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Perceptual Access Reasoning: What Are the Alternatives?

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Abstract

Karen Bartsch (2021), Charlie Lewis (2021), and Beate Sodian (2021) provided thoughtful commentaries on our Society for Research in Child Development Monograph, "Perceptual Access Reasoning (PAR) in Developing a Representational Theory of Mind" (Fabricius et al., 2021). The commentators suggested alternative accounts of our empirical findings, an alternative approach to studying ToM development more generally, and alternative ways to test PAR theory specifically. Here we provide an in-depth response to the various alternatives, as well as a brief overview of the theory and a discussion of two recent alternative accounts that challenge the theory's counter-intuitive prediction that PAR-users will fail true belief tasks.

Perceptual Access Reasoning: What Are the Alternatives?

It is important for children to learn to take others' perspectives. Good perspective-taking skills benefit personal relationships and underlie broader awareness that gender, race, and ethnicity profoundly affect how others see the world. During the last 40 years, research has focused on what children initially need to understand about the mind in order to develop good perspective-taking skills. This research falls under the rubric, development of theory of mind. Theory of mind (ToM) refers to our commonsense understanding that people have various types of mental states (e.g., wanting, perceiving, knowing, believing) that underlie their perspectives and actions. ToM research has expanded into many different areas, including but not limited to clinical disorders such as autism and schizophrenia, neuroscience, primate cognition, philosophy of mind, early education, literary theory, and human systems engineering; e.g., 49% of Google Scholar references since 2000 to "social-neuroscience" are references to "social-neuroscience and theory of mind."

ToM research was launched with the invention of a versatile laboratory measure, the false belief (FB) task (Wimmer & Perner, 1983). There are several different versions of FB tasks. In one, the FB location task, a story protagonist puts an object in one location (A), and leaves. A second character surreptitiously moves it to location B. The protagonist returns, and the test question is, "Where will [protagonist] look for the object?" When children give the correct answer, A, it is assumed that they understand that the protagonist has a false belief that the object is still in A.

False beliefs are mental representations that mis-represent the real state of affairs. Understanding that people can have false beliefs is an important developmental milestone because it signals that children have acquired a representational ToM, which is an understanding

that what mental states such as perceptions, memories, knowledge, and beliefs have in common is that they are mental representations of reality. The FB task has been called the litmus test of representational ToM. Many children pass FB tasks at age four, and almost all children pass by the time they turn six; thus, the standard model of ToM development is that the basic conceptual structure of a representational ToM is normally in place by age six.

Our recent monograph (Fabricius et al., 2021) presents a new theory of the development of representational ToM. The theory exploits a weakness in the FB task. The weakness is the structure of the task, which allows children to arrive at the correct answer without reasoning about false beliefs, but rather by using a non-representational ToM, termed perceptual access reasoning (PAR). The FB task confounds belief reasoning and PAR, and thus is not a litmus test of representational ToM.

The central tenet of the theory is that PAR is the developmental precursor of representational ToM. As a non-representational ToM in the years from four to six, PAR provides a bridge between 2- to 3-year-olds' first insights into mental states, and 7- to 8-year-olds' eventual grasp of representational mental states. We think that the theory of PAR is a more developmentally realistic view than the standard model, in which the development of representational ToM is packed into a few short, early years.

In the monograph, we offered logical arguments for the developmental plausibility of PAR, and empirical tests of the theory's predictions, all of which were supported. Three invited commentaries (Bartsch, 2021; Lewis, 2021; Sodian, 2021) all concurred that "the shattering proposal that the widely accepted description of ToM development in young children is fundamentally wrong" (Sodian, 2021, pp. 3 – 4) deserves to be taken seriously. The commentators suggested alternative accounts of our empirical findings, an alternative approach

to studying ToM development more generally, and alternative ways to test PAR theory specifically. Our invited response (Fabricius, 2022) was necessarily brief due to space constraints. Here we provide an in-depth response to the various alternatives, which we hope can suggest productive ways forward. First, however, we present a brief overview of the theory, followed by a discussion of two recent alternative accounts that challenge the theory's counter-intuitive prediction that PAR-users will fail true belief tasks.

1. Overview of PAR theory

In PAR, children are constrained to reasoning about what someone has perceptual access to in the current situation, and to understanding the person's behavior only on the basis of the information in the current situation. PAR is composed of the following two rules:

Rule 1: Perceptual access leads to knowing, and lack of perceptual access leads to not knowing.

Rule 2: Knowing leads to acting correctly, and not knowing leads to acting incorrectly.

The PAR concept of perceptual access is the well-known non-representational, or Level-1 conception, in which perceptual access is a direct connection to reality. PAR-users can identify what someone perceives and does not perceive, and why (e.g., the person's eyes are open or closed), but cannot imagine how something appears to someone (e.g., as right-side up or upside down; Flavell et al. 1981). Understanding how something appears requires the representational, Level-2 conception of perceptual access, in which perceptual appearances exist in the mind as mental representations that are distinct from reality.

