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Short Communication

Dissociating processes underlying level-1 visual perspective taking in adults

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ABSTRACT

Although reasoning about other people's mental states has typically been thought to require effortful deliberation, evidence from indirect measures suggests that people may implicitly track others' perspectives, spontaneously calculating what they see and know. We used a process-dissociation approach to investigate the unique contributions of automatic and controlled processes to level-1 visual perspective taking in adults. In Experiment 1, imposing time pressure reduced the ability to exert control over one's responses, but it left automatic processing of a target's perspective unchanged. In Experiment 2, automatic processing of a target's perspective was greater when the target was a human avatar versus a non-social entity, whereas controlled processing was relatively unaffected by the specific target. Our findings highlight the utility of a process-dissociation approach for increasing theoretical precision and generating new questions about the nature of perspective taking.

1. Introduction

Reasoning about what other people see, think, know, and want is crucial for making sense of what they say and do and for predicting their future actions. Ascribing such mental states to others has commonly been thought to require effortful deliberation, which may explain why, at times, even neuro-typical adults err when making explicit judgments about others' perspectives (Birch & Bloom, 2004; Nickerson, 1999). These occasional struggles with explicit mental-state ascription notwithstanding, evidence from *indirect* measures suggests that both adults and children may *implicitly* track others' perspectives (e.g., Kovács, Téglás, & Endress, 2010; Schneider, Bayliss, Becker, & Dux, 2012; Surtees & Apperly, 2012). Our aim here was to gain a better understanding of the processes underlying implicit visual perspective taking in adults.

2. Automatic visual perspective taking?

Samson, Apperly, Braithwaite, Andrews, and Bodley Scott (2010) recently introduced a level-1[1] visual perspective-taking (hereafter, L1-VPT) task that affords both direct and indirect measures of perspective taking. In this task, adults view a human avatar standing in a room with dots on the walls. On some trials, the avatar and participants can see the same number of dots; on other trials, the avatar cannot see some of the dots that participants can see. Two interference effects commonly emerge in this task: First, on trials where participants judge the avatar's perspective, they have difficulty doing so if their own perspective conflicts with that of the avatar. This effect – *egocentric intrusion* – resembles egocentric biases found on other direct measures requiring explicit judgments of others' perspectives (e.g., Epley, Keysar, Van Boven, & Gilovich, 2004; Keysar, Lin, & Barr, 2003; Todd, Forstmann, Burgmer, Brooks, & Galinsky, 2015; Todd, Hanko, Galinsky, & Mussweiler, 2011). Second, on trials where participants report their own perspective, they have difficulty doing so if the avatar has a different perspective; that is, processing of the avatar's perspective interferes with reporting one's own. This latter effect – *altercentric intrusion* – is commonly thought to provide an indirect measure of the relatively automatic calculation of others' visual perspectives (e.g., Baker, Levin, & Saylor, 2016; Bukowski, Hietanen, & Samson, 2015; Furlanetto, Becchio, Samson, & Apperly, 2016; Qureshi, Apperly, & Samson, 2010; Ramsey, Hansen, Apperly, & Samson, 2013), an interpretation that aligns with theoretical claims of an implicit mentalizing system that tracks others' perspectives rapidly and effortlessly (Apperly & Butterfill, 2009; for non-mentalizing alternative interpretations of altercentric-intrusion effects, see Cole, Atkinson, Le, & Smith, 2016;

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[1] Level-1 VPT entails understanding *whether* someone can see something or not; this can be contrasted with level-2 VPT, which entails understanding *how* that something appears to the person (Flavell, Everett, Croft, & Flavell, 1981).

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Cole, Smith, & Atkinson, 2015; Santiesteban, Catmur, Hopkins, Bird, & Heyes, 2014).

One potential problem with interpreting altercentric-intrusion effects on a behavioral task as reflecting automatic perspective tracking is that no single task – nor a set of trials in a task – provides a "pure" measurement of automatic processing (Jacoby, 1991). Thus, rather than assuming that a single task captures a single process (i.e., "task-dissociation" approach; see Payne, 2001), we instead assume that both automatic *and* controlled processes contribute to the strength of altercentric-intrusion effects in behavior (and, indeed, to performance on any behavioral measure). Importantly, we identify automatic processing influences on task performance as our core construct of interest (i.e., automatic altercentrism) and distinguish it from controlled processing, which may also influence performance on the L1-VPT task. It is possible that, in some cases, controlled processes and automatic processes might have opposing influences on L1-VPT task performance, potentially masking automatic perspective tracking (we return to this issue in the Discussion). Claims of automaticity, therefore, require separating the unique contributions of these processes to task performance (Payne & Cameron, 2014).

