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3

Exploring the Experience of Social Rejection in Adults and Adolescents: A Social Cognitive Neuroscience Perspective

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Charlie's mom: Well maybe there's more to high school than being well-liked.

Charlie: Like what specifically?

Charlie's mom: [long pause] Nothing comes to mind.

Though the dialogue above comes from the movie, *Charlie Bartlett*—a story about a teenage boy trying to fit into a new high school—it could just as well have come from most households across the country. Being included and well-liked is a primary goal shared by most teenagers, and the thought of not being liked or being left out is often described as “the worst thing ever!” (i.e., dreaded and avoided at all costs). Not surprisingly, social psychologists have described this need to be included or need to belong as a fundamental human need shared by individuals of all ages that, when unsatisfied, can lead to a variety of negative consequences, such as poor health and compromised well-being (Baumeister & Leary, 1995). In fact, recent research has suggested that the need to belong is so fundamental that a lack of social connection, like a lack of other basic needs (e.g., food), can feel painful—an experience that has been termed *social pain* (Eisenberger & Lieberman, 2004, 2005; Eisenberger, Lieberman, & Williams, 2003; MacDonald & Leary, 2005). Given that the need to belong is so important and that a lack of belonging can lead to negative

psychological and even physical health consequences, it is important to understand a particular time period during which acceptance and rejection take on inflated importance, namely adolescence.

Extensive developmental research has demonstrated adolescence to be a time of increased importance of peer relationships, sensitivity to social rejection, and negative psychological outcomes associated with peer rejection. As children transition into adolescence, peer rejection becomes increasingly prevalent as exclusive cliques form, and isolating and ridiculing classmates becomes associated with perceived popularity (Juvonen, Graham, & Schuster, 2003). In addition, upon entering middle school, it is common to spend increased time with peers (Csikszentmihalyi & Larson, 1984) and to place greater value on peers' approval, advice, and opinions (Brown, 1990). Thus, negative feelings associated with peer rejection may be especially salient during this stage of development because of the importance that young adolescents place on maintaining peer relationships. Several studies have documented the negative effects of social exclusion by peers on psychological adjustment, including links with depression and anxiety (Graham, Bellmore, & Juvonen, 2003; Isaacs, Card, & Hodges, 2001; Rigby, 2000, 2003), and emotionality and social withdrawal (Abecassis, Hartup, Haselager, Sholte, & Lieshout, 2002). In addition, studies have shown that not only is peer rejection psychologically harmful, but it can result in adverse mental health and physical health outcomes that persist long-term across development (e.g., Lev-Wiesel, Nuttman-Shwartz, & Sternberg, 2006; Prinstein, Sheah, & Guyer, 2005; Rigby, 2000).

Based on the profound influence that peer relationships have during adolescence as well as the potentially long-lasting effects of these early social relationships, it is crucial to understand the mechanisms by which these relationships impact adolescents' social experiences in both positive and negative ways. We begin this chapter by suggesting that the emerging discipline of social cognitive neuroscience may help to further elucidate the mechanisms that underlie the unique social and emotional processes related to peer interactions during adolescence. In particular, functional magnetic resonance imaging (fMRI) provides the opportunity to observe the processes underlying peer interactions as they are occurring, rather than relying solely on retrospective reports or observer ratings that are vulnerable to bias. To bolster this claim, we will discuss the research that has already been done in this area. Specifically, we will review previous research that has examined the neural mechanisms underlying experiences of social exclusion among adults, and we will suggest several distinct brain

regions and interacting systems that deserve attention as we explore these processes among adolescents.

In order to relate these findings from adults to peer rejection processes among adolescents, we next detail the structural and functional brain differences between adults and adolescents and suggest potential implications of these differences. Moreover, we specifically outline theories that have been put forth regarding the interaction between the developing brains of adolescents and the social behavioral outcomes that are typically observed in research on peer relations. As part of this discussion we also discuss the handful of neuroimaging studies that have begun to examine issues related to peer interactions during adolescence. Finally, we suggest one additional area that we believe is important to examine as neuroimaging is implemented by peer relations researchers—we discuss the importance of considering not only adolescents' personal experiences with rejection, but also their frequent observation of other peers being rejected, as a common aspect of their daily lives. Here, we suggest that fMRI methods may be particularly useful in understanding how a socially threatening environment, in which peer rejection is common, may influence the way that adolescents experience and respond to peer rejection. The overarching goal of this chapter is to provide a solid argument for how social cognitive neuroscience can integrate with the field of peer relations during adolescence, and in so doing, move both fields forward.

HOW CAN NEUROIMAGING TECHNIQUES CONTRIBUTE TO THE FIELD OF ADOLESCENT PEER REJECTION?

Despite the known impact of peer rejection on neuropsychiatric health, research examining peer rejection among adolescents has focused almost exclusively on behavioral methods of analysis, leaving the mechanisms underlying adolescents' individual, subjective experiences unexplored. For example, although extensive behavioral studies have explored patterns of peer rejection during adolescence, survey data and observational techniques are only able to tap emotional and behavioral *outcomes* of experiences with peer rejection, which represent a by-product of several underlying processes occurring in the moment of the experience. In contrast, neuroimaging techniques, such as fMRI, which permit the examination of these underlying processes at the time they are happening, can reveal distinct systems that contribute to the overall experience. By revealing on-line neural responses during the actual rejection experience,

fMRI can elucidate neural mechanisms related to distress and distress regulation that may explain increased salience of peer rejection during adolescence.

