



## From self to social cognition: Theory of Mind mechanisms and their relation to Executive Functioning



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### ABSTRACT

'Theory of Mind' refers to the ability to attribute mental states to oneself and other people (Premack & Woodruff, 1978). This study examined the extent to which 'Self' and 'Other' belief-attribution processes within the Theory of Mind (ToM) mechanism could be distinguished behaviourally, and whether these separable components differentially related to Executive Functioning (EF) abilities. A computerized false-belief task, utilizing a matched-design to allow direct comparison of self-oriented vs. other-oriented belief-attribution, was used to assess ToM, and a face-image Stroop task was employed to assess EF, within a population of typically-developed adults. Results revealed significantly longer reaction times when attributing beliefs to other people as opposed to recognizing and attributing beliefs to oneself. Intriguingly, results revealed that 'perspective-shift' requirements (i.e. changing from adoption of the 'self' perspective to the perspective of the 'other', or vice versa) across false-belief trials influenced reaction times. Reaction times were significantly longer when the perspective shift was from self-to-other than from other-to-self. It is suggested that the 'self' forms the stem of understanding the 'other', and is therefore processed regardless of ultimate task demands; in contrast, the 'other' perspective is only processed when explicitly required. We conclude that adopting another person's perspective, even when their belief state is matched to one's own, requires more cognitive effort than recalling and reflecting on self-oriented belief-states.

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### 1. Introduction

The ability to understand and attribute mental states, including intentions, knowledge and desires, to both ourselves and other people, is referred to as possession of a 'Theory of Mind' (Premack & Woodruff, 1978; Baron-Cohen, Leslie, & Frith, 1985). These 'mentalizing' abilities form an essential and fundamental role in many social and communicative interactions, allowing successful and mutual exchanges of information between individuals (Hamilton, 2009; Ahmed & Miller, 2011). The mechanisms

underlying Theory of Mind (ToM) abilities are not as yet clear. Recently, evidence has supported the notion of a modular structure underlying ToM abilities, with separate component parts involved in specific, differing mentalizing processes (e.g. Bodden et al., 2010; Decety & Sommerville, 2003; Harari, Shamay-Tsoory, Ravid, & Levkovitz, 2010). One such proposed delineation is between self-oriented and other-person oriented mental state attribution, where the ability to reflect on one's own mental states ('self') may utilize distinct mechanisms from those used in attributing and understanding mental states of the 'other' (e.g. Decety & Sommerville, 2003; Hartwright, Apperly, & Hansen, 2012; Jardri et al., 2011; Jeannerod & Anquetil, 2008).

The purpose of the present study was to determine whether 'Self' and 'Other' belief-attribution processes, a

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part of the ToM mechanism, could be differentiated using behavioural measures. Some prior research has examined the 'Self'/'Other' distinction within ToM, as will be discussed below. However, the present study is the first, to our knowledge, to use a matched design in a false-belief task, allowing creation of directly comparable conditions of self/other belief-attribution processes. A secondary aim of the current study was to assess the extent to which these ToM components, if found to be separable, are driven by differing aspects of Executive Functioning, as some prior research has begun to indicate (e.g. Ahmed & Miller, 2011; Brent, Rios, Happé, & Charman, 2004; German & Hehman, 2006). Executive Function (EF) refers to a set of cognitive processes that regulate, control and manage other cognitive processes, including inhibition, working memory, cognitive flexibility, and planning (Miyake et al., 2000; Miyake & Friedman, 2012; Carlson & Moses, 2001). Evidence has suggested a strong association between ToM and EF abilities (e.g. Ozonoff, Pennington, & Rogers, 1991; Sabbagh, Xu, Carlson, Moses, & Lee, 2006; Ozonoff & McEvoy, 1994), and Ahmed and Miller (2011) suggested that by examining the relationship between ToM and EF, researchers may be able to gain better insight and understanding of the mechanisms underlying ToM.

