Asymmetries in the evidence for asymmetries in the signature limits of minimal and full-blown theory of mind?

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This is a wonderful paper. Building on the seminal paper (Apperly & Butterfill, 2009) that introduced what I take to be the most promising game in town to explain the apparent tension between classical theory of mind findings and more recent infancy data – the dual system account of theory of mind- it develops a conceptually more precise account where exactly the differences between system 1 (minimal ToM) and system 2 (ToM proper) lie. Basically, what full-blown ToM can but minimal ToM cannot do, is to represent propositional attitudes proper, including their essential logical, functional and normative features, and without restrictions regarding the contents these attitudes can take. Minimal ToM, limited to the much simpler concepts of tracking and registration, is good enough for solving some false belief tasks such as change of location tasks (not by representing the protagonist's belief as belief proper, but by representing it as some proxy state of registration), but shows clear signature limits: since tracking and registration are relational states, they fail to capture the intensionality characteristic of the propositional attitudes proper and can thus not capture situations in which a protagonist refers to a given object under one aspect in contrast to another. As a consequence, minimal mindreading is not sufficient, for example, for solving false belief tasks in which a protagonist is mistaken about an object's identity.

The empirical predictions are then straightforward:

(a) Minimal mindreaders (children before age 4, roughly[1]) show signature limits in their mindreading: they can solve some tasks such as location FB tasks, but fail tasks that would require the ascription of aspectual attitudes.

(b) Full-blown mindreaders (children from age 4, roughly) show no such signature limits in explicit tasks, mastering all kinds of tasks requiring the ascription of aspectual propositional attitudes in the same ways.

Now, how does this account with these clear predictions fare in the light of empirical findings? What I would like to argue is the following: At first sight, existing findings seem to sound like bad news for the account. While some published findings supply support for (a), there is a huge body of published findings, perhaps paradoxically many of them by Ian himself, that seem to speak against (b). These findings suggest that the 4-year-olds' ToM reveals analogous signature limits in explicit tasks as those shown in infants in implicit tasks. The good news, however, is that new unpublished findings from our lab, based on Steve's and Ian's suggestions in the paper, show that these older findings do not pose a real danger for Ian's and Steve's dual system account and do actually speak in favor of both (a) and (b).

The (seemingly) bad news then first: in a wonderful recent study, Low & Watts (2013) have shown that 3-year-olds in their anticipatory looking in FB tasks modeled after Clements & Perner (1994) and Southgate et al. (2007) show exactly the signature limits proposed by the dual system theory – solving a location task but failing a task in which a protagonist was mistaken about the identity of an object. This result fits nicely with findings from Ian and Steve and colleagues (Surtees et al., 2012) that older children show signature limits in automatic/indirect task, solving level I but failing level II perspective taking. But what about claim (b) and the absence of such signature limits in full-blown mindreaders? Do 4-year-olds, once they solve standard change-of-location false belief tasks really reveal an understanding of the essential features of propositional attitudes such as their aspectuality, and do they consequently solve all kinds of tasks requiring propositional attitude ascription alike? This has been strongly doubted by some ToM researchers (Fabricius et al., 2010;

[1] and adults under conditions of automatic mindreading – I'll concentrate here on the ontogenetic aspects and focus on creatures assumed to be minimal mindreaders in principle.

Lalonde & Chandler, 2002) on the basis of findings that 4-year-olds seem not to understand one or the other aspect essential for propositional attitudes (e.g. the constructive or interpretive nature of perception). In particular, a substantial body of evidence –much of it by Ian and colleagues- suggests that children up to age 6 or even older do not understand the aspectuality of propositional attitudes and the resulting intensionality of propositional attitude reports (e.g. Apperly & Robinson, 1998, 2003; Hulme et al., 2003; Kamawar & Olson, 2009, 2011; Russell, 1987; Sprung et al., 2007). All of these studies involved situations like the ones envisage by Steve and Ian in their paper in which a protagonist is mistaken and/or ignorant about the identity of an object or person.