One of the specific processes related to peer rejection experiences that is likely to be further clarified by the use of fMRI techniques is the regulation of negative emotion. Several behavioral studies have indicated that one of the underlying contributors to individual differences in children's responses to peer rejection may be variation in emotion regulation ability. Moreover, research has demonstrated that differences in emotional competence, which is associated with greater emotion regulation ability, may help explain individual differences in psychiatric outcomes following peer rejection. Specifically, Asher and colleagues found that rejected children have difficulty managing their emotions, and rejected children with emotion regulation problems are at risk for later psychopathology development (Parker & Asher, 1987; Parkhurst & Asher, 1992). In addition, a later study found that, in order to successfully maintain friendships, children need multiple abilities: to work through conflict, display empathy, and understand how their own emotional reactions will impact their peers (Asher & Rose, 1997).

As a whole these findings suggest that inability to regulate negative affect successfully may underlie responses to rejection and contribute to psychopathological outcomes in some individuals. However, the mechanisms linking negative affect resulting from social rejection and subsequent individual differences in emotional responses cannot be comprehensively examined using the behavioral techniques most typically employed. While behavioral reporting and experiments may reveal individual differences in distress experiences resulting from an experience of rejection, it is impossible to know whether individual differences in subjective reports and observed behavioral outcomes reflect differences in the degree of affect initially elicited by the rejection episode, or differences in the degree to which negative affect is regulated. In other words, does an adolescent who is particularly sensitive to rejection simply react more strongly to the experience overall, or is his/her subjective experience one of greater distress due to an inability to regulate negative affect? Behavioral methods of analysis traditionally measure the "net" distress that an adolescent experiences as a result of peer rejection, conflating both the degree of initial emotional response that was subsequently tempered through emotional regulation, as well as the amount of regulation that occurred. In contrast, functional neuroimaging techniques allow us to make inferences about the initial emotions triggered by the rejection

experience, as well as the degree to which these emotions are regulated by examining differentiated neural activity in affective (limbic) versus emotion regulatory neural regions (prefrontal cortex).

NEUROIMAGING RESEARCH EXAMINING SIMULATED SOCIAL EXCLUSION AMONG ADULTS

Although research is just beginning to explore processes and experiences related to peer interactions among adolescents, a series of studies with adults has examined individuals' responses to social exclusion, providing clues as to the underlying neural structures that support such negative interpersonal encounters. In the first of these studies (Eisenberger, Lieberman, & Williams, 2003), participants were excluded by two supposed others while undergoing an fMRI scan, in order to identify the neural correlates of experiencing social exclusion. Thus, participants were led to believe that they were playing a virtual ball tossing game called Cyberball (Williams, Cheung, & Choi, 2000; Williams et al., 2002) via the internet with two other participants in other scanners; however, these other players were actually images controlled by a computer program. Participants first completed an "inclusion round" of Cyberball, in which the two other supposed players threw the ball back and forth with the participant throughout the game. Next, participants completed an "exclusion round," in which, after a brief period of inclusion, the two supposed players stopped throwing the ball to the participant for the remainder of the game. Immediately after the game, participants reported how much social distress they felt during the exclusion round (e.g., "I felt rejected," and "I felt invisible").

Results revealed a network of physical pain-related neural regions to be involved in the processing of distress related to social exclusion, including: (a) the dorsal anterior cingulate cortex (dACC), which has previously been associated with the unpleasantness or distressing aspects of physical pain (Foltz & White, 1962; Rainville, Duncan, Price, Carrier, & Bushnell, 1997; Sawamoto et al., 2000); (b) the insula, which has been linked to the processing of visceral sensations, (e.g., visceral pain), as well as negative affect (Aziz, Schnitzler, & Enck, 2000; Cechetto & Saper, 1987; Lane, Reiman, Ahern, Schwartz, & Davidson, 1997; Phan, Wager, Taylor, & Liberzon, 2004; Phillips et al., 1997); and (c) the right ventral prefrontal cortex (RVFPFC), which has been shown to be involved in the regulation of distress associated with physical pain and negative emotional experiences

more generally (Hariri, Bookheimer, & Mazziotta, 2000; Lieberman et al., 2004; Lieberman et al., 2007; Petrovic & Ingvar, 2002).

Three specific findings were particularly noteworthy in this study and have been subsequently replicated: (a) participants who reported more social distress during exclusion displayed more activity in the dACC, suggesting that dACC activity is an index of exclusion-related social distress; (b) participants with greater activity in the RVPFC during exclusion reported less social distress, supporting prior findings that the RVPFC plays a regulatory role in the experience of negative affect; and (c) activity in the dACC and RVPFC were negatively correlated, such that greater RVPFC activity was associated with less dACC activity. Moreover, the relationship between RVPFC activity and reported distress was fully mediated by changes in dACC activity, again suggesting that the RVPFC functions in a regulatory capacity, reducing the experience of distress by diminishing dACC activity.

