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KNOWING ME, KNOWING YOU: DEICTIC COMPLEXITY IN FALSE-BELIEF UNDERSTANDING

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Investigators examined the role of deictic complexity in the context of false-belief understanding. Deictic relations (i.e., I and YOU, HERE and THERE, and NOW and THEN) are used to describe one's perspective on events in the environment. Differences in complexity between responding in accordance with "I" (self) and "You" (other) relations are thought to be critical in explaining the relative difficulty of false-belief tasks in which taking the perspective of another plays a central role. Reaction times for false-belief tasks in which the presence of self and other relations was systematically manipulated were compared. A significant difference emerged between mean reaction times for these two sets of tasks, thus providing direct evidence that deictic relations are involved in false-belief tasks.

False-belief understanding may be defined as the ability to know that someone can have a misconception about an event (Baron-Cohen, Tager-Flusberg, & Cohen, 2000). Consider the following example of a task used by Sabbagh and Taylor (2000) to test for false belief:

Ben put a folder and a clipboard on his desk. His friend Maggie noticed that he had lots of work to do. Then Maggie went out for coffee. While Maggie was gone, Ben moved the clipboard. Ben put the clipboard on the bookshelf. He left the folder on his desk. Where will Maggie think the clipboard is?

To answer this "unexpected transfer" (UT) task correctly, respondents need to understand that Maggie will not know that Ben moved the clipboard and thus she will act on the basis of a false belief.

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Now consider an example of a task in which respondents were presented with a similar scenario involving a hypothetical photograph:

Ben put a folder and a clipboard on his desk. His friend, Maggie, took a picture of these things. Then, Maggie put the camera away. After a little while, Ben moved the clipboard. Ben put the clipboard on the bookshelf. He left the folder on his desk. Where will the clipboard be in the photograph?

To answer correctly, respondents need not “construct the mental representation of another” but may simply recount what was in the photograph. Although these are apparently similar tasks, the UT task tests false-belief understanding whereas the second task does not.

Findings from studies that involve false-belief tasks indicate that young children can respond correctly to the photograph task (nonfalse belief) before they can respond to the UT task, suggesting that false belief is a cognitive skill that appears at a particular point in normal development (Lekam & Perner, 1991; Leslie & Thaiss, 1992). Many researchers in this area work under the rubric of theory of mind (ToM), according to which false belief is conceptualized as advanced or sophisticated perspective taking. Within this framework, a child has developed a theory of mind when she can “mentally represent” another person’s beliefs, even when they are false. Research with children with autistic spectrum disorder has provided evidence to support ToM. For example, Slaughter (1998) demonstrated that this population, who lack a theory of mind and thus demonstrate poor perspective-taking skills, typically fail the standard false-belief tasks. In contrast, however, these children pass the photograph task, described above.

Some researchers have attempted to account for the development of false belief and other perspective-taking skills in terms of relational complexity (Andrews, Halford, Bunch, Bowden, & Jones, 2003). According to relational complexity (RC) theory, the core predictor of performance on ToM tasks is the number of variables that are to be related (Halford, Wilson, & Phillips, 1998). For example, the UT task involves relating three variables: the person’s environmental cue (object location), the setting condition (movement seen or not seen), and the person’s representation (represented object location). Andrews et al. (2003) demonstrated that performance on false-belief tasks was predictable from performance on non-ToM tasks that involved relating three variables. This finding suggests that it may be the level of relational complexity, not ToM understanding per se, that explains false-belief test outcomes. Interestingly, further evidence from neuropsychological research indicates that persons with ASD may have deficits in high-level reasoning and linguistic processing (e.g., Minshew, 1993; Minshew & Goldstein, 1993; Minshew & Goldstein, 1998). Insofar as these processing capacities are involved in relational performances, Minshew’s findings are consistent with the RC account of ToM.

Viewing perspective taking as inherently relational presents us with a number of broad and interesting questions that RC theory has not as

yet addressed. For example, RC theorists suggest that the development of children's relational skills is experience driven, but the details of this critical experience, or learning history, remain unclear. One theory that has begun to address the nature of the learning history that gives rise to relational abilities, including perspective taking and false belief, is relational frame theory (RFT; Hayes, Barnes-Holmes, & Roche, 2001).

