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Evidence for spontaneous level-2 perspective taking in adults

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ABSTRACT

Social interactions are fostered by humans' propensity to compute their partner's perspective online. However, due to the mindreading system's limited capacity perspective taking (PT) was argued to occur spontaneously only for level-1, but not level-2 perspectives. We propose that level-2 perspectives (containing aspectual information) can also be computed spontaneously if participants have reason to assume that the partner is indeed aware of the objects' aspectual properties. Pairs of adult participants took part in the modified version of Surtees, Butterfill, and Apperly's (2012) number verification paradigm. Participants had prior information on their partner's task, which either called for processing aspectual properties or did not. The partner's inconsistent perspective was found to interfere with RT-s providing evidence for spontaneous level-2 PT. However, such interference only occurred when the partner's task involved processing the perspective dependent object feature, suggesting that PT was sensitive to the other's awareness of the to be represented information.

1. Introduction

Visual perspective taking refers to the ability to mentally map how a certain scene looks from another person's point of view. Being part of the mind reading system, perspective taking (PT) provides the basis for attributing knowledge or beliefs to others and thus lays the foundation for smooth social interactions (Aichhorn, Perner, Kronbichler, Staffen, & Ladurner, 2006; Apperly, 2008; Wimmer, Hogrefe, & Perner, 1988). While its relevance is widely recognized, the features and functioning of PT are strongly debated. In recent literature it has been argued that visual perspective taking is not a unitary capacity either in terms of the computed representation, or regarding the mechanism that leads to that representation (Apperly & Butterfill, 2009; Flavell, Everett, Croft, & Flavell, 1981; Rakoczy, 2012). The opposition to this view claims that there is only one mindreading system that, at times, recruits other cognitive faculties as well, but uses the same concepts regardless (Carruthers, 2015a). Our findings indicate that the division between mindreading systems is not as rigid as proposed by the former approach.

Based on empirical findings in preschoolers, Flavell et al. (1981) proposed that two types of information could be achieved regarding the visual perspective of others. Level-1 PT refers to representing *whether* an agent can see an object, while level-2 PT means representing *how* exactly that object appears to him, that is, under what aspect the agent sees the object. This distinction indicates that there is a qualitative gap between knowing what the other does and does not see, and being able to

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represent the scene as it is visible to him/her. Underlying this notion it has been demonstrated that the ability to compute someone else's level-1 perspective develops earlier in life than the representationally more complex capacity of level-2 PT (Moll & Meltzoff, 2011; Moll & Tomasello, 2006; Sodian, Thoermer, & Metz, 2007).

Despite the bias often shown in children and adults towards egocentrism (for a review see, Samson & Apperly, 2010), there is evidence that level-1 perspective taking can emerge in a speeded way and without instruction to do so (Samson, Apperly, Braithwaite, Andrews, & Bodley Scott, 2010). In the number verification paradigm used by Samson et al. (2010), participants had to verify the amount of dots presented on the walls of a virtual room either from their own perspective, or from the perspective of an avatar located in the room. The amount of dots visible to the avatar either matched or did not match that visible to the participant, potentially creating a conflict with one's own perspective.

The results suggested (Samson et al., 2010) that adults computed the avatar's perspective online despite the fact that it was irrelevant for decision-making. This, in turn, interfered with participants' decisions when the avatar's perspective was inconsistent with their own (altercentric intrusion). Importantly, similar altercentric interference emerged when participants only had to make judgments based on their own perspective throughout the experiment. This rules out the possibility that the high inhibition demands of switching back and forth between perspectives, or the situation that trained participants to place themselves into the other's perspective played a role in the effect. Similar to adults, school-aged children also showed altercentric intrusions in this paradigm (Surtees & Apperly, 2012). Finally, computation of the other's perspective was found to be independent of parallel cognitive load, indicating that the process was indeed cognitively efficient (Qureshi, Apperly, & Samson, 2010).