3. Process dissociation and visual perspective taking

A prominent technique for decomposing component processes in a single task is the process-dissociation procedure (PDP). Originally developed to disentangle automatic versus controlled influences on memory (Jacoby, 1991), variants of the PDP have been used to estimate processes underlying task performance in various other domains, including decision-making under uncertainty (Ferreira, Garcia-Marques, Sherman, & Sherman, 2006), moral judgment (Cameron, Payne, Sinnott-Armstrong, Scheffer, & Inzlicht, 2016; Conway & Gawronski, 2013), and racial stereotyping (Payne, 2001; Todd, Thiem, & Neel, 2016). Unlike task-dissociation approaches, which assume that indirect (or implicit) measures capture only automatic processes, the PDP (and other process-dissociation approaches; e.g., Conrey, Sherman, Gawronski, Hugenberg, & Groom, 2005) assumes that automatic and controlled processes can be differentiated in a single task by creating conditions that put these processes both in concert and in opposition. The PDP specifies *a priori* how automatic and controlled processes interact to drive behavior in a particular task; thus, it uses task performance to estimate the probability of each process operating.

Applying the logic of PDP to the L1-VPT task, when participants and the avatar can see the same number of dots (i.e., consistent trials), automatically calculating the avatar's perspective and deliberately reporting one's own perspective lead to the same response. The probability of responding correctly is the probability of controlled processing (C) operating plus the probability of automatic processing (A) operating when control fails (1 − C):

$$P(\text{correct}|\text{consistent trials}) = C + A(1 - C) \quad (1)$$

When the number of dots visible to the avatar differs from the number visible to participants (i.e., inconsistent trials), however, automatically calculating the avatar's perspective and deliberately reporting one's own perspective lead to different responses. The probability of an incorrect response here is the probability of automatic processing operating when control fails:

$$P(\text{incorrect}|\text{inconsistent trials}) = A(1 - C) \quad (2)$$

With these two equations, one can solve algebraically for separate estimates of C and A:

$$C = P(\text{correct}|\text{consistent trials}) - P(\text{incorrect}|\text{inconsistent trials}) \quad (3)$$

$$A = P(\text{incorrect}|\text{inconsistent trials})/(1 - C) \quad (4)$$

The PDP, as we apply it here to understand altercentric-intrusion effects, characterizes automaticity and control in terms of intentionality (see also Payne, 2001). Controlled processes are those in which one's responses conform to one's performance intentions; thus, the C parameter reflects accurately reporting one's own perspective. Automatic processes, in contrast, are those that operate regardless of whether they facilitate or interfere with intentional performance. On a PDP-based account of altercentric-intrusion effects, the A parameter is of focal interest for claims about automatic visual perspective taking—this parameter reflects calculation of the target's perspective despite intending only to report one's own perspective.

4. Overview of experiments

In two experiments, we used the PDP to estimate component processes underlying altercentric-intrusion effects in L1-VPT. A primary advantage of the PDP is that it can quantify automatic and controlled processes; however, it cannot specify the conditions under which these processes operate. Thus, claims about specific operating conditions (e.g., resource efficiency) must be tested by manipulating theoretically-relevant processes. Our general strategy here was to create experimental conditions that, based on prior work, should affect one component process (but not the other) in a particular direction.

In Experiment 1, we manipulated the response deadline in the L1-VPT task. We reasoned that a fast deadline should reduce the opportunity to exert control over one's responses (Cameron et al., 2016; Conrey et al., 2005; Payne, 2001), thereby weakening controlled processing but leaving automatic processing of the avatar's perspective unchanged. In Experiment 2, we manipulated the specific target in the L1-VPT task. Based on prior work suggesting that altercentric-intrusion effects are stronger for social versus non-social targets (e.g., Nielsen, Slade, Levy, & Holmes, 2015; Samson et al., 2010; Todd & Simpson, 2016), we reasoned that automatic processing of a target's perspective should be greater if the target is a human avatar versus a non-human entity, whereas controlled processing should be relatively unaffected by the specific target.

5. Experiment 1: Time pressure

5.1. Method

Native English-speaking undergraduates ($N = 125$) participated for course credit. Data were excluded from 6 participants with below-chance task performance, which could indicate confusion about response key mappings or task instructions. The PDP assumes that parameter estimates range from 0 to 1 (Jacoby, 1991); thus, data from 2 participants (both in the short-deadline condition) with negative C estimates, which violate PDP assumptions (i.e., more errors on consistent than inconsistent trials), were excluded. Computer malfunctions resulted in data loss for 2 other participants, leaving a final sample of 115 (80 women, 34 men, 1 unreported).

Participants completed an L1-VPT task (Samson et al., 2010). They saw a room with red dots on the left and right walls. A human avatar stood in the center of the room facing left or right. On *other* trials, participants responded from the avatar's perspective; on *self* trials, they reported their own perspective. Additionally, on *consistent* trials, the number of dots visible to the avatar was identical to the number visible to participants; on *inconsistent* trials, the avatar could not see some of the dots that were visible to participants.