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Neural Systems of Positive Affect: Relevance to Understanding Child and Adolescent Depression?

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Abstract

From an affective neuroscience perspective, the goal of achieving a deeper, more mechanistic understanding of the development of depression will require rigorous models that address the core underlying affective changes. Such an understanding will necessitate developing and testing hypotheses focusing on specific components of the complex neural systems involved in the regulation of emotion and motivation. In this paper, we illustrate these principles by describing one example of this type of approach: examining the role of disruptions in neural systems of positive affect relevant to Major Depressive Disorder in school-age children and adolescents. We begin by defining positive affect, proposing that positive affect can be distinguished from negative affect by its neurobehavioral features. We provide an overview of neural systems related to reward and positive affect, with a discussion of their potential involvement in depression. We describe a developmental psychopathology framework, addressing developmental issues that could play a role in the etiology and maintenance of early-onset depression. We review the literature on altered positive affect in depression, suggesting directions for future research. Finally, we discuss the treatment implications of this framework.

Keywords

positive affect; affect regulation; depression; affective neuroscience

Among investigators interested in developmental psychopathology, the concept of affect dysregulation has become increasingly popular. Depression in particular has been conceptualized as a disorder of affect dysregulation. However, few conceptual models address the specific aspects of affect that are considered to be "dysregulated". To pose a simple analogy, it is not very helpful to say that child with a fever has a disorder of "temperature dysregulation" when, in fact, the physiologic systems of temperature regulation are operating quite effectively in response to infection. Similarly, without greater specificity regarding which aspects of emotion and/or motivation are altered and in which ways, it is probably not sufficient to say that a child with depression, anxiety, or a bipolar illness has a disorder of affect regulation. In order to effectively apply a conceptual framework emphasizing affect dysregulation to understanding affective disorders, it is important to rigorously define what exactly is being dysregulated. When applied to the study of depression, such rigorous definition has value for investigating the etiology, treatment, and prevention of the disorder.

To use another form of psychopathology as an example, an anxiety disorder seems to involve an excess activation of fearful affect that impairs functioning. But what mechanisms of affect regulation are responsible for this excess fearful affect? Excess activation of fearful affect could result from any one (or a combination) of the following mechanisms: 1) a lower threshold to

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activate fear; 2) a more intense response once fear is activated; 3) difficulty terminating a fear response; 4) activation of typical fear responses in inappropriate contexts; or 5) cognitive distortion or excess attention directed to a typical internal fear response. Likewise, depression could result from dysregulation in several different affective processes. These processes could include increased activation and/or duration of negative affect in the form of sadness or irritability *or* diminished activation of positive affect and motivation. If we focus on positive affect, depression could involve 1) an elevated threshold to activate positive affect; 2) a less intense response once positive affect is activated; 3) difficulty sustaining a response involving positive affect; 4) failure to activate typical positive affect responses in appropriate contexts; or 5) insufficient devotion of cognitive resources to initiating, sustaining, or enhancing a typical positive affect response.

From the perspective of affective neuroscience, the consideration of negative affective processes and positive affective processes in depression is not simply a semantic issue regarding internal states. Dysregulation of negative affect and dysregulation of positive affect represent fundamentally different changes in specific neurobehavioral systems. The terminology for “depression” is often interpreted as presuming that the fundamental nature of this disorder involves increases in negative affect (e.g., sadness). Yet, as we will describe in this paper, there are numerous reasons to consider the role of alterations in neural systems of positive affect, particularly early in the course of the illness. The conceptual framework we describe not only raises intriguing questions at the level of mechanistic understanding of the development of the disorder, but it also may have important implications regarding early treatment and prevention.

Case Examples

To illustrate our points about the role of dysregulation of positive affect in depression, we present the following case examples drawn from recent outpatient experiences in our clinics. Consider the clinical symptoms of two young people with major depressive disorder.

Example 1

RT is an 11-year-old boy referred for treatment by his school's guidance counselor. He is typically a pleasant, conscientious student with good grades, but over a period of four months he has become less engaged in academic activities and has been involved in physical fights with peers. His teachers are concerned about his behavior. More specifically, they reported to his family that the most striking change in his behavior has been the loss of his happy, enthusiastic manner. His mother is concerned about his mood, noting that he often appears unusually serious. During the assessment, RT reports that he has stopped participating in football, is no longer spending weekday afternoons at the playground with friends, and has stopped looking forward to an award ceremony where he will receive recognition for an essay he wrote. He states that his usual social activities and his participation on the school football team no longer seem to be fun.

Example 2

SK is a 16-year-old girl brought to an adolescent outpatient clinic by her parents, who are concerned by her recent argumentativeness at home. Her parents report that although they consider their relationship with her to be close and respectful, she has become “cranky” and “challenging” during their recent interactions. SK reports that she feels irritable and “lonely” and has become less active socially in the past month. She has dramatically reduced the amount of time she spends with her best friend. Instead of their typical 1-2-hour phone calls on weeknights and the weekends spent shopping and going to dance clubs, they now spend time together only at school. SK has also lost interest in dating, even though several boys she

previously found attractive are expressing interest in her. She also reports feeling fatigued when attempting to complete her homework, spending more time at home, and exercising less often.

Summary

In both cases, these young people are exhibiting signs of negative affect—including the sadness and irritable mood typical of childhood and adolescent depression. *Alterations in positive affect, however, may be of equal or greater significance to their functional impairments*.

From a purely clinical perspective, it can be extremely difficult to distinguish diminished positive affect from increased negative affect when describing a change in functioning. For instance, did RT quit the football team because his sadness interfered with his ability to participate? Or did he withdraw from this activity because of decreased motivation and enjoyment? Did he appear fatigued because of decreased motivation, enthusiasm, and joy? Or did he have less energy because of the burden of sad negative feelings? Did SK withdraw from rewarding social activities because she felt bad? Or did her negative feelings become much worse because she lost motivation and the subsequent enjoyment of engaging in these pleasurable activities?

Clearly some decreases in positive affect are evident in the behavior, motivation, and mood of RT and SK. Both young people feel less happiness and express positive emotions less often, but they also experience disturbances in functioning that involve other aspects of positive affect. They have decreased the frequency of their participation in their favorite activities, they express reduced interest in these activities, and they find the activities less enjoyable. They both have withdrawn from social contact and are experiencing disruption to their social relationships. In SK, the adolescent, this social disruption extends to parents and potential romantic partners as well as peers. In RT, altered positive affect includes lowered positive expectations about his future.

Although increased negative affect – crying, sadness, irritability – is a familiar characteristic of depression, the disturbance of *positive affect* may be particularly distressing to those close to the young person. As RT's mother told us, “I knew something was wrong when his teachers told me that they miss his smile”.

Objectives of this Paper

This overview of the affective features of depression presents a conceptual framework that emphasizes alterations to *positive affect* systems. We focus specifically on Major Depressive Disorder (MDD) that occurs in school-age children and adolescents. We take the stance that alterations to positive affect systems are a critical feature of depression, and we view positive affect as separate, to some extent, from negative affect. Two perspectives are essential for the proposed conceptual framework: affective neuroscience and developmental psychopathology. Affective neuroscience allows us to begin to disentangle the distinction between increased negative affect and decreased positive affect or reward-seeking. Developmental psychopathology allows us to examine normal and abnormal processes in positive affect that contribute to early-onset depression. Through combining these two perspectives, we address findings on reduced positive affect in depression, identify promising future directions, and discuss potential treatment issues.