PAR theory posits a non-representational, Level-1 concept of knowing. Three signature limitations on the PAR Level-1 concept of knowing are embedded in the two rules. Rule 1 describes how PAR-users understand the causal connection between the non- representational concepts of perceptual access and knowing. In PAR, knowing is a direct

connection to perceptual access; thus, PAR-users can only reason that if someone does not have perceptual access, then that person must not know. Consequently, the first signature limitation is that PAR-users cannot imagine that someone can know something new by drawing inferences and conclusions that go beyond what is perceived. Understanding knowing by way of inferences and conclusions requires a representational concept of knowing, in which inferences and conclusions exist in the mind as mental representations that are derived from thinking about what is perceived. The second signature limitation is that PAR-users cannot imagine that someone can continue to know something by remembering it after the situation has changed and perceptual contact is lost. Understanding knowing by way of remembering also requires a representational concept of knowing, in which memories exist in the mind as mental representations that are stored over time.

Rule 2 describes how PAR-users understand the causal connection between knowing and acting correctly. In PAR, correct actions are tied to knowing; thus, PAR-users can only reason that if someone does not know, then that person must get it wrong. Consequently, the third signature limitation on the PAR concept of knowing is that PAR-users cannot imagine that someone can act correctly by guessing. Understanding acting correctly by way of guessing also requires a representational concept of knowing, in which guesses exist in the mind as mental representations that are generated by imagining alternative courses of actions in cases where the person does not know.

In tandem, Rules 1 and 2 allow PAR-users to pass all the different versions of FB tasks. In the FB location task described above, they reason only about the new situation that arises after the protagonist returns; i.e., the protagonist does not *now* see the object in B, and thus does not know it is in B. They go on to predict that the protagonist will search incorrectly; i.e., in the

location (A) that they themselves know is empty. Thus, PAR-users' reasoning in the FB location task illustrates the second signature limitation on the PAR concept of knowing. All standard false belief tasks, surprisingly, have only one incorrect option, allowing children to answer correctly by default, using only non-representational mental state concepts.

A common misconception is that PAR is a simple heuristic. On the contrary, coordinating the two PAR rules is an effortful reasoning process. More fundamentally, PAR is a developmental level of new conceptual competence because the development of PAR has all the features of conceptual development; i.e., awareness of a new ontological distinction between reality and mind, which comes with young children's first insights into mental states; construction of new concepts of seeing and knowing; and discovery of new causal connections among seeing, knowing, and acting.

1.1 PAR and true belief

The most counter-intuitive prediction of PAR theory is that when children begin to pass FB tasks, they should likewise begin to fail the companion true belief (TB) tasks. In the TB location return task, for example, the protagonist hides the object in A, and then watches a second character move it to B. The protagonist then simply leaves and returns, and thus has a true belief that the object is still in B. The protagonist's return elicits PAR by signaling that the situation has changed. Just as in the FB location task, PAR-users in the TB location return task reason only about the current situation; i.e., the protagonist does not *now* see the object in B, does not know it is in B, and will search incorrectly, in the empty A location. Thus, TB location return tasks also illustrate the second signature limitation on the PAR concept of knowing.

The TB versions of contents and identity tasks illustrate the first signature limitation on the PAR concept of knowing. In TB contents and identity tasks, respectively, children are shown

that an M&Ms bag contains a pencil, and are allowed to feel that a fake rock is a sponge. Next, they watch the experimenter remove the pencil and put M&Ms in the bag, and remove the fake rock and place a real rock on the table. Newcomers arrive, and they look at the M&Ms bag but do not open it, and look at the rock but do not touch it. PAR-users cannot reason that they will gain true beliefs about the contents of the bag and the identity of the object by drawing inferences and conclusions from the appearances of the things. Instead, PAR-users reason that because newcomers do not see the M&Ms inside and do not touch the rock, they do not know the actual contents and the actual identity. When asked the forced-choice test questions (pencil/M&Ms; sponge/rock) about what the newcomers will think, PAR-users reason that newcomers will get it wrong and think the M&Ms bag contains a pencil, and the rock is a sponge.

We had tested these predictions in Fabricius et al. (2010) using TB location, contents, and identity tasks. As predicted, many 4- and 5-year-olds passed the companion FB tasks and failed the TB tasks, resulting in a U-shaped developmental pattern of TB performance, wherein 3-year-olds passed by reasoning only about the actual location, contents, and identity -- as if they heard the test questions to be, “Where is it?” “What is inside?” and “What is it?” -- and many 6-year-olds passed by reasoning about true beliefs.

