various sources of safety (e.g., escape routes; Derryberry & Reed, 2002). This attentional function is particularly important because by selectively facilitating information, attention can influence processing at conceptual levels and in a sense motivate and guide the person's thought (Derryberry & Reed, 1996). When combined, the motivated cognitive and behavioral responses give rise to an experienced emotional state, such as anxiety or relief in the case of defensive activation and hope or frustration in the case of appetitive activation. Because they organize behavioral, cognitive, and emotional functions, the motivational systems provide a powerful integrative tool for studying personality differences.

Furthermore, the appetitive and defensive systems can also be viewed as relatively primitive "coping" systems. The defensive system is designed to help the person cope with dangerous situations where it is crucial to recognize the threat, inhibit inappropriate responses, and find a source of safety. In contrast, the appetitive system is designed to help the person attain positive outcomes in appetitive contexts, where it is crucial to avoid or overcome obstacles in order to obtain the reward. In carrying out these functions, the subcortical motivational systems can access cortical attentional systems to make their coping responses more effective. Although the subcortical processes are highly reactive and often involuntary, they can access the anterior attentional

system to provide more voluntary control (Derryberry & Rothbart, 1997). Because the anterior system can regulate a vast array of conceptual information, more information is available prior to the response, and thus coping should be more effective. When we consider individual differences, we would expect to see differences in both the types of coping and their efficiency across personalities.

To provide a more concrete example of such coping functions, consider the circuitry of the defensive system. This circuitry interconnects processing systems within the brainstem periaqueductal gray, the limbic systems, and the frontal cortex. As one moves from the older brainstem to the newer cortical circuits, the motivational functions are extended in time from the immediate present to the near future to the more distant future. This temporal extension allows an increasing precision and flexibility in controlling behavior and attention. For example, the periaqueductal gray contains discrete columns that activate specific action patterns involving explosive escape (e.g., a predator closes in and an escape route is available), defensive aggression (e.g., the animal is cornered with no escape route), and tonic immobility (e.g., the animal is contacted or injured by the predator; Bandler & Keay, 1996). The limbic stations (hypothalamus, amygdala, and hippocampus) provide for more anticipatory, conditioned forms of anxiety, as when a signal predicts that a danger is present, will be present very soon, or has recently been present in the environment. These situations allow more time for more complex forms of defense, such as passive avoidance (not approaching the dangerous situation), directed avoidance toward a source of safety, and risk assessment (a combination of cautious approach and passive avoidance; Gray & McNaughton, 1996). The defensive functions of the frontal circuits are not well understood, but it is generally believed that these regions allow humans to process more abstract conceptual threats and use short-term memory functions to project them into the future. Thus, we tend to worry about various aspects of our selves (health, performance, morality, etc.), and we construct voluntary and elaborate coping strategies to alleviate these concerns. As can be seen, the defensive circuitry

provides many distinct coping options, depending on spatial and temporal proximity of the threat and its concrete or abstract nature.

A related advantage of viewing coping from a temperament perspective is that it affords a broader view of the general types of situations with which people must cope. Most of the coping literature emphasizes the types of stressors mentioned above that are likely to engage the defensive system, within which the individual tries to avoid danger and find safety. These are, of course, common forms of coping, but coping is also generated by activation of the appetitive system. In this case, the system carries out the function of approaching reward and avoiding obstacles. Not only must the obstacles be overcome but also must the frustrative and angry states that can interfere with effective approach. Such frustrations are not limited to physical obstacles; they can also arise from difficulties in domains involving social inclusion, social status, achievement, and morality. This is admittedly a broad approach to coping, but as will be seen in subsequent sections, it is helpful in linking coping strategies to externalizing, as well as internalizing, problems.

Interactions between traits and states

Apart from these functional issues, an obvious advantage of an individual differences framework is that it allows us to view individuals along continuous dimensions reflecting their motivational and attentional functioning. It may be natural to dichotomize people in categorical terms such as extravert versus introvert, but this oversimplification can obscure much of the important diversity in human personality. Thinking of behavioral, emotional, and cognitive processes as continuous provides much greater resolution of the underlying differences, for we can investigate relatively subtle differences between individuals who are closely together on the dimension. In the following sections, we will focus on the low and high ends of the dimensions in discussing psychopathology (e.g., low and high in anxiety), keeping in mind that people in the moderate range provide crucial reference points for understanding the extremes. By thinking in terms of continuous dimensions, studies of

“normal” personalities can inform our understanding of psychopathology, and conversely, the study of psychopathology can inform our understanding of normal personality.

Individual differences approaches become particularly powerful when multiple systems or dimensions are taken into account. Sometimes the two systems may exert independent additive effects on behavior, as in Kochanska's (1997) findings that the development of consciousness is facilitated in children who are either fearful or high in effortful control. In other instances, Trait \times Trait interactions may appear (Eisenberg, Fabes, Guthrie, & Reiser, 2000; Rothbart & Bates, 1998). For example, social competence can be predicted by an interaction of negative emotionality and regulatory skill in 6- to 8-year-olds (Eisenberg et al., 1997). Whereas regulation alone predicts social competence, the degree of prediction is stronger for children high in negative emotionality. Such studies demonstrate the added resolution and predictive power that becomes available when multiple temperament dimensions are considered simultaneously.