Depression during Childhood and Adolescence

Depression is a common mental disorder that strikes large numbers of youth and is a leading cause of disability across the lifespan (Murray & Lopez, 1996). Depression is relatively rare in childhood, but its prevalence increases sharply during adolescence (Kessler, Avenevoli, &

Merikangas, 2001), with a lifetime adolescent prevalence estimated to be as high as 25% (Lewinsohn, Rohde, & Seeley, 1998). The rise in risk for depression appears to begin in the early teenage years—especially in females—and continues to increase, with a more or less linear rise into early adulthood (Kessler & Walters, 1998; Lewinsohn et al., 1998).

Early-onset depression has serious consequences for academic and psychosocial functioning (Glied & Pine, 2002; Lewinsohn, Rohde, Seeley, Klein, & Gotlib, 2003). This form of depression has high continuity into adulthood, and children and adolescents who experience depression are likely to encounter severe, recurrent depression later in life (Costello, Angold, & Keeler, 1999; Kovacs, Gatsonis, Paulauskas, & Richards, 1989; Lewinsohn, Rohde, Klein, & Seeley, 1999; Pine, Cohen, Gurley, Brook, & Ma, 1998). Depression also contributes to significant mortality, since MDD is the strongest psychiatric correlate of suicide and suicide attempts in this age group (Brent, Perper et al., 1993).

MDD is not the only affective disorder worthy of attention from a positive affect perspective. Dysthymic disorder, another form of affective disorder, is more chronic and less severe than MDD. Like MD, dysthymic disorder in childhood and adolescence is characterized by depressed mood, like MDD. But dysthymic disorder tends to involve less severe decreases in enjoyment of pleasant activities (Kovacs, Akiskal, Gatsonis, & Parrone, 1994). Children and adolescents with depression are also at risk for developing bipolar disorder (Geller, Zimerman, Williams, Bolhofner, & Craney, 2001), a disorder posited to be characterized primarily by dysregulated positive affect (Leibenluft, Charney, & Pine, 2003). Although we focus only on MDD in this paper, we presume that our framework will also apply to dysthymic disorder and bipolar disorder in many ways.

Positive Affect: A Definition

For the purposes of this overview, we define positive affect as involving a set of hedonic, behavioral, motivational, and physiologic features. These features are organized for several goals related to the pursuit and enjoyment of rewards—including the social contexts and interactions that are the foundation of large categories of rewarding experiences in humans and other social species. Notably, while we consider subjective state a component of positive affect, we conceptualize positive affect as involving more than just the subjective experience of pleasant emotions. Emotions are inherently tendencies to act (Cole, Martin, & Dennis, 2004; Frijda, 1986), and positive affect is thus associated with a set of behaviors. These behaviors include social engagement, reward-seeking, and motor activity. Emotions have important social functions (Campos, Mumme, Kermoian, & Campos, 1994), and positive affect is critical to interpersonal goals and affiliative needs. In children and adolescents, positive affect serves to initiate and maintain relationships with friends, parents, and romantic partners. Finally, motivational characteristics are critical because positive affect can be characterized as much by the anticipation of a pleasant outcome – and the behavior inspired by that anticipation – as by the enjoyment of that outcome.

We propose that many social emotions and behaviors are involved in positive affect. In the interest of examining the neurobiological correlates of this construct, we will focus on one component: affective states and behaviors involved in the pursuit of reward. Because positive affect has neurobiological features, understanding the neural substrates of reward-seeking and reward processing is essential to understanding positive affect. Importantly, the distinction between positive affect and negative affect involves neural underpinnings, not just semantic differences. An affective neuroscience perspective on positive affect emphasizes reward-motivated behavior and defines subjective positive affect as an emotional state elicited by reward (Rolls, 1999; Schultz, 2000). Thus, examining components of reward responding provides an approach to understanding deficits in the regulation of positive affect in depression.

Components of reward responding include motivation to obtain reward, sensitivity to reward magnitude, and enjoyment of reward. Neuroscience researchers argue that it is essential to consider these components separately as a means to a sophisticated understanding of reward. For example, motivation or "wanting" is seen as having different neural substrates than enjoyment or "liking" (Berridge & Robinson, 2003). To determine the neural bases of reward processing in depression, it is necessary to examine brain activation during reward experiences.

Why Emphasize Positive Affect in Depression?

The symptoms of depression illustrate the point that changes in the experience and expression of positive affect are crucial features of depression. Depressed mood, the fundamental characteristic of the disorder, is often experienced or expressed as decreased positive affect. Anhedonia, another fundamental characteristic, is a diminished capacity to experience enjoyment. Fatigue can be conceptualized as a sign of diminished motivation and/or decreased energy to pursue enjoyable and goal-related activities. Social withdrawal, which is not a criterion symptom but is common in depression, may indicate reduced enthusiasm for interactions with others or difficulty obtaining enjoyment from those interactions.

Several components of affective processes may be disrupted with depression. Many of these components are related to positive affect systems. Notably, core aspects of depression may include any or all of the following: reduced motivation to engage in pleasant activities, reduced opportunities to experience rewarding situations that generally activate positive emotions, difficulty activating positive emotions, and difficulty sustaining positive emotions once they are activated.

Just as the study of positive experience has only recently received attention in the field of psychology (Seligman & Csikszentmihalyi, 2000), examining the specific alterations in the neural systems of positive emotion and motivation relevant to depression is a novel, exciting, but understudied approach. The view of reduced positive affect as a critical aspect of depression is consistent with emotion-based, motivation-based, behavioral, and evolutionary models of affective psychopathology. In fact, all three types of models emphasize disturbance to positive affect as a central feature of depression.

The dominant emotion-based model of depression is the tripartite model of anxiety and depression, which posits that although depression and anxiety both involve elevated distress (i.e., negative affect), reduced positive affect is a factor specific to depression (L. A. Clark & Watson, 1991). From this perspective, sadness is considered a mixed affective state that involves elements of both negative affect and positive affect (L. A. Clark & Watson, 1991).

Motivation-based models of depression (e.g., Depue & Iacono, 1989) propose a link between depression and decreased activity in the Behavioral Activation System (BAS) (Fowles, 1980; Gray, 1990). The BAS is a motivational system specialized for appetitive behavior, or behavior whose goal is obtaining reward.

Behavioral models focus on learning, claiming that depression is associated with reduced frequency of experiencing reward in the social environment (Lewinsohn, Hoberman, Teri, & Hautzinger, 1985). Low rates of reward then result in a reduction in active behaviors such as social interaction, reducing the chances of receiving reward and thereby contributing to the maintenance of depressive mood.

Finally, the social risk hypothesis of depression (Allen & Badcock, 2003) views reduced positive affect in depression within an evolutionary psychology framework. According to the model, reduced social risk-taking behavior (i.e., behavior in pursuit of reward) and low reward motivation represent an attempt to reduce the individual's burden on the social group. Although

they are inspired by different conceptual frameworks, all of these models propose a unique and important role for positive affect systems in depression.

