

Why Don't You Like Me?

The Role of the Mentalizing Network in Social Rejection

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ABSTRACT

The pain of rejection is often tied to the way that we interpret how another person thinks or feels about us. In this review, we explore evidence from the current literature to examine the role of mentalizing, the process by which we think about and understand someone else's thoughts and feelings, in the experience of social rejection. We first turn to meta-analyses investigating the neural bases of social rejection to examine whether parts of the mentalizing network are also active during the experience of rejection (Cacioppo et al., 2013; Vijayakumar, Cheng, & Pfeifer, 2017). Next, we review some evidence suggesting that developmental changes in mentalizing, such as those during early childhood and adolescence, may be associated with changes in sensitivity to rejection (e.g. Somerville, 2013; Rochat, 2003). Then, we examine the extent to which individuals who demonstrate compromised mentalizing, such as those with schizophrenia or autism, may exhibit reduced sensitivity to rejection (e.g. Bauminger & Kasari, 2000; Gradin et al., 2012). Finally, we summarize some future directions building on the possibility of a link between mentalizing and the experience of social rejection. The available evidence seems to support a role of the mentalizing network in feeling the pain of social rejection, such that understanding another person's mental state may be what allows us to understand and process rejection.

Rejection hurts. Although this phrase is typically meant metaphorically, a body of evidence suggests that social rejection may hurt literally, much like physical pain (for reviews, see Eisenberger & Lieberman, 2005; Eisenberger, 2012). But not every instance of social rejection cuts deeply. When we find out that the romantic interest who's been acting distant recently lost a loved one, or that a mutual friend who's been giving us the cold shoulder is anxious around people they don't know well, this knowledge can alter our interpretations of their behavior and lead us to feel less hurt by their actions. It seems that being socially rejected hurts not just because someone ignores or dismisses us, but rather because we feel that their rejection has something to do with how they think and feel about us. We notice how someone is acting – distant, cold, uninterested – and we wonder why they might be acting this way: “why don't they like me?” The pain of rejection, or at least some forms of rejection, seems to be inherently tied to the way that we interpret another person's thoughts or feelings.

It makes sense that the pain of social rejection relies to some extent on how we perceive the intentions of the person rejecting us. Indeed, even the experience of physical pain is more intense when we perceive our pain to be intentionally caused by someone else (Wegner & Gray, 2008). Despite this intuitive connection between the experience of social rejection and the process of thinking about and trying to understand someone else's thoughts and feelings, a process referred to as “mentalizing” (Frith & Frith, 2006), very little neuroscience research has explicitly examined the role of mentalizing in the experience of social rejection.

In this review, we explore evidence from the current literature to examine the possible role of mentalizing in the experience of social rejection. To do this, we first turn

to meta-analyses investigating the neural bases of social rejection to examine whether parts of the mentalizing network are also active during the experience of rejection (Cacioppo et al., 2013; Vijayakumar, Cheng, & Pfeifer, 2017). Next, we assess whether developmental changes in mentalizing, such as those during early childhood and adolescence, are associated with changes in sensitivity to rejection (e.g. Somerville, 2013; Rochat, 2003). Then, we examine whether individuals who demonstrate compromised mentalizing, such as those with schizophrenia or autism, exhibit reduced sensitivity to rejection (e.g. Bauminger & Kasari, 2000; Gradin et al., 2012). Finally, we summarize some future directions building on the possibility of an inherent link between mentalizing and the experience of social rejection. We suggest that the available evidence supports a potential role of the mentalizing network in feeling the pain of social rejection, such that understanding another person's mental state may be what allows us to understand and process rejection.

Are Mentalizing Regions Active During the Experience of Social Rejection?

Research suggests that we have such a strong aversion to social rejection that even rejection by a stranger, from whom we have little to gain or lose, can cause us significant distress. For example, Eisenberger et al. (2003) published the first study to use a paradigm called "Cyberball" to induce feelings of social rejection in participants who were laying alone in a functional magnetic resonance imaging (fMRI) scanner. Cyberball is a virtual ball-toss game that involves three avatars passing a ball back and forth. The participant believes that one avatar represents themselves, while the other two avatars represent the other players in the game. However, in reality, there are no other players; instead, the program is designed to include or exclude the participant from the ball-

tossing game. Initially, the participant is included in the game; however, in an exclusion condition, the participant's avatar no longer receives the ball from the other avatars. Even in this context where participants are not physically around other people and have little to lose by being excluded, participants report feeling distressed by the rejection.

The Cyberball paradigm has consistently elicited feelings of social distress in participants across populations (e.g. Gradin et al., 2012; Groschwitz et al., 2016; Masten et al., 2011), across modified versions of the paradigm (e.g. DeWall et al., 2012.; Onoda et al., 2009), and even in studies where participants know they are not really playing the game with other people (Zadro, Williams, & Richardson, 2004). The pain of rejection is so salient that researchers have theorized that the experience of rejection may have piggybacked on the physical pain system, borrowing the pain signal to denote the potential for broken social bonds, warning us to avoid them (Eisenberger & Lieberman, 2004; MacDonald & Leary, 2005; Panksepp, 2004). By allowing us to detect the threat of exclusion, which can restrict access to resources, social support, and other protective factors, social pain can help us adaptively navigate the social world and maintain the relationships that promote our well-being (Eisenberger & Lieberman, 2005).

Since the first study using Cyberball, countless studies have examined the neural mechanisms underlying feelings of rejection. While many of these studies have used the Cyberball paradigm, others have used more personally relevant paradigms, such as thinking about rejection by recounting a recent romantic break-up (Fisher et al., 2010; Kross et al. 2011). These studies have predominantly focused on examining the neural regions associated with the affective (unpleasant-feeling) component of physical pain (i.e. dorsal anterior cingulate cortex (dACC), anterior insula (AI)), and have not directly

investigated the relationship between mentalizing and social rejection. However, by examining meta-analyses of such studies, we can investigate whether there is evidence of a consistent role for mentalizing-related neural regions in the experience of social rejection. First, we will briefly describe the neural network typically associated with mentalizing. Then, we will assess the extent to which this network seems to play a role in experiencing social rejection.

