Adolescents are acutely sensitive to peer rejection. Many people can vividly recall, even as adults, instances during their teenage years in which they were excluded by a particular clique or left 'out of the loop' about parties or social plans. Rejection is undoubtedly part of the social landscape in adolescence, but why do young people find it quite so distressing? One possibility is that ongoing brain development in regions involved in emotional processing, emotion regulation, and social cognition may contribute to this phenomenon. This development could have far-reaching implications, not just for how adolescents respond to rejection, but for mental health during this crucial and formative stage of development.

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**Don’t leave me out!**

Catherine Sebastian, joint winner of the Society’s Award for Outstanding Doctoral Research Contributions to Psychology, on rejection and the adolescent brain

The idea that the brain continues to develop during adolescence has now entered popular consciousness. For example, the excellent Blame My Brain by Nicola Morgan (2005) describes for teenagers and their parents alike how changes going on in the brain may at least partially underlie stereotypically 'teenage' behaviours, such as risk-taking in the presence of peers, mood swings, sleeping late, and thrill-seeking. In the equally fascinating Teenagers: A Natural History, David Bainbridge (2010) suggests that this protracted period of brain development and plasticity is what allows the human brain to achieve adult levels of abstract thinking and social complexity. This positive spin on adolescence is a welcome antidote to the often negative portrayal of young people in the media, for example during coverage of the recent riots in England.

Thinking about adolescence seems to involve striking a balance: recognising that there are certain features of adolescent biology and cognition that need to be understood, without falling into the trap of stigmatising or patronising young people. In my PhD, I was interested in the link between ongoing brain development and social and emotional behaviour; in particular, how do young people respond to social rejection, and might ongoing brain development contribute to this response? And conversely, what do differences in behaviour and cognition tell us about how the brain develops?

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The **teenage brain**

The last decade or so has seen an upsurge in the study and understanding of adolescence. The availability of safe and non-invasive neuroimaging techniques means we now have access to a wealth of data showing that the brain continues to develop well into the second decade of life, and likely into the mid-twenties as well. Particularly influential has been data suggesting that different brain regions mature at different rates and with differing trajectories. For example, Shaw et al. (2008) showed that evolutionarily older parts of the brain, such as the limbic system, mature in a simpler linear trajectory than regions that evolved more recently, such as the neocortex. There is additional evidence that the dopaminergic system, involved in the processing of reward signals, undergoes substantial remodelling during adolescence (Steinberg, 2008).

These data have led to the development of a number of models of how ongoing brain development may help paint the picture of a ‘typical’ teenager. Several models have been proposed (Nelson et al., 2005; Steinberg, 2008; Casey et al., 2008), with all having in common the idea of a ‘developmental mismatch’ between parts of the brain involved in processing emotional and reward signals (including brain regions such as the amygdala and ventral striatum), and those responsible for regulating these responses (e.g. parts of the prefrontal cortex). During adolescence, the development of the latter lags behind the former, leaving the adolescent brain in a similar state to a ‘fast car with poor brakes’.

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**Is there more to it than that?**

Of course, adolescents don’t develop in a vacuum, and the social environment is vitally important in shaping the adolescent brain (Blakemore, 2008). Adolescence is a time of social transition: early adolescents spend more time with

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**How do you respond to social rejection?**

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**References**


Steinberg, L. (2008). Why do young people respond to rejection, and might ongoing brain development contribute to this response? And conversely, what do differences in behaviour and cognition tell us about how the brain develops?
parents than peers, but by mid-late adolescence, this pattern is reversed (Steinberg & Silverberg, 1986). Adolescents’ ability to think abstractly about themselves and other people means they have a much more sophisticated understanding of complex social phenomena such as reputation, social hierarchy, personality traits and how others see them (the ‘looking glass self’) than do younger children (Harter, 1990; Parker et al., 2006; Sebastian et al., 2008).

Indeed, while until recently it was assumed that theory of mind (understanding others’ thoughts, beliefs and intentions) develops by around age four, evidence now suggests that some aspects of theory of mind continue to develop until late adolescence. For example, Dumontheil et al. (2009) found that the ability to automatically use what we know about another person’s point of view during social interaction is still improving between late adolescence (14–17 years) and adulthood. The idea that social cognitive abilities undergo substantial development in adolescence is also supported by neuroimaging studies. In a recent review, Blakemore (2008) noted that across four recent functional magnetic resonance imaging (fMRI) studies using a range of social cognition tasks, all showed a reduction in brain activity between adolescence and adulthood in a region of the brain called medial prefrontal cortex. While the meaning of this reduction in functional terms is unclear (e.g., Does it relate to ongoing anatomical development? Could it index increasing efficiency of processing between adolescence and adulthood?), it does seem that important social cognitive development is ongoing in adolescence.