The resolution provided by temperament dimensions can also be exploited to study specific personality processes and states. Many processes are subtle and difficult to study in the laboratory, in part because they are weak or even absent in some people. However, if the researcher takes advantage of an individual differences dimension, they can amplify the process and study it more effectively. For example, Kochanska and colleagues used fear as a temperament dimension to more precisely study the affective and behavioral components of guilt in 2- to 4-year-olds (Kochanska, Gross, Lin, & Nichols, 2002). The results supported a mediational model in which the trait of fear facilitated the state of guilt, which in turn inhibited the child's tendency to violate rules. Such Trait \times State interactions are valuable tools, for we can learn more about emotional states by looking at their expression across different people and, conversely, we can learn more about the underlying traits by examining their expression across different states.

As an example from our own research, we have spent years trying to develop reaction time techniques for studying “attentional

avoidance" (i.e., attentional shifts away from a negative stimulus). This type of avoidant state has been central to many theories for many years, and yet there is very little experimental evidence of it. First we tried working with a general population of college students but no evidence of avoidance appeared. Then we included trait anxiety as a between-subjects variable, but the evidence was still ambiguous. Eventually, we added a self-report measure of attentional control, and only then found evidence of attentional avoidance (i.e., a Trait \times Trait \times State interaction). Within highly anxious subjects, those with poor attentional control had difficulty shifting from a dangerous location, whereas those with good control were better able to shift away (Derryberry & Reed, 2002). Isolating this effect could not be done without an individual differences framework, and in this case, it took two dimensions to reveal it.

The examples above are not limited to temperament models, for similar advantages are also inherent in other approaches emphasizing dimensional differences. One unique aspect of temperament approaches is that they view the underlying neural systems not only as functional systems in themselves but also as a set of interacting regulatory systems. The reward-related approach system can be viewed as the initial and most basic driving force within the child. As the defensive system begins to develop late in the first year of life, it functions in a reactive manner to inhibit the appetitive system and protect the child from approaching dangerous objects and situations. As the frontal attentional system develops, beginning in the first year but continuing across many years, both the appetitive and defensive systems are brought under increasing voluntary control (Derryberry & Rothbart, 1997; Rothbart, Derryberry, et al., 1994). This simple model will undoubtedly become more complex in the coming years. For example, regulatory mechanisms related to nurturance are intriguing in their nonselfish nature, with appetitive and defensive functions reassigned to serve another person rather than the self. One might argue that nurturant behaviors are, in large part, learned and often require voluntary effort, but at least in the case of parental

behavior, we appear to have a capacity with deep roots across much of the animal kingdom.

In addition to delineating these types of "central" regulatory systems, future theorizing needs to consider their more peripheral controls. In many instances, motivational functions are themselves regulated by fluctuating hormonal processes across relatively long time frames. For example, a key transmitter across much of the defensive circuitry is corticotropin-releasing factor. This peptide is modulated by the fluctuating levels of the adrenal hormone cortisol, which appears to play important roles in children's coping responses (e.g., Cicchetti & Walker, 2001; Gunnar, 1994). More centrally, a variety of motivational and attentional functions are regulated by central monoamines such as serotonin, norepinephrine, and dopamine. Individual differences in monoamine levels are central to current theories of depression, as well as certain forms of panic and aggressive disorders (Fowles, 1994; Gray, 1994). Finally, it has been suggested that parasympathetic activity provides a central means for regulating motivational functions (Beauchaine, 2001).

It can be seen that future models of temperament will need to incorporate a variety of additional regulatory systems. Fortunately, these are active areas of research and progress should be forthcoming. "Basic" research in psychology and the neurosciences will be essential, but its application to the real world will depend very strongly on frameworks that accommodate individual differences. Indeed, one could argue that such applicability to the real world is one of the greatest strengths of an individual differences approach. This advantage becomes particularly salient when we move beyond personality and consider psychopathology.

Temperament, Coping, and Vulnerability

In approaching psychopathology, temperament models emphasize individuals falling at either the low or high end of the underlying dimensions. It is worth noting that most of these approaches make no strong assumptions regarding the relative roles of heredity and experience in producing such vulnerabilities.

Children may be more or less reactive for genetic reasons related to the functioning of their motivational and attentional systems. However, these systems are also influenced by other nongenetic processes, such as ongoing fluctuations in the various monoamine and hormonal systems. In addition, the motivational and attentional systems are tightly linked to the child's developing cognitive representations (e.g., of the self, of others), which can change across time to progressively modify activity within the underlying temperament systems. Most obviously, changes in the child's environment can lead to relatively dramatic changes in his or her motivational and representational systems. Although we will emphasize relative enduring processes, this does not mean that an underlying vulnerability will be completely stable across years or even months.