General Definition of Affect Regulation

Because depression has been conceptualized as a disorder of affect dysregulation (Gross & Muñoz, 1995), understanding depression in children and adolescents requires understanding affect regulation. Definitions of affect regulation vary within the field of developmental psychopathology. Rather than debate the merits of each definition, we will provide the following working definition for the purposes of this overview. Affect regulation is a set of internal and external processes involved in the initiation, maintenance, or modification of the quality, intensity, or chronometry of affective responses.

In developing this definition, we have drawn from the work of several theorists of development (Cole et al., 2004; Thompson, 1994) and psychopathology (Gross & Muñoz, 1995). We emphasize that affect regulation is intertwined with affective reactivity, so that it does not simply occur after an affective reaction has begun. Importantly, affect regulation can occur as part of the process of generating or avoiding an affective state (Campos, Frankel, & Camras, 2004), not simply after the affective state begins. Affect regulation can occur in several ways. The processes involved can be automatic as well as effortful or conscious. Affect can be regulated by the self or others, and thus the social environment can play an important role in affect regulation. Finally, affect can also serve to regulate the environment around the child or adolescent, so that it can have regulatory functions as well as being the object of regulation.

Key aspects of depression can be conceptualized as changes in affect regulation. The diagnostic criteria for MDD require the presence of either persistent low mood or anhedonia (American Psychiatric Association, 2000), both of which reflect difficulties with affect regulation. Diagnostic criteria also include intensity and duration of these symptoms, further suggesting alterations in affect regulation processes. For instance, sadness may be experienced as more intense, be triggered more easily, and last longer in depressed youth. Pleasant emotions may be weaker, occur less frequently, and be elicited less readily. The unusual intensity and time course of these emotions may reflect reduced affect regulation, in that the usual change in intensity or return to baseline level does not occur easily, allowing affective processes to persist longer than they would typically.

Indeed, children and adolescents with depression or internalizing problems are often described as displaying poor affect regulation (Eisenberg et al., 2001; Garber, Braafladt, & Weiss, 1995; Rydell, Berlin, & Bohlin, 2003; Sheeber, Allen, Davis, & Sorensen, 2000; Silk, Steinberg, & Morris, 2003). Young people with depression also report using less effective affect regulation strategies (Garber et al., 1995). These difficulties with affect regulation have led to conceptualizations of depression that emphasize poor affective flexibility (Rottenberg, Wilhelm, Gross, & Gotlib, 2003). Poor flexibility can involve becoming “stuck” in terms of subjective mood, physiology, or behavior. Namely, depression is likely to involve difficulty recovering from negative affect or enhancing positive affect, responding to changing circumstances, and increasing overall activity level and time spent in social interactions.

Reward-Related Neural Circuits

To apply an affective neuroscience framework to our discussion of altered positive affect in depression, it is valuable to describe the neural substrates of reward processing. In addition, describing these neural substrates creates a basis for distinguishing positive affect from negative affect. The function and interrelation of these neural systems show specificity to behavioral manifestations, thus supporting the claim that positive affect has some independence from negative affect.

Neural circuits implicated in reward processing include the striatum, orbitofrontal cortex, and amygdala. Reward-related brain systems have functions such as detecting reward, predicting future reward, representing reward value, and representing goals (see Schultz, 2000 for a review). The regions traditionally implicated in reward processing include the striatum and orbitofrontal cortex (Dalgleish, 2004; Rolls, 2000; Schultz, 2000). The striatum has been implicated in detecting the presence of rewards and representing reward-related goals, while the orbitofrontal cortex has been implicated in processing to the magnitude or value of reward and the expectation of reward. Recent studies also suggest that the amygdala, which is thought to respond to social signals of emotion (Dalgleish, 2004), also appears to play a role in reward responding (Elliott, Newman, Longe, & Deakin, 2003; Elliott, Newman, Longe, & William Deakin, 2004) and in representing stimulus-value associations involving rewarding outcomes (Baxter & Murray, 2002). Other areas important to reward processing are midbrain dopamine neurons, which are sensitive to reward-predicting stimuli, error detection, and novel rewards, and the dorsolateral prefrontal cortex, which represents goals related to reward.

Coordination among these brain structures plays a role in guiding behavior and, by extension, influencing affective state (Schultz, 2000). For instance, midbrain dopamine neurons respond to unpredicted rewards (Ljungberg, Apicella, & Schultz, 1992). Dopamine response provides a signal to the orbitofrontal cortex, which is implicated in reward expectation (Schoenbaum, Chiba, & Gallagher, 1998), and the striatum, which has a role in detecting rewards and motivating reward-oriented behavior (Schultz & Romo, 1988). Dopamine neurons also signal the dorsolateral prefrontal cortex, which contributes to the planning of reward-directed behavior. In addition, the dopamine signal appears to be influenced by activity in the striatum, amygdala, and orbitofrontal cortex, all of which detect rewards (Schultz, Tremblay, & Hollerman, 1998).

Animal models have been essential to the study of neural systems of reward. For instance, studies of nonhuman primates have provided many of the relevant findings on the roles of midbrain dopamine (e.g., Ljungberg et al., 1992) and orbitofrontal cortex (e.g., Meunier, Bachevalier, & Mishkin, 1997) in reward. Studies of rodents have elucidated the involvement of the ventral striatum in reward (Kelley, 2004; Robbins & Everitt, 1996). As described below, studies with humans have been particularly valuable for understanding the function of the amygdala, orbitofrontal cortex, and striatum (e.g., Elliott et al., 2004; Knutson, Fong, Adams, Varner, & Hommer, 2001; O'Doherty, Kringelbach, Rolls, Hornak, & Andrews, 2001).

Studies of reward processing in healthy adult humans have implicated several brain regions. In particular, anticipation and receipt of reward appear to involve different regions. Activation in the ventral striatum, particularly the nucleus accumbens region, occurs during the anticipation of reward (Knutson et al., 2001; Knutson, Fong, Bennett, Adams, & Hommer, 2003). The ventral striatum, dorsal striatum (especially the caudate), amygdala, and ventromedial prefrontal cortex exhibit enhanced activation during receipt of reward (Delgado, Locke, Stenger, & Fiez, 2003; Delgado, Nystrom, Fissell, Noll, & Fiez, 2000; Elliott, Rubinsztein, Sahakian, & Dolan, 2002; Knutson et al., 2001; Knutson et al., 2003). Brain regions are also specialized for responding to the value of a reward. The amygdala and orbitofrontal cortex appear to exhibit sensitivity to predicted reward value (Gottfried, O'Doherty, & Dolan, 2003). The orbitofrontal cortex is implicated in processing extremes of reward magnitude (Elliott et al., 2003).

Functioning of the dopamine neurotransmitter system is also crucial to reward processing. Mesolimbic dopamine projections from the ventral tegmental area of the brain to reward-related regions such as the ventral striatum, amygdala, and orbitofrontal cortex appear to support a system critical to pleasant mood, motivation to obtain reward, and reward-related behavior (Spanagel & Weiss, 1999). In humans, feelings of euphoria are correlated with

amphetamine-induced dopamine release in the ventral striatum (Drevets et al., 2001). Dopamine is apparently released in the striatum during a goal-directed video game (Koepp et al., 1998) and during guessing tasks with variable-ratio monetary reward (Zald et al., 2004). If reduced positive affect is a key component of depression, disturbances in the dopamine system may underlie depression.

