Narcissists' social pain seen only in the brain

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Narcissism is a complex phenomenon, involving a level of defensive self-enhancement. Narcissists have avoidant attachment styles, maintain distance in relationships and claim not to need others. However, they are especially sensitive to others' evaluations, needing positive reflected appraisals to maintain their inflated self-views, and showing extreme responses (e.g. aggression) when rejected. The current study tested the hypothesis that narcissists also show hypersensitivity in brain systems associated with distress during exclusion. We measured individual differences in narcissism (Narcissistic Personality Inventory) and monitored neural responses to social exclusion (Cyberball). Narcissism was significantly associated with activity in an a priori anatomically defined social pain network (anterior insula, dorsal anterior cingulate cortex and subgenual anterior cingulate cortex) during social exclusion. Results suggest hypersensitivity to exclusion in narcissists may be a function of hypersensitivity in brain systems associated with distress, and suggests a potential pathway that connects narcissism to negative consequences for longer-term physical and mental health—findings not apparent with self-report alone.

INTRODUCTION

If no one turned around when we entered, answered when we spoke, or minded what we did, but if every person we met 'cut us dead,' and acted as if we were non-existing things, a kind of rage and impotent despair would ere long well up in us, from which the cruelest bodily torture would be a relief; for these would make us feel that, however bad might be our plight, we had not sunk to such a depth as to be unworthy of attention at all.

—William James, 1890, 293–4

Humans are fundamentally social beings, preferring to spend time with others for the majority of our waking hours (Kahneman *et al.*, 2004). When we are not physically present with other people, they are present in our thoughts, dreams, fantasies, books, and televisions. Indeed, social connection has been found to be a robust predictor of psychological and physical health, including longevity (House *et al.*, 1988; Holt-Lunstad *et al.* 2010; Konrath and Brown, 2012), and people who feel isolated or lonely are more likely to experience a variety of health problems (Cacioppo and Patrick, 2008). Interpersonal connections are so important that some scholars have argued that they fundamentally define the human experience (Baumeister and Leary, 1995; Cacioppo and Patrick, 2008).

Considering the primacy of social bonds to healthy functioning, it is important to understand what happens when those bonds are threatened by social exclusion. Exclusion experiences are painful to most people, and this is likely because at their core, they threaten our very sense of survival (Nezlek *et al.*, 1997; Panksepp, 1998; Eisenberger and

Lieberman, 2005; Macdonald and Leary, 2005). Without the protection offered by group members, the chances of survival in an evolutionary environment would dramatically diminish.

Thus, it is not surprising that rejection and social ostracism are associated with a number of negative immediate, shorter-term, and longer-term outcomes. In the immediate aftermath of ostracism, excluded people experience strong negative feelings such as anxiety or anger, high physiological arousal, and a sense of threat to their feelings of meaning and fulfillment (Leary, 1990; Shore *et al.*, 1998; Snapp and Leary, 2001; Williams and Zadro, 2001; Zadro *et al.*, 2004). Although internalizing responses to exclusion experiences are common (Parkhurst and Asher, 1992; Ladd, 2006), some individuals instead interpersonally externalize these experiences in the form of lower prosocial behaviour (Baumeister *et al.*, 2002) and increased aggression (Twenge *et al.*, 2001; Leary *et al.*, 2003).

Individual differences in social exclusion

Negative responses to exclusion are nearly universally experienced (Williams and Sommer, 1997; Williams and Zadro, 2001; Zadro *et al.*, 2004), even among infants (Tronick *et al.*, 1978; Mesman *et al.*, 2009). However, this does not rule out the possibility that some people are more susceptible to its negative effects. Some individual differences can have protective effects on social exclusion experiences such that even though these experiences remain unpleasant and painful, their longer-term negative consequences are attenuated. For example, individuals with more secure attachment styles and higher self-esteem are buffered from certain negative effects of social exclusion (Nezlek *et al.*, 1997; Waldrip, 2007; DeWall *et al.*, 2012). Several studies have also found that people who are highly self-conscious, those who have higher needs to belong and those with higher social anxiety have more detrimental reactions to social exclusion experiences (Fenigstein, 1979; Zadro *et al.*, 2006; Waldrip, 2007).