The Mentalizing Network

Social cognition researchers draw a distinction between the ways that we understand *how* others do things and *why* they do things. Understanding how someone does something involves grasping the mechanisms of an action, whereas understanding why someone does something involves reasoning about their mental states, i.e. mentalizing (Spunt et al., 2010). In the case of social rejection, understanding *how* someone is passing a ball back and forth to another person is experientially distinct from understanding *why* they are passing the ball to the other person. While *how-thinking* doesn't seem to play a role in our own feelings about the game or the other players, *why-thinking* can lead us to wonder why we are not receiving the ball from others. Such thoughts can lead to hurt feelings, self-doubt, offense, embarrassment, and a host of other negative emotions.

While mentalizing can sometimes lead to negative emotional experiences, it allows us to understand the intentions, goals, and emotions of those around us, which informs how we behave and communicate with others, and facilitates our ability to collaborate with others towards achieving joint goals (Saxe, 2006). Given the clear distinction between *how-thinking* and *why-thinking*, and the importance of reasoning

about mental states in our everyday experience, extensive research has documented the neural bases of this social cognitive process. The 'mentalizing network,' as it has come to be called, is typically thought to include regions such as the temporoparietal junction (TPJ), dorsomedial prefrontal cortex (dmPFC), precuneus, posterior superior temporal sulcus (pSTS) and the temporal poles (Frith & Frith, 2006; Gallagher & Frith, 2003; Lieberman, 2010), with some evidence suggesting that ventromedial prefrontal cortex (vmPFC) contributes to related social cognitive processes (Lieberman et al., 2019). Each of these neural regions is thought to assist with processing different sorts of information that collectively facilitate understanding the mental states of others. While the contributing role of each region is still not clearly understood, mentalizing is thought to consist of various sub-processes such as interpreting human motion in terms of goals or intentions, representing mental states, and shared-understanding of others' emotional states (Saxe, 2006).

Meta-analyses of Social Rejection

While no research has directly examined the link between the mentalizing network and the experience of social rejection, there have been several meta-analyses on the neural bases of social rejection that can indicate whether the mentalizing network tends to be active during the experience of social rejection. For example, Cacioppo et al. (2013) conducted a meta-analysis of neuroimaging studies, including 12 Cyberball studies using 244 participants, and 3 studies that involved thinking about a recent unwanted break-up from a romantic partner using 60 participants. During the latter romantic rejection studies, participants were exposed to photographs of their ex-partners and were asked to relive the memory of the unwanted break-up (e.g. (Fisher et al., 2010;

Kross et al., 2011). This meta-analysis found that during Cyberball, but not during the break-up task, there was significant activity in dmPFC, a neural region that has consistently been shown to play a role in mentalizing (Saxe, 2006; Lieberman et al., 2019). Notably, the analysis of Cyberball studies included a much larger sample (N=244) than that of the romantic rejection studies (N=60), so it is possible that the meta-analysis of romantic rejection studies was relatively underpowered to detect significant activity within neural regions such as dmPFC. Furthermore, participants in the romantic rejection studies may already have reflected on and come to understand their past rejection before taking part in the break-up task, whereas those playing Cyberball may have been trying to understand why they were being rejected during the task itself, thus recruiting greater mentalizing resources.

A more recent meta-analysis conducted by Vijaykumar et al. (2017) extended Cacioppo et al.'s work to examine 40 studies, including 1122 participants who underwent different types of social exclusion tasks, including the Social Judgment and Chatroom tasks. In both of these tasks, participants evaluate unfamiliar peers based on their photographs, and then receive feedback about how they were evaluated by those peers. This meta-analysis also specifically examined 857 participants from Cyberball tasks to compare the patterns of activation from this task to other social exclusion tasks more generally. They found that across all social exclusion studies, there was significant neural activation in regions such as the precuneus, dmPFC, and vmPFC. Meanwhile, Cyberball specifically tended to elicit activation in precuneus and vmPFC. Although not definitive, as the role of mentalizing in social rejection was not specifically examined in these

studies, these results are consistent with a role of the mentalizing network in the experience of social rejection across a variety of exclusion tasks.

Based on the findings reviewed above, the mentalizing network seems to play a role in the experience of social rejection. In the subsequent two sections, we will expand our investigation to consider whether individual differences in the mentalizing network are associated with variations in sensitivity to social rejection. First, we will consider whether developmental changes in mentalizing are associated with changes in sensitivity to social rejection. If children first become sensitive to social rejection (i.e. self-conscious) when they develop the ability to mentalize, this association would suggest a link between mentalizing and feeling the pain of social rejection. Furthermore, if adolescents who demonstrate particularly high sensitivity to social rejection also demonstrate enhanced mentalizing, this association would also suggest a potential role of mentalizing in the experience of social rejection. Then, we will review research examining whether impairments in the ability to mentalize, such as those observed in schizophrenia and autism, are associated with differences in sensitivity to social rejection. Finally, we will summarize some future directions relating to the role of the mentalizing network in feelings of social rejection.

Are Developmental Changes in Mentalizing Associated with Changes in Sensitivity to Rejection?

The way that we think about ourselves in relation to other people undergoes significant changes from early childhood through adolescence and adulthood, resulting in changes in emotional responsivity to social events across development. Two notable developmental changes in emotional responsivity linked to a growing concern for one's

social relationships are (a) the emergence of self-conscious emotions and sensitivity to social rejection in early childhood (i.e. around three to eight years old) (Rochat, 2003), and (b) heightened negative emotional responsivity to social rejection during adolescence (i.e. the time between puberty and adulthood) (Somerville, 2013). Interestingly, both of these developmental milestones are marked by significant changes in the mentalizing network. In what follows, we will describe the potential link between mentalizing and sensitivity to social rejection in terms of these two developmental time periods.