Temperamental sources of vulnerability

In any event, the appetitive and defensive systems may at times become underreactive or overreactive. Children with overreactive defensive systems may be vulnerable to anxious disorders characterized by fearful, inhibited behavior along with worrisome, pessimistic thought. In contrast, children with underreactive defensive systems may be vulnerable to impulsive disorders characterized by an inability to anticipate negative outcomes and behavioral disinhibition. More manic forms of impulsivity may arise from an overreactive appetitive system that generates strong approach behavior accompanied by reward-oriented and overly optimistic thought. Conversely, an underreactive appetitive system may contribute to depressive problems, in which the child has difficulty anticipating rewards and generating approach (e.g., Fowles, 1994; Gray, 1994; Lonigan, Hooe, David, & Kistner, 1999).

Additional models have attempted to explain disorders involving relatively spontaneous symptoms as a result of disinhibition within lower levels of the defensive circuitry. As mentioned above, the periaqueductal gray contains distinct circuits related to explosive escape, defensive aggression, and tonic im-

mobility. Normally, the periaqueductal gray is under strong inhibition by serotonergic neurons; but if the serotonin constraints become depleted, spontaneous defensive systems may be released. Some models attempt to explain spontaneous panic attacks in terms of overactivity in specific circuits controlling escape behavior (Barlow, Chorpita, & Turovsky, 1996; Gray & McNaughton, 1996). In addition, some have suggested that overactivity in circuits related to defensive aggression may give rise to spontaneous anger attacks (Barlow et al., 1996) and that the tonic immobility circuits may be related to some depressive symptoms (Bandler & Shipley, 1994).

Although these models provide a useful start in viewing psychopathology, they become more powerful when multiple dimensions are taken into account. As mentioned above, "impulsive" problems can arise from an overreactive appetitive system or an underreactive defensive system. This suggests that the children most vulnerable to impulsive and conduct problems will be those who are high in appetitive and low in defensive motivation (e.g., fear of getting into trouble). Because the defensive system normally inhibits approach behavior, low fear may amplify already strong approach tendencies. Quay (1993) has reviewed studies of children with undersocialized aggressive conduct disorder, characterized by predatory or instrumental forms of aggression (e.g., bullying, threatening). He suggests that aggressive acts reflect disinhibited approach tendencies, arising in part from diminished activity within the fear system. Finally, if we consider individual differences in effortful control, a child with good attention should be better able to constrain his or her impulses even though he or she has no fearful inhibition. However, if the child is low in effortful control, then the impulsive symptoms may be exacerbated. These predictions are supported by negative correlations between effortful control and the major factors of surgency and negative emotionality in Rothbart's model, as well as negative relations between effortful control and aggression (Rothbart, Ahadi, & Hershey, 1994). Eisenberg et al. (1996) looked for a moderating effect on externalizing behavior problems (e.g., arguing,

lying) and found such problems to be higher given poor attentional control, but only for children prone to negative emotionality.

In the case of internalizing disorders, it appears that children with strong defensive and weak appetitive motivation will be at greatest risk. Anxious children with stronger appetitive motives may be more likely at times to approach threatening situations due to their potentially rewarding aspects, and the children's pessimistic thought may be flavored with some optimism. In addition, attentional control should play an important role in moderating anxiety. Research in our laboratory has used a task in which detection targets are presented at a threatening location (where failure occurred 75% of the time) or a safe location (where success occurred 75% of the time). When targets appeared 250 ms after one location was cued, all anxious subjects were slow to disengage from the threatening location. This is consistent with many other studies showing threat-related biases in anxious people. However, when the target appeared 500 ms after the cue, only anxious students with poor attentional control showed poor disengagement; those with good control (like all low anxious subjects) could readily shift from the threatening to the safe location (Derryberry & Reed, 2002).

In young children, the ability to shift from threat to some source of safety or reassurance may help them to reduce their anxiety and perform more effectively. If this ability is limited, they may become fixated on the source of threat and cannot take advantage of safety cues in order to mobilize a coping strategy. These ideas are supported by findings of negative relations between effortful control and anxiety in adults (Derryberry & Rothbart, 1988) and children (Rothbart, Ahadi, et al., 1994). More recent research has found attentional control to moderate the effects of negative emotionality on social competence (Eisenberg et al., 1997) and shyness (Eisenberg, Shepard, Fabes, Murphy, & Guthrie, 1998). In both cases the strongest relation with attentional control occurs when negative emotionality is high.