Thus, neural responses to an episode of social exclusion recruited some of the same neural regions that are involved in the distress (dACC) and regulation (RVPFC) of physical pain experiences. These results are important for several reasons. First, they lend support to the notion that social connection is a fundamental human need by showing that a lack of social connection (in this case, through an episode of social rejection), like a lack of other basic needs, is experienced as painful. Second, these findings provide a framework for understanding the neural correlates of peer-related interactions in adolescents. Identifying the separate neural regions that are involved in the distress versus regulation of distress in response to exclusion (dACC vs. RVPFC) allows us to disentangle some of the processes that may contribute to the heightened salience of peer rejection and acceptance during adolescence. In other words, we can determine whether the heightened salience of peer rejection is due to greater inherent distress in response to rejection, reduced regulatory ability, or some combination of both based on observed patterns of neural activity in these regions.

In the next section we review the neural regions that respond to socially threatening situations more broadly, in order to provide a more comprehensive framework for understanding the neural underpinnings of peer-related rejection during adolescence. We first review regions that have been associated with affective responses to social threat (dACC, insula, subACC, amygdala) in adults and then review those that have been associated with regulating the negative affective responses to social threat (RVPFC) in adults. We also focus on additional neural regions

that may play a unique role in peer rejection experiences during adolescence (ventral striatum).

NEURAL REGIONS SUPPORTING AFFECTIVE RESPONSES TO SOCIALLY THREATENING SITUATIONS

Activity in the dACC and Responses to Social Exclusion

The dACC has now been repeatedly shown to play a role in participants' reported feelings of social distress following exclusion experiences. In addition to self-reported social distress to an episode of social exclusion correlating with dACC activity (Eisenberger et al., 2003), it has also been shown that individuals who tend to feel more rejected in their everyday social interactions (assessed using an experience-sampling methodology) also showed greater activity in the dACC in response to social rejection in the fMRI scanner (Eisenberger, Gable, & Lieberman, 2007).

In addition, a follow-up study suggested that activity in the dACC might also be an important mediator in the relationship between social support and health outcomes. Eisenberger and colleagues (Eisenberger, Taylor, Gable, Welch, & Lieberman, 2007) demonstrated that having lower social support was related to greater activation in the dACC during the exclusion round of Cyberball and that this greater dACC activity was associated with larger physiological stress responses (levels of cortisol, a stress hormone) to a similar social stressor. This finding suggests that having less social support may result in greater sensitivity to feeling excluded by others—perhaps because sensitivity to rejection is heightened when one does not have intact social bonds to buffer the pain of being rejected. Finally, another study examined whether the dACC is sensitive not only to the experience of social exclusion but also to cues that predict social exclusion as well, namely disapproving faces (Burklund, Eisenberger, & Lieberman, 2007). Although viewing disapproving faces (compared to viewing a neutral crosshair fixation) did not lead to greater dACC activity across all participants, individuals who scored higher in rejection sensitivity showed greater dACC activity while viewing disapproving faces. Moreover, rejection sensitivity correlated specifically with activity in the dACC in response to viewing disapproving faces, but not with the activity of other limbic regions (e.g., amygdala, insula), suggesting that dACC activity, rather than limbic system activity more generally, may be specifically responsive to these cues of rejection.

Activity in the Insula and Responses to Emotional Stimuli

In addition to the findings indicating that the insula is active during social exclusion experiences among adults, this region has been implicated in the subjective experience of a range of emotions that may be relevant to our understanding of peer rejection experiences during adolescence. For example, recent studies have shown that the insula is active during aversive and threat-related processing and is particularly sensitive to disgust-related as well as fear-related stimuli (Phillips et al., 1997; Schienle et al., 2002). Moreover, it has also been shown to be responsive to a variety of other types of negative emotional experiences such as feeling that one is being treated unfairly (e.g., Sanfey, Rilling, Aronson, Nystrom, & Cohen, 2003), as well as the anticipation of negative experiences and guilt (Shin, Dougherty, Orr, Pitman, & Rauch, 2000). Moreover, research has suggested that the insula may be specifically involved in the distressing experiences related to these emotions (Reiman, Lane, Ahern, Schwartz, & Davidson, 1997) and thus may be particularly relevant in trying to understand individuals' subjective experiences. Finally, in line with the role that the insula plays in visceral pain sensation (Aziz, Schnitzler, & Enck, 2000; Cechetto & Saper, 1987), many researchers have posited that insular activity underlies the link between internal somatic cues and emotional experiences, acting as a type of internal alarm to indicate when a situation is threatening (Phan et al., 2004). Given the emotional salience of experiences with peer rejection and the previous findings implicating this region's involvement among adults experiencing social exclusion (Eisenberger et al., 2003), the insula will be an important region to consider in the examination of neural patterns related to peer rejection among adolescents.

Activity in the Subgenual ACC and Responses to Emotional Stimuli

Studies examining social exclusion among adults have identified an additional area of the cingulate, the subgenual portion of the anterior cingulate (subACC), to be involved in responding to social exclusion. For example, the subACC has been shown to be more active upon learning that one has been socially accepted versus rejected by another individual (Somerville, Heatherton, & Kelley, 2006). Moreover, in the

examination of neural responses to disapproving faces (Burklund et al., 2007), individuals low in rejection sensitivity showed greater activity in the subACC while viewing disapproving faces. Studies such as these fit with previous work showing that subACC activity is associated with more positive or less threatening interpretations of potentially negative stimuli (Kim et al., 2003), a strategy that might be particularly relevant for rejected adolescents. However, there is also evidence to suggest that subACC activity may also be involved in emotional distress. Findings from clinical populations highlight a role for this region in experiences of both sadness and depression (Mayberg, 1997; Mayberg et al., 1999; Phan et al., 2004). Thus, the findings regarding the subACC are less clear than those found for the dACC. It is possible that this region operates differently for healthy participants compared to those with clinical disorders. Nonetheless, the subACC has been consistently linked with different aspects of emotional processing and could thus be potentially important when exploring these processes among adolescents.