The emergence of mentalizing in early childhood

Around the age of four to six, children become increasingly adept at understanding the thoughts and feelings of other people, even when they conflict with something they know about the external world (i.e. false beliefs) (Frith & Frith, 2003). To illustrate, if an object is placed in one location in front of a third party, but moved to a second location without that person's knowledge, we would infer that the person believes that the object is in the original location since they did not witness the object being moved. However, children before the age of four typically fail to recognize the person's false belief that the object is in the original location, instead reporting that the person must know that the object has been moved. When children develop the ability to perform this complex mentalizing task, it demonstrates their ability to infer that other people have their own thoughts and feelings that are separate from one's own thoughts and feelings (Rochat, 2003).

In an effort to better understand the development of such mentalizing abilities in early childhood, some research has examined the neural correlates of performing false belief tasks in this age group. This research finds that children who can perform these

tasks exhibit increased neural responsivity in regions associated with mentalizing, including dmPFC and TPJ, as compared to children who have not yet developed this ability (Liu et al., 2009; Sabbagh et al., 2009). These findings suggest that the maturation of the mentalizing network plays a role in the emergence of complex mentalizing abilities during this time period.

Interestingly, the emergence of mentalizing abilities in early childhood overlaps with the emergence of self-consciousness. Self-consciousness includes the experience of social emotions such as embarrassment and shame, and is attributed to children's growing awareness that other people hold some perception of them. In other words, as children begin to think about how others think and feel about them, they also begin to experience negative feelings about being perceived undesirably (Frith & Frith, 2003; Rochat, 2003). The development of these self-conscious thoughts and feelings has been explained in terms of an evolutionary need to affiliate with others and the resultant fear of social rejection that supports our ability to maintain social bonds (Rochat, 2009). More specifically, once children learn to understand the thoughts and feelings of others, they also recognize the potential for negative social evaluation that could lead to social rejection, resulting in negative social emotions that tend to modulate social behavior, such as embarrassment.

This developmental association between the ability to understand the thoughts and feelings of others and exhibiting a fear of social rejection through self-conscious behavior indicates a potential link between mentalizing and experiencing the pain of social rejection. Indeed, this research suggests that in the absence of complex mentalizing ability, children may not understand and process social rejection, and thus may not

experience the same levels of emotional distress as healthy adults when rejected.

However, further research is necessary to explicitly explore this association between mentalizing and social rejection in early childhood.

Hyper-mentalizing in adolescence

A defining feature of adolescence is the importance of peer and romantic relationships. The importance of these social relationships is thought to increase adolescents' social sensitivity such that social information becomes particularly salient (Somerville, 2013). Because of fluctuations in social relationships during this time, social rejection is common (Wang, Iannotti, & Nansel, 2009). Thus, adolescents are not only more likely to experience social rejection, but are also more likely to demonstrate heightened negativity in response to the experience of rejection.

Researchers have investigated adolescents' emotional responsiveness to social rejection in a number of ways, including Cyberball, Social Judgment, and Chatroom tasks (Silk et al., 2012; Somerville, Heatherton, & Kelley, 2006; Williams, Cheung, & Choi, 2000). Compared to adults, adolescents tend to report worse mood and anxiety following rejection (Sebastian et al., 2010), expect less favorable positive feedback from their peers (Moor et al., 2010), and show greater pupillary dilation in response to rejection (Silk et al., 2012). Given this sensitivity to social rejection, information about the thoughts and feelings of others, particularly as this information relates to the self and one's social relationships, would be especially important to adolescents. To this end, we might expect the mentalizing network to be more responsive to social information in adolescents than adults.

Indeed, research suggests that adolescents recruit mPFC to a greater extent than adults during Cyberball (Sebastian et al., 2011), and during tasks that involve considering the thoughts and intentions of others (Burnett et al., 2011). Researchers have also found greater functional connectivity in adolescents than in adults between regions of the mentalizing network, including pSTS and TPJ, and anterior rostral mPFC during tasks that involve thinking about social emotions (Burnett & Blakemore, 2009). Since the brain continues to mature throughout development, researchers have suggested that heightened sensitivity to rejection during this age range may be due to the continuing maturation of the mPFC during this time (Blakemore, 2008). Alternatively, adolescents may recruit mPFC to a greater extent because of the importance of social information at this age.

If the mentalizing network plays a role in understanding and processing social rejection, then greater sensitivity to social rejection may be associated with increased activity in the mentalizing network, potentially explaining why certain individuals are more sensitive to social rejection in the first place. The research described in this section suggests that heightened emotional sensitivity to rejection during adolescence could be related to heightened activity in the mentalizing network. Taken together with research suggesting that self-consciousness and the fear of social rejection first emerges when children develop complex mentalizing abilities, this developmental literature supports a potential role of the mentalizing network in processing and experiencing social rejection.

Thus far, we have reviewed whether neural regions associated with mentalizing are also active during the experience of social rejection, and whether developmental changes in sensitivity to rejection relate to neural activity in the mentalizing network. In the next section, we consider whether impairments in the ability to mentalize may be

associated with changes in sensitivity to social rejection. If the mentalizing network plays a role in understanding and processing social rejection, then impairments in the ability to mentalize may be associated with decreased sensitivity to social rejection.

Are Impairments in Mentalizing Associated with Reduced Sensitivity to Rejection?

Two clinical disorders that are characterized by significant impairments in the ability to infer emotional and mental states are schizophrenia (Brüne, 2005; Frith & Corcoran, 1996) and autism (American Psychiatric Association, 1994). In this section, we consider how deficits in mentalizing may be affecting the way that individuals with schizophrenia and autism process social rejection. If mentalizing is important for feeling socially rejected, then there could be evidence for decreased sensitivity to social rejection in these two populations. While neuroscience research explicitly testing this relationship in clinical populations is limited, the available research suggests that deficits in the mentalizing network may be contributing to abnormalities in how individuals with schizophrenia and autism respond to social rejection, as well as consequential difficulties in social interaction stemming from an inability to properly process social evaluative cues.