Unlike level-1 PT, level-2 PT has not been reported to occur in a spontaneous way. Surtees, Butterfill, and Apperly (2012) presented subjects with single numerals that were either symmetric/unambiguous in nature (0,8) or asymmetric/ambiguous (6,9). The numbers were presented either lying on the table between the participant and the avatar (asymmetric stimuli looked different from the two perspectives), or were displayed on the wall (all stimuli looked the same independent of perspectives). Participants had to perform a number verification task from their own or the avatar's perspective. In this case, the avatar's inconsistent perspective did not interfere with egocentric perspective judgments, suggesting that adults did not compute how the scene looked from the avatar's perspective spontaneously.

Before outlining current views on the cause of the above difference, an important distinction has to be drawn between automatic and spontaneous processing. Although there are many different approaches to automaticity, an automatic cognitive process is thought to be independent of both the participant's overt goal, and of any covert goals he might have (Carruthers, 2015a). On the other hand, while spontaneous processes are also independent of overt goals or external prompting, they do depend on participants' covert goals (for example, the general motivation to understand others, Carruthers, 2015a), or on contextual factors (Back & Apperly, 2010).[1] Samson et al.'s (2010) findings were interpreted as evidence for the "relatively automatic" computation of level-1 perspectives (Qureshi et al., 2010; Surtees & Apperly, 2012). For the sake of definitional clarity we will continue to refer to these results as spontaneous PT.

The difference in spontaneity of computation found between level-1 and level-2 PT might bring us closer to understanding the mechanism behind these abilities. It has been argued that the two skills, level-1 and level-2 PT, differ in terms of their reliance on perspective computation, and relatedly, in the degree to which they are social in nature. According to some, the ability to figure out which objects someone does or does not see (level-1 PT) might not even require reasoning about perspectives at all (Aichhorn et al., 2006; Michelon & Zacks, 2006). Aichhorn and colleagues (2006) argue that differing perceptual experiences have to refer to the same objects or scene in order to qualify as *perspectives* on those objects, while in level-1 decisions the different percepts can be interpreted as resulting from a difference in the objects that are looked at. Without using the concept of seeing, perceptual access to an object can be judged based on the spatial relation between the other person's eyes and the target object (Aichhorn et al., 2006; Michelon & Zacks, 2006). Empirical findings support this proposal. Adults are quicker to make explicit level-1 decisions when the avatar is close to the target object and are slower when the distance is greater, but the speed of computation is not affected by the angular disparity between participant and avatar (Michelon & Zacks, 2006; Surtees, Apperly, & Samson, 2013a). This indicates that the information (see/does not see) is reached through tracing the person's line of sight, which line takes longer to "draw" if the path is longer.

The idea that tracking visual access to certain objects does not involve representing the perspectives of social agents gains further support from a different line of investigation as well. Studies show altercentric interference in Samson et al.'s (2010) number verification task also when the avatar is replaced by a less or non-social, directional stimulus (Nielsen, Slade, Levy, & Holmes, 2015; Santiesteban, Catmur, Hopkins, Bird, & Heyes, 2014). Based on this, Santiesteban et al. (2014) argue that the phenomenon referred to as level-1 perspective taking is driven by domain general factors, like attentional cueing, rather than Theory of Mind. The effect in Nielsen et al.'s (2015) study was, however, stronger in the social condition compared to the less and non-social conditions. Furthermore, the effect correlated with self-reported measures of Theory of Mind in the social, but not in the other two conditions. This suggests that processes specific to the social domain also contribute to spontaneous level-1 PT.

As opposed to tracing someone's line of sight, representing appearances from another point of view, that is taking someone's level-2 perspective, presumes understanding that the same object from a different angle may give rise to different percepts. Hence, seemingly contradictory contents regarding the same referent (e.g. the object's perceived identity) may all be

[1] A related term is involuntariness (Bargh, 1989). While automaticity/spontaneity refers to the features of launching a process, involuntariness of computation indicates that a process will necessarily be performed to the end if started, it cannot be down-regulated or controlled even if the perceiver is aware of its' operation.