Little attention was paid to these, as well as previous findings of TB errors (Friedman et al., 2003; Garnham & Ruffman, 2001; Lohmann et al., 2005; Ray & Mitchell, 2004), and the subsequent studies (Perner et al., 2015; Rakoczy et al., 2015; Rubio-Fernandesz & Geurtz, 2013, 2016) continued to use TB tasks simply as controls, until Oktay-Gür and Rakoczy (2017) re-discovered the TB error. The TB location literature, but not the TB contents and identity literatures, was by then sufficient for us to derive five hypotheses from PAR theory about which

of the versions of TB location tasks that researchers had used from 1983 until 2017 should tend to elicit PAR, and which should interfere with PAR. There is no standardized TB location procedure, and there have been few tests of whether different versions affect performance. The hypotheses involved protagonist movement (stay versus return tasks), inconsequential object movement, test question (look versus look first), aspectuality tasks, and highlighting protagonists' prior perceptual access. All five hypotheses were supported in the secondary analyses of the TB location literature that we reported in Chapter II of the monograph. The hypothesis regarding return tasks was also recently supported by Pesch et al. (2020) and Schidelko et al. (2022), who replicated the Chapter II findings of substantial proportions of errors in TB location return tasks among 4½- and 5½-year-olds.

1.2 Alternative accounts of true belief errors

Two alternative accounts of children's errors in TB location tasks have recently been offered. Oktay-Gür and Rakoczy's (2017) pragmatic misinterpretation account holds that when children first begin to understand false belief, they suspect that TB test questions are too obvious and that the correct answer must be different than the obvious one. The test question is especially obvious when the protagonist stays in the scene and the question is asked immediately after the protagonist watches the second character move the object to B; thus, the pragmatic misinterpretation account predicts that children will fail TB location stay tasks. In contrast, PAR- users will pass TB location stay tasks. When the protagonist stays, there is no indication that the situation has changed, and when PAR- users do not decide that the situation has changed, they simply default to the conclusion they came to during the hiding phase, that the protagonist sees and knows and will search correctly. We found 24 TB location stay tasks[1] in the literature, and the secondary analyses of those tasks in Chapter II supported PAR theory, in that the proportion of correct responses was .94 at average age of 54 months.

Oktay-Gür and Rakoczy (2017) found that children erred in three TB location tasks in which PAR theory predicts errors; i.e., return tasks, look-first questions[2], and aspectuality tasks. For children who are beginning to coordinate the two PAR rules, the test question, "Where will [protagonist] look first?" will prime Rule 2, by implying that the first search will be wrong.

Aspectuality tasks use objects that have two identities, or aspects, and require children to understand that how protagonists mentally represent the objects, that is to say what they believe about them, will depend on what they know about the different aspects. For example, in a TB location aspectuality task in which a doll can be transformed into Superman and Clark Kent, the protagonist would be shown Clark Kent donning the Superman costume before disappearing into location A. The protagonist would then watch Superman fly from A to location B, and thus the protagonist would have a true belief that Clark Kent is in B. PAR-users will fail the test question, "Where will [protagonist] look for Clark Kent?" by reasoning, "He didn't see Clark Kent fly to B, so he doesn't know Clark Kent is there, so he will get it wrong and say he is in A." Aspectuality tasks thus illustrate a fourth limitation on the PAR concept of knowing; i.e., PAR-users cannot use what protagonists know to reason about aspectuality of protagonists' beliefs.

The pragmatic misinterpretation account does not predict how look first questions should affect performance, but it does predict for TB return and TB aspectuality tasks, and those tasks can be used

[1] Some studies used TB location leave tasks, in which the protagonist leaves and the test question is asked while the protagonist is away. It is an empirical question whether simply leaving and not returning is sufficient to suggest to PAR-users that the situation has changed. We found that stay and leave tasks did not differ, and for brevity below we refer to both tasks as stay tasks.

[2] It would be helpful to also have the original German test questions in Rakoczy and Oktay-Gür (2020) and Schidelko et al. (2021). Schidelko et al. (2022, Footnote 3) do report the original ("For the test question in FB/TB we used this German wording: 'Sag mal, wo wird Maxi denn jetzt hingehen? [Tell me, where will Maxi go now?],' avoiding "look first.")

to distinguish pragmatic misinterpretation from PAR. On the pragmatic misinterpretation account, return and aspectuality tasks should seem less obvious and arouse less suspicion than stay tasks because there are plausible reasons for protagonists to act incorrectly; e.g., protagonists might forget where they put the object after they leave and return, and protagonists might forget that the object has two identities. In that case, both tasks should raise performance in relation to stay tasks. PAR theory predicts that both tasks should lower performance in relation to stay tasks, and the Chapter II findings supported PAR theory.

TB location object movement tasks and TB location tasks that highlight protagonists' prior perceptual access also distinguish PAR from pragmatic misinterpretation. In object movement tasks, a second character briefly removes the object and immediately puts it back into the original location during the protagonist's absence. On the pragmatic misinterpretation hypothesis, the task suggests a plausible reason for protagonists to act incorrectly; namely, that they might mistakenly think that someone moved the object. In that case, performance should be higher than in stay tasks. PAR theory predicts lower performance than in stay tasks because the object movement signals a change of situation, and the Chapter II findings supported PAR theory.

In highlight tasks, children are reminded that the protagonist saw the object in the TB location immediately before the test question is asked. On the pragmatic misinterpretation hypothesis, highlight tasks should be most obvious and susceptible to pragmatic misinterpretation, and in that case, performance should be low. PAR theory predicts that highlighting the protagonist's prior perceptual access interferes with reasoning about the protagonist's current lack of perceptual access, leaving PAR-users to default to their initial conclusion that the protagonist sees and knows, and to answer correctly that the protagonist will get it right. The Chapter II findings supported PAR theory by revealing consistently high performance in TB highlight tasks.

