



Research report

Brain correlates of adult attachment style: A voxel-based morphometry study



Xing Zhang^{a,b,1}, Min Deng^{a,b,1}, Guangming Ran^c, Qingting Tang^{a,b}, Wenjian Xu^{a,b}, Yuanxiao Ma^{a,b}, Xu Chen^{a,b,*}

^a Faculty of Psychology, Southwest University, Chongqing, China

^b Key Laboratory of Cognition and Personality, Southwest University, Chongqing, China

^c Institute of Education, China West Normal University, Nanchong, China

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ABSTRACT

Evidence from human and animal studies has shown that experiences of early attachment can influence brain development and structure. Adult attachment style develops from early attachment experiences. However, little is known about the relationship between gray matter volume and attachment style. Further, the structural bases of sex-related differences in adult attachment styles remain unknown. We used voxel-based morphometry to investigate the neuroanatomical basis underlying adult attachment styles and the structural basis of sex-related differences in adult attachment styles. Participants were 106 healthy young adults (57 women and 49 men; age, 20.8 ± 1.55 years). Negative correlations were found between attachment avoidance and the volumes of the left middle temporal gyrus and the right parahippocampal gyrus, and between attachment anxiety and the right ventral anterior cingulate volume. Further analysis revealed that attachment avoidance was negatively correlated with the volume of the right middle occipital gyrus in women, but the inverse correlation was found in men. These findings suggest that differences in adult attachment styles are correlated with structural brain differences in adulthood, and that sex-related differences in adult attachment styles are associated with intrinsic structural brain differences involved in visual processing. These findings may improve our understanding of the pathophysiology of attachment-related disorder.

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1. Introduction

Attachment theory states that humans are innately predisposed to establish affective bonds and maintain proximity with their primary caregivers, who provide warmth, nutrition, and protection for infants (Bowlby, 1973; Landers and Sullivan, 2012). From interactions with primary caregivers, infants gradually develop “internal working models” of their self-worth and come to understand how one is likely to be treated by other relationship partners. These internal working models constitute the foundation of a person’s attachment style. Numerous studies have indicated that attachment style is best characterized dimensionally rather than categorically (Fraley and Spieker, 2003; Fraley et al., 2015), and that attachment in adulthood can be construed as individual

differences on two orthogonal dimensions: (a) attachment anxiety and (b) attachment avoidance (Brennan et al., 1998). Attachment anxiety involves intense worry about the availability and responsiveness of attachment figures, together with a strong desire for closeness and safety. More anxious individuals tend to adopt “hyperactivating” attachment strategies and feel starved for care and support from relationship partners (Mikulincer and Shaver, 2007). Contrary to attachment anxiety, attachment avoidance reflects a preference for interpersonal distance, and discomfort with emotional closeness. Those who score higher on attachment avoidance tend to rely on “deactivating” attachment strategies, such as suppression of attachment-related thoughts and emotions. Low levels on both dimensions denote secure attachment, while high levels of either one or both dimensions denote insecure attachment (Zhang et al., 2016a).

Attachment theory is the most influential psychological model for understanding the role of early experience in long-term social and emotional adjustment (Ainsworth et al., 2015). Indeed, numerous studies have indicated that higher levels of attachment security are associated with higher levels of well-being (Bodner and

* Corresponding author at: Faculty of Psychology, Southwest University, Tiansheng Road, Beibei, Chongqing 400715, China.

E-mail address: chenxu@swu.edu.cn (X. Chen).

¹ Xing Zhang and Min Deng contributed equally to this work and should be considered equally as first authors.

Cohen-Fridel, 2010; La Guardia et al., 2000; Zhang et al., 2016b) and more positive coping mechanisms (Li, 2008; Mikulincer and Florian, 2001; Poirier, 2014). However, due to the employment of secondary attachment strategies (e.g., hyperactivation or deactivation attachment strategies), people with insecure attachment style tend to show poorer emotional regulation and difficulty in coping with stress, which may in turn lead to higher psychological distress. For example, numerous studies have consistently shown that high levels of attachment insecurity are closely associated with higher levels of psychological distress, including higher levels of anxiety, loneliness, and depression (D'Alton et al., 2015; Mallinckrodt and Wei, 2005; Pielage et al., 2010; Wei et al., 2003; Zhang et al., 2016b). Individuals with different attachment styles tend to adopt different emotional regulation strategies; thus, the potential mechanisms behind the association between different attachment styles and psychological distress may differ accordingly, which has also been supported by many empirical studies. For example, Wei et al. (2003) found that perceived coping fully mediated the relationship between attachment anxiety and psychological distress, but only partially mediated the relationship between attachment avoidance and psychological distress. Another study found that attachment anxiety was positively related to acknowledging distress and seeking help; conversely, individuals with high attachment avoidance denied their distress and were reluctant to seek help (Vogel and Wei, 2005). In addition, Wei et al. (2005) made three distinct observations, as follows: 1) attachment anxiety and avoidance contributed to negative mood and interpersonal problems through distinct emotion regulation strategies, 2) hypersensitivity to emotional cues mediated the link between attachment anxiety and distress, and 3) emotional cutoff mediated the link with attachment avoidance. Therefore, adult attachment avoidance and anxiety affect psychological distress via different mechanisms. The underlying neural substrates of attachment style may provide brain structural evidence to explain the differing mechanisms. In addition to exploring the relationship between attachment and emotional adjustment, sex-related differences in attachment style are also an interesting and controversial topic. Many studies have found sex-related differences in peer attachment among adolescents, with girls tending to report stronger peer attachment than boys (Laible et al., 2004; Song et al., 2009; Wilkinson, 2004). Considering that adult attachment style is thought to develop from peer attachment, there may also be sex-related differences in adult attachment. For example, Del Giudice (2009) found that men were more avoidant, whereas women were more anxiously attached, which supports findings of a large cross-cultural study (Schmitt, 2008). One meta-analysis further indicated that men showed higher avoidance and lower anxiety than women (Del Giudice, 2011). An implication of these views is that there may be sex differences in attachment style, and men tend to show higher avoidance and lower anxiety than women. However, to the best of our knowledge, no study has provided evidence of structural brain differences underlying sex differences in attachment styles. Therefore, further research is needed to address this gap in knowledge.

