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Mental files and belief: A cognitive theory of how children represent belief and its intensionality

Josef Perner [a,*], Michael Huemer [a], Brian Leahy [b]

[a] Center for Cognitive Neuroscience, University of Salzburg, 5020 Salzburg, Austria
[b] Department of Linguistics, University of Konstanz, 78457 Konstanz, Germany

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ABSTRACT

We provide a cognitive analysis of how children represent belief using mental files. We explain why children who pass the false belief test are not aware of the intensionality of belief. Fifty-one 3½- to 7-year old children were familiarized with a dual object, e.g., a ball that rattles and is described as a rattle. They observed how a puppet agent witnessed the ball being put into box 1. In the agent's absence the *ball* was taken from box 1, the child was reminded of it being a *rattle*, and emphasising its being a *rattle* it was put back into box 1. Then the agent returned, the object was hidden in the experimenter's hands and removed from box 1, described as a "rattle," and transferred to box 2. Children who passed false belief had no problem saying where the puppet would look for the *ball*. However, in a different condition in which the agent was also shown that the ball was a rattle they erroneously said that the agent would look for the ball in box 1, ignoring the agent's knowledge of the identity of *rattle* and *ball*. Their problems cease with their mastery of second-order beliefs (she thinks she knows). Problems also vanish when the ball is described not as a *rattle* but as a *thing that rattles*. We describe how our theory can account for these data as well as all other relevant data in the literature.

0. Introduction

We present a theory of how children represent belief based on mental files. Mental files play an important role in philosophy, addressing longstanding issues about Russell's (1910) problem of acquaintance (Recanati, 2012) and Frege's (1892) foundational problems of logics about identity and the sense-reference distinction (Perry, 2002). As discourse referents they play a role in linguistics (Heim, 1982; Kamp & Reyle, 1993; Karttunen, 1976). In psychology they have only been used in isolated places for object files (Pylyshyn, 2007; Treisman & Gelade, 1980). They have not played any significant role in the popular area of "theory of mind" research, apart from some attempts to apply discourse referents to developmental phenomena hidden in the context of philosophy journals (Perner & Brandl, 2005; Perner, Rendl, & Garnham, 2007). This is somewhat surprising since mental files theory in philosophy has been used extensively to deal with the pernicious logical problems created by statements about beliefs and other mental terms (Recanati, 2012).

We intend to change this picture. We provide a coherent theory of belief representation and test this theory with data from children's understanding of belief and its intensionality. In Section 1 we introduce the empirical problems to which we apply our theory. In Section 2 we use this concrete material to introduce our theory. In Section 3 we describe unique predictions of our theory and present the results of testing those predictions.

1. Children understanding intensionality

There is a curious window in child development, which opens when a child first passes verbal false belief tasks[1] around 4 years and closes 2 years later when she passes second order belief tasks. During this period children appreciate that others can have beliefs that differ from their own, e.g.: Mistaken Max did not witness the transfer of his chocolate to a new location and thinks it is still in its original place (Wellman, Cross, & Watson, 2001; Wimmer & Perner, 1983). Yet they seem to misunderstand the intensionality

* Corresponding author at: Center for Cognitive Neuroscience, University of Salzburg, Hellbrunnerstrasse 34, 5020 Salzburg, Austria.
E-mail addresses: josef.perner@sbg.ac.at (J. Perner), michael.huemer2@stud.sbg.ac.at (M. Huemer), brian.leahy@uni-konstanz.de (B. Leahy).

[1] A false belief task is *verbal* just in case the subject is asked an explicit verbal question about the protagonist's belief or belief-based actions, which requires children to make a judgement about what is the case or what will soon happen. Responses may be made by simple pointing; the subject need not verbalise anything on a verbal false belief task.

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of belief, i.e., that belief about an object depends on the label under which the object is known to the believer. Understanding of intensionality appears with passing second-order belief tasks. Our theory can explain these existing data but makes a bizarre prediction of a sharp decline in performance on a novel intensionality task during this window, and subsequent sharp improvement when the window closes. These predictions were tested and confirmed.

This developmental window was discovered by Apperly and Robinson (1998, 2001, 2003). Inspired by Russell (1987), they familiarized 4- to 6-year-old subjects with two objects: a standard eraser and an eraser that was also a die. Then a puppet, Heinz, appeared and saw the two objects but was not informed of the dual nature of the die-eraser. Then the *knowledge question* was posed: "Does Heinz know that the die is an eraser?". Subjects who passed the false belief task had no problem answering "No". But when the *where-look question* was posed, "Where will Heinz look for an eraser?", the same children chose at random between the location of the standard eraser and the location of the die-eraser. Sprung, Perner, and Mitchell (2007) showed that children who passed second-order belief tasks only indicated the location of the standard eraser.

We refer to children who pass both first and second order verbal false belief tasks as (++); children who pass first-order but fail second-order verbal false belief tasks (+−); and children who fail both as (−−). The (+−) children are those in Apperly and Robinson's window. Even though (+−) children deny that Heinz knows that the die is an eraser, they treat this fact as relevant to his behaviour. So their grasp of how mental states determine behaviour seems incoherent. They do not fully understand the intensionality of belief. From "Heinz knows that there is a die in location l" and "The die is an eraser" they infer that Heinz will behave as though there is an eraser in location l. At the same time, they deny that Heinz knows that the die is an eraser. This incoherence is in dire need of explanation. No existing explanation of this incoherence covers all existing data.

Correct answers to the knowledge question might somewhat antedate passing verbal false belief tasks because past evidence has shown that children answer knowledge questions before they understand false belief (Hogrefe, Wimmer, & Perner, 1986; Sodian, Thoermer, & Dietrich, 2006). They should nevertheless be correlated because both tasks require that a subject understands how the information available from an agent's perspective differs from the information available from the child's own perspective. Children must appreciate that from Heinz' perspective, the information that the die is an eraser is unavailable. To predict when children cease to assume that Heinz will go for an eraser to where he knows the die is, Sprung et al. (2007) drew on claims from Clark (1997) and from Tomasello (1999, 2014) that describing an object using different labels provides different *perspectives* on that object. So successfully answering the question about where Heinz will look for an eraser (the where-look question) requires understanding embedded perspectives. Subjects must appreciate that from Heinz' perspective, the eraser-perspective on the die is not available. Thus correctly answering the where-look question is predicted to co-occur with passing tests of second order mental states, where a subject must evaluate whether an agent *thinks* he *knows* something (Perner & Howes, 1992).

Sprung et al. (2007) therefore predicted that 4- to 6-year old children would have no problems with the where-look question if information about an object was provided in a *predicative* manner rather than in an *individuating* manner. To say that an object is a stick is to individuate it in a certain way, to use a label that provides a perspective. To say that a stick is long is to predicate something of it, which does not provide a perspective on the object but rather provides information about it relative to the established perspective of being a stick. In Apperly and Robinson's task, the subject and the agent (Heinz) could both see an eraser and a die but only the subject knew that the die was also an eraser. In a parallel task in Sprung et al. (2007), the child and the agent could see both a long stick and a second, partially occluded stick, but only the child knew that the occluded stick was also long. In this new task, 4- to 6-year-olds had no problem with either the knowledge question ("Does Heinz know that this stick is long?") or the where-look question ("Where will Heinz go to get a long [stick]?").

Rakoczy, Bergfeld, Schwarz, and Fizke (2015) demonstrate that the curious problem with the where-look question about a die/eraser also disappears when the original task is simplified in that only a single object (the die/eraser) is used without the plain eraser. They conclude that (+−) children understand intensionality; Apperly and Robinson's observations are to be explained by excessive demands on memory load and ambiguity resolution that children cannot meet before they are around 6 years old. The crucial task (their experiment 3) involved a ball[2]/rattle instead of the die/eraser and went as follows. Children were shown that the ball was also a rattle. Then puppet Susi appeared. Child and Susi observed the ball being placed in box 1. Susi left and the ball was removed from box 1. Children were reminded that the ball was also a rattle. The object was returned to box 1. Susi returned. The experimenter reached into the box and made a *hidden transfer*: she hid the object in her hands, removed it, called it a *rattle*, shook it to make it rattle, and moved the rattle to box 2. Subjects were then asked where Susi would look for the *ball*. The correct answer is box 1, since Susi does not know that the rattle is the ball. To pass this test, subjects must suppress their knowledge that the rattle is the ball. Consequently, Rakoczy et al. (2015) maintain that this task tests the same abilities as Apperly and Robinson's first task, where children must suppress their knowledge that the die is an eraser. Rakoczy et al. found that (+−) children had no problems with this task; there was no evidence of Apperly and Robinson's curious window.