Social exclusion in the brain

Previous research examining neural responses to social exclusion has found increased activation of the dorsal anterior cingulate cortex (dACC) and anterior insula (AI) during periods of exclusion *vs* inclusion in adults (Eisenberger *et al.*, 2003; Eisenberger and Lieberman, 2004; Eisenberger, 2012a), and activation in the subgenual anterior cingulate cortex (subACC) during social exclusion experiences in

adolescents and young adults (Masten *et al.*, 2009; Onoda *et al.*, 2009). In addition, both empirical work and reviews have concluded that increased activation in the dACC correlates with self-reported increased feelings of social distress in response to exclusion (Eisenberger *et al.*, 2003; Eisenberger and Lieberman, 2004; Eisenberger, 2012a). Furthermore, in clinical studies the subACC has been implicated in depression and mood disorders (Greicius *et al.*, 2007). Finally, the AI and dACC are activated during exposure to both physical and social pain, and may constitute an affective alarm system of pain and distress (Eisenberger, 2012a).

Individual and group differences have also been shown to alter exclusion sensitivity at the neural level. For example, differences in neural responses to social exclusion depend on individuals' attachment style (DeWall *et al.*, 2012). Attachment style is a marker of how individuals approach social relationships, and is one way that individuals satisfy their need to belong (Bowlby, 1977). Individuals with anxious attachment styles show increases in the dACC and AI during exclusion *vs* inclusion experiences, whereas those with avoidant attachment styles display significantly less activity in the dACC and AI (DeWall *et al.*, 2012). As such, avoidant attachment styles may buffer individuals from negative social experiences by reducing their responsiveness to negative social cues (DeWall *et al.*, 2012).

Self-esteem is also related to neural responses to social exclusion (Onoda *et al.*, 2010). Those with higher trait self-esteem display less activation of the dACC (Onoda *et al.*, 2010). These results converge with research finding that high trait self-esteem may serve as a buffer from negative social experiences (Nezlek *et al.*, 1997). Finally, spending more time with friends during adolescence has also been found to decrease neural sensitivity to peer exclusion (Masten *et al.*, 2012).

Narcissism and social exclusion

Taken together, there are a number of factors that are associated with buffered (e.g. secure attachment, avoidant attachment, self-esteem, positive social relationships) *vs* exaggerated (e.g. self-consciousness, need to belong, social anxiety, anxious attachment, adolescent age group) negative responses to social rejection, and many of these are also evident at the neural level. In the current study, we examine whether increases in the personality trait narcissism are associated with buffered *vs* exaggerated neural responses to rejection in adolescent males.

Narcissism is a personality trait that in the extreme can be a psychological disorder (APA, 1994). It involves an excessively positive focus on the self in combination with an extremely low regard for others (APA, 1994; Konrath *et al.*, 2009), including difficulty with empathy-related tasks such as imaginatively engaging with others' viewpoints or feeling concern and compassion for others' suffering (Watson *et al.*, 1984; Watson, 1994). This low regard for others is consequential: narcissists have difficulties in maintaining healthy relationships (Campbell *et al.*, 2002) and they also tend to be hostile and aggressive (Baumeister *et al.*, 1996; Bushman and Baumeister, 1998; Baumeister *et al.*, 2000; Twenge and Campbell, 2003).

Despite a strong current understanding of behavioural characteristics associated with narcissism, little is known about the underlying neural mechanisms involved, especially with respect to responses to potential threats such as social exclusion (Konrath and Bonadonna, 2014). Therefore, an important question is how are individual differences in narcissism related to neural responses to social exclusion?

Two competing sets of hypotheses are plausible. It is possible that narcissism may buffer individuals' responses to social exclusion. This is because at least on traditional self-report indices of mental health, narcissistic individuals look quite good. For example, they report

being less depressed, anxious and lonely (Watson and Biderman, 1993; Sedikides *et al.*, 2004) and also report higher self-esteem and more happiness compared with less narcissistic people (Watson and Biderman, 1993; Rose, 2002). As reviewed above, those with high self-esteem and avoidant attachment style (Watson and Biderman, 1993; Rose, 2002; Gjerde *et al.*, 2004; Smolewska and Dion, 2005), personality characteristics associated with narcissism, show lower reactivity to social exclusion (Onoda *et al.*, 2010; DeWall *et al.*, 2012). Furthermore, narcissism has been shown to be associated with fewer negative internalized emotions in response to exclusion (Twenge and Campbell, 2003), which suggest that narcissists experience less internalized reactivity to exclusion. In that same study, however, narcissism was also associated with increased feelings of anger and increased aggression (Twenge and Campbell, 2003), both of which are self-protective responses that externalize blame to others (Tracy and Robins, 2003). Thus, it is difficult to determine how reactive narcissists are to social exclusion.

