Cognition 148 (2016) 97–105

Contents lists available at ScienceDirect

Cognition

journal homepage: www.elsevier.com/locate/COGNIT

Unintentional perspective-taking calculates whether something is seen, but not how it is seen

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ARTICLE INFO

Article history:
Received 5 September 2014
Revised 27 November 2015
Accepted 12 December 2015
Available online 2 January 2016

Keywords:
Perspective-taking
Theory of mind
Visual perspective-taking

ABSTRACT

A long established distinction exists in developmental psychology between young children's ability to judge *whether* objects are seen by another, known as "level-1" perspective-taking, and judging *how* the other sees those objects, known as "level-2" perspective-taking (Flavell, Everett, Croft, & Flavell, 1981a; Flavell, Flavell, Green, & Wilcox, 1981b). Samson, Apperly, Braithwaite, Andrews, and Bodley Scott (2010) provided evidence that there are two routes available to adults for level-1 perspective-taking: one which is triggered relatively automatically and the other requiring cognitive control. We tested whether both these routes were available for adults' level-2 perspective-taking. Explicit judgements of both level-1 and level-2 perspectives were subject to egocentric interference, suggesting a need for cognitive control. Evidence of unintentional perspective-taking was limited to level-1 judgements.

1. Introduction

In order to predict and explain the behaviour of others in even simple social environments it is often necessary to take into account their perspective on the world. People's actions are dictated by their goals and intentions, which in turn are dictated by beliefs and desires, any of which may diverge from our own. Cooperating and competing with others regularly requires representation of these perspectives. One case where such situations arise is in taking visual perspectives. Developmental psychologists have argued that perspective-taking is fundamentally different at two levels (Flavell et al., 1981a; Flavell et al., 1981b). Young children successfully understand *whether* someone sees something or not (a level-1 perspective) before they understand *how* something looks to them (a level-2 perspective). In the current paper we test whether the cognitive characteristics of adults' perspective-taking are similarly divergent and discuss the implications for how we understand the impressive performance of infants on some perspective-taking and theory of mind tasks (Luo & Baillargeon, 2007; Onishi & Bailargeon, 2005).

The traditional method for testing perspective-taking involves using *direct measures*. Participants (often children) are asked to assess the perspectives of others and either report this perspective or make judgements about what a character will do given that they hold a specific perspective. For example, Piaget and Inhelder (1956) asked children to report how an array of three mountains would appear to an experimenter and Masangka et al. (1974) asked children to judge whether someone sat opposite them would see a picture of a turtle as being the right way up, or upside down. Although tasks vary in difficulty, these direct measures all suggest that perspective-taking is relatively taxing for young children. Interestingly, children's errors are "egocentric", reflecting over-application of their own perspective (Flavell et al., 1981a; Flavell et al., 1981b; Piaget & Inhelder, 1956). Overcoming this egocentrism is thought to be crucial in the development of perspective-taking (Piaget & Inhelder, 1956) and continues to be taxing, even for adults (Epley, Keysar, Van Boven, & Gilovich, 2004a; Epley, Morewedge, & Keysar, 2004b; Kessler & Thomson, 2010; Keysar, Lin, & Barr, 2003; Michelon & Zacks, 2006; Nickerson, 1999). Taken together, these findings support a view of perspective-taking as an effortful process.

Recent research in infant (Onishi & Bailargeon, 2005; Sodian, Thoermer, & Metz, 2007; Southgate, Senju, & Csibra, 2007) and comparative (Clayton & Emery, 2007; Hare, Call, & Tomasello, 2001; Santos, Nissen, & Ferrugia, 2006) psychology has suggested that, under certain circumstances, perspective-taking might not be so difficult after all. *Indirect* measures, monitoring eye gaze and other spontaneous behaviours, seem to show that infants

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http://dx.doi.org/10.1016/j.cognition.2015.12.010
0010-0277/

and non-human animals with rather limited cognitive resources can track perspectives. One interpretation of such results is that researchers have finally been able to find measures sensitive enough to show how easy perspective-taking really is (Baillargeon, Scott, & He, 2010; Onishi & Bailargeon, 2005). Others are more sceptical about whether such evidence counts as genuine perspective-taking or "theory of mind" (Heyes, 2014a, 2014b, 2015; Perner & Ruffman, 2005; Ruffman & Perner, 2005; Ruffman, Taumoepeau, & Perkins, 2012). In contrast to these polarised positions, it will be our working hypothesis that direct measures and indirect measures of perspective-taking can both reveal interesting features about the cognitive profile of perspective-taking.

Samson et al. (2010) identified both a direct and an indirect measure of perspective-taking using a single paradigm, requiring adults to judge the number of dots that could be seen on the walls of a room (a level-1 perspective-taking task). On separate trials, adults took either their own perspective (Self trials) or that of a cartoon avatar present in the room (Other trials). On Other trials (a direct measure of perspective-taking), participants were slower and more error-prone at judging the avatar's perspective when their own perspective was different, demonstrating egocentric interference. Importantly, an analogous effect was also observed on Self trials, when participants were also slower and more error prone at judging their own perspective when the irrelevant perspective of the avatar happened to be different from their own (which they dubbed altercentric interference). This novel observation suggested that participants calculated the avatar's perspective, even though they had no reason to do so, leading to "altercentric" interference on judgements of their own perspective (see Kovács et al., 2010 for a related phenomenon). The authors suggested that this altercentric interference provided an indirect measure of the operation of a process of visual perspective-taking that had been triggered relatively automatically.