Rakoczy and Oktay-Gür (2020) recently tested several unique versions of TB location tasks to demonstrate pragmatic misinterpretation among 5-year-olds. Results were consistent with the pragmatic account in Studies 1 and 2. In Studies 4 and 5, the results were consistent with predictions in only one of the two task orders in each study. More of Rakoczy and Oktay- Gür's (2020) results were actually consistent with PAR theory. The Study 1 results were consistent with both PAR and pragmatic misinterpretation, and the results in Studies 3a, 3b, 3c, as well as in the other task order in Study 5, were consistent with PAR theory.

It might seem intuitively plausible that TB questions arouse suspicion, but only if we presume ahead of time that children understand true belief. If children use PAR, then true belief questions are not obvious. When children failed the TB return tasks in Chapter VII of the monograph, their justifications did not indicate that they were trying to find plausible reasons for protagonists to act incorrectly. Such justifications could easily have included references to protagonists forgetting, not remembering, not seeing, not paying attention, etc. It makes little developmental sense that when children begin to understand false beliefs, they should be certain enough about protagonists' beliefs to doubt why they are being asked true belief questions. Uncertainty characterizes developmental transitions generally (Siegler, 1996), and in ToM development specifically (Ruffman et al., 2001; see monograph Chapter X).

The second alternative account of children's errors in TB location tasks was proposed by Huemer et al. (2023) in two studies that tested the predictions that PAR-users will pass TB location stay tasks and fail return tasks. In the first study, 4½- to 6-year-olds failed both tasks. The authors suspected that children might not have noticed that the protagonist watched the second character move the object to location B. Children might have missed it because in both tasks the experimenter did not tell children that the protagonist watched the second character move the object, and did not ask a control question to

ensure that they recalled that crucial fact. Although there are no standardized procedures for TB location tasks, researchers have always included control questions for the important aspects of the narrative, and as noted above, the literature shows that children invariably pass TB stay tasks, making Huemer et al.'s (2023) first study an outlier.

In the second study, instead of simply telling children that the protagonist watched the second character move the object and asking a control question[3], the authors went a step farther and showed the protagonist walking with the second character to deliver the object to location B, and then bending over to look inside. That sets up a strong, recent, and unnecessary association between the protagonist and the TB location, and now children passed both tasks. The TB literature shows that children fail return tasks, despite recalling that the protagonist watched the object's movement to location B, and so Huemer et al.'s (2023) second study is also an outlier, and it is not readily apparent that there is more principled explanation than the association engendered by their unique procedure.

Huemer et al. (2023) acknowledge that their alternative account is not generalizable to TB location object movement tasks, but it is also not generalizable to TB contents or TB identity tasks. In contrast, PAR theory rests on the whole pattern of failures, across all the belief reasoning tasks, to support the standard model, for which PAR theory provides a consistent and principled explanation. The field will not best be served by investing resources in testing alternative accounts that focus on only one type of belief reasoning task to the exclusion of the others, or that stem from unique

[3] For example, in the TB location return task in Chapter IV of the monograph, the experimenter says, "Sarah's dad comes in and starts to clean the kitchen. He sees that the purple cupboard is dirty so he takes the toy out and moves it into the yellow cupboard. He says, 'Watch, Sarah. I'm moving your toy.' She says 'OK, I see. Thanks, Dad.'" The control question is, "Did Sarah watch him move her toy?"

procedural variations that are unlikely to be testable in future meta-analyses. The commentators raise the prospect of years of step-by-step testing of PAR theory. Fortunately, there is a way to use the findings in the monograph to evaluate alternative accounts before beginning testing, by pulling the thread, so to speak, to trace how far an alternative holds up throughout the whole pattern of findings, as we did above for the pragmatic misinterpretation account. We work through some other examples below in discussing the three commentaries.

2. Commentaries

2.1 Sodian Commentary

Sodian adopts the framework of the theory – that the origin of representational ToM is to be found in children's first ideas about perceptual access – and she adapts it by suggesting replacing PAR with what she labels as PAR*. In PAR*, implicit understanding of belief directs children toward the right perceptual access / behavioral rules to pass FB tasks; later, by reflecting on those rules, children construct the explicit concept of false belief. As Sodian puts it, "PAR* may not be guided by an RTM [a representational theory of mind] from the start, but it selects the behavioral and situational cues (i.e., what the protagonist *saw* in the past) that are specifically relevant for constructing an RTM (how the protagonist represents the present situation)" (p. 2).

Sodian applies PAR* to FB location tasks, in which the applicable behavioral rule is, "People will search for objects where they last *saw* them" (p. 2). Following this thread, it is easy to see how PAR* could be generalized to FB contents tasks, because there is an applicable behavioral rule, "People will say that containers contain what they *see* pictured or written on the outside." But there is not an applicable rule that would allow children to pass FB identity tasks without already having an explicit concept of mental representation. "People will say that an object *is* what it *looks like*" is not a behavioral rule; it is explicit awareness of appearance versus reality.