It is also possible that narcissism involves increased reactivity to social exclusion. Narcissism is a complex phenomenon, and involves a level of defensive self-enhancement. In fact, those scoring high in narcissism are especially sensitive to others' evaluations. Narcissists need others' admiration to maintain their positive self-views (Morf and Rhodewalt, 2001). Furthermore, even their supposed high self-esteem is in question; narcissists self-report having high self-esteem, but underlying feelings of low self-worth are evident when using implicit measures (Jordan *et al.*, 2003; Zeigler-Hill, 2006). Moreover, narcissism and self-esteem are correlated, and both traits are associated with positive self-views on agentic traits like intelligence and competence. However, what differentiates them is that non-narcissistic people with high self-esteem also see themselves as high on communal traits such as warmth and caring, whereas narcissistic people do not (Campbell *et al.*, 2002). Thus, their implicit low self-worth in combination with their troubled social interactions may suggest that narcissists' high self-esteem is of a qualitatively different nature, and may not have the typical buffering effects.

Given the complexity of their self-views and social interactions, it might not be surprising that narcissistic people have excessive physiological responses (e.g. cortisol, cardiovascular reactivity) to socially threatening situations such as giving speeches (Kelsey *et al.*, 2001, 2002; Sommer *et al.*, 2009; Edelstein *et al.*, 2010). Even in the absence of such stressors, in everyday low threat situations, their stress hormones are higher than people scoring low in narcissism (Reinhard *et al.*, 2012). Thus, their underlying physiological responses betray their supposed psychological robustness and social nonchalance. In other words, narcissistic individuals might appear to be mentally healthy and socially nonchalant on the surface, but in reality, the trait is also associated with being socially needy and defensive. Taken together, there is evidence that narcissists are physiologically and behaviourally reactive to negative social situations and rejection; however, no research has explored the relationship between narcissism and neural responses to social exclusion.

The current study

The goal of this study was to investigate the relationship between neural responses to social exclusion and narcissism within a sample of adolescent boys. It is theoretically important to understand whether narcissistic individuals are hypersensitive to negative social experiences, despite possessing many potentially buffering characteristics (e.g. high self-reported self-esteem, low anxiety, avoidant attachment). In addition, although previous social cognitive and affective neuroscience investigations have demonstrated moderating relationships between individual differences such as attachment style (DeWall *et al.*,

2012), social resources (Masten *et al.*, 2012; Onoda *et al.*, 2010) and neural responses to social exclusion, this literature has not been previously connected to the narcissism literature. Finally, it is important to examine these questions among adolescent males because adolescence is a critical developmental period when social acceptance becomes more important (Cotterell, 1996), and males tend to be more narcissistic than females (Foster *et al.*, 2003).

Thus, the current study examines the relationship between male adolescents' self-reported narcissistic personality characteristics and their responses to a social exclusion task. We examined their neural responses to exclusion using functional magnetic resonance imaging (fMRI) as well as their self-reported responses to exclusion. Findings from this study have important implications for individuals who score high in trait narcissism, which itself has been rising among American college students over time (Twenge *et al.*, 2008). If they are indeed neurally hypersensitive to negative social experiences, this could have adverse consequences for the individuals themselves and also for their interpersonal functioning and ability to connect with and communicate effectively with others. Understanding the mechanisms that contribute to such hypersensitivity may offer scholars and practitioners clues to potentially effective intervention strategies, and also offers basic science insight into factors that impact neural responses to key social situations.

METHOD
Participants

Forty-three adolescent boys were recruited through the University of Michigan Transportation Research Institute as part of a larger study examining adolescent driving behaviour. Participants were between the ages of 16 to 17 ($M = 16.8$ years, s.d. $= 0.47$ years). All were right-handed, did not suffer from claustrophobia, were not currently taking any psychological medications, had normal (or corrected to normal) vision, did not have metal in their body that was contraindicated for fMRI, and did not typically experience motion sickness. One participant was excluded from the study due to a prior Autism diagnosis. Two other subjects were excluded from the analysis: one who did not complete the narcissism measure and another who fell asleep during the social exclusion task, resulting in a final sample size of 40 participants. Legal guardians provided written informed consent and teens provided written assent.

