Development and Psychopathology, **9** (1997), 633–652
Copyright © 1997 Cambridge University Press
Printed in the United States of America

Reactive and effortful processes in the organization of temperament

DOUGLAS DERRYBERRY[a] AND MARY K. ROTHBART[b]
[a]*Oregon State University; and* [b]*University of Oregon*

Abstract
Self-organization can be approached in terms of developmental processes occurring within and between component systems of temperament. Within-system organization involves progressive shaping of cortical representations by subcortical motivational systems. As cortical representations develop, they feed back to provide motivational systems with enhanced detection and guidance capabilities. These reciprocal influences may amplify the underlying motivational functions and promote excessive impulsivity or anxiety. However, these processes also depend upon interactions arising between motivational and attentional systems. We discuss these between-system effects by considering the regulation of approach motivation by reactive attentional processes related to fear and by more voluntary processes related to effortful control. It is suggested that anxious and impulsive psychopathology may reflect limitations in these dual means of control, which can take the form of overregulation as well as underregulation.

Recent models of temperament are based on the assumption that personality differences arise in part from the reactivity of underlying neural systems. Although many systems are involved, among the most important are those serving regulatory functions related to motivation and attention. These systems respond to significant inputs by regulating other neural pathways involved in perceptual and response processing. Given a threatening input, for example, systems related to defensive motivation regulate motor and autonomic circuits to support avoidant behavior and also modulate perceptual pathways to enhance incoming information relevant to the threat and to safety (Derryberry & Rothbart, 1984; Derryberry & Tucker, 1992; Gray, 1982). By regulating the brain's input and output systems, these motivational circuits promote a temporary neural organization that is adaptive given the organism's current needs.

Although this organization is clearly important to ongoing survival, it takes on added significance when viewed in terms of the development of self-regulation. As the child develops, initially reactive forms of regulation are supplemented by an increasing capacity for voluntary or effortful forms of control (Rothbart, Posner, & Boylan, 1990; Rothbart & Bates, in press). Across time, we expect common patterns of regulation to promote a progressive stabilization of synapses within the brain, contributing to the structural organizations central to personality (Derryberry & Reed, 1994b; Derryberry & Reed, 1996). Thus, the child's cognitive representations of events in the world (as potentially rewarding or dangerous) and of the self (as efficacious or vulnerable) can be seen to be closely related to his or her underlying motivational tendencies. By relating these representations to the child's reactive and effortful forms of regulation, we can better appreciate the extent to which personality development is a self-organizing process.

We thank Laura Jones and Marjorie Reed for their thoughtful comments on earlier versions of the manuscript.

Address correspondence and reprint requests to: Douglas Derryberry, Department of Psychology, Oregon State University, Corvallis, OR 97331-5303.

https://doi.org/10.1017/S0954579497001375 Published online by Cambridge University Press

In the following pages, we examine this process of self-organization and discuss some of the factors contributing to later personality development and to adaptive and maladaptive outcomes. We begin at a physiological level, discussing individual differences in neural systems related to different types of motivational and attentional processes. In the second section, we adopt a cognitive framework and consider the differentiation that occurs within these systems as the child develops. In the final section, we discuss integrative processes that may arise from interactions among these systems. We focus first on reactive approach tendencies and consider their regulation by fear and by effortful forms of control. We conclude by considering the role of effortful control in the regulation of fear.

Systems of Temperament

Taking a developmental view of personality, the first sources of individual variability are biologically based temperamental characteristics. Not all of the temperament systems are functional at birth, but follow a developmental time course (Rothbart & Bates, in press). A general goal of temperament approaches is to relate specific neural systems to the major dimensions of personality and ultimately to understand how personality develops. In discussing these relations, we focus on those involving motivational and attentional processes. Although our descriptions are limited in physiological detail, we attempt to discuss a variety of systems involved in different aspects of motivation and attention.

Motivational systems

Motivational systems are based within limbic circuits (e.g., amygdala, hypothalamus) that have evolved to serve appetitive, defensive, and nurturant needs. The limbic circuits receive simple perceptual inputs from the thalamus, as well as more complex perceptual and conceptual information from the cortex. If they detect a significant (i.e., need-related) input, the limbic systems regulate brainstem mechanisms that serve motor, autonomic, and attentional functions, and thereby promote an adaptive response (Derryberry & Tucker, 1992; Rothbart, Derryberry, & Posner, 1994).

Appetitive and approach behavior. Perhaps the most basic of these is an appetitive system that mobilizes approach behavior to stimuli that predict positive events. The underlying circuitry has been discussed in terms of a "behavioral activation system" (Gray, 1987a, 1987b), a "behavioral facilitation system" (Depue & Iacono, 1989), and an "expectancy–foraging system" (Panksepp, 1992a). Although formulations vary, the basic idea is that the circuits within the basolateral amygdala respond to reward-related inputs by activating dopaminergic neurons within the brainstem's ventral tegmental area. The dopaminergic neurons in turn project to the nucleus accumbens, where they facilitate approach responses directed toward the rewarding input. In Gray's (1987b) model, such response facilitation can be elicited by signals predicting reward to produce approach behavior and the emotion of hope, and by signals predicting nonpunishment to produce active avoidance and the emotion of relief. Depue and Iacono (1989) suggest that in addition to facilitating approach and active avoidance, the appetitive system also promotes irritative aggression when goals are blocked. Panksepp (1986a) proposes that the system can also be engaged by regulatory imbalances (e.g., hunger) to facilitate search behavior and a state of desire.

Individual differences in the reactivity of the appetitive system are often related to a general dimension of Extraversion or Positive Emotionality (Larsen & Ketelaar, 1989; Watson & Clark, 1992). In addition, the system has been related to a dimension of impulsivity that is strongest in neurotic extraverts (Gray, 1987b). Relevant individual differences appear by 6 months of age, with infants showing early differences in smiling and laughter that are related to short latencies in approaching objects (Rothbart, 1988). In our parent-report studies of 6- to 7-year-olds, we have found a general "Surgency" factor defined by scales of approach, sensation seeking, activity level, and shyness (with a negative loading) (Ahadi, Rothbart, & Ye, 1993). These characteristics are similar to those found in extraverted

https://doi.org/10.1017/S0954579497001375 Published online by Cambridge University Press

adults, as reported in both three-factor (Eysenck, 1981) and five-factor (McCrae & Costa, 1985) models of personality. Some stability appears early in life, with approach tendencies and positive affect during infancy predicting approach tendencies at 6–7 years (Rothbart, Derryberry, & Hershey, 1995). In addition, Caspi and Silva (1995) have found that preschool children high on approach or confidence tend to be more impulsive and socially potent at the age of 18. Although environmental influences should not be overlooked, these findings are consistent with the development of a constitutionally based appetitive or approach system. As discussed in subsequent sections, this system will motivate not only the child's approach behaviors, but also his or her representation of potential rewards in the environment. The regulation of this appetitive system, through which approach behavior is limited to appropriate contexts, forms one of the major themes of socialization, and problems in regulation can leave the child vulnerable to psychopathology.

Fearful behavior. Complementing the appetitive or approach system, many authors have discussed neural mechanisms related to defensive or fear-related motivation. Examples include Gray's (1982) "behavioral inhibition system," Panksepp's (1982, 1986a) "fear system," and Gilbert and Trower's (1990) "defense system." Gray's model emphasizes circuitry centered upon the hippocampus that responds to novel signals, biologically prepared fear signals, signals predicting punishment, and signals predicting nonreward (Gray, 1982, 1987b, 1994). Upon detecting this input, the behavioral inhibition system inhibits ongoing motor behavior to promote passive avoidance, increases arousal, and directs attention toward relevant information in the environment. In addition, the behavioral inhibition system functions to regulate approach behavior via inhibitory projections to the appetitive system. In emotional terms, these multiple outputs set up a state of "anxiety" (given novelty or anticipated punishment) or "frustration" (given anticipated nonreward).

While Gray's model focuses on the hippocampus, other researchers have suggested that the hippocampus is involved primarily in processing contextual information relevant to fear, whereas circuitry within the amygdala processes fear-related object information (Davis, 1992; LeDoux, 1995, 1996). The amygdala's lateral nucleus receives conditioned fear signals from the hippocampus, thalamus, and cortex, and projects to the central nucleus via pathways through the basolateral and basal accessory nuclei. The central nucleus then projects to multiple areas of the brainstem, where it regulates specific components of fearful behavior, including freezing, reflex potentiation, facial and vocal expressions, and heart rate changes. In addition, the amygdaloid nuclei have extensive connections to reticular and cortical circuits through which they can enhance attention to threatening inputs.