Pulling the thread further, PAR* does not explain why children fail the TB location return task, in which the protagonist last saw the object in B but children say the protagonist will look in the next-to-the-last place (i.e., in A), or why they fail the TB location object movement task, in which there is only one location where the protagonist ever saw the object. Likewise, it is not clear how PAR* could account for children failing TB contents and TB identity tasks.

We agree with Sodian that, "To fully evaluate the authors' theoretical proposal, we need to consider research findings of ToM and metacognition research more broadly," (p. 4) including children's early talk about knowing – and we would add, about seeing as well – because those early conversations are the proving grounds for the construction of PAR. However, Sodian mis- reads us as arguing that "young children, in their justifications for their judgments in false belief tasks almost never refer to mental states, but rather to behaviors or states of the world" (p. 4).This mis-reading easily stems from the particular TB and FB location tasks we used in Chapter VII. In those tasks, the protagonist put the object in location A, and the parent moved it to B, and children's justifications did mostly refer to those behaviors. In those tasks, PAR-users could use the justification, "Because that's where [protagonist] put it" as shorthand for "That's where [protagonist] put it, but it's not there now because [parent] moved it;" i.e., as an implicit reference to the fact that location A is now the empty, wrong location. In different tasks, PAR-users readily give mental state justifications. In the TB location, contents, and identity tasks used in Studies 1 and 3 of Fabricius et al. (2010), between 65% and 76% of PAR-users' justifications referred to the agent not seeing or not touching the object, not knowing, or getting it wrong. Similar findings were obtained by Fedra and Schmidt (2019), who found that 70% of the 3- to 5- year-olds who consistently distinguished agents who knew from agents who did not know consistently gave justifications that referred to whether the agents had seen or not seen.

Sodian offers two suggestions about how Fedra and Schmidt's (2019) "protest task" could be modified into critical tests of whether children use Rule 1 of PAR. In the original task, one protagonist sees and knows, and the other does not see or know, and 5-year-olds protested the latter's claim to know. Sodian's first modification would use a TB return task: "When current access is blocked, would a young child protest [in accord with Rule 1] against another person's knowledge claim based on that person's *past* perceptual access?" (p. 4). In pulling this thread, it will be important to consider that in non-protest paradigms, all evidence so far is consistent with children's use of Rule 1. First, Friedman et al. (2003, Study 1) asked a knowledge question in a TB return task, and almost all 3- to 5-year-olds said that the protagonist did not know where the object was upon his return. Second, as discussed above, children fail TB return tasks, consistent with use of both rules of PAR.

Sodian's second modification involves reasoning about the past self: "When a child's own knowledge claim is challenged, would the child back up [contrary to Rule 1] their knowledge claim by referring to their own past perceptual access?" (p. 4). Representing the past self as knowing something during the interval of time between perceptual access to it and the present requires representational ToM. In pulling this thread, it is important to consider Taylor et al.'s (1994) findings that "many 5-year-old children fail to recognize a change in mental state that involves the acquisition of new factual knowledge" (p. 1600), claiming instead that they have always known something that they learned a few moments ago. Five-year-olds' difficulty with the concept of learning illustrates the second signature limitation on the PAR concept of knowing as it is applied to the self, and seems to be a striking confirmation of PAR.

Sodian suggests that PAR could be alternately read on a strategy choice model in which, during developmental transitions, children switch between different strategies, all of which make use

of the same representational concepts of perceptual access, knowledge, and belief. PAR theory does posit that children switch between reasoning strategies during developmental transitions, but it holds that those transitions involve genuine conceptual change between reality reasoning, PAR, and belief reasoning. Our new Belief Understanding Scale (BUS) in Chapter IX identifies individuals who use each reasoning strategy, and also those who switch between reality reasoning and PAR.

Sodian's broadest concern is that "it is hard to see how children—taken to be limited to a non-representational concept of knowledge up to middle childhood—are ever supposed to grasp the concept of a mental representation that is temporally and situationally stable" (p. 2). We agree with Sodian's clear statement of this fundamental problem and challenge. To us, the advantage of PAR theory is that it poses such an interesting and important question, and provides techniques to study how older children go about developing a new concept of mind, about which we so far know nothing because of the confounded false belief tasks.

Sodian also offers several alternative accounts of our empirical findings, in which the failures to support the standard model are due to task conditions that confused young children. Evaluating the generalizability of these alternatives presupposes a level of familiarity with Sodian's commentary and with the monograph that cannot be provided here. Interested and informed readers are referred to the Supplementary Materials (in Appendix 1) for detailed discussions of those alternatives.

2.2 Lewis Commentary

Lewis (2021) lauds us for "a new research task or approach … to upset the applecart" (p. 1) of the monopoly of false belief tasks. The BUS simply pairs a standard FB contents task with a TB contents task, and asks children to justify their answers. So in terms of methods, there is nothing revolutionary. It is the longer developmental route to representational ToM that is new. Lewis is sympathetic to the longer route, but he is skeptical of the BUS (no pun intended).