One of the things I aimed to do in my PhD was to reconcile models of adolescent emotional and social development into a single framework. For example, in Sebastian, Viding et al. (2010), I discussed how ‘developmental mismatch’ between emotion processing and regulation mechanisms could interact with ongoing social cognitive development to account for social behaviours specific to adolescence; in particular, sensitivity to social rejection.

### Adolescent social rejection

Social rejection, or ostracism, refers to being deliberately ignored or excluded by an individual or a group (Williams, 2007). In adolescence, social rejection is often used as a form of relational aggression or bullying, with one recent study (Wang et al., 2009), reporting that 27.4 per cent of adolescent girls had been excluded or ignored by a group of peers while at school. (Although boys do use relational aggression, there is evidence that girls are both more likely to use it as a bullying tactic and to be more upset by its consequences (Crick et al., 2002, Wang et al., 2009)). Several self-report studies had also shown that adolescents might be more sensitive to social rejection than both adults and younger children in everyday life (Kloep, 1999; O’Brien & Bierman, 1988). However, when I started my PhD, the processes underlying these effects were unclear.

In Sebastian, Viding et al. (2010), I investigated whether adolescent sensitivity to social rejection could be replicated under laboratory conditions. If so, this would suggest that the phenomenon could not be explained as an artefact of the adolescent social environment (e.g. strict social hierarchies at school, or the transition to secondary school). I used the Cyberball paradigm (Williams et al., 2000), in which participants think they are playing a game of ‘catch’ over the internet with two participants. However, in reality, one of the participants is playing alone and never responding to the participant’s throws. This results in the participant being excluded over the trial.

Several studies showed that participants in the exclusion condition were upset by its consequences, and more likely to use relational aggression, than both adults and younger children in everyday life (Crick et al., 2002; Wang et al., 2009). However, when I started my PhD, the processes underlying these effects were unclear. In Sebastian, Viding et al. (2010), I investigated whether adolescent sensitivity to social rejection could be replicated under laboratory conditions. If so, this would suggest that the phenomenon could not be explained as an artefact of the adolescent social environment (e.g. strict social hierarchies at school, or the transition to secondary school). I used the Cyberball paradigm (Williams et al., 2000), in which participants think they are playing a game of ‘catch’ over the internet with two participants. However, in reality, one of the participants is playing alone and never responding to the participant’s throws. This results in the participant being excluded over the trial.
adolescent social rejection

other players, whereas in fact the actions of the other players can be pre-programmed to either include or exclude the participant.

Relative to adult females, both young (11–13 years) and mid (14–15 years) adolescents reported lower overall mood following the rejection condition, with the young adolescents also reporting greater anxiety. The mid-adolescents did report high anxiety following rejection, but anxiety was also high following inclusion (relative to a baseline condition before they had played either game). This led to the intriguing possibility that social interaction in general can be anxiety-provoking at this age. Indeed evidence suggests that the mean age of onset for social phobia occurs in mid-adolescence at age 13 (Mancini et al., 2005). In contrast, all groups (young adolescents, mid-adolescents and adults) reported that they had been excluded by the other players to a similar degree, and reported the experience as feeling equally real. This suggests increased emotional responsivity to rejection in the adolescents, in the absence of objective differences in the perception of the rejection episode.

The rejected brain

Given that sensitivity to rejection in adolescence could be elicited in a brief online encounter when there were no lasting consequences for social reputation, I investigated whether this phenomenon might be associated with differences in how the brain processes social rejection between adolescence and adulthood. Work by Naomi Eisenberger and colleagues (2003) suggested that the adult brain processes social pain in a similar way to physical pain, and that a brain region called right ventrolateral prefrontal cortex may be involved in regulating or controlling distress associated with social rejection. This was followed up by the same laboratory with an fMRI study using Cyberball with 23 adolescents aged 12–13 (Masten et al., 2009). This study suggested some intriguing differences in the adolescent neural response to rejection, compared with previous studies in adults. However, this study did not compare adults and adolescents directly.

In Sebastian et al. (2011), we used a modified version of the Cyberball paradigm in an fMRI study directly comparing 19 adolescents (aged 14–16), and 16 adults. Regardless of age, all participants activated a network of regions involved in social evaluation and negative emotion. Of most interest was a group difference in right ventrolateral prefrontal cortex, with the adult group showing a greater response in this region during rejection than during inclusion, but the adolescent group showing no difference between conditions.