Materials and procedure

After the consent process, participants were introduced to two adolescent male confederates and were told that they would all be participating in a task together during their session. Participants were then put into separate rooms to complete a number of self-report survey measures, next they were scanned in an fMRI scanner, and finally they completed a number of post-scan survey measures. All participants were debriefed to alleviate negative responses to the social exclusion task.

Self-report measure of narcissism

Participants completed the Narcissism Personality Inventory (NPI; Raskin and Terry, 1988), which is a 40-item forced-choice measure in which participants must choose a more or less narcissistic response (e.g. 'If I ruled the world it would be a better place' or 'The thought of ruling the world scares the hell out of me.').

fMRI social exclusion task

To measure neural correlates of social exclusion, participants played the virtual ball tossing game Cyberball while undergoing an fMRI scan

(Eisenberger *et al.*, 2003). Participants were led to believe that they were playing with the two confederates from the beginning of the study, while in reality they were playing against two computer-generated participants. Participants were told that they could pass the ball to anyone they wanted, but that they should not hold the ball. In Round 1 (inclusion) of the game, the virtual participants played a game of catch in which everyone is included. In Round 2 (exclusion), the virtual participants began by including everyone, but soon excluded the participant from the game, only passing the ball between themselves.

fMRI data analysis

The data were pre-processed and analysed using Statistical Parametric Mapping (SPM8, Wellcome Department of Cognitive Neurology, Institute of Neurology, London, UK). The fMRI data were pre-processed according to a standard pre-processing stream (including realignment to correct for head motion, coregistration, normalization and smoothing). Neural activity during exclusion (compared with inclusion) was modelled for each participant in Cyberball at the single subject level. Next, a random effects model was conducted, examining associations between scores on the NPI assessed prior to the scanning session and neural activity that was greater during exclusion compared with inclusion (see Supplementary Materials for complete details).

An a priori network of interest (NOI) analysis was conducted using MarsBaR (Brett *et al.*, 2002). The regions of interest (ROIs) within the network were constructed based on prior work examining neural correlates of social exclusion, which included the AI, dACC and subACC [See Figure 1; (Eisenberger *et al.*, 2003; Eisenberger and Lieberman, 2004; Masten *et al.*, 2009; Onoda *et al.*, 2009; Eisenberger, 2012a)]. These regions were examined as a network and also analysed as individual ROIs (definitions in Supplementary Materials). Estimates of average percent signal change (exclusion > inclusion) within the entire NOI were extracted using MarsBaR, as well as within sub-regions of the network. We then examined the relationship between self-reported measures and NOI activation using multiple regression (with follow-up analyses conducted on sub-regions). Due to the sample size common of neuroimaging studies, bootstrap (10 000 samples) confidence intervals (CI) were also included.

Self-report measures of threat following exclusion

Following the scanning session, participants completed a self-report assessment of feelings during the game (threat *vs* need satisfaction), using the Need Threat Scale (NTS; van Beest and Williams, 2006). Participants were instructed to rate their level of agreement with 20 statements on a seven-point scale ranging from 'strongly disagree' to 'strongly agree' (e.g. 'I did not feel accepted by the other players' and 'I believed that my contribution to the game did not matter'). Results were coded such that higher scores indicated increased feelings of threat or distress.
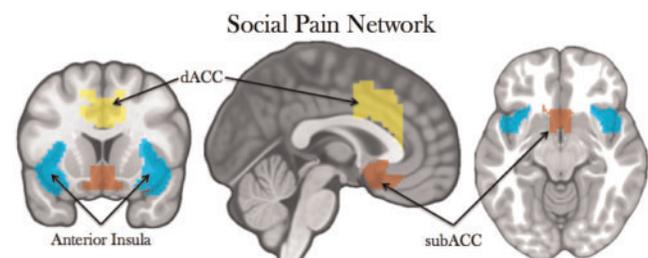