Activity in the Amygdala and Responses to Emotional Stimuli

The amygdala has long been thought to be an area supporting threat detection and sensitivity to threatening social cues. Numerous studies have demonstrated that the amygdala is responsive to threatening emotional face stimuli (angry, fearful faces) presented either supraliminally or subliminally, as well as other types of aversive images (Davis & Whalen, 2001; Hariri et al., 2000; Hariri, Mattay, Tessitore, Fera, & Weinberger, 2003; Ohman, 2005; Whalen et al., 1998). In addition, it has been shown to respond to pictures displaying physical threats (Hariri, Tessitore, Mattay, Fera, & Weinberger, 2002; Ochsner, Bunge, Gross, & Gabrieli, 2002) and novel stimuli that suggest the potential for threat (Whalen, 1999). Moreover, research on social exclusion has shown that individuals who tend to feel the most rejected in their real-world social interactions also show greater amygdala activity in response to an experimental episode of scanner-based social rejection (Eisenberger, Gable, & Lieberman, 2007). Because of the consistency of this research, as well as the timing of the amygdala's development—which is complete long before adolescence—the amygdala is an important candidate to consider when hypothesizing about the neural correlates of social rejection among adolescents.

NEURAL REGIONS SUPPORTING AFFECTIVE REGULATION DURING SOCIALLY THREATENING SITUATIONS

Activity in the RVPFC and Regulation of Social and Emotional Distress

In terms of neural regulation of social and emotional distress, studies have continued to show the importance of the RVPFC/RVLPFC (right ventrolateral prefrontal cortex—a region slightly more lateral than RVPFC) in aiding regulatory processing following a socially threatening event. Follow-up studies of social exclusion have shown that more activity in the RVPFC is related to less distress, as well as less dACC activity (e.g., Eisenberger et al., 2007), further evidencing the role of the RVPFC in regulating distress by decreasing dACC activity in response to the distressing experience.

In addition, beyond these specific findings related to distress following social exclusion, research has indicated that the prefrontal cortex more broadly plays a regulatory function in several other studies examining responses to negative stimuli. For example, the prefrontal cortex has been linked with the regulation of negative affect such as fear (e.g., Hariri, Bookheimer, & Mazziotta, 2000; Nelson et al., 2003). In studies of negative emotion labeling and facial emotion perception, the RVLPFC has specifically been shown to regulate activity in the amygdala in a reciprocal relationship similar to that between the RVPFC/RVLPFC and the dACC (Hariri et al., 2000, 2002; Lieberman, Hariri, Jarcho, Eisenberger, & Bookheimer, 2005; Lieberman et al., 2007). Specifically, several of these studies have shown that the RVPFC/RVLPFC is activated during the labeling of negative affective states, suggesting that as individuals think about the labels for negative emotions, this may provide a catalyst for the regulation of the individual's affective response to the stimuli. Similarly, the RVLPFC as well as other regions of the prefrontal cortex have been shown to be involved in the reappraisal of negative social stimuli and have been specifically linked to the reduction of negative affect during the cognitive reappraisal of aversive images (Ochsner et al., 2002; Ochsner & Gross, 2005; Wager, Davidson, Hughes, Lindquist, & Ochsner, 2008). Together, the diversity of experimental manipulations in which the RVPFC/RVLPFC serves to help regulate neural activity underlying social and emotional distress, as well as to decrease subjective feelings of distress, underscores the consistency and robustness of the apparent regulatory function of this region and lends further support

to the role of the prefrontal cortex in regulating emotional response to a variety of aversive social stimuli.

Activity in the Ventral Striatum and Regulation of Negative Affect

One additional region that may prove important in studies of peer rejection among adolescents is the ventral striatum, and in particular the nucleus accumbens (NA), neural regions involved in reward learning and approach motivation among adults and children (McClure, Berns, & Montague, 2003; Schultz, 2004; Tindell, Smith, Pecina, Berridge, & Aldridge, 2006; Wager, Scott, & Zubrieta, 2007). While this might seem counterintuitive because experiences of rejection are clearly not rewarding, the NA and ventral striatum have shown evidence of involvement in processes that likely support successful emotion regulation. For example, a recent study demonstrated greater activity in the NA when reappraising aversive images, and this greater NA activity was associated with greater reappraisal success (Wager et al., 2008), further evidencing the role of this region in supporting regulatory processes. Although NA activity is not typically seen in studies of emotion regulation, this previous work suggests that the ventral striatum and NA may play a role in affect regulation by aiding in the reinterpretation of stimuli in positive ways.