In adult studies of personality, fearful motivation is often related to a general dimension of Neuroticism or Negative Emotionality (Larsen & Ketelaar, 1989; Watson & Clark, 1992), although some have argued for a more specific Anxiety dimension that is strongest in neurotic introverts (e.g., Gray, 1982, 1987b). Individual differences in fearful, inhibited behavior appear later than approach tendencies, but can be seen by the last quarter of the 1st year of life (Rothbart, 1988). Late in the 1st year, some infants begin to show inhibited approach to unfamiliar and intense stimuli, and subsequent fearful behavior accompanied by enhanced sympathetic and adrenal reactivity. Fear and inhibition at 21 months can be predicted by a measure of combined crying and motor reactivity taken at 4 months (Kagan, Snidman, & Arcus, 1992). Additional longitudinal research suggests stability of fearful inhibition from the 2nd to the 8th year of life (Kagan, Reznick, & Snidman, 1988) and from preschool to the age of 18 (Caspi & Silva, 1995). In our studies of 6- to 7-year-olds, fear loads on a factor of Negative Affectivity, along with scales assessing discomfort, anger/frustration, sadness, and loading negatively, soothability (Ahadi et al., 1993). For children assessed in infancy and at the age of 7, a composite measure of the infant's fear predicted

https://doi.org/10.1017/S0954579497001375 Published online by Cambridge University Press

both fear and sadness at 6–7 years, and was negatively related to later activity, impulsivity, and approach (Rothbart et al., 1995). These developmental findings are consistent with physiological evidence suggesting that fear plays an important role in regulating approach behavior. As discussed in later sections, additional evidence suggests that problems in fear-related regulation, which can arise from deficient as well as excessive fear, are a central factor in several forms of psychopathology.

Frustrative and aggressive behavior. In addition to regulating appetitive approach, fear may also play a role in constraining aggressive forms of behavior. Unfortunately, the neural systems related to aggression are not well understood, perhaps because such behavior can be called upon to serve several different motives. As mentioned above, Depue and Iacono (1989) suggest that when a goal is blocked, the appetitive system promotes a form of irritative aggression aimed at removing the obstacle. In the case of predatory or instrumental aggression, Gray (1987b) and Panksepp (1982) suggest that this is also a function of the appetitive system, and thus another form of approach behavior. While the above forms of aggression arise from the appetitive system, Gray (1982) has also proposed that a state of frustration involving inhibited approach arises when the behavioral inhibition system is activated by a signal predicting nonreward. In contrast, unconditioned nonreward or punishment is thought to promote defensive aggression and the emotion of anger. The pathways relevant to defensive aggression involve connections from the amygdala and ventromedial hypothalamus to the periaqueductal gray region of the brainstem and have been described in terms of a fight–flight system (Gray, 1987b) and a rage system (Panksepp, 1982).

Given these different types of aggressive behavior, it is not surprising that adult models relate aggression to several personality dimensions. In five-factor models of personality, antagonism defines one pole of the Agreeableness–hostility dimension, but aggressive elements also can be seen in the dimensions of Extraversion (dominance and assertiveness) and Neuroticism (irritability and anger) (Costa & McCrae, 1985). During infancy, it is possible to distinguish irritable distress involving frustration and anger from fearful distress (Rothbart & Bates, in press). In addition, developmental studies suggest that frustration is related to strong approach motivation. For example, Fox (1989) has found that frustration to arm restraint at 5 months is positively related to approach of strangers and novel events at 14 months. Although fear and frustration are related in our studies of 6- to 7-year-olds, frustration tends to be positively related to measures of positive emotionality, whereas fear is negatively related to positive emotionality (Ahadi, Rothbart, & Ye, 1993). While high infant fear predicts lower approach at the age of 6–7 years, high infant anger/frustration predicts higher 6–7 year approach, and anger/frustration, but not fear, is positively related to activity level at every age we have measured it via parent reports, beginning at 6 months (Rothbart et al., 1995). Finally, aggression in 6- to 7-year-olds is negatively related to fear during infancy, but positively related to activity, smiling, and anger/frustration (Rothbart, Ahadi, & Hershey, 1994). These findings are important in differentiating two forms of negative emotionality, fear and frustration/anger. They also suggest that frustration, anger, and aggression may be more closely related to appetitive, approach motivation than to fear.

Affiliative and nurturant behavior. A fourth set of circuits important to temperament regulates social behaviors serving affiliative and nurturant needs. These circuits may prove important in differentiating a second type of reward motivation, related to affiliativeness, from the outgoing social behavior that can result from a strong approach system. Knowledge of the underlying systems remains limited, although Panksepp has discussed several possibilities. A key mechanism involved in Panksepp's (1986b) model involves inhibitory connections through which the ventromedial hypothalamus suppresses defensive aggression within the periaqueductal gray. This inhibition is thought to be enabled by social play, allowing for friendly, trusting, and helpful behaviors that promote social bonding between

https://doi.org/10.1017/S0954579497001375 Published online by Cambridge University Press

members of a species. In addition, Panksepp (1986b) suggests that social cohesion is supported by a "separation distress–panic system." This system responds to the loss of social support by mobilizing separation distress vocalizations and other agitated behaviors. When the caregiver returns, opiate neurons provide rewarding comfort to the child. Most recently, Panksepp (1992b) has suggested another mechanism, based on the limbic peptide oxytocin, that promotes social bonds. When released during caregiving situations, oxytocin is thought to evoke warm feelings of nurturance and acceptance, and thereby attraction between caregivers and receivers.

A related approach can be found in MacDonald's (1992) discussion of an "affectional system." This is thought to be a specialized social reward system that evolved to facilitate close family relationships by promoting feelings of warmth. MacDonald suggests that warmth is not only reciprocally rewarding for parents and child, but also supports feelings of empathy in the child, identification with the parents, and the adoption of parental values. Kochanska's recent research supports this model. She has found that measures of shared positive affect between the mother and toddler predict measures of internalization of conscience and committed compliance at both toddler and preschool ages (Kochanska & Aksan, 1995; Kochanska, Aksan, & Koenig, 1995). Kochanska (1995) has also found nonfearful children's internalization of conscience to be related to their security of attachment.

These types of affectionate, affiliative, and nurturant behaviors appear to be related to the dimension of Agreeableness in five-factor models, which includes facets such as trust, altruism, and tender-mindedness (Costa, McCrae, & Dye, 1991). It is interesting that Panksepp's emphasis upon the role of hypothalamic inhibition of aggression in prosocial behaviors fits well with the two poles (agreeableness vs. hostility) of this dimension. Also relevant is Cloninger's (1987) dimension of Reward Dependence, which ranges from being socially detached, tough-minded, and independent to being sentimental, warmly sympathetic, and emotionally dependent. Unfortunately, agreeableness has been a relatively neglected individual difference variable in the developmental literature, although Graziano's (1994) recent work, MacDonald's (1992) theorietical synthesis, and Kochanska and her associates' research (Kochanska & Aksan, 1995; Kochanska et al., 1995) may be changing this situation. In the future it will be important to determine the relative importance of shared positive affect and sentimental regard in the prediciton of empathy, altruism, and conscience. It will also be important to consider the role of nurturant motives in regulating appetitive and aggressive behavior.

As summarized in Table 1, temperament approaches are based upon physiologically defined motivational systems that contribute, either alone or in combination, to the major personality dimensions. Although the motivational systems are most often viewed as organizing behavioral and emotional components of personality, they also play an adaptive role in regulating attention and perceptual processing. For example, a key function of the defensive system is to help the individual cope with threat by directing attention to relevant environmental information (Gray, 1982; Derryberry & Tucker, 1992). Similarly, MacDonald's (1992) affectional system may promote family cohesiveness by directing the child's attention to parental beliefs and values. Thus, the effectiveness of the motivational systems in carrying out their functions may depend greatly upon their capacity to regulate attention. As discussed in subsequent sections, this attentional regulation will not only influence ongoing behavior, but also the storage of information in memory. By attending to threatening information, for example, the anxious person can store a representation of relevant sources of threat and safety that will help him or her cope with similar dangerous situations in the future. In addition, the child's attention to parental values and beliefs will provide them with representations for guiding his or her own behavior in a way that preserves cohesiveness within the family.

Attentional systems

Given the importance of attention in motivated behavior, researchers have also focused on individual differences in attentional sys-

https://doi.org/10.1017/S0954579497001375 Published online by Cambridge University Press

Table 1. *Simplified summary of major motivational systems, their associated emotions and personality dimensions, and some major neural structures*

Motivational Systems	Emotional States	Related Neural Structures	Personality Dimensions
Appetitive	Hope	Basolateral amygdala	Extraversion
	Relief	Ventral tegmental area	Impulsivity
	Desire	Nucleus accumbens	
Defensive	Fear	Lateral amygdala	Neuroticism
	Anxiety	Central amygdala	Anxiety
	Frustration	Hippocampus	
Aggressive	Irritation	Appetitive circuits	Hostility
	Anger	Defensive circuits	
	Rage	Ventromedial hypothalamus	
		Periacqueductal gray	
Nurturant	Warmth	Amygdala	Agreeableness
	Affection	Ventromedial hypothalamus	Reward dependence

tems. Some of these mechanisms are components of the "reticular activating system" ascending from the brainstem to the cortex. Posner has discussed a "vigilance" system involving norepinephrine projections from the locus coeruleus to the cortex (Posner & Raichle, 1994; Posner & Rothbart, 1992). This system is thought to be involved in the tonic maintenance and phasic adjustments in general alertness. Tucker has described a "tonic activation" system involving dopamine projections from the ventral tegmental area to object processing pathways in the left hemisphere (Tucker & Derryberry, 1992; Tucker & Williamson, 1984). This mechanism is thought to facilitate defensive behavior by focusing attention on important stimuli and preventing distraction.

