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Efficient belief tracking in adults: The role of task instruction, low-level associative processes and dispositional social functioning

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ABSTRACT

A growing body of evidence suggests that adults can monitor other people's beliefs in an efficient way. However, the nature and the limits of efficient belief tracking are still being debated. The present study addressed these issues by testing (a) whether adults spontaneously process other people's beliefs when overt task instructions assign priority to participants' own belief, (b) whether this processing relies on low-level associative processes and (c) whether the propensity to track other people's beliefs is linked to empathic disposition. Adult participants were asked to alternately judge an agent's belief and their own belief. These beliefs were either consistent or inconsistent with each other. Furthermore, visual association between the agent and the object at which he was looking was either possible or impeded. Results showed interference from the agent's belief when participants judged their own belief, even when low-level associations were impeded. This indicates that adults still process other people's beliefs when priority is given to their own belief at the time of computation, and that this processing does not depend on low-level associative processes. Finally, performance on the belief task was associated with the Empathy Quotient and the Perspective Taking scale of the Interpersonal Reactivity Index, indicating that efficient belief processing is linked to a dispositional dimension of social functioning.

1. Introduction

In order to guide their behaviours in social interactions, humans process what other people see, feel, desire or believe and differentiate these mental states from their own mental states, an ability referred to as mentalising or reflecting the possession and use of a "Theory of Mind" (Premack & Woodruff, 1978). Amongst the different mentalising activities, belief reasoning has for a long time been seen as one of the most complex and effortful form of mental state processing. It was mainly investigated by testing performance in classic false-belief tasks. In one version of these tasks, participants are presented with scenarios in which the protagonist sees an object at a given location, the object is then moved during the protagonist's absence and eventually the protagonist comes back. Participants are then asked to judge the protagonist's belief ("Where does he think the object is?") or to predict his behaviour ("Where does he first search for the object?"). Typically, before the age of 4, children fail to ascribe false beliefs because they suffer from an egocentric/reality bias: they respond according to their own knowledge of reality (e.g., Wimmer & Perner, 1983). Later in development, once participants are able to respond according to other people's beliefs, performance still shows a signature of egocentric interference. Indeed, adults have been found to be slower and more error-prone to judge someone else's belief when the person's belief is false compared to true (Back & Apperly, 2010; German & Hehman, 2006).

However, in the past decade, there has been accumulating evidence showing that humans at different stages of their development are able to efficiently track other people's beliefs. These studies tested belief reasoning more implicitly in experimental designs with reduced or no demands in terms of language, conceptual understanding and executive control. In such contexts, it has been shown that infants are sensitive to other people's beliefs (Kovács, Téglás, & Endress, 2010; Onishi & Baillargeon, 2005; Southgate, Senju, & Csibra, 2007), that three-year-old children have the ability to process someone else's beliefs at an implicit level before they can do it efficiently in an explicit condition (Clements & Perner, 1994; Garnham & Ruffman, 2001), and that adults spontaneously process other people's beliefs (e.g., Kovács et al., 2010; Van der Wel, Sebanz, & Knoblich, 2014), sometimes

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without awareness (Schneider, Bayliss, Becker, & Dux, 2012) and even under explicit instructions to track an object's location (Schneider, Nott, & Dux, 2014). Recently, Schuwerk et al. showed that the extent to which other people's belief interfered with judgments about the self-belief (altercentric interference) was similar to the interference from self-belief on judgments about others' belief (egocentric interference) (Schuwerk, Döhnel et al., 2014; Schuwerk, Schecklmann et al., 2014).

These pieces of evidence in favour of an early-developing and efficient belief processing mechanism are at odds with the traditional view that belief reasoning is late-developing and resource-consuming. This apparent paradox has opened debates about the validity of the evidence for efficient belief tracking and the nature of this processing. Regarding the validity of these evidence, some authors argued that the findings could be explained without referring to mentalising, either by domain-general processes that are recruited by the tasks (e.g., Heyes, 2014; Phillips et al., 2015) or by the use of behavioural rules (Perner & Ruffman, 2005). Researchers are currently developing different experimental designs to address the validity issue and have started to show association between efficient belief tracking in experimental tasks and self-reported measures of empathy in everyday life (Ferguson, Cane, Douchkov, & Wright, 2015). Regarding the nature of belief processing, some authors have suggested that efficient belief tracking is a form of mentalising that differs from explicit belief reasoning (Apperly & Butterfill, 2009; De Bruin & Newen, 2012, 2014). While explicit belief reasoning would activate full-fledged representations of beliefs, implicit belief tracking would represent "belief-like states", which is a relation between an individual and an object, for example, that is or has been in the individual's field of view. Such representations would support action predictions in fast-moving interactions, but would not allow complex beliefs to be represented (such as beliefs that involve quantifiers, complex combinations of properties or how the agent sees the object). So far empirical evidence in favour of such limits is still scarce: it has been shown that at an implicit level adults can track others' beliefs about the location and the presence of an object but not about its identity (e.g., Kovács et al., 2010; Low & Watts, 2013).