THEORETICAL PERSPECTIVES AND NEUROIMAGING RESEARCH ON PEER RELATIONSHIPS

Theoretically, it is impossible to predict exactly which aspects of adolescents' neural responses during experiences with peer rejection will be similar to those seen among adults experiencing social exclusion. However, there are important developmental considerations to take into account before previous research with adults can be useful as a basis for forming hypotheses. In the following section, we outline several theories related to structural and functional brain development, as well as how brain maturation may impact social behavior during adolescence. Specifically, we examine how brain development across adolescence might inform our understanding of adolescents' emotional and behavioral responses to peers, as well as their ability to regulate their responses to social situations. After reviewing these theoretical perspectives, we discuss the handful of studies that have begun to examine the neural

correlates of social interactions among adolescent populations and consider how these first studies may inform our understanding of social interactions during this unique period of development.

Structural and Functional Brain Development During Adolescence

In considering potential differences between adults' and adolescents' responses to rejection, differences in brain maturity are a crucial factor to consider, particularly given the recent advancements in our knowledge about structural and functional differences across development. Qualitative functional differences related to structural disparities in adolescents' and adults' frontal regions may result in behavioral differences in responses to emotion-evoking stimuli across different ages. Structural brain development is typically examined by measuring the amount of grey matter in the brain, which decreases as myelination increases within a specific region. Because lower density of grey matter in a particular region (i.e., synaptic pruning) is related to heightened efficiency and faster information processing speed, studies of structural development allow inferences to be made about the efficiency of functioning that is supported by a particular brain region.

For example, studies of structural brain development have shown that the frontal regions of the brain are among the last to complete myelination (Casey, Giedd, & Thomas, 2000; Gogtay et al., 2004) and that grey matter density decreases between adolescence and adulthood in these regions (Sowell, Thompson, & Toga, 2004). In addition, these studies have shown that the prefrontal cortex continues to develop both structurally and functionally through late adolescence and into early adulthood (Gogtay et al., 2004; Giedd, Castellanos, Rajapakse, Vaituzis, & Rapoport, 1999).

Because many aspects of emotional and cognitive processing are supported by the prefrontal cortex, there are likely to be age-specific behaviors reflecting these structural differences between adults and adolescents. Indeed, studies have shown that the cognitive processes that undergo the greatest change during adolescence are those involving the frontal lobes (Levin et al., 1991). For example, differences in prefrontal functioning related to emotion regulation ability may suggest that young adolescents, for whom experiences with peer rejection are common, may not be fully capable of regulating reactions to negative social experiences. Thus, they may experience rejection as more distressing than

adults. Furthermore, individual differences in neural regulatory ability among adolescents may also help explain why some rejected adolescents go on to develop neuropsychiatric disorders later in life.

Brain Development and Implications for Social Behavior

A handful of developmental psychologists have specifically theorized about the impact of these developmental differences in neural responding to emotional and social stimuli. One recent set of studies has looked specifically at functional changes in brain activity in order to understand potential developmental differences, specifically in social and emotional domains. Nelson and colleagues outline a model of the social information processing network (SIPN) in the brain, composed of three different types of functions, each of which independently contributes to brain function and related behavioral changes during adolescence (Nelson, Leibenluft, McClure, & Pine, 2005). They propose a detection node, in which a stimulus is labeled as "social," an affective node that attaches emotional significance to the stimulus, and a cognitive-regulatory node, in which perspective taking and judgments are made in order to determine an appropriate affective response (Nelson et al., 2005). The authors suggest that while the regions involved in the detection node are well developed by adolescence, frontal regions associated with the affective and cognitive-regulatory nodes are still undergoing functional changes that may impact social behavior and emotional processing during this time. Problems may arise if adolescents can detect a social stimulus but cannot understand the emotional significance of the situation or determine an appropriate emotional or behavioral response. In addition, while both the affective and cognitive-regulatory aspects of the SIPN undergo changes during adolescence, development of the affective node occurs primarily during puberty (Steinberg & Morris, 2001), whereas development of the cognitive regulatory node may not occur until well past puberty (Casey et al., 2000; Ochsner et al., 2002). Thus, adolescents may be able to detect a social situation and experience an emotional reaction, yet they may not be able to make meaningful assessments of others' perspectives or control their emotional responses.

Another theorist, Larry Steinberg, has pointed out that this apparent mismatch in brain development, in which the regions that react to a particular stimulus develop prior to the regions enabling the regulation and/or inhibition of these responses, may be particularly problematic in the context of peer interactions (Steinberg, 2008). As he points

out, approval by peers and even the mere presence of peers can be especially rewarding among adolescents, and the neural tools necessary to inhibit the desire to please peers and win approval through various risk-taking activities have yet to develop. Thus, this developmental period is particularly problematic in situations where strong emotional responses must be regulated (Steinberg, 2008). Clearly this theory has implications for adolescents' experiences with peer rejection. While the desire to gain approval and avoid rejection may be particularly intense, it may be impossible for adolescents to manage the emotional responses that they experience when rejection occurs.

Overall, given the findings related to structural brain development, as well as the theoretical implications of brain development for behavioral responses during adolescence, examining patterns of neural activation among adolescents during an experience of peer rejection could highlight two important issues related to how adolescents process these experiences and regulate their emotional responses. First, neuroimaging studies of peer rejection during adolescence could demonstrate how underlying regulatory processes among adolescents at different stages of development result in varying levels of emotional response. Second, neuroimaging studies of peer rejection among adolescents could reveal additional regions beyond the prefrontal cortex that might also play a role in distress regulation, given that adolescents' brains are qualitatively different from those of adults. Examining both of these issues and gaining understanding of how the prefrontal cortex and other brain regions contribute to adolescents' distress regulation could explain developmental and individual differences in psychological responses to rejection among this population for which peer rejection is particularly salient.