We will shortly criticize Rakoczy et al.'s (2015) conclusions. But whether or not the conclusions are right, the data pose a problem for Apperly and Robinson's theory. For in order to pass this test, subjects must be aware that from the puppet's perspective, the ball-perspective on the rattle is not available. Thus Apperly and Robinson would incorrectly predict that success on this task occurs after success on first-order verbal false belief tasks, counter to the findings in Rakoczy et al. (2015). For the same reasons these data also pose a problem for the appeal to embedded perspectives in Sprung et al. (2007).

However, Rakoczy et al. (2015) still have no explanation for why the curious window appears when information about an object is provided in an individuating manner, but disappears when information is provided in a predicative manner. The predicative cases seem to pose the same demands on working memory and ambiguity resolution, yet the effect is not observed. Moreover, Apperly and Robinson (2003) contrasted a false belief condition with a dual identity condition, both of which had only one critical object and identical test questions. They still found a difference in difficulty, so the number of critical objects does not seem to be the source of the difficulty.

In order to account for this inexplicable set of data we now present a mental file theory of belief representation and apply it to this set of data. In addition, we draw new predictions from it and then test these predictions on 3½- to 7-year old children.

2. Mental files

A mental file is a tool for managing information about an object in the world (say, the file's *referent* or *external referent*). Files cap-

[2] Rakoczy et al. used a pen/rattle. In our studies we used a ball/rattle, which we use here as our paradigmatic example to make it consistent with later descriptions of the same experimental conditions.

ture the predicative structure of language and thought: the distinction between what one is thinking/talking of (information that fixes the file's referent; *individuating* information) and what one thinks/says about it (the information about the referent on the file; *predicative* information). We say that a mental file is *anchored* to the object it collects information about. All of these features are illustrated in Fig. 1. A file is anchored to an external object, which individuates the object as a *butterfly* (not as an insect or an animal) and stores the predicative information that it is orange, etc.

Mental files also help us keep track of which information about an object is available from which perspective, which can be different *conceptual perspectives* (whether the rubber die is conceptualised as a die or as an eraser) or different *mental perspectives* (what different people think or know about an object). We begin by describing some features of a mature mental filing system. Then we describe how the developing filing systems of children depart from the adult standard.

When a new label for an object is used the object is *individuated* in a new way, which creates a new conceptual perspective on that object. For each new conceptual perspective on an object, a new mental file is opened that records information that is available about the external referent from that perspective. For example, the rubber die might function well as a die (it's quiet when cast) but poorly as an eraser (smudges the paper); consequently the die-file records the *predicative information* that the object functions well while the eraser-file records that it functions poorly.

Each file individuates its referent in exactly one way. But it contains all predicative information that the file's owner knows about the referent from that conceptual perspective. Nonetheless, when discussing or thinking about an object from one conceptual perspective, predicative information from other files for that object is still available to the mature thinker. For example, when asked whether the die would erase well, an adult has access to the information, stored on the eraser-file, that it does not. To model this phenomenon *horizontal links* between files that are anchored to the same referent enable free flow of information between linked files. Horizontal links establish sameness of referent between linked files. Fig. 2 illustrates two horizontally linked files, which are anchored to the same external object. Each file captures a different conceptual perspective on the object.

Note that the information "smudges paper" is written only on the eraser-file, not on the die-file. Still, that information is available from the perspective of the die-file, due to the horizontal link. We adopt the following convention in some of our diagrams below (e.g., Fig. 4). When information is written on a file B, and is available from the perspective of file A due to a horizontal link, we may write that information on file A, enclosed in parentheses to indicate that the information is not really written on file A but is available from that perspective.

In addition to the differences in conceptual perspective captured by allowing multiple files anchored to a single object, we use mental files to capture differences in *mental* perspective. For example, suppose Susi sees a ball being put in box 1; in her absence the ball is moved to box 2. How does a test subject who observes this situation store information about Susi's beliefs? For mature observers a *regular file* for the ball shows it in its new location while a *vicarious file* indexed to Susi shows it in its old location. Vicarious files are linked to regular files in order to establish sameness of referent between linked files. However, the flow of information between linked regular and vicarious files must be constrained, since a vicarious file may contain misinformation (e.g., the chocolate still being in its old location), which must be quarantined and not contaminate the information in the regular files. For this reason vicarious files are linked to regular files by *vertical links* (Recanati, 2012, chap. 14 and 15), which do not enable the transfer of information as freely as horizontal links. This is

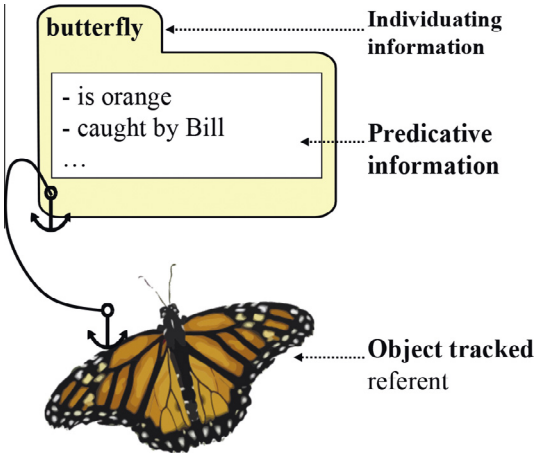

Fig. 1. A mental file.

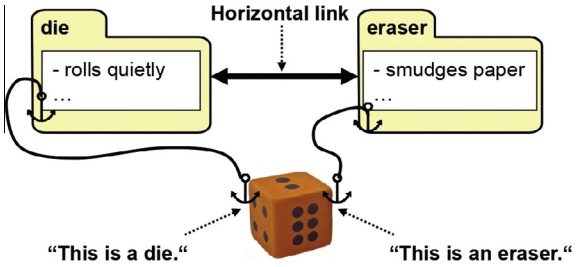

Fig. 2. Horizontal linking.

illustrated in Fig. 3, where an adolescent uses regular files to store her own information about the ball, and a vertically linked vicarious file to store puppet Susi's information about the ball. The vertical link is indicated with a dashed line, since vertical links (unlike horizontal links) do not allow free flow of information.

Children pass the false belief task at the same time as they can make sense of identity statements (e.g., "the die is the eraser"; Perner, Mauer, & Hildenbrand, 2011). Mental files theory can explain this with the developmental assumption that around 4 years children become able to link files horizontally as well as vertically (Perner & Leahy, in press). But at least three more taxing aspects of mature filing may still be absent: (i) when should a regular file be copied to a vicarious file with the same individuating label, (ii) when should horizontal links—indicating identity—between regular files be copied to vicarious files—indicating that the holder of the vicarious files is aware of the identity, and (iii) when should the predicative contents of a regular file be copied to a vicarious file?

We make three additional developmental assumptions. (1) (+−) children overperform (i), generating too many vicarious files. (2) (+−) children underperform (ii), not horizontally linking vicarious files, thereby disabling information transfer between them. (3a) (+−) children correctly perform (iii) when predicative information is provided verbally; their vertical links correctly constrain the flow of information between regular and vicarious files. (3b) However, perceptual information is not managed quite so well. When a (+−) child perceives that an agent gains perceptual information about an object under some conceptual perspective x, the child copies that information to all vicarious files anchored to that object, not only to vicarious file x.

These problems dissolve around six years of age when children become able to appreciate second-order beliefs. With these assumptions we can explain all existing data pertaining to Apperly

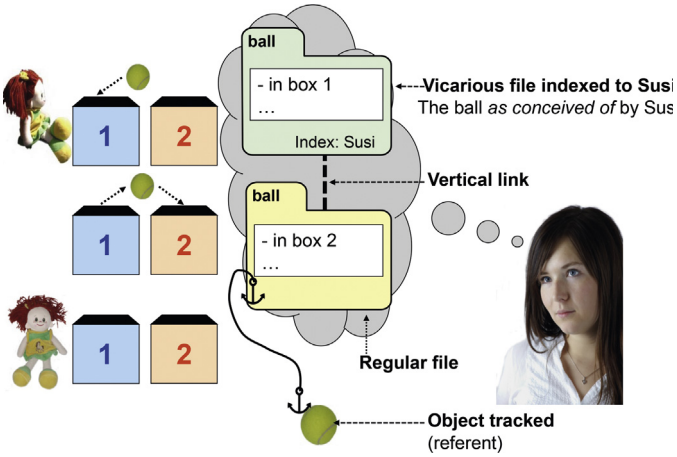

Fig. 3. An adolescent uses a vicarious file to track Susi's beliefs.

and Robinson's curious window. This includes the data from Sprung et al. (2007) and Rakoczy et al. (2015). Moreover, our theory generates new, remarkably counterintuitive predictions. We test these and find them borne out by the evidence. Only our theory makes these surprising predictions.