Social rejection in schizophrenia

Schizophrenia is often accompanied by symptoms such as delusions and hallucinations involving social content, and deficits in motivation and social skills, ultimately leading to difficulty in social interaction that impedes everyday functioning (MacDonald & Leary, 2005). These social challenges are often explained by mentalizing deficits in this population in so far as a failure to understand the thoughts and feelings of others can lead individuals with schizophrenia to perceive threat in the absence of

harmful intentions. Furthermore, failure to understand others' mental states generally makes it difficult for individuals with schizophrenia to regulate their social behavior and interactions in accordance with social feedback.

In an attempt to better understand such deficits, a growing body of research has investigated abnormalities in the structure and function of the mentalizing network in patients with schizophrenia (Benedetti et al., 2009; Mier et al., 2010; Park et al., 2011). However, few studies have investigated this network in patients explicitly during social rejection. One such study sheds some light on how abnormalities in the mentalizing network might shape the recognition and processing of social rejection. This study used a version of the Cyberball task in which exclusion was parametrically modulated (participants receive the ball some percentage of the time), as opposed to being dichotomous (participant either receives the ball proportional to other players in the game or does not receive the ball at all) (Gradin et al., 2012).

In response to social exclusion, the control group demonstrated increased activation in the vmPFC, a region sometimes implicated in mentalizing, and the ventral anterior cingulate cortex (vACC), a region that has been shown to activate to social exclusion and to be associated with social distress (Bolling, Pitskel, Deen, Crowley, McPartland, Mayes, et al., 2011; Gunther Moor et al., 2012). Meanwhile, patients with schizophrenia failed to modulate activity in these regions in accordance with percentage of exclusion, with greater positive symptom severity corresponding to lower modulation of activity. Within the schizophrenic group, but not the control group, stronger responses to social exclusion in the vmPFC were associated with greater self-reported social distress.

These findings suggest abnormal neural responsivity to social exclusion in the mentalizing network in schizophrenia. First, the schizophrenic group's failure to modulate activity within the vACC may point to a lack of sensitivity to social rejection. Moreover, although the schizophrenic group failed to modulate activity in the vmPFC overall, greater activity in the vmPFC was associated greater self-reported distress from social exclusion, suggesting that those with better mentalizing ability may have felt more social pain. Thus, individuals with schizophrenia exhibited abnormalities within the mentalizing network during social rejection, as well as diminished activation in regions of the brain associated with social distress during rejection. Impairments in the ability to accurately interpret the thoughts and feelings of others may hinder this population's ability to detect rejection when it is truly occurring, thereby inhibiting appropriate modulation of social distress in response to rejection cues, resulting in reduced sensitivity to true rejection.

A second fMRI study examining social rejection in a schizophrenic population used a virtual reality handshake task to induce feelings of social rejection in this population (Lee et al., 2014). In this task, participants' physical hand movements controlled an avatar on the screen such that when participants raised their hand, their avatar would offer a handshake to another avatar on the screen. Depending on the condition, the stranger avatar either exhibited friendly body language and accepted the handshake (i.e., acceptance), or unfriendly body language and refused the handshake (i.e., rejection).

The results of this study indicated abnormalities within the mentalizing network in the schizophrenic group during social rejection, providing some insight into the neural

mechanisms underlying the social deficits associated with this disorder. First, as compared to the control group, the schizophrenia group exhibited significantly lower activity during rejection versus acceptance in pSTS, a region within the mentalizing network associated with identifying the motivations behind bodily movements (Saxe, 2006), with greater symptom severity corresponding to less activity in pSTS. This finding suggests that individuals with schizophrenia may not be able to properly recruit the neural regions necessary to accurately interpret social cues that provide information about the goals and intentions of other people. Second, the schizophrenia group exhibited significantly greater activity during rejection versus acceptance in left vmPFC, suggesting that individuals with schizophrenia may be recruiting certain social cognitive processes to a greater extent than healthy individuals during social rejection. While these two results initially seem conflicting, together they indicate abnormal neural responsivity to social rejection in schizophrenia in regions associated with processing social information, suggesting a potential role of mentalizing deficits in how individuals with schizophrenia experience social rejection.

In terms of differences in self-reported feelings of rejection, this study found that the schizophrenia group reported greater feelings of rejection during acceptance than the control group, but exhibited no difference in such feelings during rejection. While this finding does not inform whether individuals with schizophrenia experienced differential levels of distress in response to rejection, it does help explain positive psychotic symptoms in schizophrenia such as delusions about persecution in the absence of real threat (Park et al., 2011).

In sum, the failure to appropriately modulate regions associated with mentalizing, as well as those associated with social distress, during social exclusion provides some explanation for positive psychotic symptoms in schizophrenia. In failing to accurately recognize and interpret social cues, individuals with schizophrenia may demonstrate blunted affect in cases of actual rejection, and demonstrate heightened affect in the absence of social threat. While no research has explicitly tested how impairments in mentalizing potentially impact sensitivity to social rejection in schizophrenia, the studies described in this section suggest that abnormalities in the mentalizing network may be associated with atypical responsivity to social rejection in schizophrenia.

Social rejection in autism

A core feature of autism is impairment in social interaction, which leads to difficulty in forming and maintaining social relationships (American Psychiatric Association, 1994; Baron-Cohen, 2010). When examined objectively, for example through social network analysis applied to children within classrooms, individuals with autism tend to face more instances of social rejection. For example, they tend to experience lower centrality, less acceptance, less companionship, and less reciprocity in the social networks they inhabit (Chamberlain et al., 2007).

Despite this difference in both quality and quantity of social relationships, some research suggests that children with autism do not tend to report greater feelings of loneliness or related sadness than their peers (Bauminger et al., 2008; Chamberlain et al., 2007). This finding has been interpreted in terms of the lack of awareness that individuals with autism may have about their experience of rejection. For example, Chamberlain et al. (2007) proposed that mentalizing deficits in autism might leave children unable to

recognize the shortcomings of their social relationships. In line with this hypothesis, parents of children with autism tend to report that their children seemed generally oblivious about social cues that would signal social inclusion or exclusion (Chamberlain et al., 2007).