RFT is a functional-analytic approach that accounts for the development of language and higher cognition in terms of generalized patterns of arbitrarily applicable relational responding. The simplest example of an arbitrary relation is that of coordination between words and their referents, which children begin to learn at around the age of 2 years. Continued exposure to the socioverbal environment produces increasingly complex patterns of arbitrarily applicable relational responding, including distinction, opposition, comparison, and so forth (O'Hara, Roche, Barnes-Holmes, & Smeets, 2002; Whelan, Reilly, & Barnes-Holmes, 2005). According to RFT, perspective taking is based on a particular class or type of relational responding referred to as deictic frames or relations.

Deictic relations refer to the relational processes involved in taking a perspective (McHugh, Barnes-Holmes, & Barnes-Holmes, 2004; McHugh, Barnes-Holmes, Barnes-Holmes, & Stewart, 2006). The deictic relations that are most important in this regard are I-YOU, HERE-THERE, and NOW-THEN. According to RFT, deictic relations are unique because, unlike other relations, they do not appear to have physical or nonarbitrary relational counterparts. In the case of the relation of comparison, for example, a child will learn to relate objects on the basis of actual physical size before she will start to compare objects on the basis of abstract relations. In the case of deictic relations, however, physical or formal features are less salient in providing the basis for this type of responding. Instead, deictic relations are believed to emerge in part through a history of responding to questions such as "What am I doing here?" or "What were you doing then?" Although the form of these questions is often identical across contexts, the physical environment is always different. What remains consistent are the relational properties of I versus YOU, HERE versus THERE, and NOW versus THEN. These relational properties are said to be abstracted through learning to talk about one's perspective in relation to the perspective of others (Hayes, 1984). For example, I is always from this perspective HERE and NOW but not from the perspective of another person THERE and THEN. According to this view, it is the relatively abstract (i.e., nonformal) quality of deictic relations and the fact that they depend on an already established relational repertoire that renders them relatively difficult to learn, and thus they typically emerge late in development. Consistent with this view, a recent RFT study showed that performances on relational perspective-taking tasks followed a developmental trend (see McHugh et al., 2004).

According to RFT, understanding false belief comprises relational skills not unlike perspective taking. Consider the following false-belief task. A child is presented with a candy box and is asked, "What is inside

the box?" Consistent with its common usage, a young child will likely reply that the box contains candies. However, on this trial the candy box actually contains pencils, and this fact is made apparent to the child when the box is opened. To determine the child's understanding of her own false belief regarding the contents of the box, she is then asked, "Why *did* you think there was candy inside the box?" and "Why do you think there are pencils in there now?" According to RFT, understanding and answering these questions appropriately involves responding in accordance with deictic frames and the frame of logical NOT. Consider the questions again, with the deictic relations emphasized: "What do YOU think is inside the box HERE and NOW? Why did YOU think there was candy HERE before we opened it THEN?" and "Why do YOU think there are pencils in THERE NOW?" For RFT, the correct answers are as follows: "I did NOT see inside THERE and THEN (false belief), but I do see inside HERE and Now (true belief)."

To test the RFT account of false belief, McHugh et al. (2006) employed a series of relational true- and false-belief tasks that were given to participants across five age bands from 3 to 30 years. The developmental profile that emerged indicated that the 3- to 5-year-olds performed at random across all tasks and were significantly weaker at the tasks than all other age groups. In addition, the 5- to 7-year-olds, although better at the tasks than the younger group, were significantly worse than the three older groups. This pattern of improvements across age groups was broadly consistent with the ToM literature on false belief, thus providing evidence of the RFT interpretation of this phenomenon.

In developing an RFT account of false belief, an important distinction in terms of relational complexity must be made between tasks that involve the perspective of the self (I) versus other (You). Specifically, tasks that involve the perspective of another will possess more relational complexity than those that require the perspective of the self. That is, OTHER tasks require that the participant respond in accordance with an if-then relation combined with a deictic relation between I and YOU, but SELF tasks do not require this combination. In other words, a participant has to derive "If I were you, then I would . . ." in order to take the perspective of another. This type of interaction between two relations is not necessary when operating from one's own perspective (see Figure 1). The present study will test this basic argument using a false-belief task derived from previous research by Sabbagh and Taylor (2000).