Fig. 1 The social pain network, constructed using the union of anatomically defined AI, subACC and dACC.
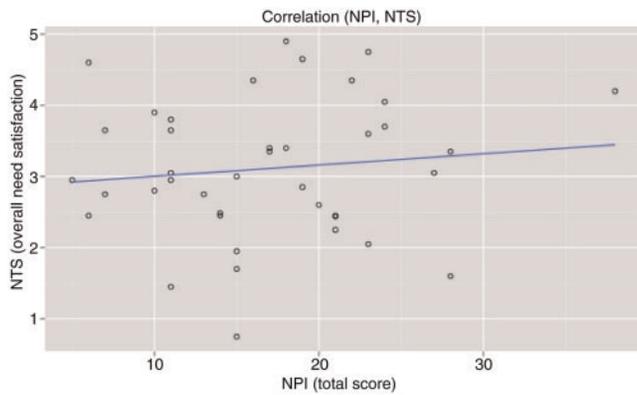
Fig. 2 Correlation examining the relationship between self-reported NPI and NTS scores. Findings indicate that feelings of threat following exclusion (NTS) were uncorrelated with NPI scores ($r = 0.12$, $P = 0.47$).
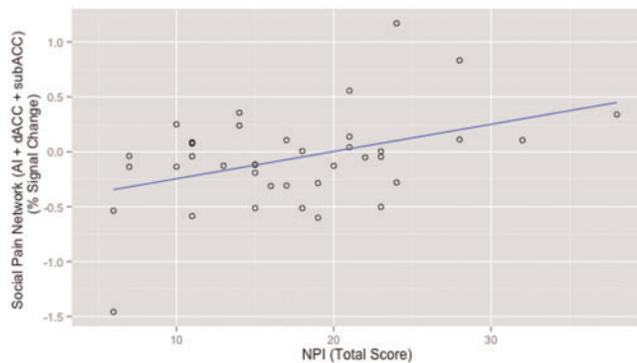

Fig. 3 Correlation examining the relationship between the social pain NOI and NPI scores. Findings indicate that participants who reported higher levels of narcissism also had significantly higher activation in the social pain network during social exclusion compared with inclusion activations ($r = 0.42$, $P = 0.009$).

RESULTS

Self-report measures

NPI scores ranged from 5 to 38 out of a total of 40 ($M = 17.12$, s.d. $= 7.39$, Cronbach's $\alpha = 0.859$), where higher scores corresponded to more narcissistic personality traits. Following the Cyberball exclusion experience, participants completed the NTS. On average participants scored near the midpoint of the seven-point scale ($M = 3.11$, s.d. $= 0.97$, Cronbach's $\alpha = 0.908$), where higher scores correspond to increased feelings of distress. These average self-reported distress scores following exclusion are consistent, within 1 s.d., with other neuroimaging studies examining Cyberball (3.25–3.99; Eisenberger *et al.*, 2006; Sebastian *et al.*, 2011; DeWall *et al.*, 2012). We next examined whether self-reported distress following exclusion correlated with self-reported levels of narcissism. We found that, consistent with the demographic group being studied (teenage boys, who are often unwilling to explicitly express distress in social situations), feelings of distress following exclusion were uncorrelated with NPI scores ($r = 0.12$, $P = 0.47$; Figure 2).

Region of interest analyses

Narcissism and neural responses to exclusion

Activation of the social pain NOI (AI, dACC and subACC) was significantly correlated with NPI scores [$r = 0.42$, $P = 0.009$, CI $= (0.12, 0.60)$; Figure 3]. Therefore, participants who reported higher levels of

narcissism also had higher activation in the social pain network during social exclusion compared with baseline inclusion activations. In addition to the NOI analysis, we examined each individual region within the network separately. Independently, both the AI and dACC significantly correlated with NPI scores [$r = 0.41$, $P = 0.01$, CI $= (0.15, 0.59)$ and $r = 0.41$, $P = 0.01$, CI $= (0.10, 0.60)$, respectively]; however, the anatomically defined subACC ROI did not significantly correlate with NPI scores on its own [$r = 0.17$, $P = 0.29$, CI $= (-0.17, 0.44)$]. Finally, following all a priori specified NOI/ROI analyses, we conducted an exploratory whole brain analysis to determine which neural regions during exclusion > inclusion were most strongly associated with narcissism (see Supplementary Materials). These findings reinforce that hypersensitivity to exclusion in narcissists may be a function of hypersensitivity in brain systems associated with social pain, with clusters of activation observed in AI, dACC and subACC/medial prefrontal cortex, among other regions.