The Affective Neuroscience of Reduced Positive Affect in Depression

Conceptual Models

The approach-withdrawal model is an explanatory framework for the component features, the systems organizing affective behavior, and the mechanisms by which neural functioning are associated with depression. The model postulates that affect is organized into approach and withdrawal systems, which have specific behavioral functions and neural correlates (Davidson, Jackson, & Kalin, 2000; Fox, 1991). The approach system is a motivational system whose function is the pursuit of reward, and it is posited to include brain structures (e.g., the nucleus accumbens) that mediate processing of reward information. From this view, depression is associated with deficits in the approach system.

Thus, depression would be expected to involve unusual functioning in brain regions or neurotransmitter systems related to reward and approach. Such unusual functioning could be evident in several ways. Reward-related brain regions could exhibit low levels of activation during anticipation or after receipt of reward. Regions sensitive to reward magnitude could fail to respond differently to large and small rewards. Dopamine function may be disrupted (Drevets, 2001), so that fewer dopamine receptors are present at synapses or less dopamine is available to bind to those receptors. Finally, areas responsible for the regulation of reward-related regions may exhibit suboptimal functioning.

Methods

Several neuroscience methods can be employed to study the neural bases of positive affect. These include electroencephalography (EEG), which measures scalp electrical activity that is reflective of regional brain function, and examination of event-related brain potentials (ERP), a method that uses EEG to measure brain activity in relation to discrete events. Magnetoencephalography (MEG) measures magnetic fields generated by brain activation, allowing three-dimensional examination of the cortical and subcortical sources of such fields. EEG, ERP, and MEG all have excellent temporal resolution, making them suited to questions about the time course of responses. Localization of function is possible with MEG but challenging with EEG or ERP, both of which have poor spatial resolution.

Neuroimaging methods, which allow more detailed measurement of brain structure and function, include magnetic resonance imaging (MRI), positron emission tomography (PET), and single photon emission computed tomography (SPECT). MRI involves the use of a large magnetic field and application of a radiofrequency pulse to create images of tissue based on the resonance of hydrogen nuclei in response to the electromagnetic changes. Functional MRI (fMRI) measures neural activation through the blood-oxygen level dependent (BOLD) response, which occurs with neural activity. PET involves the use of radiotracers, which are compounds labeled with a positron-emitting radioisotope (e.g., ^{15}O), and an imaging system to measure brain structure, neural pathways, and neurotransmitter activity. SPECT is a similar radiation-based method. Although these methods have limited temporal resolution, the combined use of fMRI and EEG or MEG has provided an effective strategy for measuring the localization of function in both time and space.

Among affective neuroscience methods, functional magnetic resonance imaging (fMRI) is one of the more feasible and appropriate for research with children and adolescents. PET and

SPECT are considered inappropriate for use with children and adolescents because they require exposure to radiation. fMRI allows the noninvasive characterization of brain activity, provides excellent spatial resolution for identifying relevant brain regions, and has been used safely and effectively with children and adolescents, including those with psychiatric disorders (Durston et al., 2003; May, Delgado et al., 2004; McClure et al., 2004). It also allows the examination of interactions between cortical and subcortical regions. Methodological issues to consider when applying fMRI to the study of affect in children and adolescents include the challenges of avoiding movement artifact during scanning and helping participants adjust to scanner noise. We have found that through training in a simulator, we are able to address these issues by helping participants become familiar with the scanner environment and the tasks they will be asked to complete.

Developmental Considerations

A developmental psychopathology approach to early-onset depression requires accounting for developmental processes integral to affective disorders. These processes can include a number of different issues, including parent socialization of children's affect expression, development of attachment, and development of the self-system. All of these have been addressed by other conceptual papers (Cicchetti & Toth, 1998). To focus on developmental processes *relevant specifically to positive affect* in childhood and adolescent depression, we address two developmental issues: temperament and pubertal development. In addition, we address a third issue related to the developmental trajectory of early-onset depression: clinical characteristics and course.

Positive Affectivity

Positive affectivity, or temperamental positive affect, is a potential source of influence on childhood and adolescent depression. Temperament refers generally to biologically based individual differences in behavior and affect that are stable across time and situation (Goldsmith et al., 1987). Affective traits are a key feature of temperament, and several theoretical models of temperament focus exclusively on affect (Buss, 1995). Most models include a factor that corresponds to positive affect, whether it is defined as a single factor (e.g., Derryberry & Rothbart, 1997; Goldsmith, 1996) or can be extracted from a combination of several factors that reflect sociability, activity, and approach (e.g., Buss, 1995; Thomas & Chess, 1977). Temperament is viewed as an influence on psychological outcomes (Kagan & Snidman, 1991), but we note that it is not considered static. Not all aspects of temperament are expected to be stable across development, as temperament can be influenced by factors such as socialization experiences, neuronal maturation, and changes in gene expression (Davidson, 1994; Fox, Henderson, Rubin, Calkins, & Schmidt, 2001; Kagan, Snidman, Arcus, & Reznick, 1994).

There are multiple routes for association between temperament and depression, and no model proposes that low temperamental positive affect develops clearly or directly into depression. Consistent with the developmental psychopathology view of multifinality (see Cicchetti & Rogosch, 1996), it is critical to emphasize that low positive affectivity is not a deterministic factor. Many possible outcomes, including depression and healthy affective functioning, may develop from individual differences in positive affectivity. Instead, low positive affectivity could be linked to depression through several routes and in interaction with other factors. Possible associations include low positive affectivity as a vulnerability factor in the development of depression, depression as an extreme point on the positive affectivity spectrum, and low positive affectivity as an influence on the phenomenology or course of depression (L. A. Clark, Watson, & Mineka, 1994).

Low positive affectivity has been associated with depression in studies of children and adolescents (see Compas, Connor-Smith, & Jaser, 2004 for a review). This pattern of findings is consistent with the pattern reported in adults with depression (Klein, Durbin, Shankman, & Santiago, 2002). Few studies have been conducted prospectively, however, and all have been limited to self-report of both temperament and depressive symptoms. As noted by Compas et al. (2004), a theoretical model for the mechanisms of association between temperament and depression is needed. Studies based on such a model will be strengthened by use of longitudinal designs and behavioral measures.

Pubertal Development

Pubertal development is associated with two changes that are central to the study of depression in childhood and adolescence. The first change is the normative increase in reward-seeking behavior. The second is an increase in rates of depression—and the emergence of the gender difference in depression. These changes emerge during adolescence, and they bear on a conceptualization of reward systems in depression. On one hand, both changes can seem to be paradoxical. Although reward seeking increases for most adolescents, the increase in depression suggests that reward-related processes shift in the opposite direction for other adolescents. Although depression rates are higher in both male and female adolescents than in children, girls become more likely than boys to develop depression during adolescence. On the other hand, both sets of changes are real and are relevant to a developmental psychopathology context.