Participants in the Sabbagh and Taylor (2000) study were presented with a short narrative that described a character's belief about the location of an object that had been relocated in his or her absence. Performances on these tasks were compared with those that described a photograph taken prior to the relocation of the object, and the results indicated that the other-belief tasks involved perspective taking, but the photograph tasks did not. The current study employed these two types of task and a third that simply involved asking participants to report their own beliefs about a scenario. The basic prediction is that reaction times to the other-perspective tasks will be longer than those recorded for self-perspective

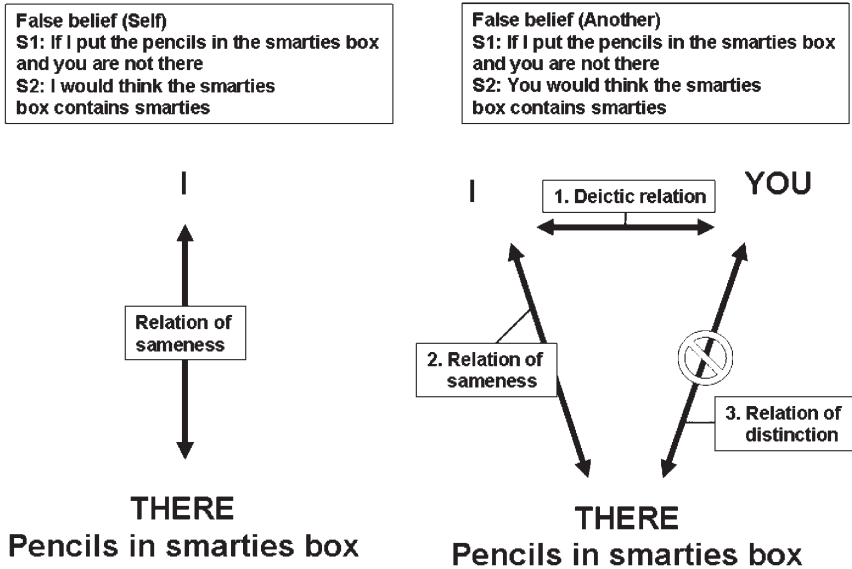


Figure 1. An example of a self-belief false-belief false task.

or photograph tasks. This prediction is based on the RFT argument that only the former task involves a critical combination of if-then and deictic relations, and thus greater relational complexity than the other two.

Method

Participants

Twenty adult volunteers participated (6 males, 14 females; age range, 21–32 years). Participants were university undergraduates recruited through faculty notice-board advertisements. They were experimentally naïve and received no financial remuneration.

Materials

Stimuli were presented and responses recorded by means of a personal computer with a 550-MHz processor programmed in Microsoft Visual Basic 6.0 and connected to a 14-inch-diameter color monitor. Three stimulus sets composed of pictures were employed: Set 1: a cookie jar, cookies, and a doll; Set 2: a toy box, a pizza, and a toy; and Set 3: pencils, a candy packet, and candies. These stimuli were selected for the purposes of the false-belief protocol because one would normally expect to find cookies rather than a doll, for example, inside a cookie jar. No *actual* objects of any kind were present during the study.

Procedure

The experiment consisted of one block of 96 test trials. These trials were differentiated along three primary dimensions: (1) perspective

taking (self, other, and photograph); (2) belief (true belief or false belief); and (3) statement type (whether the response was true or false). These distinctions generated twelve trial types, denoted as Self/True Belief/True (Response); Self/True Belief/False; Self/False Belief/True; Self/False Belief/False; Other/True Belief/True; Other/True Belief/False; Other/False Belief/True; Other/False Belief/False; Photo/True Belief /True; Photo/True Belief/False; Photo/False Belief/True; and Photo/False Belief/False.

Table 1
Examples of Self, Other, and Photograph Trial Types

SELF BELIEF			
TRUE BELIEF		FALSE BELIEF	
True Response	False Response	True Response	False Response
<i>If you put the pencils in the smarties box and I am there</i>	<i>If I put the pencils in the smarties box and you are there</i>	<i>If you put the pencils in the smarties box the and I am not there</i>	<i>If I put the pencils in smarties box and you are not there</i>
You would think the smarties box contains PENCILS?	You would think the smarties box contains SMARTIES?	You would think the smarties box contains PENCILS?	You would think the smarties box contains PENCILS?
OTHER'S BELIEF			
TRUE BELIEF		FALSE BELIEF	
True Response	False Response	True Response	False Response
<i>If you put the pencils in the smarties box and I am there</i>	<i>If you put the pencils in the smarties box and I am there</i>	<i>If I put the pencils in the smarties box and you are not there</i>	<i>If I put the pencils in the smarties box and you are not there</i>
I would think the smarties box contains PENCILS?	I would think the smarties box contains SMARTIES?	I would think the smarties box contains PENCILS?	I would think the smarties box contains SMARTIES?
PHOTOGRAPH CONTROLS			
TRUE BELIEF		FALSE BELIEF	
True Response	False Response	True Response	False Response
<i>If you photograph pencils in the smarties box and then I take the pencils out</i>	<i>If I photograph pencils in the smarties box and then you take the pencils out</i>	<i>If you photograph pencils in the smarties box and then I do not take the pencils out</i>	<i>If I photograph pencils in the smarties box and then you do not take the pencils out</i>
The photograph will show the smarties box containing PENCILS?	The photograph will show the smarties box containing SMARTIES?	The photograph will show the smarties box containing PENCILS?	The photograph will show the smarties box containing SMARTIES?