One study that sheds some light on the experience of social rejection in autism examined loneliness and friendship in a population of high-functioning children with autism (Bauminger & Kasari, 2000). They found that while children with autism desired friendship like typical children, they experienced greater loneliness as captured by the loneliness rating scale (ex. "I have nobody to talk to in class"). Upon inspecting how children with autism and typical children defined loneliness, both groups defined loneliness in terms of being alone (i.e. having no one to play with), but children with autism were much less likely than typical children to define loneliness in terms of negative emotional feelings such as sadness, depression, or fear. These results suggest that children with autism recognized that they were left out of friendships or activities, but did not necessarily internalize this rejection in a way that affected their emotional states. In other words, while children with autism did not want to be alone and recognized when they were alone, they did not seem to experience the pain of rejection in the same way as typical children who described *feelings* of loneliness.

A later study designed to explicitly explore how adolescents with autism experience social rejection as compared to healthy adolescents found that while both groups experienced similar levels of distress and anxiety during Cyberball, only the healthy adolescents showed significantly lower self-reported mood after rejection as compared with baseline and inclusion conditions (Catherine Sebastian, Blakemore, &

Charman, 2009). In other words, there seemed to be a lasting effect of social rejection in healthy individuals, but no reduction in later mood in adolescents with autism. This finding suggests that while individuals with autism may recognize and respond to social rejection in the moment, they may not process and internalize rejection in the same way as typical individuals, resulting in a lower likelihood of *feelings* of loneliness over time.

While there is no neuroscience research explicitly testing whether mentalizing impairments in autism are associated with diminished sensitivity to rejection in this population, multiple neuroimaging studies have examined how social rejection is experienced in autism (Bolling et al., 2011; Masten et al., 2011; McPartland et al., 2011). Across these studies, there were no differences in immediate self-reported responses to rejection between the autism group and the control group. However, individuals with autism demonstrated lower neural responsivity to rejection as compared with the control groups, particularly in the vACC and right AI, regions often associated with experiencing social distress (Masten et al., 2011; McPartland et al., 2011). These results suggest, again, that individuals with autism recognize and dislike social rejection, but that they may not have the same negative feelings associated with being rejected as do typically developing individuals.

A recent meta-analysis of the functional neural correlates of social and non-social tasks in autism similarly demonstrates differential neural responsivity to social stimuli more broadly in this population. This meta-analysis examined 24 studies of social processes (e.g. theory of mind, face perception) and 15 studies of non-social processes (e.g., attention control, working memory) in adults with autism (Di Martino et al., 2009). This analysis revealed decreased likelihood of activation in anterior rostral mPFC, a

region implicated in self-referential processing (Lieberman et al., 2019), as well as regions associated with social distress, such as the dACC and right AI, during social tasks versus non-social tasks in individuals with autism as compared to typical individuals. Since this meta-analysis did not include studies particularly related to social rejection, further research is necessary to examine the role of the mentalizing network in sensitivity to social rejection in autism. However, research in this area is consistent with diminished sensitivity to social rejection in autism, both in terms of lasting feelings about rejection, and in terms of immediate neural responsivity to social rejection. Of course, it is not known whether a reduced ability to mentalize precipitates diminished rejection sensitivity or whether a heightened sensitivity to rejection leads to a compensatory reduction in mentalizing; this would need to be examined in future studies. In the next and final section, we will offer some conclusory remarks and potential future directions building on the possibility of an inherent link between mentalizing and the experience of social rejection.

Conclusion and Future Directions

While limited research has examined the connection between the mentalizing network and social rejection, we have summarized a body of evidence suggesting that the mentalizing network plays a potential role in how we understand and process social rejection. First, meta-analyses investigating the neural underpinnings of social rejection with a focus on pain-related regions such as the dACC and AI have found consistent activation of mentalizing regions, such as regions within the mPFC and precuneus, in the experience of social rejection across a variety of rejection paradigms. Second, developmental research suggests that self-consciousness and fear of social rejection

emerges in early childhood when children first develop the ability to perform complex mentalizing tasks, which is marked by increased activation in mentalizing regions. Additionally, adolescents who tend to exhibit heightened sensitivity to social rejection also tend to exhibit heightened activation within the mentalizing network in response to social rejection. Third, clinical populations that are characterized by deficits in the ability to mentalize, including schizophrenia and autism, tend to demonstrate decreased sensitivity to social rejection in the form of inappropriately modulated affect in schizophrenia, blunted affect following rejection in autism, and abnormal patterns of activity during rejection in neural regions associated with social distress, such as the vACC, in both schizophrenia and autism.

A breadth of research suggests a possible inherent link between mentalizing and the experience of social rejection. However, further research explicitly testing the association between this neural network and social-emotional experiences is necessary in order to explain whether mentalizing is required for understanding and processing social rejection, and to explain the mechanism by which mentalizing potentially affects emotional experience. In addition to building on the clinical and developmental research we have summarized in this chapter, there are several additional avenues for research that could illuminate the role of mentalizing in social rejection. For example, research examining functional connectivity between mentalizing regions during social tasks can investigate whether these regions are more connected during social rejection. One such study suggests that connectivity between regions within the mentalizing network, including dmPFC, vmPFC, precuneus, and TPJ, increases during social exclusion compared to social inclusion (Schmälzle et al., 2017). Further research is necessary to

examine the consistency of this result, but this preliminary finding provides a promising direction for future research in this area.

Another potentially fruitful area for future research involves examining how individuals' mentalizing activity during social rejection may change as a function of their vulnerability to social rejection. Individuals who are at greater risk of rejection, or have more to lose if they are socially rejected, might devote greater resources to mentalizing about others so that they can better predict and thus avoid possible experiences of rejection in the future. For example, individuals who are low in social status are more vulnerable to rejection, since lower social status can mean less access to resources, and therefore greater risk of being excluded, as well as greater cost of exclusion. Such individuals seem to recruit mentalizing resources to a greater extent than typical or high status individuals during social tasks (Muscatell et al., 2012). As a second example, individuals with less dense friendship networks, suggesting less relationship stability and social support provisions (Lin, 2002), have shown greater functional connectivity within the mentalizing network (greater coupling between left and right TPJ) during social exclusion (Schmälzle et al., 2017). Such preliminary findings suggest a potential link between vulnerability to social rejection and mentalizing that could be an interesting avenue for future research.