A second set of attentional circuits is involved in orienting attention from one location to another and in adjusting the scale or breadth of attention. This "posterior attentional system" is distributed across the midbrain's superior colliculus, the pulvinar nucleus of the thalamus, and the parietal lobe within the cortex. Its functioning can be best understood in terms of component operations that allow attention to "disengage" from one location, "move" to a new location, and "engage" or enhance that location. When engaged at a particular location, the breadth of attention can also be focused to provide more detail of local features or expanded to provide a broader coverage of global information (Posner & Raichle, 1994; Posner & Rothbart, 1992; Rothbart, Posner, & Rosicky, 1994).

A third attentional system is located within the frontal cortex with its pivotal circuitry focused on the anterior cingulate region. This "anterior attentional system" is viewed as an executive system responsible for regulating the posterior attentional system and controlling attention to semantic information (Posner & Raichle, 1994; Rothbart, Derryberry, & Posner, 1994). Vogt, Finch, and Olson (1992) have proposed that the anterior cingulate cortex, with close connections to motor cortex, may provide a site for interaction between motivational and cognitive processes, especially as they affect motor output. Moreover, Posner and Rothbart (1992) suggest that the anterior system underlies the conscious, "effortful control" of behavior through which the individual can regulate more reactive motivational functions. This capacity depends upon sophisticated attentional and inhibitory processes which can be regulated in a planful way in light of representations of the self and future.

Individual differences in these attentional systems are likely related to a variety of attentional biases evident during different motivational states. For example, individuals high in trait anxiety tend to show a narrow attentional focus along with delays in disengaging from threatening inputs (Derryberry & Tucker,

https://doi.org/10.1017/S0954579497001375 Published online by Cambridge University Press

1993). The extent of such involuntary biases may reflect variability in functioning of the posterior attentional system as well as the fear-related motivational system. At a more general level, the anterior attentional system (i.e., effortful control) appears related to the variability in "attentional flexibility" (Derryberry & Rothbart, 1988; Keele & Hawkins, 1982) and "attentional efficiency" (Wells & Matthews, 1994) evident in adults. This variability may contribute to several personality dimensions. For example, individuals high in effortful control may show high levels of Conscientiousness and low Neuroticism (Ahadi & Rothbart, 1994). In recent studies with college students, we have employed a Stroop-like "spatial compatibility" task that requires subjects to make a response given conflicting spatial information (e.g., to respond with the left hand given a stimulus on the right side of the screen). Subjects who perform well on this task are apparently able to suppress the conflicting spatial information and thus inhibit the dominant tendency to respond with the hand corresponding to the location of the stimulus. Self-report measures indicate that subjects who perform well on the conflict task tend to be high in trait anxiety and attentional control, whereas those who perform poorly are high in anxiety and low in attentional control (Derryberry & Reed, 1997).

The anterior system is a relatively late-developing system, although aspects of intentional control can be seen late in the 1st year. In our research, major development of this system occurs during the toddler period. We have recently used a marker task for anterior cingulate function, a spatial conflict task very similar to that described above. Considerable development of the ability to use a rule to inhibit a dominant response occurs between the ages of 27 and 36 months. Children who perform well on this task are described on a parent-report measure of temperament as more skilled at attentional shifting and focusing, less impulsive, and less prone to frustration reactions (Gerardi, Rothbart, Posner, & Kepler, 1996). By 6 or 7 years of age, the construct of effortful control is represented by a factor defined by scales measuring attentional focusing, inhibitory control, perceptual sensitivity, and pleasure from low intensity stimulation (Ahadi et al., 1993). The stability of effortful control has received little investigation, but is suggested by findings that children who are better able to delay gratification in a conflict situation in preschool are more attentive and resistant to stress as teenagers (Shoda, Mischel, & Peake, 1990). As discussed in more detail below, effortful control contributes to a number of important developmental processes, including the ability to delay gratification, the regulation of fear, and the development of conscience (Eisenberg & Fabes, 1992; Kochanska, 1993; Rothbart, Ahadi, & Hershey, 1994).

Organization Within Temperament Systems

So far we have considered relevant neural systems and their possible general relations to personality dimensions. To better understand these relations, however, it is necessary to consider developmental processes both within and between these systems. In this section, we focus on development within the motivational systems, viewing their development as a process of self-organization. The basic idea is that as the child develops, cortical synapses are progressively stabilized to form representations that provide input to subcortical motivational systems. These cognitive representations provide motivational circuits with more detailed information that enhances their ability to evaluate complex situations and to regulate behavior accordingly. Although cortical representations depend in large part upon environmental inputs, their stabilization also depends upon activity within the underlying motivational systems. In a sense, the motivational circuits can function as specialized learning mechanisms, guiding the development of cortical representations in light of underlying appetitive and defensive needs. This leads to a progressive differentiation of representational and response processes, but in a manner that is integrated or organized in terms of the central motivational functions.

Motivation and representational organization

By representational development we refer to the progressive stabilization of connections

https://doi.org/10.1017/S0954579497001375 Published online by Cambridge University Press

within cortical regions that process perceptual and conceptual information. These representations are concerned not only with information from the external environment, but also with interoceptive hedonic and energetic information involved in ongoing emotional states, and with complex conceptual information involved in beliefs about the self, others, and the world. As they develop, these cortical structures deliver detailed input to the limbic regions, providing motivational systems with an increased capacity to predict and evaluate potentially significant events (Derryberry & Reed, 1994b, 1996). They also allow motivational processes to be influenced by the belief systems and values of the child's culture.

Representational inputs have been studied in most detail for the defensive circuits of the amygdala (LeDoux, 1995, 1996). The lateral amygdala receives a direct sensory input from the thalamus, which allows a very rapid (less than 20 ms) fear response based on low-level sensory features. Additional thalamic pathways deliver the sensory information to the cortex, where it undergoes extensive processing across sensory and association areas. Importantly, the cortical areas possess a more detailed cellular and connectional architecture compared to that of the thalamus and amygdala, allowing for more specific and elaborate processing. A number of these cortical regions convey highly processed information to the amygdala, including object information from unimodal association areas and conceptual information from polymodal areas, and also contextual information from the hippocampus (LeDoux, 1995). As they converge upon the lateral amygdala, these cortical inputs allow fear circuitry to respond based on finer distinctions between events (e.g., different facial expressions), to anticipate events in the future (e.g., a specific facial expression may be followed by a specific action), and to relate these events to the surrounding context (e.g., a specific action is more likely to occur in a specific environment). Although the functions of different cortical areas are not yet clear, it is reasonable to assume that they also contribute to more abstract sources of human fear, such as those arising from our concepts of the self and other people. In a sense, cortical representations can be viewed as part of an elaborate appraisal mechanism concerned with detecting and predicting relatively subtle forms of threat.

The development of cortical representations involves considerable plasticity. Rather than being prespecified, connections within the cortex are initially extremely diverse, with extensive interconnectivity between cell groups. Upon exposure to the environment, the more active synapses tend to be strengthened and stabilized, whereas the vast majority appear to regress. It is important to emphasize that the resulting representational networks are not shaped through passive "instruction" by the environment. Instead, internal selective processes arise from the child's motivational systems to constrain the impact of environmental events (Cicchetti & Tucker, 1994; Derryberry & Reed, 1994b; Tucker, 1992). As discussed below, these selective processes can influence which synapses are most likely to be activated by the environment, and once they are activated, which synapses are most likely to be stabilized.

One general type of motivational selection arises from a child's response tendencies, regulating the child's exposure to specific types of information. For example, a child with strong approach tendencies may often seek out novel and stimulating environments, whereas a more fearful child may avoid such stimulation in favor of more familiar and calm environments (Scarr & McCartney, 1983). In addition, children will differ in the types of information they are likely to evoke from the others. While the approach-oriented child may elicit intense social stimulation from others, the fearful child may be treated in a more gentle or protective way. Children will also differ in their exposure to interoceptive emotional information, with approach-oriented children more often experiencing positive affect and fearful children more prone to negative affect (Derryberry & Reed, 1994b; Rothbart, 1989). As a result of these influences, children with different temperaments will be exposed to different types of information, leading to different content within their developing representations.

While the above examples illustrate influ-

https://doi.org/10.1017/S0954579497001375 Published online by Cambridge University Press

ences arising from the child's response tendencies, a more specific form of motivational selection involves attention. Because the underlying motivational systems regulate attention, temperamental variability in these systems would be expected to lead to attentional differences. Our adult research has investigated these differences in visual tasks that present positive and negative cues prior to targets requiring a simple detection response. When the cues signal an opportunity to gain or lose points, individuals with strong approach tendencies (i.e., neurotic extraverts) are slow to disengage attention from the positive cues, whereas anxious individuals (e.g., neurotic introverts) are slow to shift from negative cues (Derryberry & Reed, 1994a). In addition, when attention is drawn to the location of a negative trait adjective, anxious subjects are slow to disengage and shift to targets in another location (Reed & Derryberry, 1995; Derryberry & Reed, 1996). Similar negative attentional biases have been found in studies of trait anxious and clinically anxious subjects (Eysenck, 1992; Vasey, Daleiden, Williams, & Brown, 1995; Wells & Matthews, 1994). These studies provide support for the idea that trait anxiety biases attention in favor of negative information, though evidence of positive attentional biases, such as noted above for neurotic extraverts, remains limited.