Researchers in the cognitive sciences have long argued over the most appropriate definition of automaticity. Bargh, Wyer, and Srull (1994) described the automaticity of a processes as the degree to which it displays four features: Operation outside of cognitive control, efficiency, lack of awareness and lack of intentionality. For our purposes, it is clear that the automaticity of perspective-taking is potentially interesting in the degree to which it is efficient and can operate without cognitive control, as both of these factors may make such a process available to infants and non-human animals with limited cognitive resources. There is evidence to suggest that level-1 perspectives may be processed both outside of cognitive control, and efficiently. Samson et al. (2010); see also Santiesteban, Catmur, Coughlan Hopkins, Bird, & Heyes, 2014) showed that the altercentric intrusions occurred when participants repeatedly judged their own perspective across a same block or even across the entire experiment, suggesting that they could not voluntarily ignore the irrelevant perspective of the avatar. Qureshi and colleagues found that adults computed perspectives when they did not need to, even when also completing a secondary task that loaded executive function (Qureshi, Apperly, & Samson, 2010). To just this extent we conclude that level-1 perspectives may be calculated in a relatively automatic manner, and that the consequences of this may be observed on indirect measures, such as interference from an avatar's irrelevant perspective when judging one's own "Self" perspective. This perspective calculation is not enough to drive explicit perspective judgements, for which effortful selection is required especially when "Self" and "Other" perspectives diverge.

Our key concern in the current work is whether Samson et al.'s (2010) altercentric effect would also be present for level-2 perspectives. There are two reasons to hypothesise that level-2 perspectives will not be calculated automatically. Firstly, if the abilities demonstrated on indirect measures reflect cognitively efficient processes, then there are strong theoretical reasons for supposing that this efficiency will come at the cost of inflexibility about the kinds of perspectives that can be processed (Apperly, 2010; Apperly & Butterfill, 2009; Butterfill & Apperly, 2013). Recent evidence testing predictions from this account has suggested that children's and adults' predictive gaze (an "indirect measure") anticipates the behaviour of an agent with a false belief about an object's location, but no such effect was seen when the agent's behaviour is based upon a false belief about the object's identity (Low & Watts, 2013). A related prediction is that level-2 perspectives will not be processed automatically. Secondly, there are good empirical reasons for supposing that some kinds of perspective-taking are significantly more demanding than others. As well as traditional findings from direct measures of visual perspective-taking showing that children pass level-1 tasks around the age of 2-years (Moll & Tomasello, 2006), but do not pass similar level-2 tasks till around the age of 4 or 5 (Flavell et al., 1981a; Flavell et al., 1981b; Masangka et al., 1974), the level-1/level-2 distinction also captures current limits on evidence of precocious abilities shown by infants and non-human animals (Apperly & Butterfill, 2009; Clayton & Emery, 2007; Hare et al., 2001; Song & Baillargeon, 2008). Many of these new tasks either test or imply level-1 perspective-taking, but as yet there is no positive evidence of the equivalent level-2 ability.

Surtees, Butterfill, and Apperly (2012) adapted Samson et al.'s perspective-taking ability to allow for level-2 judgments. In this study, children and adults were asked to make self and other judgments about the appearance of a numeral, making use of the fact that some numbers (6 and 9 for example) look different if viewed upside down, whilst others (e.g. 0 and 8) look the same. Across trials there was variation in the type of number used and whether the participant and the avatar looked at them from the same angle. When participants made judgements about what number the avatar saw, they found this most difficult in cases where their perspective was different from that of the avatar. Analogous to Samson et al.'s (2010) egocentrism effect, it was hardest to judge that the avatar saw a 6 when the participant saw a 9. However, no "altercentric" effect was found for level-2 judgements, as observed from the fact that there was not a specific difficulty for participants in judging that they saw a 6 when the avatar saw a 9. It was concluded from this that level-2 perspective-taking was not automatic: There was no evidence of efficiency, nor of operation outside of cognitive control. There were, however, two clear limitations to Surtees et al.'s findings. Firstly, there was no direct comparison between level-1 and level-2 perspective-taking. Secondly, to be appropriate for children, participants did relatively few trials (only 60), thus limiting power to detect signs of automaticity.

To examine the processes involved in adults' visual perspective-taking, we therefore adapted Samson et al.'s and Surtees et al.'s tasks so that we could elicit level-2 as well as level-1 judgements using very similar stimuli. We tested two aspects of automaticity, both whether adults *could* calculate the avatar's perspective rapidly enough to interfere with their given task and whether they *would* do so outside of cognitive control. To this end, we varied whether participants completed trials in separate blocks of self and other perspective or mixed blocks. Separate blocks provide more opportunity to strategically ignore the other perspective, thus providing a test of whether perspective-taking would operate outside of intentionality and cognitive control. Mixed blocks provide less opportunity to strategically ignore the other perspective, thus giving the greatest opportunity to observe whether rapid calculation would ever occur. On trials requiring explicit judgements of the "other's" perspective we follow Samson et al. (2010) and Surtees et al. (2012) in predicting evidence of egocentrism. We expected participants to calculate their own perspective relatively