In the remainder of this section we use these assumptions to answer the following questions: why can (+−) children answer Apperly and Robinson's knowledge question, but not the where-look question? Why can (++) children correctly answer both questions? Why is the critical task from Rakoczy et al. (2015) easy for (+−) children? And why are predication versions of the Heinz-task easy for (+−) children?

Why can (+−) children answer the knowledge-question but not the where-look question? In the Heinz scenario, (+−) children create a vicarious file for the die that is indexed to Heinz. Since Heinz can't tell by looking that the die is an eraser, they leave the information "is an eraser" off the vicarious die-file. This is why they can correctly answer the knowledge question, "Does Heinz know that the die is an eraser?"

The child has a regular die-file for the object, which records that it is an eraser, its location, etc., and a horizontally linked regular eraser-file for the object, which records that it is a die, its location, etc. The child correctly copies the regular die-file to a vicarious die-file but incorrectly copies the regular eraser-file to a vicarious eraser-file (assumption (1): children generate too many vicarious files). The child can see that Heinz sees where the object is; thus location information is copied onto both vicarious files (assumption (3b): perceptual information gathered by an agent under any conceptual perspective is copied to all vicarious files).

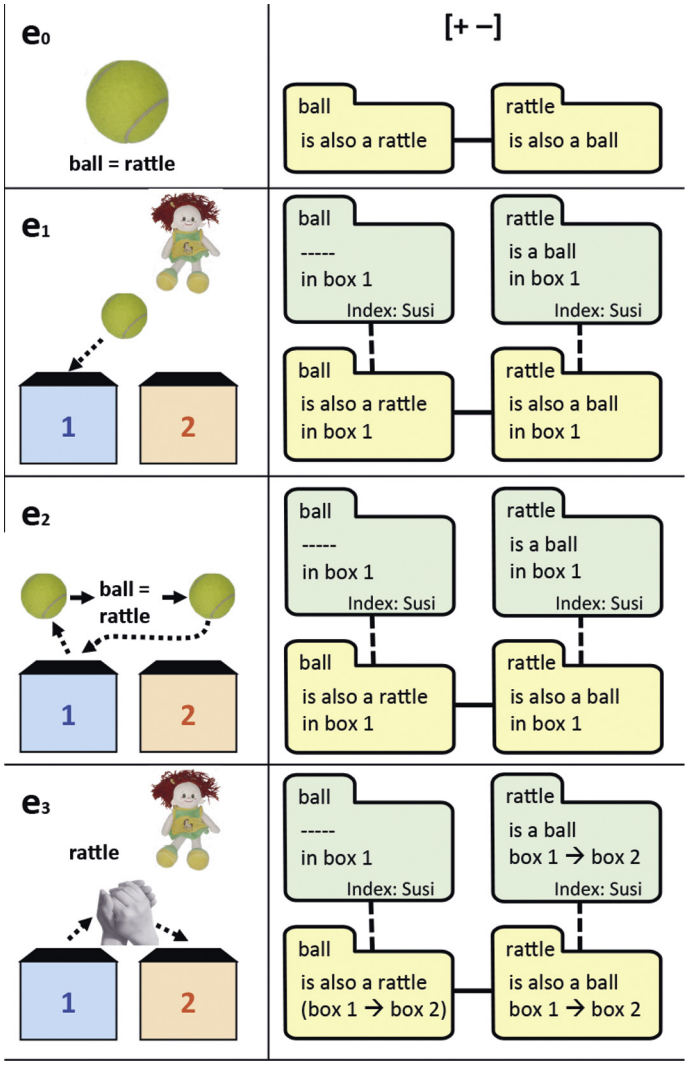

Fig. 4. Data from Rakoczy et al. (2015) explained with mental files.

This hypothesis lets us explain why children answer Apperly and Robinson's where-look question by choosing randomly between the location of the normal eraser and the die-eraser. There is a vicarious eraser-file anchored to the normal eraser, and a vicarious eraser-file anchored to the die-eraser. Both include location information, and so the child chooses one of those locations at random.

Why can (++) children answer the where-look question? Correct answers to the where-look question emerge together with correct answers to second-order belief questions. We propose that both tasks require an ability to understand embedded perspectives. The (++) children have learned that not all regular files should be copied to vicarious files. A (++) child does not copy her regular eraser-file to a vicarious eraser-file. So when asked where Heinz will look for an eraser, children check their vicarious files for Heinz, find only one file for an eraser, and answer the question with the location information on that file. These children appreciate that from Heinz' perspective, the eraser-perspective on the die is not available. That is, they understand embedded perspectives.

Why is the critical task from Rakoczy et al. (2015) easy? Assumption (2) is that (+−) children do not copy the horizontal links between their regular files when copying these files to vicarious files. Under this hypothesis, the critical task from Rakoczy et al. (2015) is a variant of the false belief task. The vicarious ball-file and the vicarious rattle-file are both anchored to the same object. But since there is no horizontal link between the files, the information that the rattle has moved to box 2 is not transmitted from the vicarious rattle-file to the vicarious ball-file. Since the agent only learns about the object's transfer linguistically,[3] information crosses vertical links correctly (assumption 3a): it moves from the regular rattle-file to the vicarious rattle-file, but not from the regular ball-file to the vicarious ball-file. So the child does not represent that the puppet knows that the ball has moved to box 2.

This is illustrated in Fig. 4. At the preparatory stage e_0, when the child is shown that the ball is also a rattle, the child anchors a regular ball- and a regular rattle-file to the object. When the child sees in e_1 how puppet Susi observes the object being put in the box, the child forms a vicarious ball- and a vicarious rattle-file, indexed to Susi (assumption 1). Since Susi sees that the object is a ball, the information "is a ball" is recorded in her vicarious rattle-file; location information is copied to both vicarious files (assumption 3b). Since she does not see that the object is a rattle, "is a rattle" is left off her vicarious ball-file. When child and Susi are linguistically informed during the e_3 hidden transfer that the rattle is being moved, this is recorded on the child's regular rattle file and on Susi's vicarious rattle file (assumption 3a). This vicarious rattle-file is not horizontally linked to the vicarious ball-file (assumption 2). So the outdated location-information "in box 1" on the ball-file will not be updated. Due to the horizontal link between the regular files the information about the move is also available in the regular ball-file. It fails to be copied from there to Susi's vicarious ball file since Susi was not told about the ball being moved (assumption 3a) and did not perceive the ball during the move (assumption 3b). Thus the child represents that Susi has a false belief about where the ball is located. For this reason they correctly answer "Box 1" when asked where Susi will look for the ball.

Why are predication tasks easy? Predicative information does not cause the construction of a new file, as individuating information does. When one is told, "This is a rattle," one opens a new regular file that individuates the ostended object as a rattle. When one is told, "This stick is long," one does not open a new "long stick" file, but rather records the information "long" on the regular stick-file for that object. When a puppet sees two sticks, one long and one partially occluded so that its length is not visible, the subject makes a vicarious file for each stick. One records that the stick is long; the other records nothing about length. So when faced with the question, "Where will puppet look for a stick that is long?", children check the puppet's vicarious files and find only one for a stick that is long. They respond with the location for that object.

[3] Since the object is hidden, the agent does not see it, and so does not have visual information about the transfer. The agent does hear the rattle shake, but this is not information about the transfer. The agent does not hear the rattle being moved from box 1 to box 2. So the agent only learns about the transfer linguistically.

3. Experiment

With the assumptions that (+−) children indiscriminately copy regular files to vicarious files but do not copy horizontal links between files, we make surprising new predictions. First, in an *agent-present* variant of the critical experiment in Rakoczy et al. (2015)—one where the puppet Susi also learns that the ball is a rattle—we predict that (+−) children will struggle with the question, "Where will Susi look for the *ball*?". For children who fail to copy links between vicarious files will not represent that Susi knows the identity of the ball and the rattle by linking the puppet's vicarious files. Without these links, the information about the transfer to box 2 will be recorded on the vicarious rattle-file but not on the vicarious ball-file. Hence they should wrongly assert that Susi will look in box 1.