Examples of each of the 12 trial types are presented in Table 1. At this point in the procedure, it is important to emphasize that “I” as it appeared on the screen always represented the perspective of the experimenter, while “You” always represented the perspective of the participant.

Consider the Self/True Belief/True trial presented in the center left portion of Table 1: “If you put the pencils in the smarties box and I am there. You would think the smarties box contains PENCILS?” This trial type involves responding in accordance with one’s own belief (i.e., the

perspective of the self), because the participant is asked to identify what she thinks about what she saw directly. It presents a scenario containing a true belief (because both parties saw what actually happened), and the second statement is true in the context of the first statement (if you put pencils in the box, you would think that there were pencils there).

Now consider the Other/False Belief/True trial presented in the center left portion of Table 1: "If I put the pencils in the smarties box and you are not there. I would think the smarties box contains PENCILS?" This trial type involves responding in accordance with the perspective of the other, because the participant is asked to identify what the experimenter thinks. It presents a scenario containing a false belief, because the child did not see the experimenter put the pencils in the box and thus the child would assume that the experimenter would think that the box contains smarties rather than pencils. Nevertheless, the response presented is TRUE because the experimenter put the pencils in the box and would therefore know that they were there.

The protocol also included trial types involving a scene that was altered after a photograph had been taken. These trials do not involve true or false beliefs but are factual situations in which the location of objects has been changed. Consider, for example, the Photo/True Belief/True trial presented in the bottom left portion of Table 1: "If you photograph pencils in the smarties box and then I take the pencils out. The photograph will show the smarties box containing PENCILS?" This trial type involves no perspective taking, because it simply states that a photograph was taken before the pencils were removed. Consequently, the distinction between true and false belief does not genuinely apply. Nonetheless, they are labeled as such to illustrate how the photograph tasks functioned as balanced controls for the other and self perspective-taking tasks.

Completing the 96 trials required approximately 45 min. At the beginning of the program, participants were provided with a brief set of instructions as follows:

During this experiment you will be presented with pairs of statements. After the first statement, a second statement about the original statement will be presented. Your job is to press Z if the second statement is true and M if the second statement is false. When you are ready to see some practice trials, click on the button below.

The program commenced with 10 practice trials, after which the experiment proper began.

Each test screen consisted of a full-size white background with the two statements for that trial in the top middle section of the screen. Each word contained within the two statements appeared on screen every 512 ms in black Arial text, font 12 (consistent with the original study by Sabbagh & Taylor, 2000). As soon as the first statement had appeared, the second statement appeared, again word by word. To respond appropriately, participants were required to click on either the Z (for true) or the M (for false) key to indicate whether they considered the second statement to be

true or false, respectively. Participants could make a response only when the final word of the second statement had been presented on the screen. Once participants had made their key selection (i.e., Z or M), the trial was complete (errors and response latencies that exceeded 2.5 s were not included in subsequent analyses). At the end of each trial, an intermediate screen appeared and remained until participants clicked with the mouse to continue to the next test trial, which began immediately.

To ensure that participants responded to the perspective-taking tasks in the same way, at the end of the program each was presented with a sheet of white paper containing the following scenario: "If I put the pencils in the smarties box and you are not there. You would think the smarties box contains pencils." Below this scenario was the question, "Does the reader of this question see themselves as 'I' or 'You'?" Participants were required to circle the appropriate response as it applied to them. To further clarify this, participants were asked,

Was it you (the reader) who put the pencils in the smarties box and someone else who was not there at the time? YES or No? Or was it someone else who put the pencils in the smarties box and you (the reader) who was not there at that time? YES or No?"

Once participants had answered these questions, the experimental session ended.