Temperament models also provide accounts of comorbid disorders. For example, external-

izing and internalizing disorders often co-occur, as in impulsive children with high anxiety. This would most likely occur in a child with highly reactive appetitive and defensive systems, with the most dominant symptoms related to whichever system is most reactive. Such a child may show conduct problems, but would still be able to anticipate negative outcomes and to feel anxious or guilty afterward (Derryberry & Rothbart, 1997). In addition, the amount of impulsivity would be less than that of a low anxious child, because the defensive system would still constrain the appetitive motivation. As expected, children with coexistent attention-deficit/hyperactivity disorder (ADHD) and anxiety show reduced impulsivity relative to those with ADHD alone (Pliszka, 1989), and aggressiveness appears to decrease between kindergarten and first grade in children who show internalizing patterns (Bates, Pettit, & Dodge, 1995). Comorbid internalizing and externalizing problems may appear in children who are not extremely high in their motivational reactivity but whose poor effortful control leaves them vulnerable. Eisenberg, Padada, and Liew (2001) have reported lower attentional regulation in children with internalizing, externalizing, and comorbid disorders compared to nondisordered children.

Another common form of comorbidity involves mixed anxiety and depression. Here vulnerability would be greatest in children with strong fear systems and weak appetitive systems, giving rise to simultaneous symptoms of worry, avoidance, low reward sensitivity, and low approach behavior. Comorbid anxiety and depression provides an interesting example of how reactivity within these systems might fluctuate over time (e.g., Gray, 1994). We might begin with a child who is highly fearful with moderate rather than low levels of appetitive motivation. If this child is faced with prolonged stress, the inhibition across time exerted by the anxiety may progressively decrease responsivity within the appetitive system. Although the initial symptoms may be anxiety related, the child may show gradually increasing depressive tendencies, such as low positive affect, low initiative, and feelings of hopelessness. Depression

is usually the second disorder of a comorbid pair to appear (Birmaher et al., 1996), and more specifically, fear in preadolescents and adolescents predicts the risk of depression at later ages (Pine, Cohen, & Brook, 2001). Again, however, it is important to consider individual differences in effortful control. Even if the child is simultaneously vulnerable to anxiety and depression, they may still be able to employ attentional strategies to attenuate their fear (Derryberry & Rothbart, 1997). Decreasing fear would in turn disinhibit their reward orientation, resulting in less negative affect and more positive affect. More simply, attentional control may help some children to directly attenuate low positive affect, as suggested by findings relating depression in preadolescents with poor attention (Lengua, Sandler, West, Wolchik, & Curran, 1999).

Another example of the utility of temperament approaches is their help in explaining patterns of convergence and divergence in development. We may rather commonly see instances of "equifinality" where children with different temperaments converge on a similar developmental outcome (Cicchetti & Rogosch, 1996). For example, behavioral "impulsivity" may arise within different types of children, such as those featuring a strong appetitive system, a weak defensive system, or relatively weak attentional control. Although specific traits of these children may differ, the general pattern of impulsivity will tend to be shared. Also common should be instances of "multifinality," where children with the same initial temperament pattern show increasing divergence as their personalities develop. Although some of this divergence may be due to additional physiological variability, the major source is likely to be the environment in which the child develops. Here it is essential to emphasize that even though motivational systems such as the appetitive and defensive systems are located within the child's brains, these systems are designed to respond to environmental rewards and punishments. Thus, the reactivity of these systems depends upon the environment that may or may not sustain them. A child may inherit a strong defensive system, but this capacity may develop more or less extensively, depending on the avail-

ability of danger and safety within the environment. If temperament systems are viewed as coping systems, then the basic coping function should be expressed in different ways across different developmental environments.

These are a few examples of the types of explanatory mechanisms afforded by a temperament approach to psychopathology. As can be seen, temperament approaches emphasize the extremes of personality dimensions; but because multiple dimensions must be taken into account, being extreme on one or even two dimensions does not necessarily predict psychopathology. The overall pattern of reactivity across multiple systems must be taken into account; and until we know more about the additional motivational and attentional systems that may be involved in temperament, precise predictions are likely to be problematic. At this point in time, we can assume that temperamental patterns place limits on the types of psychopathology that may develop but we must be satisfied with relatively general predictions.

Along similar lines, current temperament models have difficulty explaining the precise kinds of symptoms demonstrated by different children. For example, some children may show generalized anxiety, but others show more specific forms (e.g., animal phobias, separation anxiety, social anxiety). In addition, the anxiety is likely to be experienced in different ways and to be expressed through different types of defensive behaviors (e.g., escape, defensive aggression, passive avoidance, isolation). Some of these details can be explained as results of the child's experience, with the motivational system being shaped in different ways by different environments. Although it is beyond this paper's scope to consider the many ways in which environments influence developing temperament systems, this is an active research area and much progress is being made (e.g., Mineka & Zinbarg, 1996).

From a more cognitive perspective, however, we would emphasize that it is not always the case that the environment directly influences temperament. Instead, the child forms cognitive representations of the environment, which serve a mediating role between the environment and the child. Investi-

gating these representations promises a better understanding of the experiential components of vulnerability from the child's unique perspective. In addition, the child's representations shed light onto the details of his or her psychopathology, as well as toward potential avenues of intervention. Finally, focusing at the representational level provides a useful developmental approach to temperament, one that can extend our appreciation of experiments of nature.