False-belief tasks are one of the tests most often used to assess ToM abilities in both typically and atypically developed individuals (Brewer, 1991). False-belief tasks involve scenarios in which individuals are shown a situation where reality states differ from belief states, and where a clear distinction between one's own current belief states and the current belief states of another individual is created. One of the first false-belief tasks designed to assess self and other belief-attribution abilities was Perner, Leekham, and Wimmer's (1987) 'Smarties' task. In this task, children were shown a box of sweets ('Smarties') and asked what they thought would be inside. On responding sweets/chocolate, children were shown that the box actually contained pencils. The pencils were then re-hidden, and children were asked three critical questions, akin to the following: 'What did you think was in the box, before you saw inside?' (self-oriented belief attribution); 'What would your teacher, who hasn't seen inside, think was in the box?' (other-oriented belief attribution); and 'What was really in the box?' (reality test).

Converging evidence, from both the Smarties task and other verbally explicit false-belief paradigms (e.g. Wimmer & Perner, 1983; Gopnik & Astington, 1988; Williams & Happé, 2010), suggests that a developmental shift is undertaken by typically developing children at the age of about 4 years; prior to this age, children tend to fail ToM tasks, unable to inhibit their own current knowledge states. From the age of 4-years, however, a rapid improvement in ToM abilities is seen, with children successfully able to recognize separate and differing mental states of other people, acknowledging, for example, that they themselves know that there are pencils in the box, but another person, who hasn't seen inside, would think it contains chocolates (Wimmer & Perner, 1983; Perner et al., 1987; Wellman, Cross, & Watson, 2001; Doherty, 2009). The seemingly simultaneous emergence of these capacities may indicate a single 'ToM' mechanism, with no detectable

differentiation in the development of self vs. other-oriented belief-attribution abilities.

However, cases in which ToM abilities fail to fully develop or are disrupted due to illness or injury provide evidence for the occurrence of deficits that may differentially affect self and other ToM. For instance, a particular focus of past research has been Autistic Spectrum Conditions (ASC), a defining feature of which is difficulties with ToM abilities (Baron-Cohen, Wheelwright, Hill, Raste, & Plumb, 2001; Brent et al., 2004; Frith, 1989; Hillier & Allinson, 2002; Lombardo et al., 2010). Individuals diagnosed with ASC are often found to display egocentric behaviours in ToM tasks akin to those seen in typically developing children prior to the age of 4-years. Results about the type of ToM deficits experienced by individuals with ASC have been mixed, with suggestions of specific deficits in attributing mental states to other people (e.g. Hutchins, Prelock, & Bonazinga, 2011; Wimmer & Perner, 1983), problems with reflecting on one's own mental states (e.g. Williams & Happé, 2010), or deficits in both self-oriented and other-person oriented belief-attribution (e.g. Carlson, Moses, & Breton, 2002; Brent et al., 2004; Perner, Frith, Leslie, & Leekham, 1989). Most commonly, however, individuals with ASC are suggested to show a particular deficit in their social cognition abilities, specifically reduced in their capacity to comprehend and understand differing mental states of other people, which supports the notion of differentiation between the 'self' and 'other' in ToM processes (Baron-Cohen, Tager-Flusberg, & Cohen, 2000; Tager-Flusberg, 2007).

Additional evidence for the distinction between 'self' and 'other' has been offered by Samson, Apperly, Kathirgamanathan, and Humphreys (2005), who present a case study of an adult patient (WBA) with a right fronto-temporal brain lesion. Patient WBA was found to exhibit a specific problem with inhibiting the 'self-perspective', whilst retaining the ability to infer someone else's perspective. The patient could understand that other people's knowledge may vary from his own, and could successfully attribute mental states to them, but only if his own personal knowledge did not contradict the other person's, or was not too salient. For instance, if patient WBA knew the true location of an object in a false-belief task, he was unable to inhibit an egocentric pre-potent response; however, if he did not know the true location of the object, although he knew that the object had been moved and the naïve other was therefore in possession of a false-belief, he was able to successfully attribute a belief to the other person. In this way, Samson et al. (2005) argued that there is a distinction between processing of the 'self' perspective and processing of the 'other' perspective.

To further explore the extent of this differentiation, some prior literature has focused on the extent to which 'self' and 'other' perspectives are processed automatically, with results suggesting that the very presence of a secondary agent (the 'other') can influence the behaviour of an individual (e.g. Samson, Apperly, Braithwaite, & Andrews, 2010; Kovács, Téglás, & Endress, 2010). Samson et al. (2010), for instance, reported a study in which participants were slower to report the number of dots visible in a room when a secondary agent could not see all the

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