In the same fMRI session, we also gave participants a rejection emotional Stroop task, in which they used the ink colour of rejection-, acceptance- and neutral-themed words. By using this task, we aimed to look at the way the brain processes rejection-related information implicitly, as opposed to the very overt and explicit social rejection scenario in the Cyberball game. Despite these important differences between the tasks, we again found a reduced response in ventrolateral prefrontal cortex in adolescents relative to adults during the processing of rejection-related words compared with neutral and acceptance words (Sebastian, Roiser et al., 2010).

It seems that across both tasks, the regulatory response of the ventrolateral prefrontal cortex was attenuated in adolescents relative to adults. While speculative, it may be that poor regulation of distress associated with social rejection contributes to adolescent sensitivity to this phenomenon.

However, it is still unclear why this brain region should be responding suboptimally in adolescence. Is it due to ongoing anatomical maturation of the prefrontal cortex? What about connections between ventrolateral prefrontal cortex and other brain regions involved in generating feelings of rejection-related distress? Can differences between groups be explained by adults having more experience over time in dealing with rejection effectively? While there are unanswered questions, our research suggests that there should be a greater focus on training adolescents to regulate their emotions effectively, particularly within the social context.

Social rejection and the autism spectrum

While most people are likely to experience social rejection at some point during adolescence, it can be an unfortunately common occurrence for individuals whose social skills may not keep pace with those of their peers; for example, adolescents with high-

For some, social rejection is prolonged
adolescent social rejection

functioning autism or Asperger's syndrome. There is evidence that adolescents with autism spectrum conditions (ASC) perceive themselves to hold lower peer approval than their typically developing peers, while placing the same emphasis on its importance (Williamson et al., 2008). At the same time, individuals with ASC often report a desire for friendship (Frith, 2004), while experiencing greater levels of loneliness (Bauminger & Kasari, 2000) and bullying (Van Roekel et al., 2010) than their peers. Given this picture, it is surprising that very little research has addressed the question of how individuals with ASC experience and process social rejection.

Using the Cyberball paradigm, we found that adolescent males with ASC and matched controls (mean age 16.9) reported very similar reactions to social rejection (Sebastian et al., 2009). According to Williams' (1997) need-threat model, social rejection threatens four fundamental social needs: self-esteem, belonging, control, and a sense of meaningful existence. These needs are threatened reflexively, and are not necessarily modulated by context; for example, Zadro et al. (2004) showed that these needs are threatened even when we know that the Cyberball game is controlled by a computer. Adolescents with ASC reported similar or greater levels of need-threat across all four needs compared with controls; and also showed similar modulation of anxiety levels between inclusion and rejection conditions. The only difference between groups was seen for self-reported mood, for which controls showed a greater reduction in mood following exclusion than did individuals with ASC.

While this study explored responses to social rejection behaviourally, three recent follow-up studies have used neuroimaging techniques to investigate responses to social rejection in adolescents with ASC (Bolling et al., 2011; Masten, Colich et al., 2011; McPartland et al., 2011). All found a similar picture of preserved self-reported responses to rejection, but reduced responses in brain regions activated by social rejection, relative to control groups. This is interesting, as it suggests that the picture is more complex than a case of responses to rejection being either 'preserved' or 'deficient' in ASC. It is clear, however, that adolescents with ASC find social rejection distressing. Since data suggest that this group are more likely to experience social rejection than are their peers, it makes sense to focus on bullying prevention in this group, as well as on helping these individuals to develop effective coping strategies for dealing with social rejection in everyday life.

Conclusions

Social rejection is painful at any age, but it seems that adolescents may be particularly sensitive to the emotional consequences of social rejection, possibly due to a mismatch in the timing of development of regions involved in emotion processing versus emotion regulation. While for most adolescents, social rejection will have no more than a transitory impact, some will experience more prolonged relational bullying (including rejection), which can feed into feelings of low self-esteem, depression and even, in extreme cases, to suicide. But even responses to a single rejection episode can be informative. One recent fMRI study showed that the way in which the adolescent brain responds to rejection can be used to predict depressive symptoms one year later (Masten, Eisenberger et al., 2011). Future research should focus on the processes by which responses to negative social experiences in adolescence feed into adverse mental health outcomes. With adolescence being a key time for the onset of both internalising and externalising conditions (Kessler et al., 2005; Pau et al., 2008), efforts focused on understanding and prevention at this early stage are likely to be particularly effective.

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