With the development and advancement of neuroimaging technology, numerous studies have explored the neural correlates of adult attachment style. Such studies have shown that avoidantly and anxiously attached individuals show different neural activation patterns during aversive stimulus processing (Vrtička, 2017). Namely, avoidantly attached individuals tend to show relatively decreased activation patterns, while anxiously attached individuals tend to show relatively increased activation patterns. For example, using social (negative emotional faces) and linguistic threat stimuli, Norman et al. (2014) found that, the degree of attachment insecurity was positively related with amygdala activation. This indicates that threat stimulus may induce more activation on

emotion-related brain activity in insecure attached individuals. In addition, Dewall et al. (2012) found reduced anterior insula and dorsal anterior cingulate cortex activity in avoidantly attached participants in the context of social rejection. Another study showed that masked sad faces induced a weaker activation in the somatosensory cortex in avoidantly attached participants (Suslow et al., 2009), which was interpreted to reflect their habitual unwillingness to cope with partners' distress and needs for proximity. However, contrary to the avoidantly attached participants, an increased anterior insula and dorsal anterior cingulate cortex activation was found in anxiously attached participants in the context of social rejection (Dewall et al., 2012). Furthermore, using emotional face stimuli, two other studies also found that anxiously attached participants had increased amygdala activity in response to negative emotional faces (Norman et al., 2014; Redlich et al., 2015). Therefore, the relative insensitivity or hypersensitivity to negative stimuli supports the idea that avoidantly attached individuals' deactivate attachment strategies and anxiously attached individuals' hyperactivate attachment strategies. The adoption of secondary attachment strategies means that insecure attached individuals tend to show impaired emotion regulation capacities, and that avoidantly attached individuals are more likely to employ response-focused emotion regulation such as suppression, while anxiously attached individuals tend to upregulate their emotions through hyperactivating secondary attachment strategies (Vrtička, 2017). Indeed, when asked to think about negative situations (conflict, breakup, or death of a partner), anxiously attached participants showed increased activity in emotion-related areas (e.g., the anterior temporal pole), but less activity in emotion regulation-related brain regions (e.g., the orbitofrontal cortex) (Gillath et al., 2005), this suggests that anxiously attached individuals may easily be affected by negative attachment information, but cannot manage it effectively. Another study found that anxiously attached participants showed increased amygdala activation for negative social images during spontaneous viewing of social-emotional scenes, which reflects the upregulation of emotion. However, avoidantly attached participants showed heightened cognitive and emotional conflict (indicated by anterior cingulate cortex activation) and increased regulatory inhibition (indicated by lateral and medial dorsal prefrontal cortex activation) during spontaneous viewing of social-emotional scenes. Even in the expressive suppression condition, attachment avoidance was associated with stronger responses to positive social images in the supplementary motor area and caudate, indicating that suppression requires higher regulatory efforts (Vrtička et al., 2012). These studies provide neuroimaging evidence for differences in emotional regulation among people with different attachment styles. In addition, other studies also explored the neural mechanisms of attachment style from other perspectives. For example, Schneider-Hassloff et al. (2015) found that avoidantly attached individuals had increased activation in brain areas involved in emotion regulation and cognitive control to a larger extent than did anxiously attached individuals during mentalizing. The attachment security primes seemed to result in different brain activation depending on an individual's attachment style (Canterberry and Gillath, 2013). To summarize, evidence from neuroimaging studies suggest that individual differences in adult attachment are closely associated with the functioning of the networks involved in emotion regulation and cognitive control.

Early experiences not only play an important role in shaping personality, but also have a profound effect on brain development. Indeed, animal studies have indicated that early attachment experiences may influence brain development and result in permanent structural and functional alterations, especially within the limbic system (Insel and Young, 2001; Sullivan, 2005; Zimmerberg et al., 2003). In a recent longitudinal study, insecure

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