*Temperament's influence
on cognitive representations*

Motivational and attentional systems develop in line with biological maturation of various circuits within the limbic and frontal regions. Similarly, representational and other cognitive processes develop as the functional capacity of other cortical areas increases. Both the motivational and representational domains are tightly linked from the earliest stages of development. For example, representations provide new and more detailed inputs into the child's motivational systems. In terms of "appraisal" models, these representations allow the child to assess a threat in progressively more specific terms, such as its potential to do harm, its immediacy, the child's capacity to cope with it, and so on. Such appraisals are viewed as adaptive processes that afford a more detailed, multidimensional analysis of the situation, hopefully leading to a more efficient coping strategy.

From a temperament perspective, however, representational development is not due to simple instruction by the environment but rather to a selective process guided by the child's motivational and attentional systems (Derryberry & Reed, 1994). Children will pay the most attention to information that is relevant to their needs, including information related to reward and frustration for the appetitive system, and that is related to threat and safety for the defensive system. Such attentional biases have an immediate effect of helping the child cope with the ongoing situation; in addition, they have a long-range effect of increasing the probability that the attended information is stored in memory. In some

cases attention may directly stabilize active synapses, or in others it might promote the rehearsal and elaboration that facilitates storage. In either case, external, conceptual, and affective information relevant to the current need state is selectively stored so that it can influence future experiences and coping.

As the child develops, his or her representations are progressively shaped in terms of their underlying motives (Derryberry & Reed, 1996). Because the representations feed back into the motivational systems, the developmental process can be viewed as one in which the subcortical motivational systems recruit the representational powers of the cortex, in a sense constructing specific recognition and guidance systems (i.e., more complex appraisal processes) that can be used in the future. Thus, the child's representations can be viewed as developmental extensions of his or her temperament systems, like the branches of a tree developing from an underlying root system. The process is self-organizing and reciprocal, and both the motivational and representational components act selectively upon one another. Although the process may appear relatively self-contained, it must be kept in mind that it remains open to the environment and is in fact designed for coping with the environment. Environmental input provides the specific content for the developing representations, so that as environmental events change, so will the child's representational network. Again, one would not expect too much stability in a child's temperament.

The development of temperament involves extensive individual differences at the cognitive level. Within the self-concept, for example, children with a stronger reward orientation may emphasize more positive aspects such as their social acceptability, achievement successes, and physical skills. In contrast, more defensive children may emphasize their potential for rejection, failures, and physical deficiencies. Many studies support such links between anxiety and low self-esteem (e.g., Miyamoto et al., 2001; Ohannessian, Lerner, Lerner, & von Eye, 1999). Depending upon their attentional skills, such children may also emphasize additional information related to the frustrating and relieving aspects of their

self. For example, an anxious child with good attention may be able to link threatening content with a relieving concept (e.g., "I'm bad at math but good at reading"), while an anxious child with poor attention would be more vulnerable to automatic associations (e.g., "I'm bad at math and bad at spelling"; cf. Showers & Kling, 1996).

In addition to perceptual and conceptual information, the child's representations also store information regarding the affective outcomes related to various stimuli and responses. Children with strong reward orientation may develop representations linking conceptual content to feelings of reward and frustration, whereas those with strong defensive systems may emphasize fear and relief in their representations. For example, it has been suggested that strong fear-related feelings may be internalized along with moral principles that facilitate the development of conscience (Dienstbier, 1984; Kochanska, Murray, & Coy, 1997). Although the affective components often function in the periphery of awareness, they can provide an immediate evaluation of new information as good or bad (Damasio, 1994). This evaluation would occur prior to, and sometimes in the absence of, a more complete motivational reaction. It is worth emphasizing that children are not always behaving but also spend a great deal of time fantasizing, planning, and elaborating the events of the day. Studying the differences that emerge from such extensive cognition again allows us to take advantage of experiments of nature in understanding children's unique experiences.

Furthermore, the child's representations provide new views of the coping strategies. As mentioned earlier, the subcortical motivational systems are primitive mechanisms that carry out reactive coping through attentional and behavioral adjustments. As representations develop, coping functions are provided with more articulated information that allows for more complex strategies, particularly in cognitive terms, than those resulting from subcortical mechanisms. Nevertheless, we would expect these complex strategies to be closely related to the child's underlying motivational tendencies. In the next section, we examine

such strategies and consider how they might be influenced by temperamental differences.

Cognitive Contributions to Coping

Although the cortex makes many contributions to coping, particularly important are those that allow the coping process to be extended in time, beginning well in advance of a stressful event. These anticipatory processes depend in large part on frontal lobe functions, which provide the subcortical systems with greater flexibility in selecting and planning a response, and thereby more room for voluntary self-control of coping.