Reward-seeking behavior—Although it is a time at which the prevalence of depression increases, adolescence is also remarkable for the sharp increase in reward-related and risk-taking behavior that occurs. This increase takes place in domains including substance use, sexual behavior, and accidents (Dahl & Spear, 2004; Steinberg, 2004). Affective intensity, affective lability, and reward responsiveness also appear to be enhanced during adolescence (Larson, Csikszentmihalyi, & Graef, 1980; Steinberg, 2004). Furthermore, these changes in reward-seeking and risk-taking are consistent across species (Spear, 2000).

Developmental changes toward increased depression but at the same time toward increased reward-seeking in adolescence are seemingly counterintuitive. However, they may indicate that neural systems underlying reward are undergoing important change during this period. These systems may be vulnerable to dysregulation in the form of depression, even as their responses to rewarding stimuli are undergoing developmental change. The difficulties that adolescents experience in tempering reward-seeking with cognition illustrate the possibility that reward systems are not yet subject to the full regulatory influence of prefrontal cortical systems. Namely, despite cognitive understanding of the risks and consequences of various dangerous activities, adolescents nonetheless display less mature decision-making and consequently engage in such activities (Cauffman & Steinberg, 2000).

Despite the apparent normative increase in behavior associated with reward during adolescence, knowledge of the mechanisms of this developmental change is scant. Neurobiological maturation is likely to be a critical influence on affective and behavioral changes. The development of brain regions involved in affect regulation, reward processing, and decision-making continues through the late teen years (Giedd et al., 1999). It is thus critical to increase understanding of changes in reward-related functioning during adolescence.

The few studies conducted to date that address adolescents' reward processing have suggested that healthy adolescents are similar to adults in some important ways, including the brain regions active during rewarding events (Bjork et al., 2004; May, Dahl et al., 2004). But these studies have also found differences between adolescents' and adults' reward processing. For instance, while adolescents exhibit similar activation in the ventral striatum during a guessing

task in which they can win money, they do not exhibit the caudate activation typical of adults during this task (May et al., 2004). This suggests that changes in reward system functioning occur with brain development and continue into late adolescence. It is likely that the enhanced reward-seeking behavior evident during adolescence is reflected in differences between adolescents' and adults' brain activation. Research is needed to address neural correlates of typical adolescent reward processing.

Increases in reward-seeking behavior include the use of rewarding substances. In fact, altered reward processing has implications for the development of substance use disorders (Kelley & Berridge, 2002). Although a review of the literature on adolescent substance abuse is beyond the scope of this paper, we note that substance use disorders and depression are highly comorbid (D. B. Clark, Parker, & Lynch, 1999; Grant et al., 2004). Furthermore, the dysregulated use of rewarding substances can create problems that influence mood (D. B. Clark et al., 1999).

Gender differences—In terms of affect, gender may modify the relation between pubertal development and increased negative affect in depression. A study with depressed and healthy children and adolescents found that negative affect, while higher in the depressed group overall, was especially high in adolescent girls (Forbes, Williamson, Ryan, & Dahl, 2004). A worthy consideration for future studies is whether male and female adolescents exhibit different patterns of reward processing during pubertal development or a depressive episode.

Clinical Characteristics and Course

Adult-onset depression and depression with onset in childhood or adolescence differ in important ways. In fact, differences in neurobiological characteristics and treatment response between adult-onset depression and depression with onset in childhood and adolescence have led some scientists to question whether there are separate subtypes of MDD (Kaufman, Martin, King, & Charney, 2001). Such observations lead to questions about the role of developmental factors in affective processes related to the clinical presentation and course of depression. Specifically, is positive affect similarly disrupted in early-onset depression and adult-onset depression?

Although clinical course is not itself a developmental issue, the onset of depression early in life may have implications for socioemotional development, brain development, and the development of responses to stress. Many areas of cognitive and affective functioning undergo development through adolescence. Could development in these areas be disrupted by the experience of depression during childhood or adolescence? For instance, does depression that occurs during childhood compromise the development of affect regulation?

Conversely, changes in affective functioning may, in turn, influence the course of depression. Recurrence, chronicity, and duration of episodes may all vary with developmental factors such as the effective refinement of affect regulation skills. Troubled parent-child relationships, abuse, and other chronic stressors could also contribute to the clinical course of depression. Research on allostatic load, or the costs of physiological adjustment to chronic stress, illustrates the ways that depression and stress responses are intertwined (McEwen, 1998). Chronic stress during childhood is linked to mental health outcomes, including depression. But depression can also serve as a source of chronic stress, leading to long-term problems in physical and mental health (McEwen, 2003).

The age of onset of depression and the clinical course of the disorder may have implications for the role of altered positive affect in depression. There is a dearth of investigations addressing these issues, however, so we offer the following questions for consideration. First, is reduced positive affect more evident in early episodes than in later episodes of depression? In a recent study, first-episode but not recurrent depression was associated with diminished response to

pleasant stimuli (Nandrino, Dodin, Martin, & Henniaux, 2004), for instance. There may be an early developmental sensitivity to disruptions in positive affect, so that episodes occurring early in the illness involve alterations to positive affect responding whereas later episodes do not. Second, and relatedly, is low positive affect a more prominent characteristic of childhood or adolescent depression than of later-life depression? An alternative explanation for the above finding on response to pleasant stimuli is that the experience of recurrent depressive episodes influences the development of neural systems related to positive and negative affect. As a result, the balance of these systems could shift to reflect the disruption of negative affect rather than positive affect in episodes that occur later in life. Finally, it is possible that long-term changes in the regular functioning of positive affect systems occur with repeated or chronic experience of depression. In this case, positive affect during euthymic, symptom-free periods may also be compromised.

In addition, low positive affect seems to be a predictor of later depression. One study of children reported that a combination of low positive affect and high negative affect predicted depressive symptoms three years later (Lee & Rebok, 2002). In studies focusing on symptoms, anhedonia in children or adolescents with subclinical depression is a particularly important predictor of depression during adulthood (Pine, Cohen, Cohen, & Brook, 1999; Wilcox & Anthony, 2004). These findings suggest that decreased levels of positive affect may precede depressive episodes by years. Conversely, aspects of positive affect may also play a protective role in young people with depression. In adolescent boys with major depressive disorder, positive attributional style predicts lower likelihood of recurrence during adulthood (Lewinsohn, Rohde, Seeley, Klein, & Gotlib, 2000). Depressed adolescents with low levels of pleasurable social engagement have lower recovery rates one year later (Joiner, Lewinsohn, & Seeley, 2002). Positive affect – whether absent in the symptom of anhedonia or present in cognitive style – may thus be an important prognostic characteristic of children and adolescents at risk for adult-onset depression.

Evidence for Altered Positive Affect in Depression

Below, we provide an overview of findings relevant to the hypothesis that depression involves alterations in positive affect. Because a considerable amount of the work in this area has been conducted with adults, we include a section on that literature.

Evidence from Studies of Adults

Research on adults with depression indicates that they experience decreased subjective positive affect (Watson, Clark, & Carey, 1988; Watson et al., 1995). In some cases, adults with depression exhibit differences in self-reported positive but not negative affect. For instance, studies with pleasant and unpleasant pictures have reported that adults with MDD show a diminished response to pleasant stimuli (Rottenberg, Kasch, Gross, & Gotlib, 2002; Sloan, Strauss, Quirk, & Sajatovic, 1997). Adults with depression also exhibit differences in cognition and memory in relation to pleasant material. They expect to experience fewer positive future events (Andersen & Limpert, 2001), and they have poor memory for pleasant stimuli (Blaney, 1986; Sloan, Strauss, & Wisner, 2001). They also exhibit poor discrimination accuracy for happy facial expressions, tending to identify them as happy less often than do healthy adults (Surguladze et al., 2004).