Moreover, much evidence from neuroscience (e.g., Singer, 1990) and developmental psychology (Ruff & Rothbart, 1996) suggests that attention plays a central role in enabling cortical plasticity and explicit forms of learning. This in turn suggests that because individuals with different temperaments attend to different types of information, they will tend to selectively store different information. Consistent with this proposal, anxious individuals form stronger short-term memory representations for attended negative words (Reed & Derryberry, 1995), and a number of studies have demonstrated that trait anxious individuals show enhanced recall of negative information (e.g., Eysenck & Byrne, 1994; Eysenck & Mogg, 1992; Kennedy & Craighead, 1988; for reviews, see Eysenck, 1992; Wells & Matthews, 1994). These types of attentional effects on memory appear to make good adaptive sense, for they allow the motivational system to promote the storage of information that may prove useful to its future functioning.

When viewed developmentally, these findings suggest that motivated attentional biases may progressively shape the child's cognitive representations in a manner that reflects their underlying temperament (Derryberry & Reed, 1996). Across time, the cortical appraisal mechanism can be fine tuned in light of the child's needs and concerns. This representational sculpting should depend not only upon the more reactive attentional processes related to subcortical motivational systems, but also upon the effortful processes arising from the anterior attentional system. For example, an anxious child may construct representations that emphasize potential dangers in the world, and perhaps also the sources of safety and relief that can help them cope with these threats. Many fearful children also represent the self as vulnerable and ineffective. In contrast, the approach oriented child may develop representations that emphasize the rewards in the world, other people as sources of pleasant stimulation, and the self as active and efficacious. The child with a strong affectional system may form representations emphasizing the nurturant potential of others, developing views of the self as lovable and accepted or unlovable and rejected. As suggested by MacDonald (1992), the affectional system may be important in directing the child's attention to the values of the parent and can thus facilitate the transmission of a wide range of cultural values. In addition, it can facilitate development of a rich representation of information about others, including their needs and requirements, as well as strategies for protecting and serving others.

Organizational processes

These representational developments can also be viewed as allowing differentiation of the underlying motivational processes. Because it depends on both environmental and temperamental processes, differentiation will proceed in varied ways across different children. To focus on defensive motivation, for example,

https://doi.org/10.1017/S0954579497001375 Published online by Cambridge University Press

some anxious childrens' fearful representations may emphasize physical threats in the environment. In severe cases, these children may become vulnerable to physical phobias related to animals, heights, contamination, and so on. Other children's fear may differentiate primarily within the social domain, leading to possible representations of others as critical and the self as vulnerable and inferior. These children may become susceptible to social anxieties related to avoidant disorder and school phobia. Still others may represent threats across a wide range of physical and social situations, and may thus become vulnerable to the more generalized type of fear evident in overanxious disorder. Although much of this differentiation depends upon information from the environment, it is worth noting that these different types of fear appear particularly adaptive in terms of evolutionary environments (Marks & Neese, 1994).

From a physiological perspective, cortical representations can be viewed as developing extensions of limbic motivational processes (Panksepp, 1992a). In a sense, motivational systems organize cortical connectivity so as to enhance the storage and future processing of important information. As they project back upon the limbic systems, these cortical representations can then provide the motivational processes with enhanced detection and guidance capabilities (Derryberry & Reed, 1996). They allow for more detailed anticipation and evaluation of potential threats and rewards, and provide images and maps that can guide response selection. Such reciprocal effects can give rise to positive feedback interactions between limbic and cortical processes, a type of interaction often considered central to self-organization (Lewis, 1995). Unfortunately, such positive feedback loops may form a vicious cycle leading to progressive problems for some children. A fearful temperament may facilitate representations involved in detecting and avoiding threat, which may in turn exacerbate the child's fear. Similarly, an approach-oriented temperament may promote reward-related representations that feed back to enhance the child's impulsivity. Given the tight coupling between cognitive and motivational processes, such accelerating forms of self-organization may be a common feature of many childhood disorders.

However, several additional regulatory processes may protect against such accelerating interactions. First, we have suggested that motivational systems may promote relatively balanced representations that provide negative as well as positive influences. For example, defensive motivation may facilitate information related to threat, but it should also promote attention to information relevant to safety, relief, and coping with the threat (Derryberry & Reed, 1996). By facilitating relieving as well as threatening information, the defensive system can more adaptively guide the individual's responses (i.e., away from the threat and toward safety). The resulting representational content can be called upon in the future to help the child cope with a threatening situation, and should guard against an accelerating potential for anxiety. Similarly, appetitive forms of motivation should function most effectively when potentially frustrating as well as rewarding information is attended. The stored representations can help the child circumvent frustration while approaching rewards, thereby constraining his or her impulsivity. From this perspective, the motivational systems can be viewed as incorporating negative as well as positive feedback mechanisms, allowing them to function as more balanced regulatory systems, especially when combined with attentional control allowing flexible shifting from one mental content to another, as we indicate below. A similar approach can be found in Higgins' (1996) discussion of "outcome-focused" regulatory systems.

Second, it is necessary to consider regulatory processes arising from other motivational and attentional systems. As mentioned earlier, physiological and developmental evidence suggests that fear motivation may provide important, but relatively involuntary, controls over appetitive motivation. While such fear regulation may be primarily reactive, additional cortical development increases the child's capacity for voluntary or effortful forms of control. More specifically, the developing representations allow the child to anticipate futures states of the self and world, to evaluate the consequences of potential ac-

https://doi.org/10.1017/S0954579497001375 Published online by Cambridge University Press

tions, and thus to access informational content necessary for strategic voluntary control (LeDoux, 1994). But to effectively utilize this information, the processing capacity of the frontal and cingulate regions is necessary. In particular, the anterior attentional system can regulate the more reactive posterior system, and can modulate the reactivity or automaticity inherent in activated representations. These executive attentional functions allow the child to rely on an increasing range of conscious representational content, to more flexibly coordinate this content, and to generate behaviors aimed at future states of affairs (Posner & Rothbart, 1992). As discussed in the next section, these effortful processes can be viewed as providing an additional capacity for self-regulation, beyond that provided by reactive motivational influences.

Organization Between Temperament Systems

In this section, we move beyond organizational processes within a single motivational system to consider processes arising from interactions between temperament systems. These interactions are likely to be highly complex, involving both reactive and regulatory processes at subcortical and cortical levels. To provide a beginning framework, we approach these interactions in terms of regulatory effects upon more reactive systems. We begin by considering the role of fear in regulating approach, followed by a discussion of effortful control and approach. We conclude by considering the regulatory influence of effortful control on fear.

Regulatory influences of fear

Many models of motivation propose that circuits related to fear possess inhibitory connections to those involved in appetitive approach behavior (Fowles, 1994; Gray, 1987b). These inhibitory connections allow anticipatory activity within the fear system to suppress approach responses that might lead the organism into a harmful situation. In human social situations, for example, many types of reward-seeking and approach behaviors are considered inappropriate and can evoke aggression or rejection from others.

Consider a relatively fearless child with strong approach tendencies. In general, such a child should show many approach behaviors directed toward environmental sources of reward. Although they may be subject to frustration (Depue & Iacono, 1989), their emotional tone, at least initially, should be generally hopeful and enthusiastic. At a cognitive level, their representations should emphasize rewarding aspects of the world and other people, and they may develop views of themselves as worthwhile and effective.

However, their relative lack of fear at times may lead them to respond with too much impulsivity. Newman and his colleagues have provided evidence that individuals with strong approach tendencies do not always stop and reflect upon punishment. As a result, their representations may include weak associations between punishment and incorrect behavior (Newman, 1987; Wallace, Newman, & Bachorowski, 1991). If a child's representations emphasize rewards at the expense of punishments, it will be easy to anticipate the positive consequences of approach behavior but more difficult to predict the negative outcomes that might occur. In severe cases, such children may be vulnerable to externalizing or "disinhibitory" problems such as those involved in conduct disorder.

In contrast, the children with strong approach who are also fearful should be better able to inhibit impulsive approach tendencies. Given findings that anxious individuals show enhanced attention to threats (Derryberry & Reed, 1994a, 1996; Vasey et al., 1995), such children should be more responsive to negative events that arise within a situation. Also, their representations should be fairly balanced in covering the positive and negative aspects of the world, allowing them to anticipate potential problems that might result from their appetitive behavior. However, these children may also be vulnerable to conflicts and indecisiveness in ambiguous situations. If problems arise, children high in fear and approach may demonstrate comorbid externalizing and internalizing symptoms. For example, such a child may develop problems related to con-

https://doi.org/10.1017/S0954579497001375 Published online by Cambridge University Press

duct disorder or attentional deficit hyperactivity disorder (ADHD), but in contrast to the child above, may still feel anxious and guilty about their inappropriate behavior. In addition, given the regulatory influence of fear, the externalizing behavior should be somewhat attenuated. Children with coexistent ADHD and anxiety show reduced impulsivity relative to those with ADHD alone (Pliszka, 1989).