Second, these problems should disappear in a predicative version of the agent-present variant. In this version, when the experimenter makes the hidden transfer, he describes the dual object hidden in his hand as a "thing that rattles" instead of as "a rattle". We predict that the information that the object rattles is simply recorded onto the vicarious ball-file, and so (+−) children will have no problem answering "Where will Susi look for the ball?" correctly (box 2). The following experiment tests these predictions.

3.1. Method

3.1.1. Participants

Fifty-one children (29 female, 22 male) from one kindergarten and one elementary school between the age of 44 months and 83 months (median age: 67 months, S.D. = 13.3) participated in this experiment. Parents were previously informed and gave written consent to experimental participation. One additional girl could not finish all tests and her data were not included.

3.1.2. Design

Each child was given four dual description "intensionality" tasks as a result of two factors, *individuation (IND)* vs. *predication (PRED)* and agent *present* vs. *absent*. For each task a different material was used: pen/lamp, ball/rattle, dolphin/squirter, or die/eraser.

In addition each child was given the vocabulary sub-test of the HAWIK IV to assess their verbal intelligence, and one false belief task and one knowledge task, each with a first order-belief question ("If we ask Susi, 'Where is the marble?' what will she say?") and a second-order belief question ("If we ask Susi: Do you know where the marble is? What will she say? Will she say 'Yes, I know' or 'No, I don't know'?") in this sequence.

The seven tasks were administered in the following order: the verbal intelligence test, an individuation and predication in counterbalanced order, a false belief or knowledge task, individuation and predication (counterbalanced order), and a knowledge or false belief test. Each of the four conditions agent absent/individuation, agent present/individuation, agent absent/predication, and agent present/predication occurred equally often in first position. The second task of this kind alternated for individuation and predication, and for present and absent, e.g.: agent present/individuation, agent absent/predication. The following tasks repeated the sequence but with

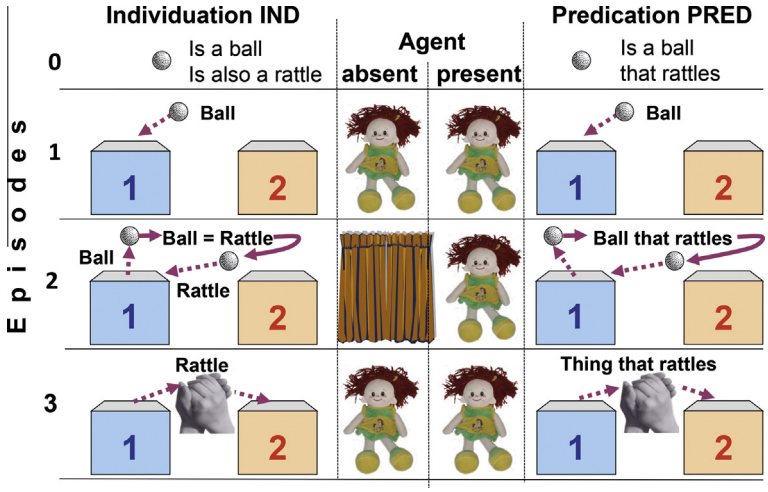

Fig. 5. Illustration of the agent-absent and -present conditions (centre panels) when individuating expressions (left panel) or predicative expressions (right panel) are used. Broken line arrows symbolize movements, full line arrows changes in description. *Episode 0*: in the absence of puppet Susi children were familiarized with the dual function object described as "a ball" and for individuating (IND) expressions also as "a rattle," and in the predicative (PRED) description as "a ball that rattles". *Episode 1*: in Susi's presence the ball was put in box 1. *Episode 2*: the ball was taken from box 1, its rattling property demonstrated and in the individuation condition described as "a rattle", in the predication condition as "a ball that rattles" and put back into box 1. This demonstration took place in Susi's absence in the *agent-absent* conditions and in her presence in the *agent-present* conditions. *Episode 3*: In Susi's presence the object was taken from box 1 hidden in the experimenter's hands. After its rattling sound was demonstrated, it was described as "a rattle" (individuation) or as "a thing that rattles" (predication) and moved to box 2.

present and absent exchanged, e.g.: agent absent/individuation, agent present/predication. The resulting four orders of conditions were counterbalanced with a Latin Square design of story material (pen/lamp, ball/rattle, dolphin/squirter, or die/eraser) resulting in 16 combinations. Each combination was given with either the false belief task or the knowledge task in positions 3 and 6, respectively, resulting in 32 different sequences altogether. Each child was assigned randomly to one of the sequences until each sequence had been used once whereupon a new random assignment was begun until all children had been tested.

3.1.3. Procedure

All children were tested by a male experimenter in a quiet room of their kindergarten or elementary school, respectively. Each session lasted between 15 and 20 minutes.

3.1.3.1. Dual description "Intensionality" tasks.

Individuation conditions (IND). The procedure of these tasks is taken from Rakoczy et al. (2015), Experiment 3 (see our Fig. 4). The detailed procedure is here described in four episodes, using the ball/rattle as an example. The changes needed for agent-absent and -present conditions are mentioned for each episode; those needed for the predication conditions in a separate section (see Fig. 5).

Episode 0: General familiarization with the objects.

The child is introduced to puppet Susi, who is then put away. Then the experimenter shows the child the two boxes and that they are empty. Then he introduces the ball/rattle, points out that the ball can be used as a rattle and explicitly mentions that Susi is playing elsewhere and cannot see or hear what is going on. After the demonstration of the ball/rattle the experimenter emphasized again that absent Susi could not have seen the demonstration and asked the *Know- question 1:* "Does Susi know that the ball is also a rattle?"

Episode 1. Placing of the object in first location

Susi entered the scene, and the object was introduced as a ball to Susi. Then it was put inside box 1. At the end Susi left the scene (*agent absent conditions*) or stayed on for the next episode (*agent present conditions*).

Episode 2. Reminder of the object's two aspects (identities)

The experimenter took the ball from box 1, called it 'a ball', and demonstrated that the ball was also a rattle. Calling the object 'the rattle', he put it back into box 1. During this episode Susi was away on the playground in the *agent-absent condition* but present in the *agent-present condition* and, thus, aware of the dual nature of the object. The child then was asked for a second time the *Know- question 2:* "Does Susi know that the ball is also a rattle?"

Episode 3. Transfer of the object to box 2

In the agent-present condition Susi was already present. In the agent-absent condition Susi came back from the playground and entered the scene again. With Susi present the experimenter took the object out of box 1 hiding the object in his hand and saying "Look Susi, I have here a rattle in my hand (shaking it to make the rattling sound). I am putting it now over into this box (box 2)." Great care was taken to cover the object with his hands so that neither child nor puppet Susi could see any of it. Then the battery of test questions followed in this order:

Memory question: "Where did we put the ball in the beginning?"
Reality question: "Where is the ball now?"
Where-look question: "Where will Susi look for the *ball*?"
Where-look (control): "Where will Susi look for the *rattle*?"

No feedback was given to the child after a trial. The object was then removed and Susi left the scene before a new trial was started.

Predication conditions. These conditions were the same as the individuation conditions with the following changes (using the ball/rattle as example): in Episode 0 and Episode 2 the ball was described as *a ball that rattles* and never as a rattle. The *Know- question* was accordingly changed to: "Does Susi know that the ball rattles?" In Episode 3 Susi was told: "Look Susi, I have here a *thing* in my hand *that rattles* (shaking it to make the rattling sound). The *where-look question (control)* was accordingly modified: "Where will Susi look for the *thing that rattles*?