Neuroimaging Studies of Peer Interactions Among Adolescents

Although previous neuroimaging research has not directly examined adolescents' experiences with peer exclusion, a small number of studies have recently begun to explore neural patterns related to peer interaction, specifically among adolescent populations. One recent experiment examined adolescents' neural responses to experimentally manipulated peer feedback during a chat room game in which participants believed they were participating with other same-age peers and were repeatedly accepted and rejected by different peers in the chat room (Guyer, McClure-Tome, Shiffrin, Pine, & Nelson, in press). Findings indicated that during peer

acceptance, compared to rejection, there was significant activation in the ventral pallidum, a region that has previously been implicated in reward processing (Ikemoto & Wise, 2004; Waraczynski, 2006). This finding provides support for Steinberg's theory (2008) that the presence of peers in itself is rewarding to adolescents, and that peer group situations are likely to engage regions associated with emotional and reward processing in adolescents, regardless of the exact nature of the task. In a different study using the same chat room paradigm, clinically anxious adolescents—who typically judge themselves as being unaccepted by peers—displayed significantly more amygdala activation than typically developing adolescents when anticipating feedback from peers who were previously rated to be more likely to provide negative feedback (Guyer et al., 2008). This interesting finding suggests that clinically anxious adolescents might be significantly more sensitive to expected negative peer feedback and again supports the role of the amygdala in the neural processing of socially threatening stimuli.

One other recent study examined how individual differences in self-reported resistance to peer influence impacted adolescents' neural responses while viewing videos of angry faces compared to responses while viewing videos of neutral faces (Grosbras et al., 2007). Results from this study revealed that adolescents who were less able to resist peer influence also displayed heightened neural sensitivity, including increased activity in the dACC, when watching angry faces. This finding suggests that individuals who are more sensitive to peer pressure might display heightened affective responses to threatening social-emotional stimuli and may use more attentional resources when viewing threatening social cues (Grosbras et al., 2007). Consistent with previous studies of social exclusion with adults, this study suggests that adolescents may use similar neural resources when processing socially threatening stimuli; however, their neural patterns of activation may be dependent, in part, on individual differences in responses to peer influence.

Finally, a recent study conducted in our lab has specifically examined neural processes among adolescents during an experience of simulated peer rejection. Using the same Cyberball task that has been used previously (Eisenberger et al., 2003, 2007), we scanned 23 adolescents (ages 12–13) while they were first included and then excluded by two other same-age apparent participants who were actually controlled by the computer. Following the scan, participants completed self-reports of distress felt during the exclusion round of the task. In addition, adolescents completed self-reports of rejection sensitivity and their parents

completed reports of their interpersonal competence (e.g., has lots of friends, fights at school), so that we could examine how sensitivity to peer rejection and social skills might interact with neural and distress responses to peer rejection.

Overall, data from this study (Masten et al., in press) has revealed interesting findings that help explain how adolescents may experience peer rejection in unique ways. During exclusion, adolescents displayed some brain activation similar to adults; however, results indicated that adolescents might also process the experience of exclusion in ways specific to this unique stage of development. For example, adolescents' regulatory processes during rejection were supported, not only by the RVL PFC but also by the ventral striatum, a region that has been found to help with affect regulation among adults (Wager et al., 2008), as well as among individuals with atypical prefrontal cortex function that undermines the normal functioning of their regulatory systems (e.g., Dickstein & Leibenluft, 2006). Because the prefrontal cortex is not fully developed until adulthood (Gogtay et al., 2004), ventral striatum activity may help regulate adolescents' affective responses to threatening stimuli during this stage of development and compensate for an underdeveloped prefrontal cortex. Results further revealed that adolescents who scored higher on parent-reported interpersonal competence were actually more sensitive to rejection, as indexed by both higher self-reported rejection sensitivity as well as greater distress-related neural activity during the rejection episode. A potential implication of this neural link between interpersonal competence and responses to rejection during adolescence is that being able to understand and be affected by rejection may be an important aspect of being able to get along well with others, particularly during this developmental period.

EMPATHIC RESPONSES TO PEER REJECTION IN ADOLESCENCE: NEURAL RESPONSES TO WITNESSING THE REJECTION OF OTHERS

Observing Peer Rejection During Adolescence

In considering how adolescents' responses to rejection might differ from adults, it is critical to consider the social environment that is typical of the adolescent period. In contrast to most adults, adolescents are affected not only by personal experiences with rejection but also by their larger environment in which rejection is exceedingly common. Adolescents who

