

Brain Structure and Individual Differences in Social Behaviors

Ryota Kanai

Institute of Cognitive Neuroscience, University College London
17 Queen Square, London, WC1N 3AR, United Kingdom
r.kanai@ucl.ac.uk

Abstract

Brain structure exhibits systematic relationships with a variety of an individual's cognitive abilities and such relationships can be captured by voxel-based morphometry (VBM) that computes regional gray matter volume based on anatomical MRIs. This method has been successfully used to reveal brain regions that are associated with individual differences in a broad range of contexts such as perceptual performance, attention control, face recognition, introspection and personality traits (Kanai & Rees 2011).

Here, we show that such relationships with brain structure extend to complex social behaviors by presenting our recent VBM studies that examined the relationships between brain structure and diverse aspects of socio-cognitive behavioral traits. Specifically, we identified brain regions in which individual differences in gray matter volumes were associated with political orientation, moral sentiment, empathy and loneliness. These findings suggest that information derived from standard MRI scans could be used to extract information about an individual's real-world and online social behavior. Unlike conventional functional neuroimaging research, our structural neuroimaging approach does not require a virtual environment that emulates social interactions and thus can directly link brain structure to real-world human behavior. As such, our approach based on individual differences in brain structure and behavior provides an important anchor point that integrates genetic and environmental factors determining diversity of human cognition and behavior.

Results

Political orientation

First, we show that individual differences in political orientation are reflected in the variability of the gray matter volume of the right amygdala and anterior cingulate cortex. Conservatives exhibit greater volume of the right amygdala, whereas liberals possess larger anterior cingulate cortex (Kanai et al., 2011). These findings extend the previous findings that motivational and psychological factors govern an individual's political attitude by providing neuronal bases mediating the link between personality traits and political leanings.

Moral foundations

Second, we tested whether differences on two major dimensions of moral values are associated with gray matter volume in regions previously linked to cognitive processes relevant to these moral concerns. The two clusters of moral values assessed were "individualizing" (values of harm/care and fairness), and "binding" (deference to authority, in-group loyalty, and purity/sanctity) (Haidt, 2007). The fairness sub-scale correlated positively with dorsomedial prefrontal cortex volume, while the harm/care sub-scale was negatively correlated with both precuneus and left postcentral gyrus (somatosensory) volumes. For binding, significant positive associations were found for bilateral subcallosal gyrus and left anterior insula volumes. These findings again demonstrate that variation in moral sentiment reflects individual differences in brain structure.

Empathy

Third, we show that inter-individual variability in different components of empathy are associated with differences in brain structure. Different facets of empathy were measured by the Interpersonal Reactivity Index (IRI) questionnaire (Davis, 1983). Our results show that individual differences in affective empathic abilities oriented towards another person were predicted by gray matter volume in the left precuneus and left inferior frontal gyrus. In contrast, differences in self-oriented affective empathy were predicted by gray matter volume of the left somatosensory cortex and left anterior insula; cognitive perspective taking abilities were predicted by gray matter volume of the left precuneus; and the ability to empathize with fictional characters was related to gray matter changes in the left inferior temporal and dorsolateral prefrontal gyrus.

Loneliness

Forth, we examined how loneliness is reflected in the brain. Our study shows that lonely individuals have smaller STS. This suggests that lonely individuals may have poorer ability to recognize social signals. To further test this conjecture, we tested behavioral performance of recognizing faces and reading social cues in lonely individuals and confirmed this to be indeed the case.

Fifth, the number of friends declared on Facebook correlates with the size of posterior superior temporal sulcus (STS) and right entorhinal cortex. These areas have been implicated in recognizing social cues from other people's body movements and the memory of face-name associations, respectively. This experiment suggests the possibility of data obtained from online Web behaviors with brain structure and function.

Conclusions

Finally, all of these findings suggest that information derived from standard MRI scans could be used to predict an individual's real-world social behaviors. Unlike conventional functional neuroimaging research, our structural neuroimaging approach does not require a virtual environment that emulates social interactions and thus can directly link brain structure to real-world human behavior. As such, our approach based on individual differences in brain structure and behavior provides an important anchor point that integrates genetic and environmental factors determining diversity of human cognition and behavior.

References

- Davis, M.H. 1983. Measuring individual differences in empathy: evidence for a multidimensional approach. *Journal of Personality and Social Psychology*, 44, 113-126.
- Haidt, J. 2007. The new synthesis in moral psychology. *Science*, 316, 998-1002.
- Kanai, R. and Rees, G. 2011. The structural basis of inter-individual differences in human behaviour and cognition. *Nature Reviews Neuroscience*, 12, 231-242.
- Kanai, R., Feilden, T., Firth, C. and Rees, G. 2011. Political orientations are correlated with brain structure in young adults. *Current Biology*, 21, 677-680.
- Kanai, R., Bahrami, B., Roylance, R. and Rees, G. 2011. Online social network size is reflected in human brain structure. *Proceedings of the Royal Society B: Biological Sciences*, Published online, doi:10.1098/rspb.2011.1959.