Fear may also play a role in controlling aggressive as well as reward-oriented approach. For example, aggressiveness appears to decrease between kindergarten and first grade in children who show internalizing patterns (Bates, Pettit, & Dodge, 1995). Quay (1993) has reviewed studies of children with undersocialized aggressive conduct disorder, who appear to be characterized by predatory or instrumental forms of aggression (e.g., bullying, threatening). Quay suggests that aggressive acts reflect disinhibited approach motivation, resulting in part from diminished activity within the fear system (which normally inhibits approach). Consistent with this perspective are findings that when conduct disorder is accompanied by anxious symptoms, children show fewer peer nominations as fighting the most or being the meanest (Walker et al., 1991).

These examples point out the adaptive value of fear motivation in regulating approach behaviors (Rothbart & Bates, in press). It is worth noting, however, that strong fear can also result in an overregulation of approach motivation, particularly for children with relatively weak approach tendencies. For example, a socially anxious child may tend to avoid social situations where threat is anticipated, regardless of the potential rewards that are available. Such avoidance can lead the child to miss opportunities for positive and novel experiences. In addition, the child may fail to gain experience that could help him or her cope with social situations in the future. He or she may fail to develop representations that help him or her to anticipate how threatening and relieving events develop within the situation, and to prepare responses appropriate to these events. Even if the child possesses such representations and manages to approach the threatening situation, his or her ongoing behavior may still be overregulated by fear. The negative attentional bias and strong behavioral inhibition may make it difficult to initiate spontaneous actions and to keep up with ongoing events, and he or she may become overly cautious and self-conscious (Gilbert & Trower, 1990; Leary & Kowalski, 1995).

Another example of overregulated approach motivation involves depression. Some models suggest that depressive symptoms result in part from anxiety-related inhibition of appetitive motivation (e.g., Fowles, 1994; Gray, 1994). If exposed to prolonged stress, the resulting inhibition may attenuate the child's reward sensitivity. This could contribute to the decreased positive affect often seen in depression and perhaps to feelings of hopelessness and pessimism about the future. In addition, the inhibition may suppress the dopaminergic systems responsible for response facilitation. Such an inability to mobilize responses could promote the psychomotor retardation, lack of initiative, and feelings of low energy common in depression. Combined with decreased reward sensitivity, the perception of low energy may lead the child to view themselves as ineffective and helpless. Our prediction of sadness at the age of 7 from infant fearfulness may be related to these processes (Rothbart et al., 1995).

It can be seen that although fear can provide beneficial regulation of undercontrolled approach behavior, it can also lead to problems involving overcontrol. This distinction has been basic to Block and Block's (1980) theorizing, which emphasizes a dimension of ego control ranging from a lack of control to constricted, inflexible behavior. The question of how much control is optimal is a difficult one, and is well summarized in Block and Kremen's (1996) comment that "the human goal is to be as undercontrolled as possible and as overcontrolled as necessary." One of the advantages of a temperament approach is its ability to view the issue of undercontrol versus overcontrol in light of several interacting systems. As discussed above, whether fear leads to too little or too much control depends not only upon the strength of fear motivation,

https://doi.org/10.1017/S0954579497001375 Published online by Cambridge University Press

but also on the strength of the regulated approach motivation. As discussed in the next section, it will also depend on a second type of regulatory influence, that arising from effortful control.

Regulatory influences of effortful control

As mentioned earlier, effortful control reflects individual differences in the anterior attentional system, a set of circuits crucial in controlling attention to spatial and semantic information. Given its extensive access to representational content within the cortex, and its ability to coordinate spatial and semantic attention, effortful control provides a more flexible means of regulation compared to that afforded by fear. One way of conceptualizing these two types of control focuses on differences between passive and active attentional processes. Fear regulation can be highly reflexive, enhancing attention to immediate sources of threat in the environment, and thereby making it difficult for the child to approach certain situations. Effortful control may allow the child to voluntarily decrease attention to threatening inputs, and perhaps to increase attention to relieving inputs. By flexibly distributing attention between these inputs, a more effective coping strategy can be implemented. For example, a child with high, unregulated fear may anxiously watch other children playing roughly on a preschool playyard. Another child, also fearful, may busily play in the sandbox, taking occasional breaks to observe other children's activities.

These children may differ in ways related to Block and Block's (1980) constructs of ego control and ego resiliency. Ego control refers to an emotion-related (fear) system that is associated with categorical, restrictive control of behavior. The child who is anxiously watching may be locked into this system and unable to flexibly construct a strategy to reduce anxiety. In contrast, ego resiliency refers to flexible adaptation to changing circumstances, very much like the effortful control dimension of temperament. The child in the sandbox is structuring the situation to meet her needs, and thereby modulating an otherwise inflexible fear control. This child can switch attention from threatening information ("If I play I might get hurt") to alternative strategies ("So I'll play in the sandbox instead").

It seems likely that limitations in effortful control may contribute to a variety of childhood problems. In the case of externalizing or disinhibitory psychopathologies, we have described models that emphasize strong approach tendencies alone or as a result of weak fear regulation (e.g., Newman, 1987; Quay, 1993). In addition, however, effortful control is also likely to play a role. In children with ADHD, for example, there is evidence of impulsive response to rewards and proneness to frustration (Parry & Douglas, 1983). It is important to keep in mind, however, that many children show these characteristics. Some are nevertheless able to voluntarily constrain their impulsivity, perhaps by limiting attention to potential rewards, by enhancing attention to potential punishments, or simply by following the rules. Those who lack these effortful controls who may be most vulnerable to ADHD (Ruff & Rothbart, 1996).

Aggressive problems also appear to be related to strong approach and weak fear motivation (Quay, 1993), along with deficits in effortful control. Adult psychopaths have been found to be slow to disengage attention when it is focused on a rewarding goal, which may make it difficult for them to access the negative consequences of their actions (Kosson & Newman, 1989). In 4- to 6-year-old children, boys with good attentional control tend to deal with anger by using nonhostile, verbal methods rather than more overt aggressive methods (Eisenberg, Fabes, Nyman, Bernzweig, & Pinuelas, 1994). In our studies of 6- to 7-year-olds, aggression was positively related to an approach factor (Surgency) and to a Negative Affectivity factor (especially anger) (Rothbart et al., 1994). Effortful control was negatively correlated with aggression but made no unique contribution. Since effortful control was negatively related to surgency and negative affectivity, effortful control may regulate aggression indirectly by controlling reactive tendencies underlying surgency and negative affectivity. For example, children high in attentional control may be able to direct attention away from the rewarding as-

https://doi.org/10.1017/S0954579497001375 Published online by Cambridge University Press

pects of aggression. Similarly, they may be able to decrease the influence of negative affectivity by shifting attention away from the negative cues related to anger.

To better understand aggression and other impulsive problems, it is helpful to consider the relationship between effortful control and additional emotional processes related to empathy and guilt. Adult research suggests that anxious individuals tend to be high in empathy (Dias & Pickering, 1993). Empathy in 6- to 7-year-olds is positively related to negative affectivity (but negatively related to anger), and can be predicted by high levels of fear during infancy (Rothbart et al., 1994). In addition, however, a stronger correlation was found between empathy and effortful control, with children high in effortful control showing greater empathy. In a self-report study of elderly hospital volunteers, Eisenberg and Okun (1996) assessed empathy-related components of sympathy, perspective taking, and personal distress. Negative emotional intensity was positively related to sympathy and personal distress, while attentional control was positively related to sympathy and perspective taking, and negatively related to personal distress. These studies suggest that effortful control may support empathy by allowing the individual to attend to the thoughts and feelings of another without becoming distracted by their own distress.

Adult studies indicate that empathy is also related to guilt (Tangney, Burggraf, & Wagner, 1995). Hoffman (1988) has suggested that guilt is a special case of empathy, involving feelings of concern for the other coupled with a sense of personal responsibility. Like empathy, guilt in 6- to 7-year-olds is positively related to Negative Affectivity and Effortful Control (Rothbart et al., 1994). Following Dienstbier (1984), negative affectivity may contribute to guilt by providing the individual with strong internal cues of discomfort, thereby increasing the probability that the cause of these feelings is attributed to an internal rather than external cause. Effortful control may contribute further by providing the attentional flexibility needed to relate these negative feelings of responsibility to one's own specific actions and to the negative consequences for another. Adult studies suggest that guilt involves a rather complex attentional pattern focusing on a specific deficient behavior, its effects upon others, and the means of making amends (Tangney et al., 1995). Developing representations of possibilities for prosocial actions are also important in developing outcomes for empathy and guilt. Attentional flexibility can facilitate accessing these representations and information relevant to dealing with the situation. Without adequate attentional control, the child may link the deficiency to general aspects of his or her character, and may thus experience global, debilitating feelings of shame. It is also possible that attentional limitations may lead the child to attribute blame externally, and to the experience of anger directed toward another.

