Supporting Online Material for

Identity: Key to Children’s Understanding of Belief

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Supporting Online Material for

Identity: Key to Children’s Understanding of Belief.

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Detailed methods and results for Study 1.
Detailed methods and results for Study 2.
1. Study 1

1.1 Method

1.1.1 Participants

Forty one children (16 girls) from two nursery schools in Munich, Germany participated in Study 1. The 21 “3-year olds” had a mean age of 3.5 years (S.D. = .29) and the 22 “4-year olds” 4.7 years (S.D. = .35).

1.1.2 Design

Children were first given an introduction to finding the right keys for a set of boxes. This was followed by the two test conditions (identity and dual function) in counterbalanced order. For each condition different story materials (zoo, farm) were used by random assignment. At the end of the session children were given a false belief test. Each session lasted for 10 to 15 minutes.

1.1.3 Procedure and Materials

1.1.3.1 Introduction.

This was to familiarize children with the materials, the use of keys to open boxes and, in particular, with the fact that one key could open more than one box and that the color mark of the key need not match the color of the box it opens. Three wooden boxes (10 cm × 10 cm × 10 cm) painted black, white, and purple, respectively were presented in a randomly determined spatial array. Then the investigator picked the key which opened the black box, but carried a purple marker, from a dish with several keys and asked the child:

“I got a key with a purple marker. What do you think: which box does this key open?”

Almost all children (81%) chose the purple box and tried unsuccessfully to open the box, whereupon the investigator said: “Look, it doesn’t work! The key belongs to another box. Which one would you like to try?” Now the child tried to open the other boxes with success on the black one and the investigator said: “Yes, indeed! The key with the purple marker opens the black box!” She put back the purple key and took the key with the black marker asking the child to find out which box it would open. The key opened two boxes, white and purple. After discovering one of them the child was encouraged to see whether the key might open yet another box. Children’s understanding that one key could open more than one lock and that the color of the key need not match the color of the box was tested with two questions:

Q1: “Can you show me again, which box does the key with the purple marker open?” [correct answer: black box]

Q2: “And which box does the key with the black marker open?” [white and purple box]

Following this introduction the materials were removed and the materials for the test session were set up, which consisted in counterbalanced order of the identity and the dual function condition. These conditions are illustrated below using the zoo scenario. The verbatim versions of zoo and farm scenario can be found in the Appendix.

1.1.3.2 Identity condition (ID).
In the zoo-story three wooden boxes (16 cm x 16 cm x 16 cm) with a barrel-lock represented the two cages for the lion and the snake, and the food storage room (see Figure 1). Each of the cages carried a picture of its inhabitant animal and they were placed randomly to the left and the right of the food box. The investigator introduced a 6 cm tall male puppet as Max, the zoo keeper with a problem: he doesn’t know which of his many keys opens which box. He asks the child for help while he has to do something else. In Max’s absence, the investigator took a key out of the dish and said: “Let’s try it on the food storage!” and continued after the unsuccessful attempt: “The key doesn’t open the food storage! Well then let’s see if the key opens this cage (lion cage).” The investigator then successfully opened that cage and said: “Yes, it worked! The key opens the lion cage! We should mark it so that we don’t mix it up with the other keys in the dish!” and the investigator put a yellow [for the yellow lion] marker on one side of the key. Then she put the key back into the dish and picked out another key, which in fact happened to be the same one as before, but was held in such a way that the child could only see its unmarked side and thought it was a different key, and said: “Let’s try this one on the food storage.” After an unsuccessful attempt she continued: “The key doesn’t open the food storage! Well then let’s see if the key opens this cage (snake cage).” The investigator then successfully opened the snake cage and said: “Yes, it worked! The key opens the snake cage! Now we have to mark this key, too,” and the investigator put the green color marker [for the green snake] on it. The investigator was about to return the key to the dish when she happened to notice something unusual: “Oh! Look… what is this?” and turned the key from side to side making the child aware of the fact that the same key had the yellow marker on one and the green marker on its other side, i.e., that the yellow and the green key were the same object (identity information): “Look at the key! This yellow key is the same as the green key!” and handed the key to the child for further inspection. After this discovery the key was left in front of the child with its green side up (only green marker visible). When Max returned to feed the animals the investigator asked the critical questions:

ID-1: “Max wants to feed the lion: can he open the door of the (yellow) lion cage with this (green-side-up) key?” [correct answer: “yes”]

Whether the child answered correctly or not the investigator demonstrated that the key with the green marker opens the lion’s box. Then she pointed out that Max needed to first get the food from the food box and asked:

ID-2: “To get food, can Max open the food box with this key?” [correct answer: “no”]

The investigator showed that the key doesn’t open the box. Then Max wanted to feed the snake and the investigator asked the obvious question about the key with its green side up:

ID-3: “Can Max also open the (green) snake cage with this (green-side-up) key?” [correct answer: “yes”]