Anticipatory coping through planning

As cortical representations develop, long-range expectations linking events, responses, and outcomes become available. At the same time, developing attentional and other frontal lobe functions allow these expectations to be coordinated into a plan. To begin, the planning process involves an evaluation of various coping options in terms of their potential outcomes (i.e., whether they are likely to decrease or increase the child's distress), and selecting an option or sequence of options that seems most likely to achieve the child's goal. In selecting a plan, the child may employ stored affective representations (e.g., hope, frustration, fear, relief) that have become associated with response options. For example, a defensive state activates various options connected to the fear and relief outcomes, which can then serve as somatic markers (Damasio, 1994) or affective maps (Derryberry & Reed, 1994) for guiding the selection.

For children with strong appetitive motives, one risk is that the planning process may be cut short by their strong approach tendencies. This could result in a coping response that is poorly coordinated or misdirected and thus an aggravation of the child's frustration. Planning may often be more compatible with anxious coping, because the dominant inhibitory tendencies constrain the impulse to act too soon. The anxious child may imagine a future event, attempting to generate a response option that will minimize the dan-

ger (fear) and maximize their sense of safety or relief. In some cases, attention may be biased in favor of the potential dangers and related feelings, such that the planning process tends to deteriorate and the child's thinking becomes more worrisome and ruminative. Even if a coping plan is successfully constructed, anxious children may still have problems implementing it, especially if their fear continues to inhibit approach behavior (Compas & Boyer, 2001). For anxious children with better attentional control, however, the potential fears inherent in planning may be countered by attention to coping options related to more relieving outcomes. Attention to these sources of relief should attenuate their fear, making an effective plan and its implementation more likely.

As can be seen, the planning process described so far depends upon the same types of processing as that arising from subcortical motivational systems (i.e., obtaining rewards and avoiding dangers). However, the child's developing representations afford more specific processes through which coping options can be further evaluated. These *appraisals* involve more complex evaluations based on what the child believes "should" and "can" be done. Beginning with the *should* component, older children become able to appraise coping options in relation to their moral principles and personal standards. Such appraisals are referred to as "norm/self compatibility checks" in the adult literature (Scherer, 1993), and they provide a means for eliminating options that are incompatible. For example, two children with strong reward orientation may consider the possibility of confrontative coping when frustrated by a peer. One child may believe he or she would be justified in retaliating, whereas the other rules this out on ethical grounds. Again, the selection process is not purely cognitive and can be aided by attached affective markers such as feelings of "pride" and "guilt" associated with various options. This standard-based selection process is crucial in allowing the child's culture to regulate coping.

Although personal standards depend on environmental inputs, temperament appears to play important roles in their representation. A

series of studies by Kochanska identified two separable temperament pathways at work (Kochanska, 1991, 1997; Kochanska, Aksan, & Koenig, 1995; Kochanska, Murray, Jacques, Koenig, & Vandegest, 1996). One involves the more reactive influence of fear, showing moral standards being internalized more effectively in fearful preschoolers subjected to gentle discipline. The other pathway involves high effortful control, perhaps reflecting the attentional flexibility to link moral principles to one's behavior. These findings are consistent with others relating moral emotions, such as empathy and guilt, to both high fear and high effortful control (Kochanska et al., 2002; Rothbart, Ahadi, et al., 1994). Thus, children with high fear and/or good attention should be most likely to screen coping options in terms of their personal standards.

In addition to what the child believes should be done are appraisals regarding what can be done. Such "perceived control" involves several related appraisals (Skinner, Zimmer-Gembeck, & Connell, 1998). One involves the extent to which the child views the situation as modifiable or controllable, apart from his or her own coping efforts. If the child views the parents as completely inflexible, for example, this appraisal may rule out a variety of active strategies. Although passive strategies are often problematic, it should be noted that in some instances these may be the most realistic and effective options. High stress family situations are often uncontrollable and active coping may lead to increased distress for the child. Avoidance coping has been found to be associated with lower levels of depression and conduct problems in girls facing family stress (Gonzales, Tein, Sandler, & Friedman, 2001).

A second appraisal related to perceived control involves the ability or competence to effect the outcome (Bandura, 1997). Based on previous experiences, a shy child may believe that he or she lacks the skills or knowledge to cope with a novel social situation. Alternately, in an achievement context, a child may consider a plan to perform better in school, but may not have confidence in their ability learn the material. Given adult findings of relations between neuroticism, introversion, and low

self-confidence (e.g., Watson, Suls, & Haig, 2002), we might expect children with strong defensive motives or depressed positive emotionality to underestimate their abilities and reject active or difficult coping options. This is supported by findings that low self-efficacy in adolescents is related to passive and avoidant coping (Muris, Schmidt, Lambrichs, & Meesters, 2001) and to concurrent and subsequent depression (Bandura, Pastorelli, Barbaranelli, & Caprara, 1999).