Kochanska's (1991, 1993, 1995) recent work nicely ties together temperamental and environmental influences on the development of conscience. Fearful preschool-aged children were found to show better internalization of moral principles, with this relationship heightened when mothers used gentle, nonpower-oriented discipline. This supports Hoffman's (1988) proposal that too much power assertion may interfere with internalization by directing the child's attention away from the consequences of his or her act. In contrast, nonfearful children's internalized control was associated with security of attachment (Kochanska, 1995), a finding consistent with MacDonald's (1992) suggestion that feelings of warmth may facilitate the child's adoption of the parent's values. Finally, Kochanska has found a main effect involving effortful control in the development of conscience (Kochanska, Murray, Jacques, Koenig, & Vandegeest, 1996). This is consistent with the notion that children with greater attentional flexibility may be better able to resist distraction and to attend to the appropriate information for linking negative feelings, the consequences of their actions, and moral principles. It also supports the notion that effortful control can allow the child to act in situations where he or she might otherwise be paralyzed by distress.

While these examples emphasize the regulation of approach behavior, effortful control

https://doi.org/10.1017/S0954579497001375 Published online by Cambridge University Press

can also be important in regulating fear. If we first consider the fearful child with low effortful control, such a child's attention may be frequently controlled by the more reactive influences of fear. Our adult studies suggest that these reactive influences include tendencies to narrowly focus attention under threatening situations, and to be slow to shift attention away from threatening and relieving signals (Derryberry & Reed, in press). If an anxious child focuses too narrowly or has difficulty disengaging from a threatening stimulus, their feelings of anxiety are likely to increase, and they may be limited in their ability to process additional information relevant to safety and relief. Even if their representations possess information relevant to relief and coping, their attentional inflexibility may limit their ability to take advantage of this information by using strategies involving action. Many threatening situations require that attention shift fluidly among potential sources of threat and relief, and strategies for achieving the latter, and the anxious child may have trouble in coordinating such information.

In contrast, the fearful child with greater effortful control may be able to voluntarily regulate attention in a way that attenuates these reactive influences and reduces their anxiety. Our adult studies have found that individuals reporting efficient attentional control tend to show low levels of anxiety and frustration (Derryberry & Rothbart, 1988). Even during infancy, babies who can easily disengage attention from an arousing stimulus are reported to be more soothable and less subject to negative affect by their mothers (Rothbart, Ziaie, & O'Boyle, 1992). More specifically, the child with good attentional control may be able to disengage from environmental threats, from internal feelings of anxiety, or from negative self-concepts such as those involving failure and vulnerability. Clinical research indicates that such forms of attentional distraction can prove effective in reducing ongoing anxiety, as in children undergoing dental treatment (Wells & Matthews, 1994).

In addition to limiting the impact of threatening information, effortful control may allow the child to enhance positive information, including situational sources of relief and safety, internal feelings of confidence and energy, and self-concepts related to success and efficacy. In short, effortful control may be crucial in coordinating the various sources of threatening and relieving information required in defensive contexts, and in allowing for adaptive action in situations where children would otherwise be subject to inhibition and a focus on their own distress. Even given high levels of effortful control, however, this kind of coordination may not come easily. The reactive aspects of fear, including the attentional restrictions and potentially distracting autonomic arousal, may make it difficult to accomplish.

As a result of these difficulties, children may come to rely upon a variety of attentional strategies to regulate their anxiety. Because these strategies differ in the deployment of attention, they may also differ in their long-term adaptiveness. As mentioned above, some children may be able to attend in some detail to threatening information, while at the same time flexibly disengaging in order to process and and act upon information relevant to safety and coping. However, other children may come to rely upon primarily avoidant strategies, disengaging attention from the threatening situation without attending to sources of relief and available coping options. This may temporarily reduce the child's anxiety, but it is also likely to limit his or her ability to learn about the threatening situation and the various ways of coping with it (Cortez & Bugental, 1995; Wells & Matthews, 1994). The child may fail to learn that he or she can actively cope with certain situations, and may thus continue to represent the self as vulnerable rather than efficacious. Similarly, some children may be able to reduce the experience of fear by directing attention away from their anxious bodily sensations. This may improve their affective state and help them stay engaged in an ongoing task. But if this strategy were used too extensively, the child may fail to benefit from the more positive aspects of felt anxiety. As noted above, negative feelings play important roles in impulse control, empathy, and conscience. In addition, adult research has identified a group of

https://doi.org/10.1017/S0954579497001375 Published online by Cambridge University Press

"repressive" individuals who report low anxiety but demonstrate strong physiological signs of stress. Although the attentional mechanisms remain unclear, evidence suggests that individuals who suppress emotional feelings are prone to a variety of health problems (Schwartz, 1990).

Related avoidant strategies may involve enhanced attention to sources of relief and safety in the environment. In these instances, the anxious child may cope with threat by actively seeking assistance or comfort from another person, employing strategies that may require good attentional control. If the other is supportive, the child may come to represent threatening situations in such a way that feelings of relief are primarily associated with other people rather than with his or her own actions. As a result, the child may continue to represent him- or herself as vulnerable, especially in situations where the other is unavailable. In extreme cases, these types of strategies and representations may give rise to problems involving dependent behavior, as in separation anxiety disorder and school phobia (Derryberry & Reed, 1996). Problems involving dependency may also vary with the child's social reward motivation, becoming most likely in families with affectionate and warm relationships (McDonald, 1992).

While these examples illustrate effortful control based on a reduction of attention to sources of fear, some children may attempt to control fear by increasing attention to threatening information. This may prove to be an attractive strategy for an anxious child, because the effortful component is compatible with the reactive influence of fear (i.e., enhanced attention to threat). In many cases, the extra attention may also provide them with additional information that facilitates coping. Again, however, such strategies can cause problems. For example, some children may adopt effortful strategies focusing attention on small details of their behavior, noting very slight discrepancies between their performance and a standard. This may be useful in helping them make fine adjustments in their behavior, but it may also contribute to the perfectionism that often accompanies anxiety and depression (Lundh & Ost, 1996; Terry–Short, Owens, Slade, & Dewey, 1995). Along similar lines, some children may prepare for a threatening event by attempting to anticipate everything that might go wrong, and intentionally focusing upon a set of behaviors (e.g., being highly planful or organized) that have proven effective in the past. These behaviors appear highly conscientious and may allow the child to develop effective strategies for avoiding anxiety. However, such excessive planning can also take the form of extended worry, and can lead to an overly deliberate and compulsive coping style that limits spontaneity and flexibility (Tucker & Derryberry, 1992). Although these examples are speculative, they point out that self-regulation is a matter of degree, and that the effects of overcontrol as well as undercontrol need to be considered.

Conclusions

In this paper we have approached personality in terms of the self-organizing processes related to motivational and attentional systems. This self-organization can be viewed in terms of specific motivational processes that regulate and stabilize the child's representations of self and world. In a sense, the subcortical systems can be viewed as extending into the cortex, where they organize cortical representations in terms of underlying motivational tendencies. At the same time, these cortical representations feed back upon the motivational circuits, providing new means of anticipatory control and guidance. By investigating interactions between the cognitive and motivational components, we can better understand emotional problems in terms of the child's experience, and to relate such thoughts and feelings to the problematic behaviors.

In addition, the organization within temperament systems is influenced by his or her interactions with other systems. Although many such interactions are possible, we focused on the regulatory effects exerted by fear and effortful control upon approach behavior. To understand impulsive disorders, it may not be enough to consider only the child's approach motivation, though this is clearly important. We also need to consider the impact

https://doi.org/10.1017/S0954579497001375 Published online by Cambridge University Press

of fear in regulating approach, as well as the more voluntary influences of effortful control. Similarly, to understand anxious disorders, we need to move beyond fear to consider the child's capacity for self-regulation through effortful control. Finally, we have tried to point out that problems may arise not only from an underregulated system, but also from motivational tendencies subjected to overregulation. It is possible that many of the symptoms related to anxious disorders arise from overcontrol.

Although temperament approaches have gained increasing influence in recent years, it should be clear that we are only beginning to understand the underlying processes. In particular, we need clarification concerning the set of motivational systems that are actually basic to personality, as well as a better understanding of how they interact with attentional mechanisms. In addition, more research is needed concerning interactions between reactive and effortful forms of attention. Nevertheless, we feel that this general approach is promising. When applied to psychopathology, it provides an improved understanding of symptoms, an appreciation of their continuity with normal personality, and a functional view of the links between the affective and cognitive components of these disorders. In these ways, a temperament perspective provides a broad approach to prevention and treatment.

References

Ahadi, S. A., & Rothbart, M. K. (1994). Temperament, development, and the big five. In C. F. Halverson, Jr., G. A. Kohnstamm, & R. P. Martin (Eds.), *The developing structure of temperament and personality from infancy to adulthood* (pp. 189–207). Hillsdale, NJ: Erlbaum.

Ahadi, S. A., Rothbart, M. K., & Ye, R. M. (1993). Children's temperament in the US and China: Similarities and differences. *European Journal of Psychology, 7*, 359–377.

Bates, J. E., Pettit, B. S., & Dodge, K. A. (1995). Family and child factors in stability and change in children's aggressiveness in elementary school. In J. McCord (Ed.), *Coercion and punishment in long-term perspectives*. New York: Cambridge University Press.

Block, J., & Kremen, A. M. (1996). IQ and ego-resiliency: Conceptual and empirical connections and separateness. *Journal of Personality and Social Psychology, 70*, 349–361.

Block, J. H., & Block, J. (1980). The role of ego-control and ego-resiliency in the organization of behavior. In W. A. Collins (Ed.), *The Minnesota Symposia on Child Psychology* (Vol. 13, pp. 39–101). Hillsdale, NJ: Erlbaum.