For example, in the studies by Ian and Liz Robinson tasks with the following structure were used:

(1) There is an A in box 1

(2) There is a B in box 2

(3) The B in box 2 is also an A

(4) The protagonist knows that (1) and (2), but does not know that (3)

Test question: The protagonist is looking for an A. Where will he go to find an A? (correct answer: box 1)

These studies require the subject to grasp that the protagonist might have incomplete knowledge/false beliefs about the identities of objects, representing them only under some aspects/descriptions and not under others – in the above case that the protagonist believes of the A in box 1 that it is an A, but does not believe of the A in box 2 that it is an A. Now, empirically all of these studies consistently revealed that these tasks were failed by 4- and 5-year-olds and were much more difficult than standard FB tasks (with the exception of one condition in Sprung et al., 2007). In other words, it seems that the very same asymmetry between location and identity problems can be found in direct tasks in older children as those found in indirect tasks in younger children. Do these findings thus refute the central empirical claim of the dual system account – that the infant minimal ToM competence is

characterized by signature limits that do not apply to the 4-year-old full-blown ToM competence?

And here is the good news: they do not necessarily. Why? Because, arguably, these studies documenting older children's failure on aspectuality/intensionality tasks do in fact require what they aim to measure (children's understanding that propositional attitudes hold only under some aspects) – but perhaps much more. For example, the tasks by Ian and Liz Robinson involve ambiguity of referential expressions ("an A") and therefore the necessity for reference resolution (which A?) – which, as we know, even adults find often difficult (Keysar, Lin, & Barr, 2003). And these tasks required children to coordinate information from different sense modalities: the dual aspect object, e.g. a dice (A) that was also a rubber (B) was fully visible all the time such that its A-aspect was directly discernible. Its B-aspect, in contrast, was only accessible via some other modalities, mainly touch (and using the object as a rubber). The child thus had to coordinate sensory information from two modalities – a capacity that has been found to be surprisingly demanding and to reveal protracted development until well into school age (O'Neill, Astington, & Flavell, 1992; Waters & Beck, 2009).

What we did, therefore, in a recent set of studies, is to develop a task of understanding aspectuality and beliefs about objects' identity, based on Steve's and Ian's suggestions, that could be used both in an explicit version to follow up on previous aspectuality/intensionality findings, and in a more implicit action based version to follow up on recent infancy findings. In the explicit aspectuality version, all potential performance factors were removed that might have affected previous tasks (ambiguity, reference resolution, coordination of information from different sensory modalities etc.), and the structure of the task was kept as analogous as possible compared to standard FB change-of-location tasks. The basis experimental logic is depicted in Figure 1: There is an object that is both an A and a B that is put into box 1 in the presence of the protagonist under its A-aspect[2]. In the second step, the object is taken out of the box and transformed to reveal its other aspect (B) and put back into box 1 under this B-aspect. In the final step, visible to the protagonist, the object is moved from box 1 to box 2. There were three conditions: in the crucial "intensional"

[2] The objects used either had two sortal identities, e.g. a toy that could be turned inside out and was both a bunny (one side) and a carrot (other side), or two properties, e.g. a sock that was red on one side and blue on the other.

condition, the protagonist is not present at step 2 and thus unaware that the A and the B are identical. Here the test question is where she will look for her [A]. In the extensional condition, she is also not present at step 2 and therefore unaware of the identity of A and B, but the test question is where she will look for her [B], and in the true belief condition she was aware of the identity and the test question was where she would look for here [A]. The results of two studies with this task (Rakoczy et al., submitted) were the following:

- Children aged 3 to 6 were competent at solving the simplified task, answering "box 1" significantly more often than expected by chance in the crucial "intensional" condition (and "box 2" in the two control conditions).
- The tasks was no more difficult than standard 1st order FB tasks
- The two types of tasks were strongly correlated, even if age and verbal ability were controlled for.
- That is, what the findings in this new radically simplified task suggests is that previous negative findings in aspectuality tasks might have been due to performance factors extraneous to the capacity to understand aspectuality.