The third appraisal assesses whether the child has enough energy or effort available to carry out a coping strategy. In many instances, we know what is the right thing to do and know we can do it effectively, but the fact remains that it will be difficult and require much effort. Some children may short circuit active coping because they feel too tired or weak to carry it through. In contrast, others may actually have some doubts about their abilities, but their energetic mood leads them to believe that they can do it through effort. This form of appraisal develops between the age of 10 and 12, as the child develops the cognitive capacity to distinguish ability and effort (Skinner et al., 1998).

Unfortunately, the psychological and physiological mechanisms underlying such "felt energy" are poorly understood. Thayer (1989) and others have suggested that energetic dimensions of "energetic arousal" and "tense arousal" are related to hedonic dimensions of "positive affect" and "negative affect," respectively. The positive energetic arousal has been related to physiological processes such as peripheral catecholamines (Dienstbier, 1989) and dopaminergic projections to the frontal lobe (Matthews, 1997). Prolonged stress appears to deplete feelings of energy, and even short-term exertion of effort seems to deplete energy available for subsequent regulatory tasks (Muraven, Tice, & Baumeister, 1998). Such decreases in felt energy may contribute to the low initiative and feelings of hopelessness that accompany depression. These findings suggest that children with strong defensive systems or weak appetitive systems may find active coping plans to be difficult due to their low energy levels. Children high in effortful control may be at an advantage, per-

haps due to their ability to attend to and make better use of their available energy.

To summarize, although the child's subcortical motivational systems provide a general framework for coping, cortical development allows coping to shift in an anticipatory direction and to incorporate crucial selective processes related to conscience and perceived control. Given the complexity of the planning processes, reactive expectancies may often overcome the efforts for voluntary control. In general, we might expect such inefficient planning to be less likely in children with good attentional skills, but more research is required. Also, it should be kept in mind that regardless of the child's attentional ability, planned strategies still depend on the his or her representations and belief systems. If these belief systems are maladaptive, then the child with good attention may face an increased risk.

Coping and self-control

A final and more general way through which a temperament perspective may inform theories of coping involves the general notion of self-control. Many situations arise in which natural tendencies to approach or avoid are in conflict with environmental constraints or with the child's beliefs regarding morality and perceived control. Coping can be extremely difficult because it requires not only the suppression of the dominant tendencies but also the execution of a strategy that runs counter to the reactive impulse. Many situations arise in which the shy child must control his or her fear and approach a stranger, and an impulsive child must constrain his or her desire and resist a temptation. Such self-control is influential in the planning process but is more generally influential in initiating and sustaining the subsequent coping response.

Mischel has pioneered research in this area using the delay of gratification task (Mischel, 1983). The ability to delay depends on various attentional strategies that serve to amplify the "cool" relative to the "hot" aspects of the situation. For example, children are better able to delay eating a marshmallow when they look away from it or think of it as a puffy

white cloud (Metcalf & Mischel, 1999). Relatively stable individual differences appear involved with preschool ability to delay gratification, predicting competent coping during adolescence (Shoda, Mischel, & Peake, 1990) and coping with rejection sensitivity in the early 30s (Ayduk et al., 2000). In addition, toddlers' use of effective attention deployment to cope with separation from their mother predicts effective delay of gratification strategies at the age of 5 (Sethi, Mischel, Aber, Shoda, & Rodriguez, 2000). The remarkable stability of this ability, along with the central role played by attention, is consistent with a temperamental basis.

One of the difficulties in self-control arises from the increased frustration and anger that arises in some children. Young children scoring high on effortful control have been found effective in modulating their anger (Kochanska, Murray, & Harlan, 2000). More recently, Gilliom, Shaw, Beck, Schonberg, and Lukon (2002) examined the effectiveness of different anger-regulating strategies in 3.5-year-olds while they waited to eat a cookie. Children who used strategies of distraction, passive waiting (e.g., not looking at the cookie), and information seeking (e.g., asking when they could get the cookie) were most effective in controlling their anger. In contrast, children who focused on the cookie showed increased anger. When assessed at the age of 6, children who had used passive waiting and distraction strategies showed fewer externalizing symptoms, whereas those who focused on the cookie showed more externalizing. Cooperation at the age of 6 was predicted positively by passive waiting and negatively by focusing on the cookie, and assertiveness was predicted positively by the earlier strategy of information seeking. This study again indicates that attentional strategies aid self-control and anger-decreasing strategies may protect against externalizing symptoms.