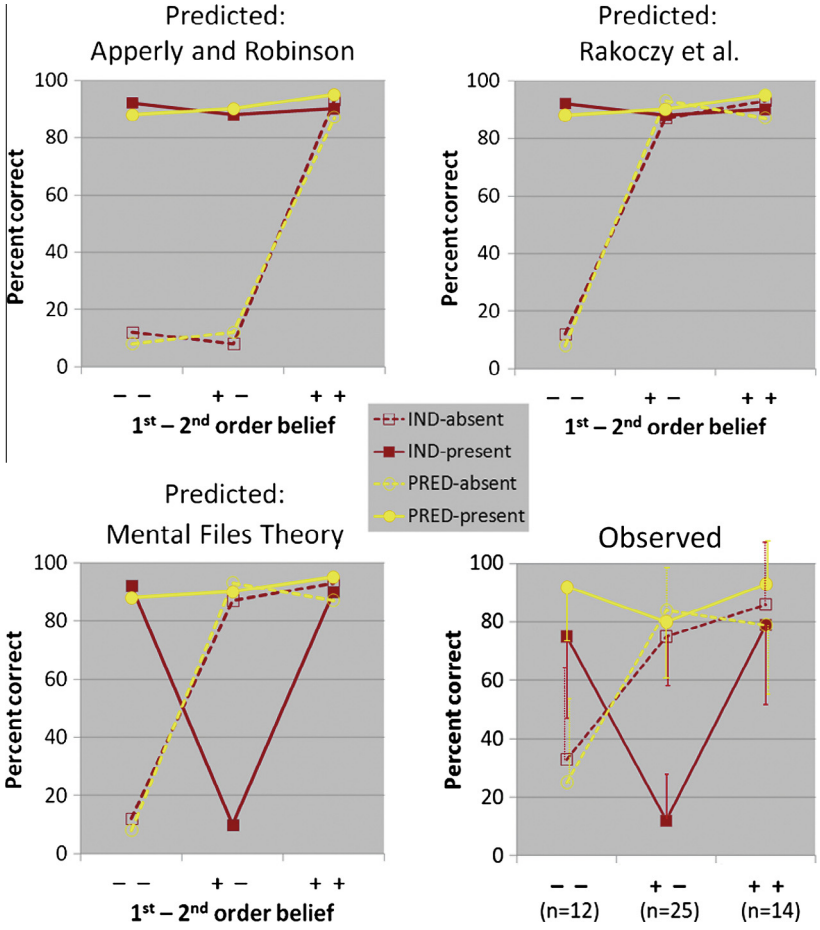

Fig. 6. Percentage of correct responses to the where-look question. IND denotes the use of individuating descriptions and PRED the use of predicates for reference. "Absent" and "present" refer to the absence or presence of the puppet agent in Episode 2. The *x*-axis in each panel shows the three categories of children according to their failing or passing the 1st and 2nd order false belief test. The four lines correspond to the four conditions. For better visibility of theoretical predictions and to avoid overlap, predictions of 100% and 0% correct are scattered around 90% and 10%, respectively. Error bars for the observed data show ±CI.

3.1.3.2. False belief tasks. Children were given one false belief task and one knowledge task, each with a 1st and a 2nd order test question (modelled after Perner & Howes, 1992). Susi put an object (without a dual aspect, e.g. a marble) into box 1 and then either left the scene (false belief task) or stayed put (knowledge task). Then the object was transferred by the experimenter from box 1 to box 2. Then Susi returned and the child was asked the following questions in the following order:

Memory question: "Where did we put the marble in the beginning?"
Reality question: "Where is the marble now?"
Test question 1st order: "If we ask Susi: Where is the marble? What will she say?"
Test question 2nd order: "If we ask Susi: Do you know where the marble is? What will she say? Will she say 'Yes, I know' or 'No, I don't know'?"
Verbal intelligence test.

3.1.3.3. Verbal intelligence measure. In the HAWIK IV vocabulary test (Petermann & Petermann, 2010) children were asked to describe the meaning of words like 'clock', 'transparent', or 'leaving'.

3.2. Results

3.2.1. False belief task

Performance on the Memory and Reality questions was perfect in the false belief and knowledge tasks. 12 children failed the first order false belief test and were classified as (––). Although 9 of them gave a fortuitously "correct" answer to the second-order question, this does not indicate any understanding of second-order belief but is a natural consequence of mistakenly believing that Susi knows where the ball is. The 24 children who passed the 1st order test but failed the 2nd order test were classified as (+–) and the remaining 14 children who passed both tests as (++).

3.2.2. Dual description "Intensionality" tasks

Only 4 mistakes were made by the 51 children on the memory, reality,[4] and the two knowledge questions in all 4 conditions. Also the where-look control question (Where will Susi look for the *rattle*?) was answered correctly in 91% of all cases. Our main analyses will rely exclusively on the first where-look question (Where will Susi look for the *ball*?). We checked that scoring children as correct only when both where-look questions were answered correctly did

[4] Perner and Leahy (in press) argue that (––) children cannot link files. An anonymous reviewer drew our attention to the following problem with that claim. According to the present data, (––) children correctly answer the reality question, "Where is the ball now?". But if (––) children cannot link files, why do they recognize that the ball has moved to box 2 when they have only heard of the rattle being moved to box 2? One possibility is that they are aided by the information, provided in Episode 0, that the boxes were both empty before the ball/rattle was deposited. Hence, they know that the only object in box 1 is the ball/rattle. When told that it is being taken out children have both files, the ball- and the rattle-file anchored to it and can register on both files that it is moved to box 2. The experimenter's verbally referring to the object as "the rattle" provides only redundant information and will not quench the already activated ball-file. Hence when asked where the ball is they can give a correct answer. Future studies will test this proposal.

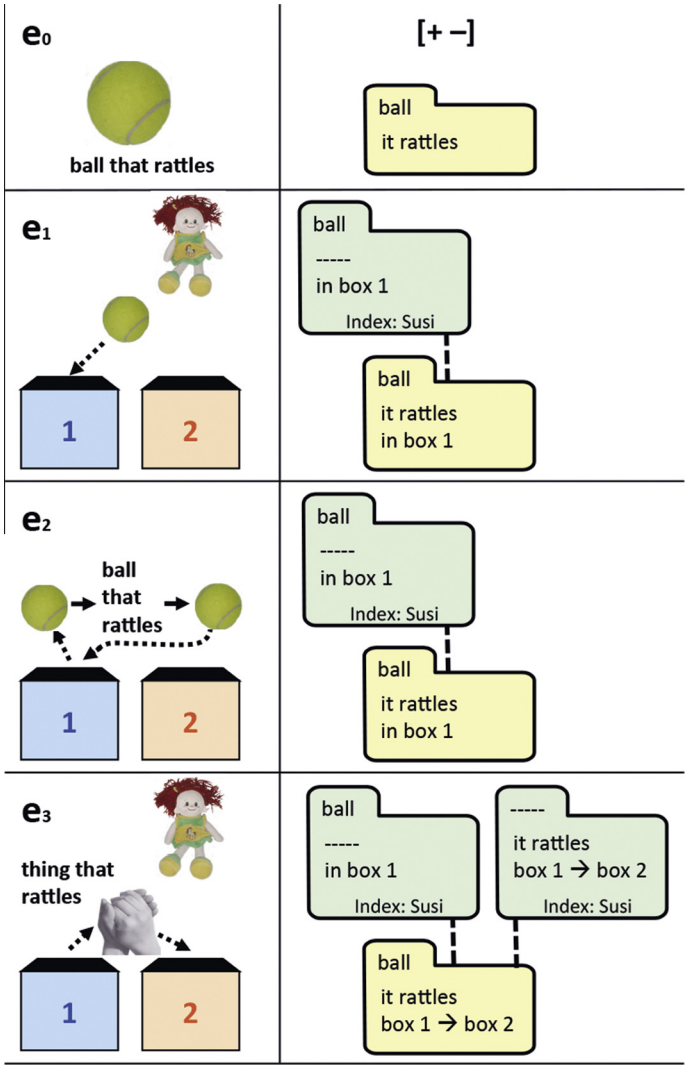

Fig. 7. The agent absent/predication condition.

not affect the interpretation of our results. The percent correct answers to the critical where-look question are shown in Fig. 6 (bottom right panel) together with predictions from two proposals in the literature and from our mental files analysis. Predictions for each category of children are as follows.

For (−−) children all three theories make the same prediction. They should succeed on the agent-present conditions and fail on the agent-absent conditions since the agent's absence leads to a false belief about the location of the ball. Perner and Leahy (in press) argue that this is because children who fail the first-order false belief task cannot form vicarious files. (−−) children answer the where-look question on the basis of regular files that record the object's real location. This yields correct answers in both agent-present conditions and incorrect answers in both agent-absent conditions. Observations confirmed this prediction (bottom right panel). Combined performance on the two agent-absent tasks (dotted lines) is significantly below that of the two agent-present tasks (Wilcoxon signed rank test: $p \leqslant .006$).

For (+−) children the theories make quite different predictions. Apperly and Robinson (1998, 2003) proposed that children's problems in their tasks occur whenever an agent knows about an object's location under one description but is ignorant about it under another description. This is the case in both agent-absent conditions. Therefore, children should fail on these tasks. Rakoczy et al. (2015) claim that the problems found in Apperly and Robinson's tasks vanish in their single object versions: hence the prediction is that children who pass 1st order false belief should pass the agent-absent condition, as Rakoczy et al. have shown. They should, presumably, also pass the new agent-present condition since it is, if anything, even easier than the agent-absent condition.