Caspi, A., & Silva, P. A. (1995). Temperamental qualities at age three predict personality traits in young adulthood: Longitudinal evidence from a birth cohort. *Child Development, 66*, 486–498.

Cicchetti, D., & Tucker, D. (1994). Development and self-regulatory structures of the mind. *Development and Psychopathology, 6*, 533–549.

Cloninger, C. R. (1987). A systematic method for clinical description and classification of personality variants. *Archives of General Psychiatry, 44*, 573–588.

Cortez, V. L., & Bugental, D. B. (1995). Priming of perceived control in young children as a buffer against fear-inducing events. *Child Development, 66*, 687–696.

Costa, P. T., Jr., & McCrae, R. R. (1985). *The NEO Personality Inventory Manual*. Odessa, FL: Psychological Assessment Resources.

Costa, P. T., Jr., McCrae, R. R., & Dye, D. A. (1991). Facet scales for Agreeableness and Conscientiousness: A revision of the NEO personality inventory. *Personality and Individual Differences, 12*, 887–898.

Davis, M. (1992). The role of the amygdala in fear and anxiety. *Annual Review of Neuroscience, 1992, 15*, 353–375.

Depue, R. A., & Iacono, W. G. (1989). Neurobehavioral aspects of affective disorders. *Annual Review of Psychology, 40*, 457–492.

Derryberry, D., & Reed, M. A. (1994a). Temperament and attention: Orienting toward and away from positive and negative signals. *Journal of Personality and Social Psychology, 66*, 1128–1139.

Derryberry, D., & Reed, M. A. (1994b). Temperament and the self-organization of personality. *Development and Psychopathology, 6*, 653–676.

Derryberry, D., & Reed, M. A. (1996). Regulatory processes and the development of cognitive representations. *Development and Psychopathology, 8*, 215–234.

Derryberry, D., & Reed, M. A. (in press). Motivational and attentional components of personality. In G. Matthews (Ed.), *Cognitive science perspectives on personality and emotion*. Amsterdam: Elsevier Science Publishers.

Derryberry, D., & Reed, M. A. (1997). Individual differences in trait anxiety and attentional efficiency exert separable effects in regulating conflicting information. Manuscript in preparation.

Derryberry, D., & Rothbart, M. K. (1984). Emotion, attention, and temperament. In C. E. Izard, J. Kagan, & R. B. Zajonc (Eds.), *Emotions, cognition, and behavior* (pp. 132–166). Cambridge, England: Cambridge University Press.

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

Derryberry, D., & Tucker, D. M. (1992). Neural mechanisms of emotion. *Journal of Consulting and Clinical Psychology, 60*, 329–338.

Derryberry, D., & Tucker, D. M. (1993). Motivating the

https://doi.org/10.1017/S0954579497001375 Published online by Cambridge University Press

focus of attention. In P. Niedenthal & S. Kitayama (Eds.), *The heart's eye: Emotional influences in perception and attention* (pp. 170–196). San Diego, CA: Academic Press.

Dias, A., & Pickering, A. D. (1993). The relationship between Gray's and Eysenck's personality spaces. *Personality and Individual Differences, 15,* 297–306.

Dienstbier, R. A. (1984). The role of emotion in moral socialization. In C. E. Izard, J. Kagan, & R. B. Zajonc (Eds.), *Emotions, cognition, and behavior* (pp. 484–514). Cambridge: Cambridge University Press.

Eisenberg, N., & Fabes, R. A. (1992). Emotion, regulation and the development of social competence. In M. S. Clark (Ed.), *Emotion and social behavior. Vol. 14. Review of Personality and Social Psychology* (pp. 119–150). Newberry Park, CA: Sage.

Eisenberg, N., Fabes, R. A., Nyman, M., Bernzweig, J., & Pinulas, A. (1994). The relations of emotionality and regulation to children's anger-related reactions. *Child Development, 65,* 109–128.

Eisenberg, N., & Okun, M. A. (1996). The relations of dispositional regulation and emotionality to elders' empathy-related responding and affect while volunteering. *Journal of Personality, 64,* 157–183.

Eysenck, H. J. (1981). General features of the model. In H. J. Eysenck (Ed.), *A model of personality* (pp. 1–37). New York: Springer–Verlag.

Eysenck, M. W. (1992). *Anxiety: The cognitive perspective*. Hillsdale, NJ: Erlbaum.

Eysenck, M. W., & Byrne, A. (1994). Implicit memory bias, explicit memory bias, and anxiety. *Cognition and Emotion, 8,* 415–431.

Eysenck, M. W., & Mogg, K. (1992). Clinical anxiety, trait anxiety, and memory bias. In S. Christianson (Ed.), *The handbook of emotion and memory: Research and theory* (pp. 429–450). Hillsdale, NJ: Erlbaum.

Fowles, D. C. (1994). A motivational theory of psychopathology. In W. G. Spaulding (Ed.), *Nebraska symposium on motivation, Vol. 41. Integrative views of motivation, cognition, and emotion* (pp. 181–238). Lincoln, NE: University of Nebraska Press.

Fox, N. A. (1989). Psychophysical correlates of emotional reactivity during the first year of life. *Developmental Psychology, 25,* 364–372.

Gerardi, G., Rothbart, M. K., Posner, M. I., & Kepler, S. (1996, April). *The development of attentional control: Performance on a spatial Stroop-like task at 24, 30, and 36–38 months of age*. Poster session presented at the annual meeting of the International Society for Infant Studies, Providence, RI.

Gilbert, P., & Trower, P. (1990). The evolution and manifestation of social anxiety. In W. R. Crozier (Ed.), *Shyness and embarrassment: Perspectives from social psychology* (pp. 144–177). Cambridge: Cambridge University Press.

Gray, J. A. (1982). *The neuropsychology of anxiety*. London: Oxford.

Gray, J. A. (1987a). Perspectives on anxiety and impulsivity: A commentary. *Journal of Research in Personality, 21,* 493–509.

Gray, J. A. (1987b). *The psychology of fear and stress* (2nd ed.). New York: McGraw–Hill.

Gray, J. A. (1994). Framework for a taxonomy of psychiatric disorder. In S. H. M. van Goozen, N. E. Van de Poll, & J. A. Sergeant (Eds.), *Emotions: Essays on emotion theory* (pp. 29–60). Hillsdale, NJ: Erlbaum.

Graziano, W. G. (1994). The development of agreeableness as a dimension of personality. In C. F. Halverson Jr, G. A. Kohnstamm, & R. P. Martin (Eds.), *The developing structure of temperament and personality from infancy to adulthood* (pp. 339–354). Hillsdale, NJ: Erlbaum.

Higgins, E. T. (1996). Ideals, oughts, and regulatory focus: Affect and motivation from distinct pains and pleasures. In P. M. Gollwitzer & J. A. Bargh (Eds.), *The psychology of action: Linking cognition and motivation to behavior* (pp. 91–114). New York: Guilford.

Hoffman, M. L. (1988). Moral development. In M. H. Bornstein & M. E. Lamb (Eds.), *Developmental psychology: An advanced textbook* (2nd ed.) (pp. 497–548). Hillsdale, NJ: Erlbaum.

Kagan, J., Reznick, J. S., & Snidman, N. (1988). Biological bases of childhood shyness. *Science, 240,* 167–173.

Kagan, J., Snidman, N., & Arcus, D. M. (1992). Initial reactions to unfamiliarity. *Current Directions in Psychological Science, 1,* 171–173.

Keele, S. W., & Hawkins, H. H. (1982). Explorations of individual differences relevant to high level skill. *Journal of Motor Behavior, 14,* 3–23.

Kennedy, R. E., & Craighead, W. E. (1988). Differential effects of depression and anxiety on recall of feedback in a learning task. *Behavior Therapy, 19,* 437–454.

Kochanska, G. (1991). Socialization and temperament in the development of guilt and conscience. *Child Development, 62,* 1379–1392.

Kochanska, G. (1993). Toward a synthesis of parental socialization and child temperament in early development of conscience. *Child Development, 64,* 324–347.

Kochanska, G. (1995). Children's temperament, mothers' discipline, and security of attachment: Multiple pathways to emerging internalization. *Child Development, 66,* 597–615.

Kochanska, G., & Aksan, N. (1995). Mother–child mutually positive affect, the quality of child compliance to requests and prohibitions, and maternal control as correlates of early internalization. *Child Development, 66,* 236–254.

Kochanska, G., Aksan, N., & Koenig, A. L. (1995). A longitudinal study of the roots of preschoolers' conscience: Committed compliance and emerging internalization. *Child Development, 66,* 1752–1769.

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

Kosson, D. S., & Newman, J. P. (1989). Socialization and attentional deficits under focusing and divided attention conditions. *Journal of Personality and Social Psychology, 57,* 87–99.

Larsen, R. J., & Ketelaar, T. (1989). Extraversion, neuroticism and susceptibility to positive and negative mood induction procedures. *Personality and Individual Differences, 10,* 1221–1228.

Leary, M. R., & Kowalski, R. M. (1995). *Social Anxiety*. New York: Guilford.