Most research on self-control has involved appetitive situations in which the child must inhibit approaching a desirable object. However, much self-control, especially that related to coping, arises in unpleasant situations where the child must activate and sustain a difficult or unpleasant activity. Recent studies by Ko-

chanska and her colleagues have examined temperamental differences related to both forms of self-control in two types of compliance tasks. (Kochanska, Coy, & Murray, 2001; Kochanska, Tjebkes, & Forman, 1998). One was the typical *don't* task in which the child was required to inhibit an enjoyable activity (i.e., to stop playing), whereas the other was a *do* task in which the child was required to carry out a sustained unpleasant task (i.e., putting toys away). Compliance in the *don't* task was predicted by high fearfulness and also high effortful control. This is consistent with two forms of inhibitory self-control, a more reactive one related to fear and a more voluntary one involving effortful control. As might also be expected, fearfulness was not related to compliance in the *do* task, which requires behavioral activation rather than inhibition. Effortful control did predict compliance in the *do* context, but the relations were modest and smaller than those in the *don't* context. These findings are important in demonstrating that effortful control exerts a broader and more flexible regulation than fearfulness, but also suggests that additional factors may be involved when sustained activity is required. More generally, it underscores the idea that self-control is not always inhibitory in nature and, as is the case in many types of coping, requires activation of less preferred behaviors.

Although more research is required, a combination of temperament and cognitive constructs provides a relatively simple framework for viewing self-control. Self-control can be viewed as arising in a situation where two motives are in conflict, with the initially weaker motive recruiting voluntary attentional processes in order to supersede the dominant motive. More specifically, the weaker motive can employ attention to inhibit the environmental, conceptual, and affective cues that fuel the stronger motive, and to facilitate the cues that support itself. Mischel's research demonstrates how a weaker motive (delaying in order to comply) may recruit strategies of attending to relatively "cool" stimuli and images (Metcalf & Mischel, 1999). As development proceeds, the self-control process may be aided by selectively attending to representational information, in particular that related to moral-

ity and perceived control as describe above. For example, the weaker motive may strengthen itself by directing attention to the reasons why it “should” be done and why the stronger motive “shouldn’t be done.” Attention may also be directed toward the affective outcomes if either the weaker (pride) or stronger (guilt) motives are performed. In addition, the weaker motive may strengthen itself by enhancing the child’s sense of perceived control, which might be accomplished by attending to one’s ability and the energy available for accomplishing the goal. Again, we should emphasize that the underlying processing is highly complex, and clearly, our efforts for self-control often fail. However, if adequate representations and attentional skills are available and if the necessary effort can be sustained, quite difficult forms of coping can be accomplished.

Conclusions and Future Research

In this paper we have tried to demonstrate the value of an individual differences approach in understanding children’s vulnerability and coping. Coping can be viewed as grounded in the child’s appetitive and defensive systems and aided by his or her capacity for effortful control. With development, temperamental systems extend into the cortex to assimilate new representational capacities. In turn, these representational capacities allow an extension of the coping process in time, with anticipatory functions and cognitive representations playing an increasingly important role. Coping is by no means easy, and there are many different ways in which the process can go wrong. Inefficient or maladaptive coping may be due to the child’s motivational systems, attentional systems, or cognitive representations. If these limitations can be identified, they will help us better understand the child’s problems, and moreover, provide more specific targets for intervention.

Our approach suggests that extensive variability will occur in the ways children represent and attempt to cope with the world, with this variability organized in terms of underlying motivational and attentional systems, as well as by the many events coming from the

external environment. In many ways, each child is a unique experiment of nature, designed to cope in different ways with the different environments in which development occurs. Some of these experiments adapt quite well, and such children can be studied to gain understanding of the more effective patterns of motivation, representation, and coping. However, children expressing other patterns may become more vulnerable, depending on the environment, to the sources of stress arising from anxiety and frustration. Studying these children promises new insights into the sources of psychopathology, not simply in terms of underlying motivational and attentional processes, but also in terms of childrens’ more advanced representations and coping strategies.

The coming years will see more research linking ideas from the temperament and coping literature. Connor–Smith and colleagues have used factor analytic techniques to identify five general coping factors in adolescents: involuntary engagement (e.g., rumination, intrusive thoughts), involuntary disengagement (e.g., emotional numbing, escape), voluntary engagement with primary control (e.g., problem solving, emotional regulation), voluntary engagement with secondary control (e.g., positive thinking, cognitive restructuring), and voluntary disengagement (avoidance, wishful thinking; Connor–Smith, Compas, Wadsworth, Thomsen, & Saltzman, 2000). This model is particularly interesting from a temperament perspective in that it distinguishes voluntary and involuntary strategies, as well as those based on engagement (approaching) and disengagement (avoidance) of the stressor. Connor–Smith et al. found that the voluntary engagement strategies were negatively related to internalizing and externalizing problems, whereas both involuntary strategies and voluntary disengagement were positively related.

The many strategies identified in factor analytic studies go beyond existing temperament models, but the nature of the factors suggests that the two frameworks are compatible. Furthermore, if temperament and coping differences can be linked to representational and symptom differences, then more complete causal models can be derived that provide

stronger predictions regarding symptoms and possible interventions. This may be a difficult research task, but studies along these lines are beginning to appear and the results are en-

couraging (Lengua et al., 1999). Thus, our emphasis on temperament provides only a partial view of the value of individual differences approaches.

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