Depressed adults also exhibit unusual affective behavior in pleasant contexts. Depressed women display fewer and less intense facial expressions while viewing pleasant pictures (Sloan et al., 2001), and adults with MDD are less facially expressive to pleasant stimuli (Berenbaum & Oltmanns, 1992). As would be expected from changes in a system involving social affiliation, depressed women display less positive affect during typical interactions with their family members. During face-to-face dyadic interactions with their infants, depressed mothers

exhibit less positive affect than do healthy mothers (Cohn & Campbell, 1992). During routine interactions with family members, depressed mothers also exhibit less positive affect (Hops et al., 1987).

Psychophysiology studies indicate that adults with depression display unusual physiologic responses to pleasant stimuli. Dysphoric adults fail to show the typical increase activity in the zygomatic major facial muscle while viewing pictures of happy faces (Sloan, Bradley, Dimoulas, & Lang, 2002). A study of event-related brain potentials noted that adults with depression exhibit a slow-wave response to pleasant stimuli, indicating a memory bias against pleasant information (Deldin, Deveney, Kim, Casas, & Best, 2001). Adults with depression may even respond to pleasant stimuli as though the stimuli are aversive. In a study of affect modulation of the startle eyeblink response, severely depressed adults displayed increased startle to pleasant pictures (Allen, Trinder, & Brennan, 1999). This pattern is the opposite of that in healthy adults, as startle is usually attenuated during pleasant visual stimuli and potentiated during unpleasant visual stimuli (Bradley, Cuthbert, & Lang, 1999).

Depressed adults, as well as infants of depressed mothers, exhibit decreased left frontal resting EEG activity (Dawson et al., 1999; Field, Fox, Pickens, & Nawrocki, 1995; Henriques & Davidson, 1991). According to the approach-withdrawal model of frontal asymmetry and emotion (Davidson et al., 2000; Fox, 1991), this pattern of asymmetry reflects decreased activity in the approach motivational system. Because this motivational system is thought to encompass behaviors aimed at obtaining reward, depression is thus linked to physiologic characteristics of reduced reward-seeking.

Adults' reward sensitivity appears to be diminished during depressive states. In studies with signal detection tasks involving monetary reward, findings have been consistent with hypotheses about reward responding and depression. During conditions in which correct answers were rewarded, adults with depression (Henriques & Davidson, 2000), dysphoria (Henriques, Glowacki, & Davidson, 1994), or elevated depressive symptoms (Pizzagalli, Jahn, & O'shea, 2005) fail to exhibit response bias. Response bias, or increased tendency to endorse items as targets, is evident in healthy adults during reward conditions. Similarly, in another study employing monetary reward, depressed adults made fewer responses during a progressive ratio reinforcement task and consequently earned less money (Hughes, Pleasants, & Pickens, 1985).

Neuroimaging studies of depression in adults have indicated disruption in the structure and function of several reward-related areas (Drevets, 2001). One pertinent set of findings is a pattern of increased activation in ventral brain regions considered important for emotion perception and the generation of emotional responses (M. L. Phillips, Drevets, Rauch, & Lane, 2003). For example, depressed adults exhibit increased blood flow in the amygdala (Drevets et al., 1992) and the ventral striatum (Mayberg et al., 1999) at rest. During affective contexts, depressed adults exhibit increased activation in the amygdala in response to faces with fear expressions (Sheline et al., 2001) and more sustained amygdala activation in response to negatively valenced words (Siegle, Steinhauer, Thase, Stenger, & Carter, 2002). When viewing facial expressions of happiness, however, adults with depression fail to display the increased ventral striatal activation displayed by healthy adults (Lawrence et al., 2004; M. L. Phillips, 2004). In addition, unlike healthy adults, adults with depression do not exhibit a linear increase in activation in the putamen (part of the striatum) to increasing intensity of happy facial expressions (Surguladze et al., 2005).

Together, studies of adult depression suggest several important considerations for research with depressed children and adolescents. Subjective, behavioral, and physiologic components of positive affect may all be disrupted with depression. Behavior in both laboratory and social

contexts should be examined for depression-related diminishment in positive affect. Finally, reward responding as well as behavioral displays of positive affect should be assessed.

Evidence from Studies of Children and Adolescents

Relatively little is known about positive affect in childhood and adolescent depression. Children and adolescents with depression report reduced subjective experiences of positive affect on questionnaire measures (Chorpita, Plummer, & Moffitt, 2000; Joiner & Lonigan, 2000; Lonigan, Carey, & Finch, 1994; Lonigan, Phillips, & Hooe, 2003) and mood ratings (Forbes et al., 2004). Low self-reported positive affect is also related to higher depressive symptoms in children who do not have diagnoses of affective disorders (Chorpita, 2002; Lonigan, Hooe, David, & Kistner, 1999; B. M. Phillips, Lonigan, Driscoll, & Hooe, 2002). In a study in our lab, children and adolescents with depression reported an unusual pattern of positive affect over time: in the course of a three-day assessment, subjective positive affect declined in the depressed group but was consistent for the control group (Forbes et al., 2004). This suggests that the two groups may have initially found the laboratory environment reinforcing or engaging, but that the depressed group found it less so as the assessment went on. In a preliminary study focusing on mood ratings in natural settings (Axelson et al., 2003), depression was also associated with lower self-reported positive affect and social activity.

Few studies have addressed behavior related to positive affect in childhood and adolescent depression. One valuable line of research involves the observation of affective behavior during dyadic parent-child interaction. This approach allows the examination not only of adolescents' affect but also of the parent-child relationship and the family affective environment. Using this method, Sheeber and Sorensen (1998) reported that depressed adolescents and their mothers display less facilitative behavior, which reflects caring, positive communications. A similar approach involves the observation of children's behavior during an affective challenge. For instance, a study employing a task in which children were required to wait for an appealing prize found that for children with a maternal history of depression, low anticipatory positive affect was associated with higher levels of internalizing problems (Silk, Shaw, Forbes, Lane, & Kovacs, under review).

Another approach is to investigate reward-related *behavior*. This direction is a relatively new one in developmental affective neuroscience, but studies of guessing, gambling, or decision-making suggest that it will be worthwhile. For example, Ernst and colleagues have developed the wheel of fortune, a paradigm for investigating reward choice, anticipation, and outcome. The paradigm yields behavioral data, has been applied to questions about reward and punishment in early-onset bipolar disorder (Ernst, Dickstein et al., 2004), and has been used successfully in an fMRI study (Ernst, Nelson et al., 2004).

Using the reward-contingent decision task (Rogers et al., 2004; Rogers et al., 2003), which entails choices involving varying probability and magnitude of reward, we have examined reward-related decisions in a high-risk group of 11-year-old boys (Forbes, Shaw, & Dahl, under review). We found that reduced reward-seeking behavior – specifically, failure to choose an option with a high probability of yielding a high-magnitude reward – was associated with concurrent internalizing diagnoses. In addition, failure to choose this high-probability, high-magnitude option predicted internalizing diagnoses, self-reported depression, and mother-reported internalizing problems one year later. We interpret these findings as indicating that reward-related choices and behavior may play a role not only in current depression but in the continuity of depression or the prediction of future depression. In addition, it is possible that disrupted reward responsiveness and depression have reciprocal influence, so that the experience of either may enhance dispositions toward the other.