The BUS falls far short of the type of research methodology that Lewis recognizes is necessary to reveal the transactional processes that occur during the social construction of children's theory of mind. We agree with Lewis that focusing on the social construction of ToM is an important perspective because it challenges the traditional child-as-scientist perspective, in which conceptual development is the result of proximal internal processes in the child's mind, while distal inputs such as social interactions and language serve as data and feedback.

On the socio-cultural account (for want of a better term), the young child's ToM develops out of interactions with adults, and what develops is practical, implicit knowledge of how to interact in contexts involving emotions, desires, perceptions, beliefs, etc. For example, the child's first meaning of what it is to know is embedded in the background context of meaningful cultural practices that might emphasize either knowing-how or knowing-that; in the immediate dyadic context of shared intentions and practical activity; and in the functional role that the mental state term for knowing plays in the linguistic context of "discussing the content and meaning of another person's perspective with an interlocutor" (Lewis, p. 3). Methods to reveal processes of social construction within cultural practices that frame the child's ToM are demanding. As Ebert et al. (2017, p. 33) put it:

> "To observe, transcribe, and code everyday conversational interactions between parents and children in enough depth … is very time consuming and potentially unreliable given the low frequency of family talk about mental states. Long observation intervals are needed and due to the effort only small numbers of parent-child dyads are likely to be included. Thus, the power of statistical analyses is limited and longitudinal follow up may not be feasible."

On the socio-cultural account, mental states exist in, and are accessed while engaging in, on-going practical activities, and the embedded aspects of cultural meaning of mental state terms are not

fully represented by explicit concepts. Lewis is correct that our "theoretical position is individual and dualistic in that the word 'knowing' refers to internal representations" (p. 3). PAR theory focuses on how children develop a representational concept of, among other mental states, knowing, which allows them to unite many instances of knowing in contexts not currently or even previously experienced, and make new moral, epistemic, strategic, and other judgments about those situations. Humans do have the ability to step back from practical activity and take a detached stance and use explicit concepts of things as well as of mental states. We think that studying both aspects of ToM is important, with a view toward understanding the developmental interconnections.

Thus we agree when Lewis says that the PAR account "needs to accommodate accounts in which the child's access to mental states is understood within their social interactions" (p. 3). We think that where the socio-cultural and representational-conceptual levels of ToM intersect is the self. For adults, practical activity and coping in social interactions necessarily includes some kind of experience of a self existing in time that experiences all coping as "mine." Representational ToM necessarily includes a representational awareness of self in terms of autobiographical memories and self-concepts, but also in terms of awareness of just on-going thinking. We think that PAR theory raises questions about the development of awareness of a self existing in time. The evidence for PAR is that young children are as unaware of their own thinking as they are of others' thinking. The evidence includes the many difficulties young children have representing the past self, as well as the present self (Chapter I). For example, in summarizing their findings regarding young children's unawareness of what they are presently thinking, and even that they are thinking, Flavell and Flavell (2004, p. 451) concluded that

> "A family of fundamental intuitions concerning the what and when of thinking [i.e., attentional focus, inner speech, controllability and uncontrollability, unconsciousness, thought-

emotion and thought-action links] … are in the process of acquisition during the late preschool and middle-childhood years."

These intuitions are a family because they are all related to the self, born of awareness of the self having thoughts. If young children do have some type of experience of a self existing in time during practical activity, then the question that PAR theory raises is, why does it take children so long to become aware of having thoughts? There appears to be a very gradual development of self-awareness of seeing and knowing in present situations (Chapter I); i.e., self-awareness of seeing at around 2½ years of age, and self-awareness of knowing at around 3½. By about age 4, children discover PAR Rule 1, that seeing leads to knowing. Discovering the causal connection between seeing and knowing allows PAR-users to reason about others, but at the same time it could allow children to have their first self-awareness of having interconnected thoughts that span at least a short interval of time (e.g., "I saw it, that's why I know it's there."). It would seem that acquiring Rule 1 could open the flood gates of awareness of having thoughts, but it appears to take another two years, which suggests that the development of the new concept of mental representation is also the development of a new concept of an autobiographical self that is thinking these thoughts.

2.3 Bartsch Commentary

Bartsch (2021) identifies, engages with, and gives her take on the key points, especially regarding mechanisms, and suggests paths forward using longitudinal and observational methods. She also voices the biggest sticking point when she says that, "Intuitively, it is hard to conceive of a 6- or 7-year-old with no conception of mental representation," (p. 2) and she offers a hypothetical real-world example to think through from the PAR perspective. The situation is the reverse of the decidedly non-real-life story of Little Red Riding Hood. In the fairy tale, the reality (wolf) is scary and the costume (grandmother) is friendly; in Bartsch's example, the reality (uncle) is friendly and

the costume (bear) is scary, and the sister "watches her uncle put on a bear costume to chase after the girl's twin brother, who runs away crying and hides in a closet" (p. 2).

