Investigating the Neural Correlates of “Theory of Mind”

Helen Louise Gallagher
University College London - 2002

ABSTRACT

Mentalising or “theory of mind” is the ability to attribute independent mental states to self and others in order to explain and predict behaviour. It is an automatic and universal function in humans and a fundamental element of social cognition. It has been suggested that mentalising ability arises from an innate, dedicated, domain-specific, and possibly modular cognitive mechanism [Fodor, 1991;Leslie and Thaiss, 1992]. This proposal gains particular support from studies of autism, a biologically-based developmental disorder which appears to be characterised by a selective impairment in theory of mind. Frith [1991] has suggested that this impairment accounts for almost all of abnormal social, communicative and imaginative behaviour manifested by individuals with autism. Interest in the brain basis of normal theory of mind, is fired by the hope of better understanding the neural systems which are abnormal in people with autism.

This thesis describes five experiments which attempt to elucidate the neural correlates underlying this ability. The first study sort to examine anatomical convergence between verbal and non-verbal mentalising tasks by exploiting the superior spatial resolution of fMRI over PET. The story comprehension task used in a previous study of mentalising ability [Fletcher et al., 1995] study was adapted for compatability with fMRI. This was compared with an equivalent non-verbal task involving the meaning of captionless cartoons. The results were consistent with the two previous PET studies, pinpointing the medial pre-frontal region to be an area of the paracingulate cortex. The tempero-parietal junctions bilaterally were also significantly activated during the theory of mind conditions.

The aim of the second experiment was to devise an “online” mentalising task to examine mentalising in real time. Previous studies have used tasks in which the subject is presented with a scenario and they have to explain why the persons behaved the way they did. The “online” mentalising task, which was a modification of the playground game “stone paper scissors”, required subjects to predict the response of their opponent and outwit or second guess them. The mentalising condition was compared with two other conditions which involved the same cognitive processes with the exception of mentalising. This proved to be a well controlled study in which the only region seen to be active as result of mentalising was the paracingulate cortex. Other regions activated in the control conditions compared to the theory of mind conditions. These are regions normally associated with working memory and sustained attention. This would suggest that the mentalising condition exerted a lighter load on these processes which corroborates the theory of a dedicated mechnism for this ability.

The main aim of the final three experiments was to test the hypothesis that the right temporo-parietal junction which activated in association with mentalising (experiment 1, Brunet et al., 2000) is involved in a network of social perception that contributes to, but is not essential for, mentalising ability. This region may be a necessary prerequisite for the development of this ability in children (Frith and Frith, 2000). A previous study has shown that Autistic children do not use gestures to express their feelings (expressive) but do use gestures which convey commands (instrumental). This is thought to be due to their inability to represent mental states. Experiment 3 describes a behavioural study which demonstrates that normal children develop the ability to represent both instrumental and expressive gestures simultaeneously around the age of 5. While experiment 4 shows that autistic individuals are impaired on their recognition of expressive gestures, which is why they fail to respond to or produce them themselves. This is consistent with the notion that autistic individuals do not have a theory of mind. This result suggests that the two categories of gesture involve divergent neural pathways. Chapter 6 describes an imaging study performed on normal adults to establish the neural substrates of representing gestures and examine differences between expressive and instrumental gestures. This showed that the brain regions involved in representing expressive gestures include the R tempero-parietal junction, medial prefrontal cortex and the amygdala. This is in contrast to the representation of instrumental gestures which appears to involve left hemisphere brain regions including the left inferior frontal cortex (BA 44/45).

The results from these studies are discussed in relation to the cognitive mechanisms underpinning our everyday ability to ‘mind-read’.