Ultimately, we have suggested that mentalizing may play a role in understanding and processing social rejection insofar as understanding how someone else thinks and feels about you may underpin the pain of feeling rejected. While on the one hand, understanding someone else's thoughts and feelings may allow you to interpret their behavior as lacking malice (e.g. They are just in a bad mood today.), it can also provide

you with insight into how others view you (e.g. They don't like me.) Wondering why someone doesn't like us may bring us to the undesirable conclusion that there is something about us that is disagreeable to others. However, understanding and processing this rejection seems to be part of learning to build and maintain social bonds – without which we would suffer significantly greater pains than the pain of a single rejection.

References

- Baron-Cohen, S. (2010). The Empathizing-Systematizing (E-S) Theory of Autism: A Cognitive Developmental Account. In *The Wiley-Blackwell Handbook of Childhood Cognitive Development, Second edition* (pp. 626–639). Oxford, UK: Wiley-Blackwell. <https://doi.org/10.1002/9781444325485.ch24>
- Bauminger, N., & Kasari, C. (2000). Loneliness and friendship in high-functioning children with autism. *Child Development, 71*(2), 447–456. <https://doi.org/10.1111/1467-8624.00156>
- Bauminger, N., Solomon, M., Aviezer, A., Heung, K., Gazit, L., Brown, J., & Rogers, S. J. (2008). Children with autism and their friends: A multidimensional study of friendship in high-functioning autism spectrum disorder. *Journal of Abnormal Child Psychology, 36*(2), 135–150. <https://doi.org/10.1007/s10802-007-9156-x>
- Benedetti, F., Bernasconi, A., Bosia, M., Cavallaro, R., Dallspezia, S., Falini, A., ... Smeraldi, E. (2009). Functional and structural brain correlates of theory of mind and empathy deficits in schizophrenia. *Schizophrenia Research, 114*(1), 154–160. Retrieved from <https://www.sciencedirect.com/science/article/pii/S0920996409002916>
- Blakemore, S. J. (2008). The social brain in action. *Nature Reviews Neuroscience, 9*(4), 267. Retrieved from <https://www.nature.com/articles/nrn2353>
- Bolling, D. Z., Pitskel, N. B., Deen, B., Crowley, M. J., McPartland, J. C., Kaiser, M. D., ... Pelphrey, K. A. (2011). Enhanced neural responses to rule violation in children with autism: A comparison to social exclusion. *Developmental Cognitive Neuroscience, 1*(3), 280–294. <https://doi.org/10.1016/j.dcn.2011.02.002>

- Bolling, D. Z., Pitskel, N. B., Deen, B., Crowley, M. J., McPartland, J. C., Mayes, L. C., & Pelphrey, K. A. (2011). Dissociable brain mechanisms for processing social exclusion and rule violation. *NeuroImage*, *54*(3), 2462–2471.
<https://doi.org/10.1016/j.neuroimage.2010.10.049>
- Brüne, M. (2005). “Theory of mind” in schizophrenia: A review of the literature. *Schizophrenia Bulletin*, *31*(1), 21–42. <https://doi.org/10.1093/schbul/sbi002>
- Burnett, S., & Blakemore, S. J. (2009). Functional connectivity during a social emotion task in adolescents and in adults. *European Journal of Neuroscience*, *29*(6), 1294–1301. <https://doi.org/10.1111/j.1460-9568.2009.06674.x>
- Burnett, S., Sebastian, C., Cohen Kadosh, K., & Blakemore, S. J. (2011). The social brain in adolescence: Evidence from functional magnetic resonance imaging and behavioural studies. *Neuroscience and Biobehavioral Reviews*.
<https://doi.org/10.1016/j.neubiorev.2010.10.011>
- Cacioppo, S., Frum, C., Asp, E., Weiss, R. M., Lewis, J. W., & Cacioppo, J. T. (2013). A quantitative meta-analysis of functional imaging studies of social rejection. *Scientific Reports*, *3*. <https://doi.org/10.1038/srep02027>
- Chamberlain, B., Kasari, C., & Rotheram-Fuller, E. (2007). Involvement or isolation? The social networks of children with autism in regular classrooms. *Journal of Autism and Developmental Disorders*, *37*(2), 230–242.
<https://doi.org/10.1007/s10803-006-0164-4>
- Dewall, C. N., Masten, C. L., Powell, C., Combs, D., Schurtz, D. R., & Eisenberger, N. I. (2012). Do neural responses to rejection depend on attachment style? An fMRI study. *Social Cognitive and Affective Neuroscience*, *7*(2), 184–192.

<https://doi.org/10.1093/scan/nsq107>

- Di Martino, A., Ross, K., Uddin, L. Q., Sklar, A. B., Castellanos, F. X., & Milham, M. P. (2009). Functional Brain Correlates of Social and Nonsocial Processes in Autism Spectrum Disorders: An Activation Likelihood Estimation Meta-Analysis. *Biological Psychiatry*, *65*(1), 63–74. <https://doi.org/10.1016/j.biopsych.2008.09.022>
- Eisenberger, N. I. (2012). The pain of social disconnection: Examining the shared neural underpinnings of physical and social pain. *Nature Reviews Neuroscience*, *13*(6), 421–434. <https://doi.org/10.1038/nrn3231>
- Eisenberger, N. I., & Lieberman, M. D. (2004). Why rejection hurts: a common neural alarm system for physical and social pain. *Trends in Cognitive Sciences*, *8*(7). <https://doi.org/10.1016/j.tics.2004.05.010>
- Eisenberger, N. I., & Lieberman, M. D. (2005). Why It Hurts to Be Left Out The Neurocognitive Overlap Between Physical and Social Pain. In *The social outcast: Ostracism, social exclusion, rejection, and bullying* (p. 130).
- Fisher, H. E., Brown, L. L., Aron, A., Strong, G., & Mashek, D. (2010). Reward, Addiction, and Emotion Regulation Systems Associated With Rejection in Love. *J Neurophysiol*, *104*, 51–60. <https://doi.org/10.1152/jn.00784.2009>
- Frith, C. D., & Corcoran, R. (1996). Exploring “theory of mind” in people with schizophrenia. *Psychological Medicine*, *26*(03), 521. <https://doi.org/10.1017/S0033291700035601>
- Frith, C. D., & Frith, U. (2006). Minireview The Neural Basis of Mentalizing. *Neuron*, *50*, 531–534. <https://doi.org/10.1016/j.neuron.2006.05.001>
- Frith, U., & Frith, C. D. (2003). Development and neurophysiology of mentalizing.