The implicit version (Fizke Butterfill & Rakoczy, 2013) had basically the same setup and structurally analogous false belief (FB) and true belief (TB) conditions, but a different, less explicit dependent measure (see the right two columns in Fig. 1). This measure was modeled after a study showing competence at a change-of-location FB task in infants and toddlers (Buttelmann et al., 2009): at test, the protagonist tried to open box 1, and the question was whether children would help her to open box 1 or would help her to find the object and thus refer her to box 2. The identity conditions were compared to pure change-of-location conditions like in the Buttelmann et al. (2009) study, in which the protagonist put an object (with a single identity) into box 1, which was then transferred to box 2, and then the protagonist tried to open box 1. In the FB condition, she had been absent during the change of location, and in the TB condition she had been present. The results of this study were the following:

- In the change of location conditions, 2-year-olds helped the protagonist to search the object in box 2 significantly more often in the FB than in the TB condition – indicating

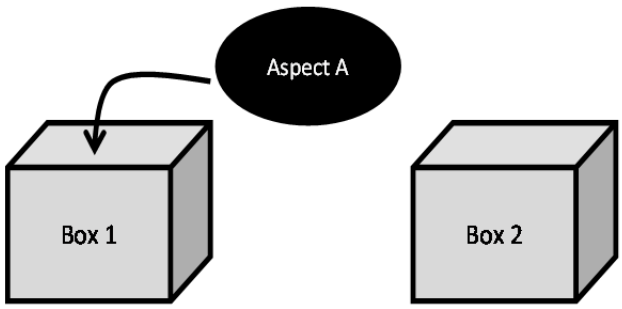
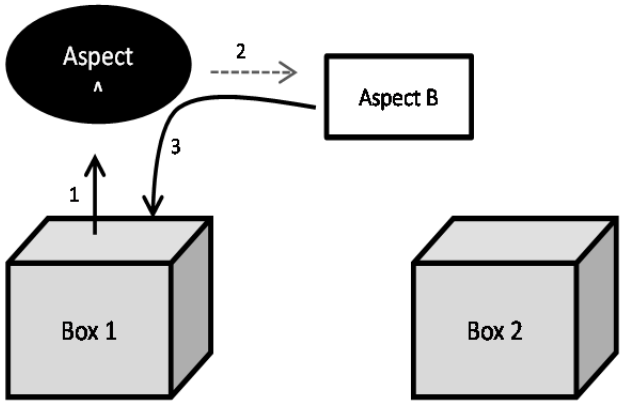
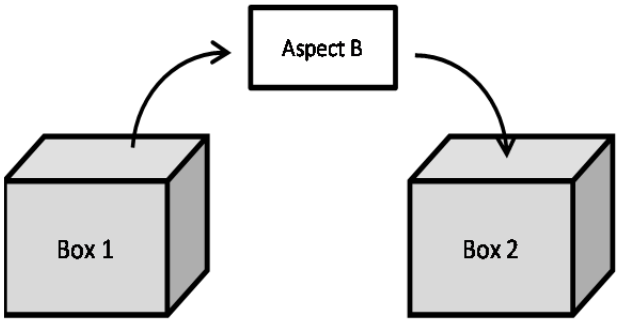
that they did track the protagonist's belief-like state in some ways (replicating Buttlemann et al, 2009).

- In contrast, in the identity condition, children did not behave differently in the FB and TB conditions (mostly helping the protagonist to open box 1).

So taken together, what these findings suggest is that there is indeed strong symmetry and unity in the explicit performance of older children in diverse FB tasks, including those in which subjects have to represent the aspectuality of the propositional attitudes and corresponding beliefs about identity. This symmetry and unity is missing in the younger children's performance in less explicit tasks which reveal clear signature limits along the lines predicted by Steve and Ian.