If the sister is a PAR-user, she reasons that her brother cannot see his uncle, does not know it is uncle, so he acts wrongly and runs away, just like Little Red Riding Hood, who doesn't know it's a wolf and who makes a bigger mistake by not running away. Bartsch is right that the PAR view might be intuitively hard to swallow; in her vivid example, it does seem compelling that the sister must understand that her brother has a false belief, and that she must understand his emotional reaction as stemming from that belief.

But it is also compelling to watch PAR-users fail TB identity tasks (Chapters II, III and IV) by failing to understand that the mere appearance of an object causes a belief about what it is. On the PAR view, watching her uncle put on the costume only means to the sister that her brother cannot see uncle, and the type of costume, like the picture on a familiar box or the appearance of a deceptive object, does not figure into how she reasons about brother. She does not think, "He sees [his uncle as] a bear," although she knows what physical objects he sees. If we asked her who her brother thought was chasing him, his uncle or a bear, she would choose bear by default because she reasons that her brother does not know it is uncle, and so he will be wrong. If given a third option, e.g., a different family member, she would be as likely to say that her brother thought that person was chasing him because that is also wrong.

The fairy tale seems to be written for PAR-users, because Little Red Riding Hood is portrayed as oddly clueless, having no suspicion from the increasing hints she is given that the appearance could be different than the reality, until the wolf fully reveals itself. PAR-users understand that Little Red Riding Hood at the door does not know it is a wolf inside, but they nevertheless think that she is afraid (Harris et al., 2014), because without understanding that she has a

false belief that it is her grandmother, they must fall back on the objective situation to predict her emotion; i.e., they predict she will be afraid because there is a wolf inside. Likewise, before uncle starts chasing him, the sister would predict that her brother will not be afraid of his uncle in the costume.

Bartsch hones in on the issue of mechanisms, asking the penetrating question, "Is there any such general mechanism associated with PAR, and, if not, will more than one theory be needed to account for changes at different points?" (p. 3). There are likely to be several mechanisms (Chapter X). The transition from reality reasoning to PAR would involve searching for the meaning of mental state terms. When the parent says, "See the cat," how is the child to know what see means? Learning that seeing and knowing refer to the mind might require a ToM- specific mechanism of adult-guided introspective access. Parent-child conversations about seeing and knowing could guide children's introspective access to those states, but introspective access also likely depends on executive function abilities. Children's own theorizing could play a role later in discovering the PAR Rule 1 causal link between perceptual access and knowing. The transition from PAR to belief reasoning would involve further conceptual change and theory change, and so the general cognitive development mechanism of experience of anomaly likely comes into play. It must seem like nonsense to a child who has finally arrived at PAR that people can sometimes get it right when they do not have perceptual access in the current situation.

Bartsch notes that the monograph includes no observational studies of behavior in real conversations and contexts, and we agree that such studies will be important to evaluate and to extend the theory. Ebert et al. (2017) provide a validated method to examine everyday parent- child conversations about mental states, by asking parents to report how they typically respond, including whether they provide elaborated explanations of seeing and knowing (e.g., "Dad doesn't know

what is inside the box, because he can't see inside the box now that it is all wrapped up."). A seminar student[4] recently hit on a simple, direct, and potentially rich method by asking her 7-year-old what it means to see, want, know, and think. The girl gave two examples of knowing: One involved the practical activity of knowing ("If your friend's coming over you know not to be mean to her."), and the other involved the representational self existing in the future ("Or you know that you're going to watch a specific movie.")

We offer just one cautionary note. Belief reasoning and PAR can be confounded and hard to distinguish in real-world situations (e.g., the bear costume example). Real conversations might not include contrastive situations that could provide evidence for how to interpret children's belief language (Chapters VII and VIII). It is difficult to determine when children begin to talk about mental states. In the past, when children said in conversation, "I don't know" and "Know what?" those statements were not coded as genuine references to knowing, but recent re-analyses of those conversations suggest that such statements might indicate some conception of knowledge (Harris et al., 2017). The word think is especially slippery because it can refer to false beliefs or to uncertainty ("I think maybe …"), desires ("I think I'll have …"), and stream of consciousness ("I'm thinking about…"). In Chapter VIII, children explained, "[Protagonist] thinks that it is in there" equally often when protagonists had false beliefs and when protagonists had no beliefs at all, suggesting that those explanations were PAR-users' references to the protagonists getting it wrong in both cases. Thus, while observational studies can provide important tests and extensions of PAR theory, the theory can sharpen our focus on what the real- world observations might be showing us.