In order to further understand the nature of efficient belief tracking and situational and dispositional factors that influence this processing, the current study addressed three key issues. 1. Do adults compute other people's belief when there are objective reasons to give priority to their own beliefs, and if so, is the altercentric interference as strong as the egocentric interference? 2. To what extent is such processing influenced by the availability of external cues that can boost low-level associations? 3. Is such processing related to dispositional factors such as empathic skills, and if so, to which component of empathic skills? The ways in which we address each of these issues are explained below.

First, we tested whether adults compute other people's beliefs when they are instructed to give priority to their own belief before belief-related events unfold. Finding an altercentric interference effect in such a context would be of particular interest because it would indicate that implicit belief tracking is not disrupted by the explicit instruction to track self-belief. This would extend the finding that implicit belief tracking is not disrupted by the explicit instruction to track reality (Schneider et al., 2014). Furthermore, we hypothesised that the dynamics between the self- and the other-belief processing, and hence the balance between egocentric and altercentric interference effects, depends on situational factors such as the time point at which priority could be given to the self and the other-beliefs. We hypothesised that when priority can be assigned at the time of computation, it would be easier to give priority to self-related information and to ignore other-related information than the reverse due to a natural tendency to prioritise self-related information (e.g., Sui & Humphreys, 2015). This would lead to a smaller altercentric interference effect compared to the egocentric interference effect. This asymmetry in the magnitude of the egocentric and the altercentric interference effects would contrast with the symmetry shown by Schuwerk, Döhnel et al. (2014) and Schuwerk, Schecklmann et al. (2014)when the to-be-judged belief was indicated at the end of the belief scenarios, once the belief-related events had been unfolded.

In order to test efficient belief tracking in a context in which priority can be given to the self before belief computation, we asked adult participants to watch belief scenarios and to judge whether a given picture matched their own belief or the protagonist's belief. The to-be-judged belief was indicated prior to the unfolding of the events. Such an experimental context provides a measure of an implicit form of other-belief processing (the degree to which an agent's belief affects participants' judgement about their own belief, or the altercentric interference effect) that can be compared to the classic egocentric interference effect (the degree to which the participant's own belief affects the judgement about the agent's belief) in order to assess the balance between the self- and the other-belief processing. Implicit belief processing should be understood here as processing of another person's belief in the absence of explicit instruction to track that person's belief. We do not assume automaticity by using this term in the present paper as both the self- and other-beliefs were relevant in the general context of the task.

Second, we tested the hypothesis that implicit belief tracking could be explained by the registration of associations between the social agent and the object in the line of sight of the agent (e.g., Apperly & Butterfill, 2009; De Bruin & Newen, 2012, 2014). We reasoned that such association would be based on the visual perception of both the agent and the object. We hypothesised that if such processes underlie any altercentric interference effect in our experimental design, then any altercentric interference effect should only be observed when both the agent and the object are visible from the participant's view. In order to test this hypothesis, participants performed two different versions of the belief task. In one version, the agent and the object in his line of sight were visible to participants at the critical point in time when associations should be stored (when the object reached the last location before the agent's exit of the scene). In another version, the object was not visible but its position could be inferred from an indirect cue (sound). The first version allowed a direct visual association between the agent and the potential content of the agent's belief to be formed while the second version did not.

Third, we aimed to extend the understanding of the association between self-reported empathic skills and belief processing by testing associations between performance in the new belief task used in the current study and different self-reported measures of empathy (global measure vs. measure of the distinct components of this construct). Participants filled in the Empathy Quotient (EQ; Baron-Cohen & Wheelwright, 2004), a global measure of empathy, and the Interpersonal Reactivity Index (IRI; Davis, 1983) that consists of four scales assessing distinct components of empathy: the perspective taking scale "assesses the tendency to spontaneously adopt the psychological point of view of others", the fantasy scale "taps respondent's tendency to transpose themselves imaginatively into the feelings and actions of fictitious characters in books, movies, and plays", the empathic concern scale "assesses other-oriented feelings of sympathy and concern for unfortunate others" and the personal distress scale "measures self-oriented feelings of personal anxiety and unease in tense interpersonal settings" (Davis, 1983). Ferguson et al. (2015) showed an association between the EQ and the spontaneous computation of another person's belief in a passive reading task. In the current study, we expected that participants who reported high levels of empathy on the EQ should be more oriented toward others and less