are not being directly excluded by peers may anticipate rejection, feel anxious about avoiding rejection, and experience feelings of empathy for their peers who are being rejected. Among developmental psychologists specifically, empathy has traditionally been defined as an affective response resulting from one's understanding and anticipation of another's emotional state that is similar to the emotion that this other person feels (Eisenberg, 2000; Eisenberg, Fabes, Schaller, Carlo, & Miller, 1991; Eisenberg, Miller, Shell, McNally, & Shea, 1991). Thus, empathy involves aspects of cognitive perspective taking, as well as *actually experiencing* the same emotion as the observed individual. Although ability to empathize plays an adaptive role in social interaction—that is, empathic experiences have been associated with prosocial behavior and are thought to encourage successful social communication for both children and adults (Denham, Renwick-DeBardi, & Hewes, 1994; de Vignemont & Singer, 2006; Zahn-Waxler et al., 1992)—research also suggests that when observing someone else during a stressful social situation, individuals will themselves experience distress at both emotional and physical levels. For example, one study found that on a daily basis, both being rejected by peers and witnessing another individual being rejected by peers resulted in equally elevated levels of anxiety (Nishina & Juvonen, 2005). This finding suggests that concern about rejection during adolescence is likely to be salient to the majority of adolescents, regardless of their own social status among their peers.

Regulation of Empathic Distress

Experiences of empathic distress—feeling personally distressed as part of an empathic experience—are particularly important when considering emotion regulation demands on adolescents. Researchers have shown that empathic distress is directly related to emotion regulation ability, such that those who feel more empathic distress show reduced ability to regulate emotion (Eisenberg, Fabes, Murphy, Karbon, & Maszk, 1994; Eisenberg, Wentzel, & Harris, 1998; Eisenberg et al., 1996). Many types of social reasoning skills, including the ability to regulate empathic responses, improve significantly between childhood and adolescence as regulatory ability improves (Eisenberg, Miller, Shell, McNally, & Shea, 1991). Thus, these cognitive advancements such as emotion regulation ability will likely impact how empathic events are subjectively experienced as individuals transition through adolescence and should be carefully considered.

Examining Both Personal and Empathic Distress Resulting From Peer Rejection

Given the evidence that witnessing peer rejection can be significantly distressing, as well as dependent on emotion-regulation abilities, it may be important to account for both subjective and empathic experiences that result from peer rejection when considering which methodological tools will best measure individuals' experiences. In other words, to be comprehensive, analytical techniques designed to measure responses to rejection should tap into direct, personal experiences of rejection, observed experiences of others' rejection, and the regulatory systems that support both of these experiences. Neuroimaging may be particularly useful in this regard, given the contributions that neuroimaging studies have recently made to our understanding of both subjective and empathic responses in social situations more generally. For example, research has shown that individuals not only show neural evidence of distress when they directly experience a negative event but also when they witness another person experiencing a negative event (e.g., Singer et al., 2004, 2006). Uncovering these types of common underlying mechanisms for both experiencing and observing a negative social situation will likely help explain why certain events impact well-being, regardless of whether they are directly experienced, or just observed.

Neural Responses During Empathic Emotional Experiences Among Adults and Adolescents

Although neuroimaging research is just beginning to consider empathy related to peer rejection, recent neuroimaging research with adults has begun to identify some of the neural correlates of empathic processes that may provide clues about how empathic experiences of peer rejection are processed neurally by adolescents. Specifically, studies have consistently shown the dorsomedial prefrontal cortex (dmPFC) to be related to thoughts about the self and others, including processing of reflected appraisals (i.e., thinking about what others think about oneself; Frith & Frith, 1999, 2006), theory of mind and perspective taking (Vogeley et al., 2001), and self processing (Heatherton et al., 2006; Lieberman et al., 2004; Pfeifer, Lieberman, & Dapretto, 2007; Frith & Frith, 1999). Neuroimaging work has also suggested a potential mechanism for how individuals experience others' emotional states as their own. Several studies of adults have provided evidence that there

is overlapping brain activity when people both experience an emotion and observe someone else feeling the same emotion, for example disgust (Wicker et al., 2003) and fear (Whalen et al., 2001), as well as pain-related distress (Botvinick et al., 2005; Jackson, Brunet, Meltzoff, & Decety, 2006; Singer et al., 2004). In addition, new evidence in children suggests overlapping brain regions when making an emotional expression and when observing another child making the same emotional expression (Pfeifer, Iacoboni, Mazziotta, & Dapretto, 2008).

This work suggests that perhaps the reason individuals are able to empathize with others and experience their emotions is precisely because of the shared neural representations during the experience and observation of emotional stimuli. It is further posited by de Vignemont and Singer (2006) that the degree of neural overlap is dependent on an individual's appraisal of a situation, so that if an observed emotion is viewed as appropriate given the social context, an empathic response is more likely than if the emotion is viewed as inappropriate or unjustified. Thus in cases where adolescents experience exclusion and then observe another adolescent being excluded, they may be more likely to anticipate that the other adolescent feels rejected and that this emotion is justified, given that they previously experienced the same emotion. In this case there would likely be an overlap of neural activity reflecting the similarity between the adolescent's own distress response and his or her empathic distress response when observing another adolescent's similar experience with exclusion. As a whole, these adult studies of the neural correlates of empathic processing provide a context for thinking about the experiences of adolescents and specifically, how witnessing peer rejection may be represented in the brain.