LeDoux, J. E. (1994). The degree of emotional control depends on the kind of personal system involved. In P. Ekman & R. J. Davidson (Eds.), *The nature of emotion: Fundamental questions* (pp. 270–272). New York: Oxford University Press.

LeDoux, J. E. (1995). In search of an emotional system in the brain: Leaping from fear to emotion and con-

https://doi.org/10.1017/S0954579497001375 Published online by Cambridge University Press

sciousness. In M. S. Gazzaniga (Ed.), *The cognitive neurosciences* (pp. 1049–1062). Cambridge, MA: MIT Press.
LeDoux, J. E.(1996). *The emotional brain*. New York: Simon & Schuster.
Lewis, M. D. (1995). Cognition–emotion feedback and the self-organization of developmental paths. *Human Development, 38,* 71–102.
Lundh, L., & Ost, L. (1996). Stroop interference, self focus and perfectionism in social phobics. *Personality and Individual Differences, 20,* 725–731.
MacDonald, K. (1992). Warmth as a developmental contruct: An evolutionary analysis. *Child Development, 63,* 753–773.
Marks, I. M., & Neese, R. M. (1994). Fear and fitness: An evolutionary analysis of anxiety disorders. *Ethology and Sociobiology, 15,* 247–261.
McCrae, R. R., & Costa, P. T. (1985). Comparison of EPI and Psychoticism scales with measures of the five-factor model of personality. *Personality and Individual Differences, 6,* 587–589.
Newman, J. P. (1987). Reaction to punishment in extraverts and psychopaths: Implications for the impulsive behavior of disinhibited individuals. *Journal of Research in Personality, 21,* 464–480.
Panksepp, J. (1982). Toward a general psychobiological theory of emotions. *Behavioral and Brain Sciences, 5,* 407–467.
Panksepp, J. (1986a). The anatomy of emotions. In R. Plutchik & H. Kellerman (Eds.), *Emotion: Theory, research and experience. Vol. 3. Biological foundations of emotions* (pp. 91–124). San Diego, CA: Academic Press.
Panksepp, J. (1986b). The psychobiology of prosocial behaviors: Separation distress, play, and altruism. In C. Zahn–Waxler, E. M. Cummings, & R. Iannotti (Eds.), *Altruism and aggression: Biological and social origins* (pp. 19–57). Cambridge: Cambridge University Press.
Panksepp, J. (1992a). A critical role for "affective neuroscience" in resolving what is basic about basic emotions. *Psychological Review, 99,* 554–560.
Panksepp, J. (1992b). Oxytocin effects on emotional processes: Separation distress, social bonding, and relationships to psychiatric disorders. *Annals of the New York Academy of Sciences, 652,* 243–252.
Parry, P., & Douglas, V. I. (1983). Effects of reinforcement on concept identification in hyperactive children. *Journal of Abnormal Child Psychology, 11,* 327–340.
Pliszka, S. R. (1989). Effect of anxiety on cognition, behavior, and stimulant response in ADHD. *Journal of the American Academy of Child and Adolescent Psychiatry, 28,* 882–887.
Posner, M. I., & Raichle, M. E. (1994). *Images of mind*. New York: Scientific American Library.
Posner, M. I., & Rothbart, M. K. (1992). Attentional mechanisms and conscious experience. In D. Milner & M. Rugg (Eds.), *The neuropsychology of consciousness* (pp. 91–111). San Diego, CA: Academic Press.
Quay, H. C. (1993). The psychobiology of undersocialized aggressive conduct disorder: A theoretical perspective. *Development and Psychopathology, 5,* 165–180.
Reed, M. A., & Derryberry, D. (1995). Temperament and attention to positive and negative trait information. *Personality and Individual Differences, 18,* 135–147.
Rothbart, M. K. (1988). Temperament and the development of inhibited approach. *Child Development, 59,* 1241–1250.
Rothbart, M. K. (1989). Temperament and development. In G. A. Kohnstamm, J. E. Bates, & M. K. Rothbart (Eds.), *Temperament in childhood* (pp. 187–247). New York: Wiley.
Rothbart, M. K., Ahadi, S. A., & Hershey, K. L. (1994). Temperament and social behavior in childhood. *Merrill–Palmer Quarterly, 40,* 21–39.
Rothbart, M. K., Posner, M. I., & Rosicky, J. (1994). Orienting in normal and pathological development. *Development and Psychopathology, 6,* 635–652.
Rothbart, M. K., & Bates, J. E. (in press). Temperament. In W. Damon & N. Eisenberg (Eds.), *Handbook of child psychology: Vol. 3. Social, emotional and personality development* (5th ed.). New York: Wiley.
Rothbart, M. K., Derryberry, D., & Hershey, K. (1995). *Stability of temperament in childhood: Laboratory infant assessment to parent report at seven years*. Unpublished manuscript.
Rothbart, M. K., Derryberry, D., & Posner, M. I. (1994). A psychobiological approach to the development of temperament. In J. E. Bates & T. D. Wachs (Eds.), *Temperament: Individual differences at the interface of biology and behavior* (pp. 83–116). Washington, DC: American Psychological Association.
Rothbart, M. K., Posner, M. I., & Boylan, A. (1990). Regulatory mechanisms in infant development. In J. T. Enns (Ed.), *The development of attention: Research and theory* (pp. 47–66). New York: Elsevier Science.
Rothbart, M. K., Ziaie, H., & O'Boyle, C. (1992). Self-regulation and emotion in infancy. In N. Eisenberg & R. A. Fabes (Eds.), *Emotion and self-regulation in early development: New directions in child development* (pp. 7–24). San Francisco: Jossey–Bass.
Ruff, H. A., & Rothbart, M. K. (1996). *Attention in early development: Themes and variations*. New York: Oxford University Press.
Scarr, S., & McCartney, K. (1983). How people make their own environments: A theory of genotype-environment effects. *Child Development, 54,* 424–435.
Schwartz, G. E. (1990). Psychobiology of repression and health: A systems approach. In J. L. Singer (Ed.), *Repression and dissociation: Implications for personality theory, psychopathology, and health* (pp. 405–434). Chicago: University of Chicago Press.
Shoda, Y., Mischel, W., & Peake, P. K. (1990). Predicting adolescent cognitive and self-regulatory competencies from preschool delay of gratification: Identifying diagnostic conditions. *Developmental Psychology, 26,* 978–986.
Singer, W. (1990). Role of acetylcholine in use-dependent plasticity of the visual cortex. In M. Steriade & D. Biesold (Eds.), *Brain cholinergic systems* (pp. 314–336). Oxford: Oxford University Press.
Tangney, J. P., Burggraf, S. A., & Wagner, P. E. (1995). Shame-proneness, guilt-proneness, and psychological symptoms. In J. P. Tangney & K. W. Fischer (Eds.), *Self-conscious emotions: The psychology of shame, guilt, embarrassment, and pride* (pp. 343–367). New York: Guilford.
Terry–Short, L. A., Owens, R. G., Slade, P. D., & Dewey, M. E. (1995). Positive and negative perfectionism. *Personality and Individual Differences, 18,* 663–668.
Tucker, D. M. (1992). Developing emotions and cortical networks. In M. Gunnar & C. A. Nelson (Eds.), *Minnesota Symposium on Child Psychology. Vol. 24. De-*

https://doi.org/10.1017/S0954579497001375 Published online by Cambridge University Press

velopmental behavioral neuroscience (pp. 75–128). Hillsdale, NJ: Erlbaum.

Tucker, D. M., & Derryberry, D. (1992). Motivated attention: Anxiety and the frontal executive mechanisms. *Neuropsychiatry, Neuropsychology, and Behavioral Neurology, 5,* 233–252.

Tucker, D. M., & Williamson, P. A. (1984). Asymmetric neural control systems in human self-regulation. *Psychological Review, 91,* 185–215.

Vasey, M. W., Daleiden, E. L., Williams, L. L., & Brown, L. M. (1995). Biased attention in childhood anxiety disorders: A preliminary study. *Journal of Abnormal Child Psychology, 23,* 267–279.

Vogt, B. A., Finch, D. M., & Olson, C. R. (1992). Overview: Functional heterogeneity in cingulate cortex: The anterior executive and posterior evaluative regions. *Cerebral Cortex, 2,* 435–443.

Walker, J. S., Lahey, B. B., Russo, M. F., Frick, P. J., Christ, M. A. G., McBurnett, K., Loeber, R., Stouthamer–Loeber, M., & Green, S. (1991). Anxiety, inhibition, and conduct disorder in children: I. Relations to social impairments. *Journal of the American Academy of Child and Adolescent Psychiatry, 30,* 187–191.

Wallace, J. F., Newman, J. P., & Bachorowski, J. (1991). Failures of response modulation: Impulsive behavior in anxious and impulsive individuals. *Journal of Research in Personality, 25,* 23–44.

Watson, D., & Clark, L. A. (1992). On traits and temperament: General and specific factors of emotional experience and their relation to the five-factor model. *Journal of Personality, 60,* 441–476.

Wells, A., & Matthews, G. (1994). *Attention and emotion: A clinical perspective*. Hillsdale, NJ: Erlbaum.

https://doi.org/10.1017/S0954579497001375 Published online by Cambridge University Press