Suggested Research Directions

Most studies to date have operationalized positive affect as self-reported subjective experience and have obtained data on positive affect in laboratory settings. As a result, the literature on positive affect in childhood and adolescent depression has neglected behavioral and neural indices of positive affect. Furthermore, most studies to date have been conducted without consideration of developmental issues. We recommend the examination of four issues: (1) positive affect experienced and expressed in natural settings; (2) neural bases of reward processing; (3) the relation of phenomenologic and neural indices of positive affect; and (4) depression in the context of normative puberty-related changes in reward-seeking. These approaches will provide the foundation for obtaining a richer description of positive affect in childhood and adolescent depression.

Positive Affect in Natural Settings

A new step toward understanding the phenomenology of positive affect in depression involves assessment in natural settings such as home, school, and peer environments. Findings of traditional studies with self-report measures administered in the laboratory leave unanswered, imperative questions about the relation of such measures to children's and adolescents' true experience. Retrospective reports of subjective experience tend to have little relation to real-time reports. Rather, retrospective reports reflect factors such as peak intensity (Redelmeier & Kahneman, 1996), not overall affective experience. With respect to positive affect, predicted and retrospective self-reports tend to be higher than real-time report (Wirtz, Kruger, Napa Scollon, & Diener, 2003). Because the relevant laboratory self-report techniques have important limitations, it is necessary to seek innovative methods for assessing positive affect.

Focusing on ecologically valid contexts and measuring behaviors in natural settings can provide accurate assessments of key aspects of emotion and motivation that are extremely difficult to assess in a laboratory setting. When studying positive affect, naturalistic assessments are valuable for truly capturing the construct because positive affect includes motivation to obtain reward and engagement in pleasant activities, not merely subjective mood. As suggested by a recent study on amygdala activation in adults who were classified as behaviorally inhibited as infants (Schwartz, Wright, Shin, Kagan, & Rauch, 2003), it is critical to examine the relation between behavioral and neural characteristics of affect. Measurement of positive affect in natural settings can thus inform investigations of the neural circuitry of affective disorders. Techniques for measuring positive affect in real-life settings also have important applications for examining treatment effects.

A promising technique for assessing positive affect in natural settings is experience sampling or ecological momentary assessment (EMA). With this technique, participants report on mood and current activities using mobile technology such as a cellular phone or PDA. Using EMA, it is possible to measure mood, reward-seeking behavior, social activities, and responses to real-life events. EMA has important differences from short-term retrospective self-report (Stone et al., 1998), and it has been used to measure affect in adult psychopathology (Shiffman et al., 2002). Recently, EMA has been applied successfully to affect in children and adolescents. A study of school-age children reported that those who experience more intense affect and use less effective affect regulation strategies have higher depressive symptoms (Silk et al., 2003). In a recent study from our research group, depression in participants ages 10-17 years was associated with decreased peer interactions, increased boredom, and overall low positive affect (Axelson et al., 2003).

The Neural Bases of Reward Processing

The neural bases of reward processing have been examined more consistently in adults than in children or adolescents. Notably, nearly all studies of affective processing in depression have emphasized aversive affective stimuli to the exclusion of pleasant stimuli. Thus, it is essential to examine the neural bases of reward-related behavior in childhood and adolescent depression. Examining reward processing in depressed children and adolescents will allow the generation of hypotheses about the mechanisms of pathological affective processing (Drevets, 2001). If, for instance, children and adolescents with depression exhibit less activation in the dorsal striatum during the receipt of reward, it is possible that depression involves abnormal neural detection of reward. This abnormal detection of reward could then result in a decreased response after reward is obtained.

Positive affect – whether defined behaviorally or physiologically – has multiple components, and it is possible that some but not others are disrupted in depression. Thus, we recommend that neuroimaging studies measure multiple components of positive affect. Further, it is possible that adult depression and childhood or adolescent depression involve disruption of different processes. For instance, in an ongoing fMRI study, we have hypothesized, based on behavioral observation, that anticipation of reward but not response to reward outcome is abnormal in early-onset depression. In contrast, we have hypothesized that both processes are abnormal in adult depression.

Relation of Phenomenological and Neural Aspects of Positive Affect

We recommend the application of multiple, converging methods – including fMRI, psychophysiology, and self-reported affect in natural settings – as a means to describing the interrelation of multiple aspects of positive affect. The few efforts to examine associations between neural and subjective indices indicate that they are likely to be related to each other (Nitschke et al., 2004) and highlight the value of subjective measures of affect as a way to ground knowledge about neural processing of affective information. While measuring phenomenological and neural aspects of positive affect, for example, can provide evidence relevant to the different components of affect, combining the two types of information can forge an important link between laboratory-observed brain activation and real affective behavior. Studies of affect using fMRI have not attempted to validate their findings through assessment of subjective affect in natural settings, and the possibility of combining the two methods remains an exciting and innovative step toward describing affect in depression.

Normative Developmental Change in Reward-Seeking

Because a developmental psychopathology approach requires understanding psychopathology within the context of normal development (Cicchetti, 1993; Sroufe & Rutter, 1984), the study of altered positive affect in childhood and adolescent depression must incorporate the understanding of normal changes in positive affect. Specifically, reward-seeking appears to be enhanced in healthy adolescents but diminished in adolescents with depression. Given the increase in depression that occurs during adolescence, does depression represent a developmental pathway in which changes in reward systems occur in an unusual way? The approach to understanding this issue will require longitudinal design, careful examination of reward processing in healthy adolescents, and examination of both behavioral and neural characteristics of positive affect.

Treatment Implications

Understanding positive affect in childhood and adolescent depression may have implications for developing effective treatments. Targeting anhedonia may be particularly important. Because positive affect includes several processes, addressing other features related to positive

affect could be critical. Promoting increased activity level, reducing social withdrawal, and increasing pleasant activities may be especially valuable.

Below, we consider the value of targeting alterations of positive affect in psychosocial treatments for depression. Positive affect may be enhanced through several treatment avenues for depression, including pharmacotherapy (Emslie et al., 2002; Ryan, 2003), but we focus on psychosocial approaches for several reasons. First, overviews of the literature on the treatment of childhood and adolescent depression emphasize that both pharmacologic and psychosocial interventions are recommended (Birmaher, Ryan, Williamson, Brent, & Kaufman, 1996). The practice parameters outlined by the American Association of Child and Adolescent Psychiatry state that “psychotherapy is an appropriate treatment for all children and adolescents with depressive disorders” (Birmaher, Brent, & Benson, 1998, p. 1234). Second, psychosocial approaches may be preferred by children and caregivers, especially given recent evidence that treatment with selective serotonin reuptake inhibitors (SSRIs) may be associated with suicidal ideation and behavior (Brent, 2004). Third, psychosocial treatments allow an explicit emphasis on increasing activation in positive affect systems.