Self-reported threat and neural responses to exclusion

The social pain NOI was not significantly correlated with self-reported scores of threat following exclusion ($r = -0.11$, $P = 0.51$). In addition, self-reported threat following exclusion was uncorrelated with activity in the AI ($r = -0.11$, $P = 0.50$), dACC ($r = -0.09$, $P = 0.58$), and subACC ($r = -0.09$, $P = 0.58$). Results indicated that although participants showed reactivity within the social pain network in the brain, there may be variability in willingness to report, and awareness of the extent to which they are affected by social exclusion.

DISCUSSION

In this study, we expanded our current understanding of the potential intrapersonal costs of narcissism by uncovering narcissists' neural responses to social exclusion. Adolescent males who scored higher in narcissism showed exaggerated neural responses in the putative social pain network during exclusion, compared with inclusion experiences. The current study also expands our understanding of individual differences in response to social exclusion, by exploring whether narcissistic individuals experience buffered *vs* exaggerated neural responses to social exclusion. Such exaggerated neural responses to social pain may indicate a neural mechanism that contributes to narcissists' hypersensitivity to negative social experiences. These findings suggest that despite the potentially buffering correlates of narcissism (e.g. avoidant attachment style, high-trait self-esteem, low anxiety; Watson and Biderman, 1993; Rose, 2002; Gjerde *et al.*, 2004; Smolewska and Dion, 2005), narcissistic individuals still have heightened neural responses to exclusion within the hypothesized social pain network. This may ultimately help to explain longer-term negative consequences of narcissism (Twenge *et al.*, 2010). In fact, increased activity in regions associated with social threat or distress correlate with increased sympathetic nervous system and hypothalamic–pituitary–adrenal axis activity, which when chronically stressed have been associated with long-term disease; (for a review, see: Eisenberger and Cole, 2012). Furthermore, these results were not apparent when examining self-reported distress, thus demonstrating the utility of using neural imaging methodology to enhance our understanding of psychological phenomena.

Although these findings are consistent with current literature on narcissists' behavioural hypersensitivity to social exclusion (e.g. aggression; Twenge and Campbell, 2003), they also point to the complex nature of narcissism. On the one hand, narcissists seem to benefit from an abundance of self-love and ego-protective traits (Watson and Biderman, 1993; Rose, 2002; Sedikides *et al.*, 2004). However, on the other hand, they seem to be overly sensitive to social experiences that threaten their egos (Kelsey *et al.*, 2001, 2002; Twenge and

Campbell, 2003; Sommer *et al.*, 2009; Edelstein *et al.*, 2010; Reinhard *et al.*, 2012). Some studies resolve this apparent contradiction by noting that narcissists' positive self-views only seem to exist on explicit self-report measures, but negative self-views are evident in implicit measures, over which individuals have limited control (Jordan *et al.*, 2003; Zeigler-Hill, 2006).

These results may shed light onto why narcissistic individuals are prone to certain behavioural reactions. Hypersensitivity to negative social experiences may be an underlying factor driving some of the prominent interpersonal behaviours associated with narcissism. In particular, narcissism is associated with interpersonal difficulties such as avoidant attachment styles, distance in social relationships and a potentially isolating sense of self-sufficiency and independence (Campbell, Foster, *et al.*, 2002; Campbell and Foster, 2002; Campbell *et al.* 2004; Gjerde *et al.*, 2004). However, this apparent lack of interest in social relationships may mask or be a coping mechanism for dealing with oversensitivity to exclusion. Hence, although narcissistic individuals tend to appear socially confident and relaxed on the surface, they may be focused on avoiding social exclusion because of exaggerated underlying physiological responses to negative social experiences (though the current data cannot directly address causality). Avoidant attachment styles may be one form of unconscious coping because avoidant attachment styles have been shown to buffer activation of the AI and dACC during social exclusion (DeWall *et al.*, 2012). Such neural reflections of social pain may also help to explain narcissists' aggressive responses after exclusion experiences (Twenge and Campbell, 2003). Furthermore, it is possible that to compensate, narcissistic people may experience a higher allostatic load—that is, narcissists may require extra physiological compensatory mechanisms to maintain external balance (Edelstein *et al.*, 2010; Reinhard *et al.*, 2012). This possibility suggests potential avenues to pursue linking narcissism with longer-term health outcomes (Konrath and Bonadonna, 2014).