In an ongoing study (Masten et al., 2008), we are attempting to identify some of the neural regions that may be involved in empathic responses to peer rejection experiences during adolescence. A group of adolescents (aged 12–13) completed a version of the Cyberball task in which, after playing the game themselves, they were asked to observe closely while another supposed participant played the game with two supposed peers (in this version all three of these supposed players were controlled by a preset computer program). As with previous Cyberball studies, the supposed participant was first included and then excluded by the other two players. Preliminary analysis of this dataset has revealed common neural activations during personal rejection and empathic rejection in regions that have been previously linked to distress and regulation during pain processing (subACC, insula, and RVL PFC). The presence of these shared

neural representations for both experiencing and witnessing rejection suggest that these two experiences rely on overlapping neural circuitry, which may explain why witnessing others' rejection may be painful and harmful to well-being in ways similar to personal rejection.

SUMMARY AND CONCLUSION

In the preceding discussion we have attempted to demonstrate the unique contribution that social cognitive neuroscience can make to developmental psychologists' understanding of the salience of peer rejection during adolescence. We have outlined the ways in which fMRI can allow scientists to observe neural processes responsible for adolescents' responses to rejection as they are occurring, and we have specifically suggested that neuroimaging techniques will increase our knowledge about how distress related to peer rejection is regulated and thus how individuals may display a wide range of responses to a rejection experience. We also reviewed previous social cognitive neuroscience research with adults, which has clearly implicated specific limbic and frontal regions in the neural processing of social exclusion, and we discussed what differences we might expect when analyzing these processes in an adolescent population. Specifically we highlighted the importance of considering structural and functional differences resulting from immaturity of frontal regions among adolescents, and we outlined the ways that these differences might interact with social behavior and alter behavioral outcomes in the context of peer relationships. In addition, although little peer interaction research has been performed among adolescents using fMRI methods, we summarized the handful of studies that have begun to pave this new direction of research. Finally, in an attempt to consider some less traditionally examined aspects of peer rejection experiences during adolescence, we hypothesized that examining empathic responses to witnessed peer rejection may broaden our understanding of peer rejection salience during adolescence, and that neuroimaging techniques may be particularly useful in elucidating why witnessed rejection is so salient for adolescents' well-being.

As social cognitive neuroscience is integrated into the field of adolescent peer relations, it is our hope that many of these issues will be clarified and new directions of research will be identified. As this research progresses, there is no limit to the knowledge that may be gained by incorporating behavioral and neuroimaging techniques in this field.

For example, in addition to identifying the neural substrates of peer rejection among adolescents and examining potential mechanisms that might contribute to individual response differences, future research has the potential to examine the beneficial effects of friends and social support in the context of peer rejection, to characterize chronically rejected adolescents at the neural level, to investigate neural correlates of bullying and/or peer rejection from the perspective of the perpetrator, and to predict future psychopathology based on current individual differences in neural sensitivity to peer rejection. These new directions of research, forged by the intersection of adolescent peer relations and social cognitive neuroscience, have unlimited potential for new understanding, and we believe that the translational quality of peer relationships research is likely to become even more multidimensional as this field progresses.

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4

Why's Everybody Always Picking on Me? Social Cognition, Emotion Regulation, and Chronic Peer Victimization in Children

PAUL J. ROSEN, RICHARD MILICH,
AND MONICA J. HARRIS

Why's everybody always pickin' on me?

—The Coasters

Peer victimization refers to a broad spectrum of social interactions whereby one individual causes physical, emotional, social, or psychological harm to one or more peers. Virtually all children experience victimization at the hands of their peers at some point in their lifespan (Kochenderfer-Ladd & Ladd, 2001). For a subset of children, however, victimization is a stable and chronic phenomenon. Olweus (1991) indicated that approximately 10% of children report being victimized by peers on a regular basis, and stability coefficients for victimization have been reported ranging from .80 over a period of months (Boulton & Smith, 1994) to .41 for a period of a year (Kochenderfer-Ladd & Ladd, 2001). Chronic peer victims often experience serious short- and long-term consequences including internalizing and externalizing disorders, school avoidance, academic dysfunction, and increased suicidal ideation (Hawker & Boulton, 2000; Hodges & Perry, 1999; Kochenderfer & Ladd, 1996a, 1996b), and peer victimization has recently been recognized as a major public health problem of childhood in a recent APA resolution (American Psychological Association, 2004).

Contents

Contributors xi

Preface xiii

PART I: INTRODUCTION 1

- 1** Taking Bullying and Rejection (Inter)Personally: Benefits of a Social Psychological Approach to Peer Victimization 3
Monica J. Harris

PART II: THEORETICAL PERSPECTIVES 25

- 2** A Child and Environment Framework for Studying Risk for Peer Victimization 27
Becky Kochenderfer-Ladd, Gary W. Ladd, and Karen P. Kochel
- 3** Exploring the Experience of Social Rejection in Adults and Adolescents: A Social Cognitive Neuroscience Perspective 53
Carrie L. Masten and Naomi I. Eisenberger
- 4** Why's Everybody Always Picking on Me? Social Cognition, Emotion Regulation, and Chronic Peer Victimization in Children 79
Paul J. Rosen, Richard Milich, and Monica J. Harris

PART III: AGGRESSION AND VICTIMIZATION 101

- 5** The Importance of Personality and Effortful Control Processes in Victimization 103
Lauri A. Jensen-Campbell, Jennifer M. Knack, Amy Waldrip, and Marie Ramirez

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Bullying, Rejection, and Peer Victimization

A Social Cognitive Neuroscience Perspective

MONICA J. HARRIS, PhD

Editor

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