Philosophical Transactions of the Royal Society B: Biological Sciences.

<https://doi.org/10.1098/rstb.2002.1218>

Gallagher, H. L., & Frith, C. D. (2003). Network and Psychological Effects in URBAN MOVEMENT.pdf, 7(2), 77–83. [https://doi.org/10.1016/S1364-6613\(02\)00025-6](https://doi.org/10.1016/S1364-6613(02)00025-6)

Gradin, V. B., Waiter, G., Kumar, P., Stickle, C., & Milders, M. (2012). Abnormal Neural Responses to Social Exclusion in Schizophrenia. *PLoS ONE*, 7(8), 42608. <https://doi.org/10.1371/journal.pone.0042608>

Groschwitz, R. C., Plener, P. L., Groen, G., Bonenberger, M., & Abler, B. (2016). Differential neural processing of social exclusion in adolescents with non-suicidal self-injury: An fMRI study. *Psychiatry Research - Neuroimaging*, 255, 43–49. <https://doi.org/10.1016/j.psychresns.2016.08.001>

Gunther Moor, B., Güroğlu, B., Op de Macks, Z. A., Rombouts, S. A. R. B., Van der Molen, M. W., Crone, E. A., ... Grafton, S. (2012). Social exclusion and punishment of excluders: Neural correlates and developmental trajectories. *NeuroImage*, 59(1), 708–717. Retrieved from <https://www.sciencedirect.com/science/article/pii/S1053811911007890>

Kross, E., Berman, M. G., Mischel, W., Smith, E. E., & Wager, T. D. (2011). Social rejection shares somatosensory representations with physical pain. *Proceedings of the National Academy of Sciences*, 108(15), 6270–6275. <https://doi.org/10.1073/pnas.1102693108>

Lee, H., Ku, J., Kim, J., Jang, D.-P., Yoon, K. J., Kim, S. I., & Kim, J.-J. (2014). Aberrant neural responses to social rejection in patients with schizophrenia. *Social Neuroscience*, 9(4), 412–423. <https://doi.org/10.1080/17470919.2014.907202>

- Lieberman, M. D. (2010). Social cognitive neuroscience. In *Handbook of social psychology* (pp. 143–193).
- Lieberman, M. D., Straccia, M. A., Meyer, M. L., Du, M., & Tan, K. M. (2019). Social, Self, (Situational), and Affective Processes in Medial Prefrontal Cortex (MPFC): Causal, Multivariate, and Reverse Inference Evidence. *Neuroscience & Biobehavioral Reviews*. <https://doi.org/10.1016/J.NEUBIOREV.2018.12.021>
- Lin, N. (2002). *Social capital: A theory of social structure and action*. Retrieved from [https://books.google.com/books?hl=en&lr=&id=fvBzIu5-yuMC&oi=fnd&pg=PR11&dq=Lin+N+\(2002\)+Social+Capital:+A+Theory+of+Social+Structure+and+Action+\(Cambridge+Univ+Press,&ots=UW-Di_wHAX&sig=6AkGq8fNfELQ6d_I3h-laoCH30Q](https://books.google.com/books?hl=en&lr=&id=fvBzIu5-yuMC&oi=fnd&pg=PR11&dq=Lin+N+(2002)+Social+Capital:+A+Theory+of+Social+Structure+and+Action+(Cambridge+Univ+Press,&ots=UW-Di_wHAX&sig=6AkGq8fNfELQ6d_I3h-laoCH30Q)
- Liu, D., Sabbagh, M. A., Gehring, W. J., & Wellman, H. M. (2009). Neural correlates of children's theory of mind development. *Child Development*, *80*(2), 318–326. <https://doi.org/10.1111/j.1467-8624.2009.01262.x>
- MacDonald, G., & Leary, M. R. (2005). Why does social exclusion hurt? The relationship between social and physical pain. *Psychological Bulletin*. <https://doi.org/10.1037/0033-2909.131.2.202>
- Masten, C. L., Colich, N. L., Rudie, J. D., Bookheimer, S. Y., Eisenberger, N. I., & Dapretto, M. (2011). An fMRI investigation of responses to peer rejection in adolescents with autism spectrum disorders. *Developmental Cognitive Neuroscience*, *1*(3), 260–270. <https://doi.org/10.1016/J.DCN.2011.01.004>
- McPartland, J. C., Crowley, M. J., Perszyk, D. R., Naples, A. J., Mukerji, C. E., Wu, J., ... Mayes, L. C. (2011). Temporal dynamics reveal atypical brain response to social

exclusion in autism. *Developmental Cognitive Neuroscience*, 1(3), 271–279.

<https://doi.org/10.1016/j.dcn.2011.02.003>

Mier, D., Sauer, C., Lis, S., Esslinger, C., Wilhelm, J., Gallhofer, B., & Kirsch, P. (2010).

Neuronal correlates of affective theory of mind in schizophrenia out-patients:

Evidence for a baseline deficit. *Psychological Medicine*, 40(10), 1607–1617.

<https://doi.org/10.1017/S0033291709992133>

Moor, B. G., van Leijenhorst, L., Rombouts, S. A. R. B., Crone, E. A., & van der Molen,

M. W. (2010). Do you like me? Neural correlates of social evaluation and

developmental trajectories. *Social Neuroscience*, 5(5), 461–482.