There is a considerable body of research implicating our a priori identified neural ROIs in the distress of exclusion (so-called social pain). However, it should be noted that neural regions (dACC, AI and subACC) in the social pain network are also involved in other functions. Imaging studies have found the dACC to be associated with multiple functions including conflict monitoring, emotional awareness, cognitive dissonance, and reward-based decision making (Botvinick *et al.*, 1999; Bush *et al.*, 2002; Weissman *et al.*, 2003; McRae *et al.*, 2008; van Veen *et al.*, 2009; Jarcho *et al.*, 2011). Additionally, the AI has been implicated in various functions, including attention, decision making, intentions and awareness of sensations and movement; (for a review, see: Craig, 2009). Likewise, the subACC is implicated in depression and mood disorders (Greicius *et al.*, 2007). Therefore, the idea of the social pain network is a possible neural mechanism that contributes to narcissists' hypersensitivity to exclusion should be interpreted as one of several possible explanations. As with all studies of this type, the usual caution regarding reverse inference applies (Poldrack, 2006). Additionally, because the current work is correlational, there is the possibility that an unaccounted third variable may explain the current findings. Despite these limitations, the use of a priori ROIs and a theoretical framework strengthen our claim, and we suggest that this interpretation is parsimonious when considering other research on narcissism.

This study suggests the potential for several practical implications. For example, it can offer insight into potential testable interventions for narcissists. It is impossible to remove all sources of exclusion from a narcissist's life; however, it may be possible to treat feelings of pain that result from them. As these feelings seem to be more strongly detected in physiological measures, perhaps effective treatments could also be physiological. For example, research has found acetaminophen, a commonly used over-the-counter pain reliever, is also effective at reducing social pain, whether that pain is measured using self-reports or fMRIs (Dewall *et al.*, 2010). In one study, participants who took a 3-week regimen of acetaminophen reported having less hurt feelings, and participants in a separate experiment showed less neural activity in regions associated with social pain (dACC and AI), in response to social exclusion (Dewall *et al.*, 2010). Indeed, narcissism is known to be associated with a variety of addictive and compulsive behaviours (Craig *et al.*, 1985; Luhtanen and Crocker, 2005; Campbell *et al.*, 2006; Rose, 2007; Carter *et al.*, 2012), many which may serve self-medicating functions; as such, attention to multiple factors is warranted when considering the mental and physical health of narcissists. Furthermore, because neural mechanisms of social pain are closely tied with mechanisms of physical pain (Eisenberger, 2012b), coping strategies aimed at reducing physical pain may also be effective (Van Damme *et al.*, 2008). For example, using relaxation techniques such as deep breathing may help to reduce tension in the body.

A more general question this study raises is under which contexts do individuals experience exaggerated *vs* buffered social pain? The current study capitalizes on the use of a homogeneous sample, consisting of males aged 16 to 17, in the context of social exclusion, outlining a clear context and demographic of individuals who show increased susceptibility to social exclusion. Prior work has found that narcissism is associated with high cortisol overall and in response to stressors, but only among males (Edelstein *et al.*, 2010; Reinhard *et al.*, 2012). Furthermore, adolescence is a key developmental period in which relations with peers are solidified and the brain undergoes rapid development in networks supporting social cognition and emotion regulation, yet cognitive control systems are slower to mature (Steinberg, 2007; Crone and Dahl, 2012). Future research should examine whether the current findings are consistent across different ages, among women, and in other populations. In addition, future work could further examine motivations, goals and the salience of negative social experiences in narcissistic individuals to better understand why they experience exaggerated social pain.

CONCLUSION

This study examined neural mechanisms associated with social exclusion and self-reported levels of narcissism. The current study enriches our understanding of individual differences that exaggerate effects of exclusion by (i) demonstrating that those who report higher levels of narcissism also experience exaggerated responses to exclusion in the brain, and (ii) suggesting that a social pain NOI, driven primarily by activity in the AI and dACC, may be one potential mechanism involved in this increased sensitivity to exclusion. Future investigations should examine the possibility that behavioural consequences of hypersensitivity to exclusion in narcissistic individuals may be a function of hypersensitivity in brain systems associated with distress more generally. Meanwhile, the current study suggests a pathway that may connect narcissism to negative consequences for longer-term physical and mental health—findings not apparent with self-report alone.

SUPPLEMENTARY DATA

Supplementary data are available at *SCAN* online.

Conflict of Interest

None declared.

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