Mental files theory predicts correct answers by (+−) children in both agent-absent conditions and in the agent-present/predication condition. Our predictions for the absent/individuation condition were already described in connection with Fig. 4, above. In the agent absent/predication condition (Fig. 7), (+−) children construct a regular ball-file at episode e_0 and record the predicative information that it rattles. At e_1 they add the predicative information that it is in box 1. The regular ball-file is copied to a vicarious ball-file indexed to Susi. Since Susi can see the object put inside box 1, this information is recorded on her vicarious file, but not the information that it rattles, which Susi does not have. Episode 2 makes no difference to the files; it is redundant given the events of e_1. When they are told "I have a thing in my hand that rattles" during the hidden transfer, they do not introduce a new regular file, since "thing that rattles" matches their ball file, but they do introduce a new vicarious file

for Susi because the information "a thing that rattles" is not answered by any of Susi's existing files.[5] This captures the fact that Susi does not know that the transferred object is the ball. Since no sortal was used, the file does not receive header information, but the file is still vertically linked to the regular ball file, capturing the child's understanding that Susi's knowledge is about the ball. Predicative information that the object rattles and that it is moved from box 1 to box 2 is stored in this new vicarious file. The vicarious ball-file is not horizontally linked to the unheaded vicarious file (assumption 2), so the information about the move does not cross to the vicarious ball-file. Since Susi was told about the rattle's move but did not perceive it, information about the move is not copied from the regular ball-file to the vicarious ball-file (assumption 3a). When asked where Susi will look for the ball, (+−) children consult their vicarious ball-file, find the information "in box 1" written there, and so say that Susi will look in box 1.

In the agent present/predication condition (Fig. 8), Susi sees that the ball rattles in Episode 2 and this property is registered on her vicarious ball file. For this reason, the information given in e_3 ("the thing that rattles") matches Susi's ball file and no extra vicarious file needs to be created; and the transfer from box 1 to box 2 witnessed by Susi is recorded on her vicarious ball-file. Thus when asked "Where will Susi look for the ball?", (+−) children consult Susi's vicarious ball-file and find the information that it is in box 2.

Mental files theory predicts incorrect answers in the agent-present/individuation condition (Fig. 9) because (+−) children fail to horizontally link vicarious files. When told at e_0 that the ball is a rattle, they construct horizontally linked regular ball- and rattle-files; each records the object's dual identity as predicative information. At e_1 the regular files are both copied to vicarious files (assumption 1) and predicative information about the location in box 1 is recorded in all vicarious files (assumption 3b). Since Susi cannot see that the object is a rattle but can see that it is a ball, (+−) children withhold the predicative information "is a rattle" from the vicarious ball-file but do copy "is a ball" to the vicarious rattle-file (assumption 3b). The vicarious files are not horizontally linked (assumption 2). At e_2 the predicative information "is also a rattle" is added to the vicarious ball-file (assumption 3a). At e_3 linguistic information is given about the rattle. Only the regular rattle file and Susi's vicarious rattle file are addressed. So the information about the transfer to box 2 is recorded in the two rattle-files (assumption 3a). Horizontal linking between regular files makes this information available from the perspective of the regular ball-file. Lack of horizontal linking between vicarious files prevents the information from reaching the vicarious ball-file from the vicarious rattle-file. The information also fails to be copied from the regular ball file to Susi's vicarious ball file since Susi was only told about the rattle's move (assumption 3a) and did not perceive

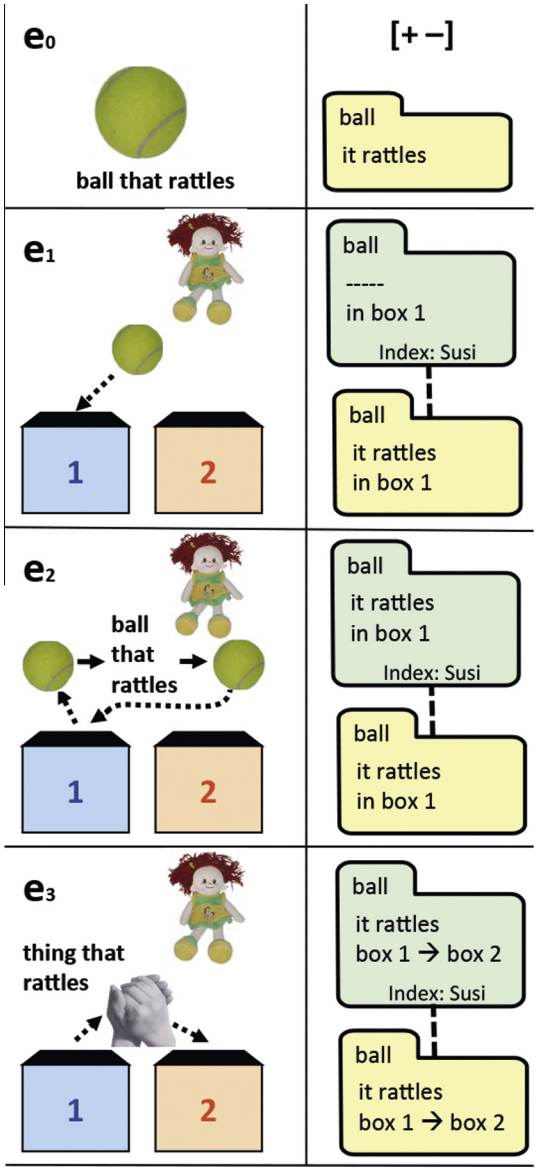

Fig. 8. Agent present/predication condition.

the object's move (assumption 3b).[6] Hence when asked where Susi will look for the ball, only the outdated "Box 1" information is available, and so the incorrect answer is produced.

The data (Fig. 6, bottom right panel) confirm the predictions by mental file theory remarkably well. In the agent-present/predication condition and in both agent-absent conditions answers were 80% or more correct (each above chance: Kolmogorov Smirnov, $p \leqslant .001$). In contrast, correct responses in the agent-present/individuation condition appeared only 20% of the time. This is significantly below chance (Kolmogorov Smirnov, $p \leqslant .001$). Moreover, performance in the agent-present/individuation condition was also significantly below children's performance on knowledge questions 1 and 2 (related samples sign test, $p \leqslant .001$).

Finally, for (++) children, all theories make the same prediction that children should eventually pass all four conditions. This was observed: there is no reliable difference between the tasks (Wil-

[5] To cover this case we need to extend our initial limited discussion of when children open new files in response to linguistic information. The general rule is that when a referential expression is encountered, one first checks whether it matches any existing file. If it does not match an existing file a new file is created. So when they encounter the referential expression "thing that rattles" children check whether it matches an existing file. We maintain that "thing", at least as used here, is not a sortal, but rather a place-holder for a sortal just like "I have one that rattles". Nevertheless, together with "that rattles" the expression matches the child's regular ball file, which contains the information that it rattles. Hence the child knows that the thing being moved is the ball. Importantly, we assume here that children independently check for matching files among Susi's vicarious files. Since there is no vicarious file that says anything about rattling, none matches the referential expression and so a new file is created. Since "thing" does not provide a sortal, it remains open what kind (sort) of thing it might be. Susi only knows that it rattles, whatever it may be. This is captured by an unlabelled file that contains 'it rattles' as predicative information. Moreover, since (+−) children are able to understand identity they can understand that what Susi has been made to think about (a thing that rattles) is identical to the ball. Hence they can vertically link the new vicarious file to their regular ball file.

[6] Again, Susi did not see the object while it was moved, and though the rattle was shaken, Susi could not hear the rattle being moved from box 1 to box 2. Susi only learns about the move via linguistic information. Compare footnote 3.