Results

All participants responded accurately to at least 95% of the trial types. Mean response latencies were calculated for each participant for each of the twelve trial types, and the overall means calculated across participants are presented in Figure 2. Latencies for the four OTHER trial types were longer ($M = 1.34$ s) than those for either the SELF ($M = 1.13$ s) or PHOTOGRAPH trial types ($M = 1.07$ s).

The response latency data were subjected to a 3 (self, other, photograph) \times 2 (true or false belief) \times 2 (true or false response) repeated measures analyses of variance. These analyses revealed a significant main effect for perspective, $F(2, 38)$, 5.88, $p < .01$, but no other main or interaction effects, p 's $> .09$. Results of three Bonferroni post hoc tests indicated that response latencies for the OTHER trial types were significantly longer than for the SELF ($p < .01$) and PHOTOGRAPH trial types ($p < .01$), but the latter did not differ significantly ($p > .05$).

Discussion

The results from the current study indicate a clear difference in response latencies to tasks that required taking another's perspective, relative to those tasks that required taking one's own perspective or simply reporting on the content of a photograph. Latencies did not differ significantly between the latter two tasks. These findings suggest that there is a functional distinction between responding to tasks that involve one's

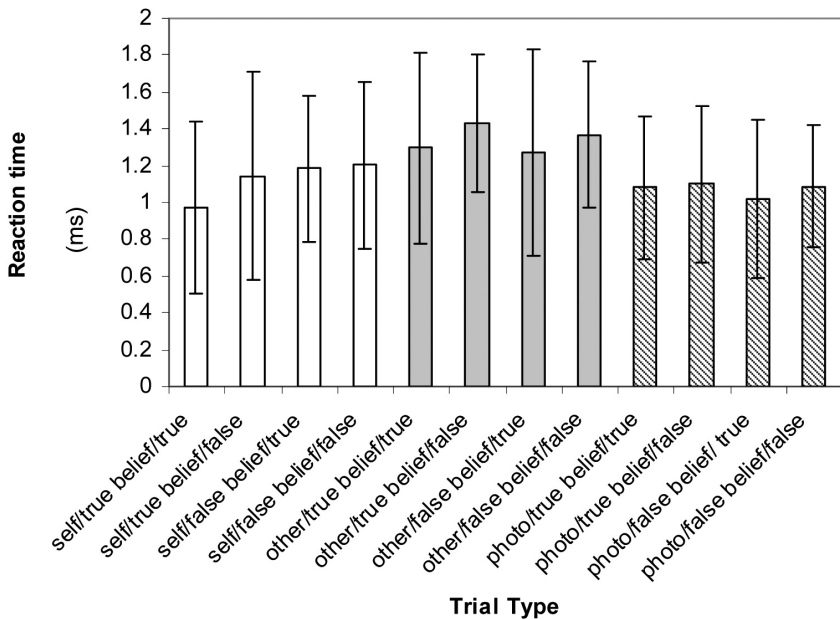


Figure 2. The mean reaction times for participants across the different trial types.

own perspective, relative to taking the perspective of another. The data are consistent with the RFT prediction that reaction times to other-perspective tasks will be longer than for self-perspective or photograph tasks because the former involves greater relational complexity than the latter two.

It is interesting that the current study failed to show any significant differences between the true- and false-belief tasks, for either self or other perspectives. A broadly similar result was obtained in a recent study of false belief (McHugh et al., 2006). Specifically, no difference was found when comparing tasks with and without logical NOT, rather than deictic complexity per se. Taken together, these data suggest that the combination of if-then and deictic relations together increases the relational complexity involved in taking the perspective of another.

Although the current data support a prediction based on RFT, it is important to recognize that the theory constitutes a behavioral approach to cognition and thus its predictions always are constrained by historical and contextual variables. Recognizing this fact is particularly important in the uncontrolled world of natural language where an individual's history of derived relational responding typically is unknown. Consequently a different history might produce a different set of predictions. Imagine participants who had just been exposed to a long series of tasks that required them to take the perspective of another. With such a history, it is possible that response latencies on other-perspective tasks would be significantly reduced. Indeed, if perspective-taking abilities proved to be malleable, at least to some extent, then perhaps the test trials

employed in the current study could be adapted for training non-typically-developing populations for whom perspective taking and false-belief skills are deficient. In fact, the successful adaptation of the current work to the applied domain would constitute an excellent test of the RFT approach to human perspective taking.

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