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Brief article

Task instructions and implicit theory of mind

Dana Schneider [a,b,*], Zoie E. Nott [a], Paul E. Dux [a,*]

[a] School of Psychology, The University of Queensland, Australia
[b] Institute of Psychology, Friedrich Schiller University of Jena, Germany

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ABSTRACT

It has been hypothesized that humans are able to track other's mental states efficiently and without being conscious of doing so using their *implicit* theory of mind (iToM) system. However, while iToM appears to operate unconsciously recent work suggests it does draw on executive attentional resources (Schneider, Lam, Bayliss, & Dux, 2012) bringing into question whether iToM is engaged efficiently. Here, we examined other aspects relating to automatic processing: The extent to which the operation of iToM is *controllable* and how it is influenced by behavioral *intentions*. This was implemented by assessing how task instructions affect eye-movement patterns in a Sally–Anne false-belief task. One group of subjects was given no task instructions (No Instructions), another overtly judged the location of a ball a protagonist interacted with (Ball Tracking) and a third indicated the location consistent with the actor's belief about the ball's location (Belief Tracking). Despite different task goals, all groups' eye-movement patterns were consistent with belief analysis, and the No Instructions and Ball Tracking groups reported no explicit mentalizing when debriefed. These findings represent definitive evidence that humans implicitly track the belief states of others in an uncontrollable and unintentional manner.

1. Introduction

Theory of Mind (ToM; mentalizing) refers to humans' ability to reason about the mental processes (e.g., beliefs) of others and to recognize that these may be different from their own (Premack & Woodruff, 1978). ToM is a topic of intense investigation across a range of disciplines. This is the case as its operations, particularly those tied to belief reasoning, are thought to reflect a uniquely human ability (Call & Tomasello, 2008); a key developmental milestone (Perner & Lang, 1999); and to be impaired in several psychiatric and developmental disorders, including schizophrenia and autism (Baron-Cohen, 1995; Baron-Cohen, Leslie & Frith, 1985; Frith, 2001, 2004).

Key for assessing ToM is the 'Sally–Anne' false-belief task where subjects make judgments on the mental state of another individual (Wimmer & Perner, 1983). Specifically, using actors, still images or movies, a subject watches a character 'Sally' observe an object (e.g., a ball) being moved to a box and then exit the room. Following this, another character 'Anne' moves the object to a different box, hiding it from Sally. Upon reentering the room, Sally now has a false-belief regarding the ball's location. To pass this task subjects must identify the location that they think Sally will search for the object first, thus they must represent Sally's *belief*, which is contrary to their own knowledge.

Recently, Apperly and Butterfill (2009) have offered a major theoretical development in the conceptualization of ToM. They propose two distinct ToM systems: One,

* Corresponding authors. Address: Institute of Psychology, Department of General Psychology and Cognitive Neuroscience, Friedrich Schiller University of Jena, Am Steiger 3, Haus 1, 07743 Jena, Germany. Tel.: +49 3641 945 117 (D. Schneider). Address: School of Psychology, University of Queensland, McElwain Building, St Lucia, QLD 4072, Australia. Tel.: +61 7 336 568 85 (P.E. Dux).

E-mail addresses: msdanaschneider@gmail.com (D. Schneider), paul.e.dux@gmail.com (P.E. Dux).

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which is present early in life, operates implicitly/unconsciously (iToM; Schneider, Bayliss, Becker, & Dux, 2012; Schneider, Lam, Bayliss, & Dux, 2012) and is involved in efficient monitoring of 'belief-like' states. And another later-developing system that operates in a deliberative/controlled manner and allows conscious/explicit ToM inferences. We (Schneider, Bayliss et al., 2012; Schneider, Lam et al., 2012; Schneider, Slaughter, Bayliss, & Dux, 2013) have provided evidence for such implicit belief processing in the mature healthy cognitive system using a false-belief anticipatory looking paradigm, Importantly, this work went beyond previous studies (e.g., Kovács, Téglás, & Endress, 2010; Senju, Southgate, White, & Frith, 2009; see also Rubio-Fernández, 2013) by employing a large number of false- and true-belief trials along with a concurrent distraction task and an extensive post-experimental debriefing. Thus, increasing the likelihood that subjects were indeed engaged in sustained and implicit ToM processing. Using this approach we observed eye-movement patterns consistent with belief-tracking in those who reported no knowledge of consciously engaging in mentalizing and who displayed high accuracy on the distraction task. In addition, support for a dissociation between iToM and eToM comes from two lines of work. Firstly, subjects younger than two years display eye-movement patterns in false-belief tasks consistent with belief tracking however are unable to pass explicit false-belief tests until 3–4 years (Clements & Perner, 1994; Kovács et al., 2010; Onishi & Baillargeon, 2005; Southgate, Senju, & Csibra, 2007; Senju, Southgate, Shape, Leonard, & Csibra, 2011). Secondly, individuals with an autism spectrum disorder can pass explicit ToM tests, but do not appear to engage in iToM (Schneider et al., 2013; Senju et al., 2009).