Psychosocial Treatments that Address Positive Affect

We propose that focusing specifically on the positive affect components of depression may enhance the effectiveness of psychosocial treatments for the disorder. The existing empirically supported psychosocial treatments for childhood and adolescent depression include, to a certain extent, strategies for enhancing positive affect. Two promising treatments that have received empirical support (primarily with adolescents) are cognitive behavioral therapy (CBT) and interpersonal psychotherapy (IPT). Both emphasize the reduction of depressive symptoms, including depressed mood, and there is evidence for the value of both (Brent et al., 1997; Clarke et al., 2002; Clarke, Rohde, Lewinsohn, Hops, & Seeley, 1999; Mufson et al., 2004).

CBT and IPT differ in their approach toward achieving the goal of reducing depression. In CBT, which has been employed in both individual (e.g., Brent et al., 1997) and group formats (e.g., Clarke et al., 1999) with children and adolescents, the components of treatment include cognitive restructuring, behavioral activation, problem solving, and occasionally relaxation training (Clarke, DeBar, & Lewinsohn, 2003; Weersing & Brent, 2003). The most obvious way that CBT addresses enhancement of positive affect is through the behavioral activation component. The focus of this component is increasing the frequency of pleasant activities, as well as the overall activity level, with the rationale that increasing the experience of pleasant activities will both elicit positive affect and reinforce the behavior required to participate in the activities.

IPT, which has been adapted for use with adolescents (Mufson & Pollack Dorta, 2003), focuses on the interpersonal context of depressive symptoms by encouraging change in social behavior (Weissman, Markowitz, & Klerman, 2000). In IPT, the client and therapist identify a specific interpersonal target area — a such as transition to a new social role — that is believed to play a role in the current depressive episode. Based on the problem area identified, the therapist employs strategies designed to improve the adolescent's related relationship functioning. Although IPT does not contain a specific positive affect component, its encouragement of improved interpersonal relatedness, improved relationships, and decreased conflict may serve to indirectly target the decreased social activity and low mood that occur in depression.

Although positive affect may be increased through CBT, IPT, or a combination of the two, it is not an explicit focus of either treatment. There may also be differences in the extent to which positive affect elements of treatment are emphasized either in treatment studies or in actual clinical practice. It will be worthwhile for treatment studies to explore the ways in which these elements can be highlighted and whether greater focus on positive affect improves treatment

effectiveness. In addition, investigations of these treatments could measure the extent to which positive affect – in terms of anhedonia, social behavior, or mood – improves as a result of treatment. Studies of characteristics that predict response to psychosocial treatment have been conducted (e.g., Brent et al., 1998), but these have not typically included characteristics related to positive affect.

Although not yet extensively supported empirically, dialectical behavior therapy (DBT) is another candidate for a psychosocial treatment to address positive affect. DBT has recently been adapted for treatment adolescents with depression and suicidality, and it appears to be valuable for reducing depressive symptoms (Katz, Cox, Gunasekara, & Miller, 2004; Robins & Chapman, 2004). DBT is especially relevant to our conceptual framework because unlike many other psychosocial treatments, DBT identifies increased positive emotions as a treatment target. DBT was originally designed as a treatment for borderline personality disorder, a disorder considered to be fundamentally characterized by dysregulation of affect (Linehan, 1993a). DBT adapts CBT, with other elements, to specific behavioral areas. A key component of DBT is the teaching of skills involving self-regulation (Linehan, 1993b). For skills related to positive affect, patients learn to increase current pleasant events, work toward long-term goals involving positive affect, and apply mindfulness techniques to positive affect. The application of DBT to adolescents includes a family therapy component (Miller, Glinski, Woodberry, Mitchell, & Indik, 2002; Woodberry, Miller, Glinski, Indik, & Mitchell, 2002). Studies of DBT in this age group have focused on adolescents with depression, suicidality, and borderline personality characteristics (Katz et al., 2004; Rathus & Miller, 2002). The reported reductions in depressive symptoms in these treatment studies indicate that DBT could be worthwhile for use with children and adolescents with MDD alone.

Long-Term Implications of Targeting Positive Affect?

Positive affect may also be critical to efforts to reduce recurrence. Adults' reduced response to pleasant stimuli is associated with poor recovery from a depressive episode (Rottenberg et al., 2002). Low self-reported activity in the behavioral activation system, which is related to reward motivation, also predicts poor outcome in depressed adults (Kasch, Rottenberg, Arnow, & Gotlib, 2002). A similar phenomenon may exist with depressed children and adolescents who exhibit low levels of positive affect. If positive affect can be successfully enhanced through treatment, there could be implications for length of episode, likelihood of recurrence, and chronicity of depressed mood.

Family Factors

Because positive affect is especially relevant to social behavior and because parents play an important role in children and adolescents' affect regulation, it is worth considering whether psychosocial interventions should also involve family members. For instance, in a preventive intervention with children of depressed parents, change in parents was associated with benefits to children's functioning (Beardslee, Gladstone, Wright, & Cooper, 2003). Family environment and parent-child relationships may thus be a fruitful focus of treatments. Treatments for adolescent depression have addressed this issue by including parent psychoeducation components (e.g., Brent, Poling, McKain, & Baugher, 1993) or encouraging parent participation in some of the adolescent's psychotherapy sessions (e.g., Mufson & Pollack Dorta, 2003).

Early-onset depression tends to involve high rates of depression in family members, and children and adolescents who are depressed are therefore likely to have a parent with a depressive disorder (Beardslee, Versage, & Gladstone, 1998; Downey & Coyne, 1990). In addition to providing treatment for the family, assessing and treating parent depression may be a useful adjunct to treatment for depression in children and adolescents.

A related but essential public health issue is that the proportion of children and adolescents with depression who receive treatment is low (Coyle et al., 2003; Olfson, Gameroff, Marcus, & Waslick, 2003). Although effective treatments have been developed, the treatments applied to children and adolescents with depression in the community are not consistently tailored developmentally or provided by psychotherapists with training in the needs of young populations (Compton, Burns, Egger, & Robertson, 2002; Coyle et al., 2003). For positive affect considerations to have impact on the treatment of depression in young people, it will be critical to improve the delivery of the current psychosocial treatments.

Summary and Conclusions

We have proposed a conceptual framework for examining the neurobehavioral aspects of alterations of positive affect in child and adolescent depression. Changes in positive affect are not the entire story behind depression, but the consideration of those changes from an affective neuroscience perspective is relevant to advancing knowledge of the developmental psychopathology of depression. The proposed framework provides a starting point for generating and testing hypotheses, and it has the potential to provide a more mechanistic understanding of depression that occurs early in life. In addition, this framework has implications for treatment and early intervention efforts. Behavioral and physiological evidence supports the claim that alterations in positive affect systems are critical to depression, but additional work is also needed to examine the relation between positive affect systems and depression in greater detail. Finally, the conceptual framework detailed in this paper hopefully can serve as an example of moving beyond a general “affect dysregulation” model. Instead, the goal of research on the affective characteristics of depression can be revised to focus on alterations in specific components of affective processes and their underlying neural systems within a developmental psychopathology framework. Ideally, this approach can also be applied to other affective disorders. We hope that progress in such mechanistic understanding will ultimately inform intervention and prevention strategies for a variety of disorders.

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