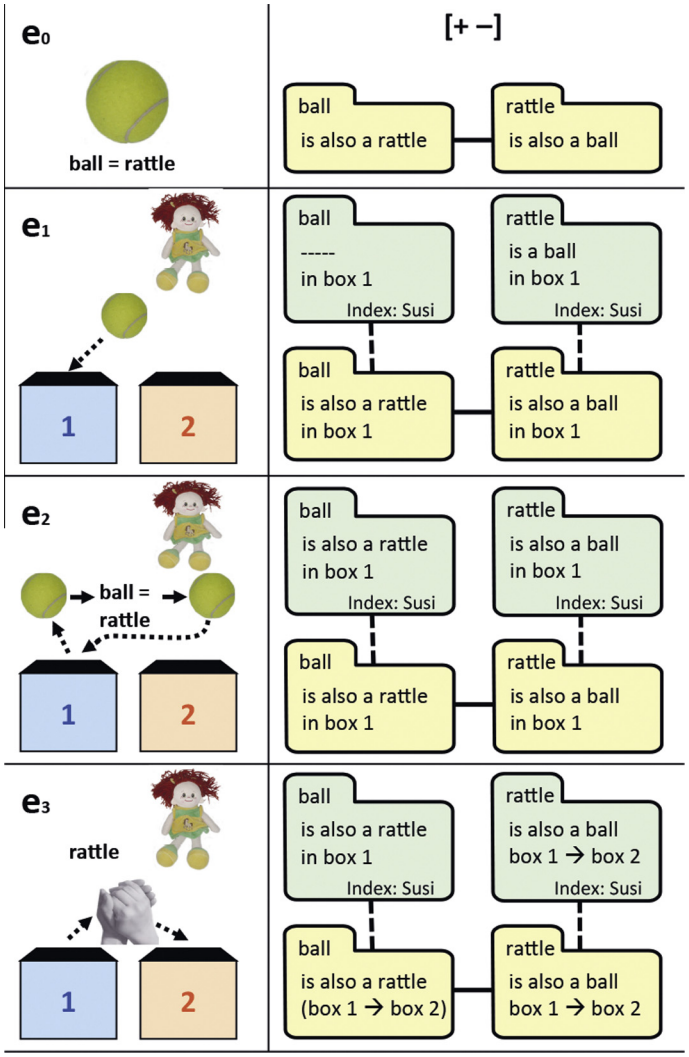

Fig. 9. Agent present/individuation condition.

coxon signed rank tests: all $p \geqslant .083$) and performance on all is above chance (Kolmogorov Smirnov, all $p \leqslant .003$). However, only the mental files theory links the improvement in performance from (+−) children to (++) on the agent-present/individuation condition to the understanding of second-order beliefs. The observed drastic improvement was highly significant (Mann Whitney U: $p < .001$). This improvement stayed significant when covariance due to children's age and verbal IQ was accounted for (logistic regression: Wald(1) = 5.64, $p < .02$), which shows that understanding second-order beliefs is specifically related to mastery of intensionality problems.

The results from our experiment make clear that mental files theory can predict an unusual, unexpected pattern of performance that other proposals do not match. The most critical feature of the results is the fact that performance on the agent-present individuation condition deteriorates as children pass false belief tests and recovers when they understand second-order beliefs. Due to its importance we replicated this pattern of results with 6 (−−), 21 (+−) and 5 (++) children for the two individuation conditions. Percent correct for the three groups were 50%, 81%, and 100% for the agent-absent condition and 83%, 24%, and 80% for the agent-present condition. The critical difference between agent-present and agent-absent conditions for (+−) children was statistically reliable (related samples sign test, $p \leqslant .001$).

3.2.3. Alternative views

Our explanation for our data proceeds from the assumption that children who fail verbal false belief tasks are unable to track people's beliefs by using vicarious files, as defended in Perner and Leahy (in press). This assumption leaves room for accommodating the rapidly increasing evidence that even infants show some sensitivity to people's beliefs (Kovacs, Teglas, & Endress, 2010; Onishi & Baillargeon, 2005; Southgate & Vernetti, 2014; Surian et al., 2007) and the possibility that these children track beliefs by some other means for which various proposals have been made (Butterfill & Apperly, 2013; Perner & Roessler, 2012; Ruffman, 2014; Wellman, 2014). Our mental files analysis may help to pin down the difference between knowledge underlying non-verbal measures and knowledge underlying verbal measures of understanding belief. An interesting suggestion comes from one of our anonymous reviewers: perhaps (−−) children do not use files headed by linguistic terms for the non-verbal tests; they may use fully mature but non-linguistic conceptual files instead. (−−) children generate their non-verbal responses by employing a single conceptual file for the objects they see, with different kind-properties stored as predicative information such as "is a rattle" and "is a ball". With success on verbal false belief tasks, children start to use linguistic files. When they encounter different terms for a single object, they open multiple files for that object, resulting in

some confusion. By age 6 these shortcomings have been cleared up. This suggestion, like any other, needs to be worked out in detail. One central hurdle for all potential suggestions is to explain why children use the non-linguistic conceptual files for their anticipatory looking (anticipating Mistaken Max to return to where he thinks his chocolate is) and use the linguistic files for answering the question where Max will look for his chocolate. The two measures strongly dissociate in young three year olds for otherwise identical presentation of the stories (Clements & Perner, 1994; Garnham & Perner, 2001; Low, 2010; Low, Drummond, Walmsley, & Wang, 2014; Low & Watts, 2012).

Another of our reviewers provided a similar alternative specifically addressing features of our data. (−−) children are not sensitive to the linguistically encoded difference between predicative and individuative information, therefore they give correct answers in both conditions. In contrast (+−) children are sensitive to this difference but interpret linguistically encoded individuative information in a manner that is at odds with the identity of the ball and the rattle. They are unable to inhibit or overcome this tendency, which yields wrong answers in the agent present/individuation condition. This explains the drop in performance from (−−) to (+−) children. The findings in the literature that (−−) children have problems with alternative naming (Doherty & Perner, 1998; Perner, Stummer, Sprung, & Doherty, 2002) shows that they are sensitive to individuative information or else they would not have the problems with alternative naming that they have. Moreover, the reviewer's assumption that (+−) children have problems with the identity of the ball and the rattle is at odds with the finding that children who pass the false belief test are also good at understanding identity (Perner et al., 2011) and with the fact that they have no problem tracking the identity of the ball and the rattle in answering the reality question ("Where is the ball?"), though they do struggle with "Where will Susi look for the ball" in the agent present/individuation condition.[7]

3.3. Discussion

The larger question behind this research is how a theory of mind can be acquired and whether it comes as a piece or in parts. Some nativist theorists (Baillargeon, Scott, & He, 2010; Leslie, 1994) are modularists and treat theory of mind as an unanalysed ability provided by evolution. Even theorists in favour of an ontogenetic acquisition of theory of mind (Gopnik & Meltzoff, 1997; Wellman, 1990, 2014) only describe the acquisition process in terms of component concepts available from our everyday explanations of behaviour. Notably Wellman (1990) characterised the transition around 4 years as one from a desire psychology to a belief-desire psychology, and Tomasello and Call (2006) describe the level of understanding achieved by animals in terms of "seeing", "knowing", etc. The reluctance to open discussion about deeper subpersonal processes underlying the acquisition of these common sense concepts stems from the fact that most of our concepts cannot be defined in terms of more basic concepts (Fodor, 1981) and the lack of a systematic theory of how concepts can be acquired, which led Fodor to posit the innateness of even the most abstract concepts (LOT: Fodor, 1975).

Against this background Apperly and Robinson's window poses serious problems. Children seem to master the concept of belief when they pass the false belief task. Hence it makes no sense that it takes another 2 years for them to come to grips with the intensionality of belief. Rakoczy et al. (2015) tried to solve this enigma with reference to task difficulty. Their simplified task used only one object, reducing memory load and referential ambiguity. The enigma disappeared: children who passed the false belief task also passed the agent-absent "intensionality" task. However, children's problems with intensionality re-emerge full force in our agent-present/individuation condition. This re-emergence is difficult to reconcile with a difference in task complexity. The agent-present conditions cannot be harder than the agent-absent conditions, since the agent and subject share all knowledge.

[7] The alternative proposal might appeal to the fact that there is nothing other than the ball in the two boxes, as we did do explain the same ability in (−−) children. See footnote 5.

4. Conclusion

Mental files have a proven track record in several disciplines, but have seen only limited use in the psychological literature. We have drawn on work from linguistics and philosophy to produce a theory of information storage and retrieval in terms of mental files. The resulting theory shows how the ability to understand belief is a cumulative process, and is alone in the literature in being able to account for all existing data regarding the understanding of the intensionality of belief. Particularly challenging is explaining how the ability to understand the intensionality of belief develops. Our theory generated novel and remarkable predictions that were not generated by any other theory, and empirical tests consequently recommended our theory over the alternatives.

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References

Apperly, I. A., & Robinson, E. J. (1998). Children's mental representation of referential relations. *Cognition, 67*, 287–309. http://dx.doi.org/10.1016/S0010-0277(98)00030-4.

Apperly, I. A., & Robinson, E. J. (2001). Children's difficulties handling dual identity. *Journal of Experimental Child Psychology, 78*(4), 374–397. http://dx.doi.org/10.1006/jecp.2000.2571.

Apperly, I. A., & Robinson, E. J. (2003). When can children handle referential opacity? Evidence for systematic variation in 5–6 year old children's reasoning about beliefs and belief reports. *Journal of Experimental Child Psychology, 85*, 297–311. http://dx.doi.org/10.1016/S0022-0965(03)00099-7.

