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Thesis abstract

The cognitive and neural mechanisms of joint attention: a second person approach

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This project investigated the cognitive and neural mechanisms of joint attention in typical development and in high-functioning autism. A novel gaze-contingent virtual reality tasks was developed and implemented in a number of studies using a range of techniques, including functional magnetic resonance imaging (fMRI), event-related potentials (ERP) and eye tracking.

The first aim of this project was to develop an experimental joint attention paradigm that (1) captured both the initiating and responding functions of joint attention, (2) could be applied in both behavioural and neurophysiological experiments, (3) provided full experimental control over non-social task demands, and (4) established an ecologically valid context for joint attention interactions.

Chapter 2 of this dissertation reviewed the current approaches for measuring joint attention in experimental settings and introduced a new virtual reality paradigm of joint attention that achieves both experimental control and ecological validity. Critical issues associated with the measurement of joint attention are discussed.

The second aim of this project was to use this paradigm to investigate the neural and cognitive mechanisms that support joint attention in typical development and in autism.

In **Chapter 3**, fMRI was used to investigate the neural correlates that were unique and common to initiating and responding to joint attention bids in 13 adults with typical development. A right-lateralised frontotemporoparietal network was found to be common to both initiating and responding to joint attention bids and comprised the middle frontal gyrus (MFG), inferior frontal gyrus (IFG), middle temporal gyrus (MTG), precentral gyrus, posterior superior temporal sulcus (pSTS), temporoparietal junction (TPJ) and precuneus. Compared to responding to joint attention bids, initiating joint attention was associated with additional activation of the MFG, IFG, TPJ and precuneus.

In **Chapter 4**, eye-tracking was used to investigate joint attention performance in 17 adults with high-functioning autism and 17 adults with typical development (controls). Individuals with autism made significantly more errors than controls when initiating and responding to joint attention bids.

In **Chapter 5**, another virtual reality paradigm was developed and employed in an event-related potential study which investigated the time course of neural processes associated with evaluating self-initiated joint attention bids. In a sample of 19 participants with typical development, centro-parietal P350 and P500 ERPs were significantly larger when gaze shifts resulted

in the avoidance, rather than the achievement of joint attention. This P350 and P500 morphology was absent in a second sample of 19 participants who completed a non-social version of the same task in which arrows replaced the gaze of the virtual character.

In **Chapter 6**, the same paradigm was used to investigate whether the P350 effect observed in **Chapter 5** was influenced by participants' beliefs of their virtual partner's agency. The P350 effect was only observed in participants who believed that their partner was controlled by a human (n = 19), and not in a second group of individuals who were informed that the virtual character was controlled by a computer program (n = 19).

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