Despite the mounting evidence for different mechanisms underlying iToM and eToM they appear to overlap somewhat as both draw on executive attentional resources (McKinnon & Moscovitch, 2007; Rowe, Bullock, Polkey, & Morris, 2001; Schneider, Lam et al., 2012). For example, both explicit and implicit ToM processing are impaired under dual-task conditions when a working-memory load task is paired with the central ToM task. It is now established that individuals across the lifespan track the beliefs of others' both without instruction and conscious knowledge of doing so. But, iToM does not appear to operate as efficiently as previously proposed (Apperly & Butterfill, 2009) as it taps executive resources. Automatic processing has been conceptualized as consisting of 4 qualities: the extent to which behavior and thoughts are unconscious, efficient in their use of attentional resources, controllable and unintentional (see Bargh, 1994; Shiffrin & Schneider, 1977). As noted above, presently, research has addressed the first two of these characteristics in relation to iToM, however the extent to which implicit belief processing is influenced by intentions and under top-down, volitional control remains to be established. Indeed, humans may have a default preference to track the internal cognitions of others (as suggested by Leslie (1987, 1994a, 1994b)), however do not engage in this process if they have task goals that are incongruent with this operation.

Here, to examine the role played by intentions and control in iToM we assessed eye-movement patterns in a Sally–Anne task where groups of subjects had distinct task instructions. Specifically, along with one group who received the standard no instructions and therefore watched Sally–Anne type movies freely, we explicitly instructed one group to track the belief state of the displayed protagonist and another to track the object in the paradigm. In addition, we used a large number of trials and employed a distractor task and extensive follow up debriefing to ensure we were tapping sustained *implicit* mentalizing in the no instructions and object tracking groups. Thus, if the latter group displays eye-movements consistent with engaging in mentalizing despite having an incongruent task instruction and goal (i.e., to concentrate only on the object in the movies) this would provide evidence that iToM operates unintentionally and uncontrollably.

2. Methods

One hundred and four neurotypical volunteers from The University of Queensland (M = 19.6 years, 68 females) participated and the School of Psychology Ethics Committee approved the protocol. All subjects scored below the clinical cutoff (32/50) on the Autism-Spectrum Quotient questionnaire which was performed at the end of the experiment (AQ; 15.4, Baron-Cohen, Wheelwright, Skinner, Martin, & Clubley, 2001). Thirty-seven subjects were in the standard/No Instructions group, 34 in the Ball Tracking group and 33 in the Belief Tracking group. Two subjects from the No Instructions group and 4 from the Ball Tracking group were excluded as they provided responses during debriefing (see details below) which suggested they engaged in explicit ToM processing. A further 5 subjects were removed from the Belief Tracking group as they performed at or below chance (50%) on the explicit belief tracking task (see details below). Thus, final group sizes were 35 for No Instructions, 30 for Ball Tracking and 28 for Belief Tracking. We settled on this number of participants because an a priori power analysis indicated that this sample, assuming a medium effect size (f = .25, and a within-subjects correlation of .5 [the default value in G∗Power]), gave us sufficient power (>.97) to detect a 3-way interaction (see below; G∗Power; Faul, Erdfelder, Lang, & Buchner, 2007).

Subjects viewed Sally–Anne like movies and filler trials that were pseudo randomly presented across an hour. Stimuli appeared on a 17-inch LCD monitor and were controlled via *Presentation* (Neurobehavioural Systems, Inc., Albany, CA, USA). Subjects sat 58 cm from the monitor (controlled via chin rest) and had their eye-movements tracked using an Eyelink 1000 (sampling rate: 500 Hz; SR Research, Mississauga, Ontario, Canada).

In filler trials subjects viewed an actor sitting behind a desk with two boxes on it. There were two types of filler trials: In one, a red ball sat on top of one of the boxes (duration: 3 s) and in the other a koala puppet moved the red ball into one of the boxes (duration: 29 s). At the end of the filler movies a bell sounded and the actor reached for