Baillargeon, R., Scott, R. M., & He, Z. (2010). False-belief understanding in infants. *Trends in Cognitive Sciences, 14*(3), 110–118. http://dx.doi.org/10.1016/j.tics.2009.12.006.

Butterfill, S. A., & Apperly, I. A. (2013). How to construct a minimal theory of mind. *Mind & Language, 28*, 606–637.

Clark, E. V. (1997). Conceptual perspective and lexical choice in acquisition. *Cognition, 64*, 1–37. http://dx.doi.org/10.1016/S0010-0277(97)00010-3.

Clements, W., & Perner, J. (1994). Implicit understanding of belief. *Cognitive Development, 9*, 377–397.

Doherty, M. J., & Perner, J. (1998). Metalinguistic awareness and theory of mind: Just two words for the same thing? *Cognitive Development, 13*, 279–305.

Fodor, J. A. (1975). *The language of thought*. Cambridge, MA: Harvard University Press.

Fodor, J. A. (1981). The current state of the innateness controversy. In J. A. Fodor (Ed.). *Representations* (Vols. 1-Book, 1-Section). Cambridge, MA: MIT Press.

Frege, G. (1892). Über Sinn und Bedeutung. *Zeitschrift für Philosophie und philosophische Kritik, 100*, 25–50.

Garnham, W. A., & Perner, J. (2001). When actions really do speak louder than words—but only implicitly: Young children's understanding of false belief in action. *British Journal of Developmental Psychology, 19*, 413–432.

Gopnik, A., & Meltzoff, A. N. (1997). *Word, thoughts, and theories*. Cambridge, Massachusetts: A Bradford Book, The MIT Press.

Heim, I. (1982). *The semantics of definite and indefinite noun phrases*. Doctoral dissertation. Amherst: University of Massachusetts.

Hogrefe, G. J., Wimmer, H., & Perner, J. (1986). Ignorance versus false belief: A developmental lag in attribution of epistemic states. *Child Development, 57*, 567–582.

Kamp, H., & Reyle, U. (1993). *From discourse to logic. Introduction to modeltheoretic semantics of natural language, formal logic and discourse representation theory*. Dordrecht, Boston, London: Kluwer Academic Publishers.

Karttunen, L. (1976). Discourse referents. In J. McCawley (Ed.), *Notes from the linguistic underground (syntax and semantics, vol. 7)* (Vols. 1-Book, 1-Section, pp. 363–385).

Kovacs, A. M., Teglas, E., & Endress, A. D. (2010). The social sense: Susceptibility to others' beliefs in human infants and adults. *Science (New York, N.Y.), 330*(6012), 1830–1834. http://dx.doi.org/10.1126/science.1190792.

Leslie, A. M. (1994). ToMM, ToBy, and Agency: Core architecture and domain specificity. In L. A. Hirschfeld, & S. A. Gelman (Eds.), *Mapping the mind: Domain specificity in cognition and culture* (pp. 119–148).

Low, J. (2010). Preschoolers' implicit and explicit false-belief understanding: Relations with complex syntactical mastery. *Child Development, 81*(2), 597–615. http://dx.doi.org/10.1111/j.1467-8624.2009.01418.x.

Low, J., Drummond, W., Walmsley, A., & Wang, B. (2014). Representing how rabbits quack and competitors act: limits on preschoolers' efficient ability to track perspective. *Child development, 85*(4), 1519–1534.

Low, J., & Watts, J. (2013). Attributing false-belief about object identity reveals a signature blind spot in humans' efficient mind-reading system. *Psychological Science, 24*(3), 305–311.

Onishi, K. H., & Baillargeon, R. (2005). Do 15-month-old infants understand false beliefs? *Science, 308*, 255–258. http://dx.doi.org/10.1126/science.1107621.

Perner, J., & Brandl, J. (2005). File change semantics for preschoolers: Alternative naming and belief understanding. *Interaction Studies, 6*, 483–501. http://dx.doi.org/10.1075/is.6.3.11per.

Perner, J., & Howes, D. (1992). "He thinks he knows"; and more developmental evidence against the simulation (role-taking) theory. *Mind & Language, 7*, 72–86. http://dx.doi.org/10.1111/j.1468-0017.1992.tb00197.x.

Perner, J., & Leahy, B. (in press). Mental files in development: Dual naming, false belief, identity and intensionality. *Review of Philosophy and Psychology*. http://dx.doi.org/10.1007/s13164-015-0235-6.

Perner, J., Mauer, M. C., & Hildenbrand, M. (2011). Identity: Key to children's understanding of belief. *Science (New York, N.Y.), 333*(6041), 474–477. http://dx.doi.org/10.1126/science.1201216.

Perner, J., Rendl, B., & Garnham, A. (2007). Objects of desire, thought, and reality: Problems of anchoring discourse referents in development. *Mind & Language, 22*, 475–513. http://dx.doi.org/10.1111/j.1468-0017.2007.00317.x.

Perner, J., & Roessler, J. (2012). From Infants' to Children's Appreciation of Belief. *Trends in Cognitive Sciences, 16*(10), 519–525.

Perner, J., Stummer, S., Sprung, M., & Doherty, M. J. (2002). Theory of mind finds its Piagetian Perspective: Why alternative naming comes with understanding belief. *Cognitive Development, 17*, 1451–1472.

Perry, J. (2002). *Identity, personal identity and the self*. Cambridge: Hackett Publishing.

Petermann, F., & Petermann, U. (Eds.). (2010). *HAWIK-IV* (3rd ed.. Bern: Huber.

Pylyshyn, Z. (2007). *Things and places: How the mind connects with the world*. Cambridge: MIT Press.

Rakoczy, H., Bergfeld, D., Schwarz, I., & Fizke, E. (2015). Explicit theory of mind is even more unified than previously assumed: Belief ascription and understanding aspectuality emerge together in development. *Child Development, 86*(2), 486–502. http://dx.doi.org/10.1111/cdev.12311.

Recanati, F. (2012). *Mental files*. Oxford: Oxford University Press.

Ruffman, T. (2014). To belief or not belief: Children's theory of mind. *Developmental Review, 34*, 265–293.

Russell, B. (1910). Knowledge by acquaintance and knowledge by description. *Proceedings of the Aristotelian Society, 11*, 108–128.

Russell, J. (1987). "Can we say …?" Children's understanding of intensionality. *Cognition, 25*, 289–308. http://dx.doi.org/10.1016/S0010-0277(87)80007-0.

Sodian, B., Thoermer, C., & Dietrich, N. (2006). Two- to four-year-old children's differentiation of knowing and guessing in a non-verbal task. *European Journal of Developmental Psychology, 3*, 222–237. http://dx.doi.org/10.1080/17405620500423173.

Southgate, V., & Vernetti, A. (2014). Belief-based action prediction in preverbal infants. *Cognition, 130*. http://dx.doi.org/10.1016/j.cognition.2013.08.008.

Sprung, M., Perner, J., & Mitchell, P. (2007). Opacity and embedded perspectives: Object identity and object properties. *Mind & Language, 22*, 215–245. http://dx.doi.org/10.1111/j.1468-0017.2007.00307.x.

Tomasello, M. (1999). *The cultural origins of human cognition*. Cambridge: Harvard University Press.

Tomasello, M. (2014). *A natural history of human thinking*. Cambridge: Harvard University Press.

Tomasello, M., & Call, J. (2006). Do chimpanzees know what others see – Or only what they are looking at? In S. Hurley & M. Nudds (Eds.). *Rational animals* (Vols. 1-Book, 1-Section, pp. 371–384). Oxford: Oxford University Press.

Treisman, A. M., & Gelade, G. (1980). A feature-integration theory of attention. *Cognitive Psychology, 12*(1), 97–136. http://dx.doi.org/10.1016/0010-0285(80)90005-5.

Wellman, H. M. (1990). *The child's theory of mind*. Cambridge, MA: MIT Press. A Bradford Book.

Wellman, H. M. (2014). *Making minds: How theory of mind develops*. University of Michigan.

Wellman, H. M., Cross, D., & Watson, J. (2001). Meta-analysis of theory of mind development: The truth about false belief. *Child Development, 72*, 655–684.

Wimmer, H., & Perner, J. (1983). Beliefs about beliefs: Representation and constraining function of wrong beliefs in young children's understanding of deception. *Cognition, 13*(1), 103–128. http://dx.doi.org/10.1016/0010-0277(83)90004-5.