<https://doi.org/10.1080/17470910903526155>

Muscatell, K. A., Morelli, S. A., Falk, E. B., Way, B. M., Pfeifer, J. H., Galinsky, A. D.,

... Eisenberger, N. I. (2012). Social status modulates neural activity in the

mentalizing network. *NeuroImage*, 60(3), 1771–1777.

<https://doi.org/10.1016/j.neuroimage.2012.01.080>

Onoda, K., Okamoto, Y., Nakashima, K., Nittono, H., Ura, M., & Yamawaki, S. (2009).

Decreased ventral anterior cingulate cortex activity is associated with reduced social pain during emotional support. *Social Neuroscience*, 4(5), 443–454.

<https://doi.org/10.1080/17470910902955884>

Panksepp, J. (2004). *Affective neuroscience: The foundations of human and animal*

emotions. Oxford university press.

Park, I. H., Ku, J., Lee, H., Kim, S. Y., Kim, S. I., Yoon, K. J., & Kim, J. J. (2011).

Disrupted theory of mind network processing in response to idea of reference evocation in schizophrenia. *Acta Psychiatrica Scandinavica*, 123(1), 43–54.

<https://doi.org/10.1111/j.1600-0447.2010.01597.x>

Rochat, P. (2003). Five levels of self-awareness as they unfold early in life. In

Consciousness and Cognition (Vol. 12, pp. 717–731).

[https://doi.org/10.1016/S1053-8100\(03\)00081-3](https://doi.org/10.1016/S1053-8100(03)00081-3)

Sabbagh, M. A., Bowman, L. C., Evraire, L. E., & Ito, J. M. B. (2009).

Neurodevelopmental Correlates of Theory of Mind in Preschool Children. *Child*

Development, 80(4), 1147–1162. <https://doi.org/10.1111/j.1467-8624.2009.01322.x>

Saxe, R. (2006). Uniquely human social cognition. *Current Opinion in Neurobiology*,

16(2), 235–239. <https://doi.org/10.1016/j.conb.2006.03.001>

Schmälzle, R., Brook O'Donnell, M., Garcia, J. O., Cascio, C. N., Bayer, J., Bassett, D.

S., ... Falk, E. B. (2017). Brain connectivity dynamics during social interaction

reflect social network structure. *Proceedings of the National Academy of Sciences*,

114(20), 5153–5158. <https://doi.org/10.1073/pnas.1616130114>

Sebastian, C., Blakemore, S. J., & Charman, T. (2009). Reactions to ostracism in

adolescents with autism spectrum conditions. *Journal of Autism and Developmental*

Disorders, 39(8), 1122–1130. <https://doi.org/10.1007/s10803-009-0725-4>

Sebastian, C. L., Tan, G. C. Y., Roiser, J. P., Viding, E., Dumontheil, I., & Blakemore,

S.-J. (2011). Developmental influences on the neural bases of responses to social

rejection: Implications of social neuroscience for education. *NeuroImage*, 57(3),

686–694. Retrieved from

<https://www.sciencedirect.com/science/article/pii/S1053811910012656>

Sebastian, C., Viding, E., Williams, K. D., & Blakemore, S. J. (2010). Social brain

development and the affective consequences of ostracism in adolescence. *Brain and*

Cognition, 72(1), 134–145. Retrieved from

<https://www.sciencedirect.com/science/article/pii/S0278262609001055>

- Silk, J. S., Stroud, L. R., Siegle, G. J., Dahl, R. E., Lee, K. H., & Nelson, E. E. (2012). Peer acceptance and rejection through the eyes of youth: pupillary, eyetracking and ecological data from the Chatroom Interact task. *Social Cognitive and Affective Neuroscience*. Retrieved from <https://academic.oup.com/scan/article-abstract/7/1/93/1638951>
- Somerville, L. H. (2013). The Teenage Brain: Sensitivity to Social Evaluation. *Current Directions in Psychological Science*. <https://doi.org/10.1177/0963721413476512>
- Somerville, L. H., Heatherton, T. F., & Kelley, W. M. (2006). Anterior cingulate cortex responds differentially to expectancy violation and social rejection. *Nature Neuroscience*, 9, 1007+. Retrieved from <https://www.nature.com/articles/nn1728>
- Spunt, R. P., Falk, E. B., & Lieberman, M. D. (2010). Dissociable Neural Systems Support Retrieval of How and Why Action Knowledge. *Psychological Science*, 21(11), 1593–1598. <https://doi.org/10.1177/0956797610386618>
- Vijayakumar, N., Cheng, T. W., & Pfeifer, J. H. (2017). Neural correlates of social exclusion across ages: A coordinate-based meta-analysis of functional MRI studies. *NeuroImage*, 153, 359–368. <https://doi.org/10.1016/j.neuroimage.2017.02.050>
- Wang, J., Iannotti, R. J., & Nansel, T. R. (2009). School Bullying Among Adolescents in the United States: Physical, Verbal, Relational, and Cyber. *Journal of Adolescent Health*, 45(4), 368–375. <https://doi.org/10.1016/j.jadohealth.2009.03.021>
- Wegner, D. M., & Gray, K. (2008). The sting of intentional pain. *Psychological Science*, 19, 1260–1262. <https://doi.org/10.1088/0960-1317/20/10/104002>

Williams, K. D., Cheung, C. K., & Choi, W. (2000). Cyberostracism: effects of being ignored over the Internet. *Journal of Personality and Social Psychology, 79*(5), 748–762. Retrieved from <http://psycnet.apa.org/journals/psp/79/5/748.html?uid=2000-00920-006>

Zadro, L., Williams, K. D., & Richardson, R. (2004). How low can you go? Ostracism by a computer is sufficient to lower self-reported levels of belonging, control, self-esteem, and meaningful existence. *Journal of Experimental Social Psychology, 40*, 560–567. <https://doi.org/10.1016/j.jesp.2003.11.006>