3. Concluding thought: PAR and innateness

The standard model does not identify children's first understanding of belief. TB tasks cannot

[4] Thanks to Therese Clark for this example.

pinpoint the origin of belief reasoning, because attributing true beliefs is confounded with reality reasoning. Attributing false beliefs is not confounded with reality reasoning because it requires inhibiting reality reasoning, but that requirement was assumed to make FB tasks harder than TB tasks. Thus, the standard model only purports to show the earliest age of unambiguous evidence of belief understanding, and leaves the origin of belief understanding unknown. Asking about diverse beliefs when neither belief is shown to be false and there is no reality response to inhibit (e.g., "Linda thinks her cat is in the garage, but you think it is in the living room. Where will she look?") could get closer to the origin of belief understanding, but still could be more difficult than reasoning about a single individual's true belief. English-speaking children pass diverse beliefs tasks before they even understand that seeing leads to knowing (Wellman & Liu, 2004)[5]. Attributing beliefs before learning what causes beliefs sounds like the work of an innate ToM module. Thus, on the standard model there is no principled argument that the origin of belief understanding is not sometime very early in development, leaving the door open to claims of innateness of ToM. PAR raises a serious obstacle to claims of innateness; i.e., how to explain why it takes children so much longer than portrayed in the standard model to understand true as well as false beliefs. Watching young children fail TB tasks, and listening, without presupposition, to their justifications of their reasoning, is compelling, and should deter us from expecting more social competence of young children than they can bear.

[5] Children might pass diverse beliefs tasks at first by interpreting the word think to mean want (Perner, 1989; Wellman & Bartsch, 1988). Mandarin-speaking Chinese children pass diverse belief tasks after they understand that seeing leads to knowing (Wellman et al., 2006), and so it would be useful to know if the Mandarin task used the truth-neutral think verb *xiǎng*, which also can connote want, or the verb for think falsely, *yi3wei2*.

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Appendix 1

Supplementary Materials

In the section *Scrutinizing the Evidence for PAR*, Sodian first suggests that in Location tasks, memory demands might be higher in TB return than in FB, because in TB the object transfer from A to B happens before Maxi's departure and return, whereas in FB the transfer happens between those events. It is important to consider that Pesch et al. (2020) found no significant correlations between working memory and TB return or standard FB location tasks. Also, in the TB object movement task, the object movement out of A and back into A also happens between Maxi's departure and return, but children fail that TB task as well. More broadly, it is not obvious how memory demands might be higher in the TB versions of contents and identity tasks than in the FB versions. However, the most important question to consider is why, in principle, should memory demands outweigh the demands of inhibiting the reality response in making reasoning about true beliefs *more difficult* than reasoning about false beliefs?

Second, Sodian suggests that differential memory demands might also explain performance variation in 3-option FB location tasks. She points to two potentially memory-relevant procedural variations across the nine location tasks in Chapter III: Whether Maxi put the object in the false belief location or watched another character do so, and whether the child was reminded or not of the story events before the control questions were asked. It is important to consider that Pesch et al. (2020) found no significant correlations between working memory and 3- or 4-option FB location tasks. The clearest factor at work in the 3-option location tasks was not memory-related. The test question asked where Maxi would look first, and children tended to answer that he would look first in whichever of the two empty locations had contained the object first. That response resulted in worse performance in the four studies (Studies 3, 4, 5, and 7) with the I-FB-R transfer order (supported by Pesch et al., 2020) than in the remaining five studies with the FB-I-R order. If reminders had improved performance, then the

opposite pattern should have occurred, because three of the four studies in I-FB-R included a reminder, whereas only one of the five studies in FB-I-R included a reminder. Within FB-I-R, the proportion of correct answers was equally high in the two Maxi-as-observer studies (.87) as in the three Maxi-as-actor studies (.89). There are no other critical comparisons to test the two memory-relevant factors that include at least two studies in each comparison condition, and selecting individual studies to compare is not well-justified because of the low power of each study.

Sodian notes (p. 3) that "Fabricius and colleagues (Chapter III) replicated Perner and Horn (2003) when using these authors' exact procedures," which refers to Study 1 of our seven replication studies. In Study 1, we did obtain the same results as they did in each of their three tasks, but that included the non-significant difference in the contents task between the number of children who chose the FB option versus the Irrelevant option, and this non-significant difference held up especially strongly in the subsequent replication studies. The whole set of nine studies, which included all three of Perner and Horn's (2003) original tasks, had so much power that successful replication of a true effect would have been virtually guaranteed, as shown by simulations (Braver et al., 2014). None of our superficial procedural variations altered the basic belief structure of the tasks. They are just the types of variations that independent labs would have used without much anticipation of their potential impact, and are just the sort of variations that should be tested to ensure that the children were reasoning about false beliefs.

Third, Sodian suggests that pragmatics of the test question in the no-belief (NB) location tasks of Chapter V could lead children to suspect that the ignorant protagonist has some reason to prefer one possibility over the other. But in that case, it would still seem that children's predictions of the protagonists' choices would be random in aggregate, because different children should think of different reasons why the protagonist would prefer one possibility over the other. What other reason than PAR would explain why children do not understand guessing (Chapter I), and instead think that ignorant

protagonists will get it wrong as often, *and with as much certainty*, as they think protagonists with false beliefs will get it wrong? The false belief should carry some weight. In pulling this thread, it is important to consider Rohwer et al.'s (2012) findings regarding reasoning about the present self: When given partial information indicating that either of two things could be in a box, many 5-year-olds claim to know what is inside. Comparing one's own current thoughts about two possibilities, and realizing that either possibility could be the case and that one must therefore guess, requires the same metarepresentational ability as understanding guessing in others.

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