Everything turns out fine. There is no need for Ian to become schizophrenic. First appearances to the contrary, his old findings due not jeopardize his and Steve's new theory after all. Fortunately, the dual system theory remains the most interesting and promising game in town.

Figure 1. Basic experimental logic and setup of the implicit and explicit conditions of the new aspectuality task (adapted from Rakoczy et al., submitted)

		Explicit			Implicit	
	intensional	**extensional**	**true belief**	**FB**	**TB**
	**Protagonist present**				
	**Protagonist absent**	**Protagonist absent**	**Protagonist present**	**Protagonist absent**	**Protagonist present**
	**Protagonist present**				
	Where will protagonist look for...			**Protagonist comes and tries to open box 1 → will child help her to open box 1 or refer her to box 2?**	
	...aspect [A]?	**...aspect [B]?**	**...aspect [A]?**		

References

Apperly, I., & Butterfill, S. A. (2009). Do humans have two systems to track beliefs and belief-like states? *Psychological Review, 116*(4), 953-970.

Apperly, I., & Robinson, E. (1998). Children's mental representation of referential relations. *Cognition, 67*(3), 287-309.

Apperly, I., & Robinson, E. (2003). When can children handle referential opacity? Evidence for systematic variation in 5- and 6-year-old children's reasoning about beliefs and belief reports. *Journal of Experimental Child Psychology, 85*(4), 297-311.

Fabricius, W. V., Boyer, T. W., Weimer, A. A., & Carroll, K. (2010). True or false: Do 5-year-olds understand belief? *Developmental Psychology, 46*(6), 1402-1416. doi: 10.1037/a0017648

Fizke, E., Butterfill, S., & Rakoczy, H. (2013). Toddler's understanding of false beliefs about an object's identity. Poster presented at the Biennial Meeting of the SRCD, Seattle.

Hulme, S., Mitchell, P., & Wood, D. (2003). Six-year-olds's difficulties handling intensional contexts. *Cognition, 87*, 73-99.

Kamawar, D., & Olson, D. R. (2009). Children's understanding of referentially opaque contexts: The role of metarepresentational and metalinguistic ability. *Journal of Cognition and Development, 10*(4), 285-305. doi: 10.1080/15248370903389499

Kamawar, D., & Olson, D. R. (2011). Thinking about representations: The case of opaque contexts. *Journal of Experimental Child Psychology, 108*(4), 734-746. doi: 10.1016/j.jecp.2010.10.005

Keysar, B., Lin, S., & Barr, D. J. (2003). Limits on theory of mind use in adults. *Cognition, 89*(1), 25-41.

Lalonde, C. E., & Chandler, M. J. (2002). Children's understanding of interpretation. *New Ideas in Psychology, 20*(2-3), 163-198. doi: 10.1016/s0732-118x(02)00007-7

Low, J., & Watts, J. (2013). Attributing False Beliefs About Object Identity Reveals a Signature Blind Spot in Humans' Efficient Mind-Reading System. *Psychological Science, 24*(3), 305-311. doi: 10.1177/0956797612451469

O'Neill, D. K., Astington, J. W., & Flavell, J. H. (1992). Young children's understanding of the role that sensory experiences play in knowledge acquisition. *Child Development, 63*(2), 474-490.

Rakoczy, H., Fizke, E., Bergfeld, D., & Schwarz, I. (submitted). Theory of mind and understanding intensionality emerge together in development. Russell, J. (1987). 'Can we say ...?' Children's understanding of intensionality. *Cognition, 25*, 289-308.

Sprung, M., Perner, J., & Mitchell, P. (2007). Opacity and discourse referents: Object identity and object properties. *Mind & Language, 22*(3), 215-245.

Waters, G. M., & Beck, S. R. (2009). The development and robustness of young children's understanding of aspectuality. *Journal of Experimental Child Psychology, 103*(1), 108-114. doi: 10.1016/j.jecp.2009.02.008