1.1.3.3 Dual Function condition (DF).

This condition differed only in one critical point from the identity condition, namely the point in time when it became clear that a single key opens the lion and the snake cage. After marking the key with a yellow marker because it opened the lion’s cage the investigator—and that is the critical difference to the identity condition—tried this
key right away on the snake cage, which it opened. She pointed that out to the child: “Oh, look, it also opens this cage! Now we have to mark it with this color (green marker), too,” and the investigator put the green color marker on the other side. Then for the remainder of this condition the procedure followed exactly that of the identity condition: The key was left green side up and when Max came back to feed the animals children were asked the three questions:

DF-1: “Max wants to feed the lion: can he open the door of the (yellow) lion cage with this (green-side-up) key?” [correct answer: “yes”]
DF-2: “To get food, can Max open the food box with this key?” [correct answer: “no”]
DF-3: “Can Max also open the (green) snake cage with this (green-side-up) key?” [correct answer: “yes”]

For the farm stories with Carla the farmer the three wooden boxes represented a farmhouse, a storage container for apples and a storage container for prunes. The storage containers carried pictures of a blue prune and red apple. The respective key was marked with a blue or a red marker.

1.1.3.4 False belief task.

After dual function and identity tasks one false belief task was presented as a PowerPoint animation on a 15” laptop screen with the investigator narrating the story and asking the questions. The protagonist Laura entered a room with two boxes: a yellow one and a green one. She put her book into the yellow box and left the scene. Then her brother Thomas came into the room and looked into the yellow box, found the book, put it into the green box, and left the scene. The children were asked three control questions:

**Location:** “Where is the book now?” [green box]
**Memory 1:** “Who put it in there?” [Thomas]
**Memory 2:** “Where did Laura put her book at the beginning of the story?” [yellow box]

Laura returned and wanted to read her book. The children were asked the first critical test question:

**Prediction:** “Where will Laura look for her book first?” [correct answer: “yellow box”]

Depending on whether the child gave the correct or incorrect answer, the investigator said, “Yes, that’s right” or “No, she doesn’t go there,” and then continued: “Laura goes to the yellow box. She opens it and it is all empty.” The second test question was asked:

**Explanation:** “Why did Laura look for her book in the yellow box?”

Answers were scored according to the scheme developed by Wimmer & Mayringer(30): as correct if children pointed out what Laura thought, didn’t know or see, that she had been absent, or that the book had originally been in the yellow box. If children answered “because she wants her book,” “because the ball isn’t in here”, “because the ball is over there,” or “don’t know,” they were scored as failing.

1.2 Results
1.2.1 Key conditions.
Five children made a mistake in the dual function control condition on question 1 and 7 on question 2 and none on question 3. In the identity condition only 3 children made a mistake on question 3, but 13 on question 2 and 14 on question 1. Figure 2a shows how many 3- and 4-year old children answered all three questions in each condition correctly. The difference between dual function control and identity condition was highly significant (McNemar’s \( \chi^2 = 16.0, p < .001 \)). There was a significant improvement with age in the identity condition (Fisher’s Exact Test: \( p < .004 \)), but not in the dual function control condition (Fisher’s Exact Test: \( p = .067 \)).

1.2.2 False Belief Test.

All 41 children answered all three control questions correctly but only 24 children made correct predictions and only 13 of these could explain Laura’s erroneous action. One child made the wrong prediction but gave a sensible explanation. To make the measure for passing false belief as comparable as possible to answering three questions correctly in the identity and dual function conditions, we required children to make a correct prediction and provide a correct explanation. The data in Figure 2a show that the numbers of children passing false belief and passing the identity condition were very similar in each age group and there was, consequently, a similar improvement with age (Fisher’s Exact Test: \( p < .003 \)).

1.2.3 Correlations between Identity and False Belief.

Passing the false belief test and passing the identity questions were not merely of similar difficulty, they also correlated with each other (\( r = .57, \) Table 1). When children’s age was controlled this relationship remained at \( r = .39 \). The statistical significance of this result was checked with logistic regression. Entering identity after children’s age, both age (\( p = .016 \)) and passing identity (\( .026 \)) made a significant contribution to classifying children as passing the false belief task.

2. Study 2

2.1 Method

2.1.1 Participants

Seventy-eight children (40 girls and 38 boys), aged 2;11 to 5;11 years, from seven nursery schools and toddler groups in Salzburg and Hallein, Austria and Bad Reichenhall and Freilassing, Germany participated in the study. The sample was divided into 21 “younger 3-year olds” (mean age = 3.2 years, S.D. = .17), 22 “older 3-year olds” (mean age = 3.7 years, S.D. = .13), 25 “4-year olds” (mean age = 4.4 years, S.D. = .30) and 10 “5-year olds” (mean age = 5.6 years, S.D. = .24). All children were native German speakers.

2.1.2 Design

The study consisted of two sessions on different days, each taking about 10 to 15 minutes. Across these two sessions, two Identity tasks, one Attribution and one Memory Control task, two False Belief tasks and the vocabulary subtest of the K-ABC were administered. Each session consisted of one of the Identity tasks, one of the False Belief tasks (assigned to the two sessions in counterbalanced order) and either the Attribution or
the Memory Control task, presented in counterbalanced order. Additionally, the vocabulary subtest of the K-ABC was conducted at the beginning of session two.

The identity task as well as the attribute and the memory control task were available in four different versions (fire station, bakery, police station and hospital). These versions were assigned to the four tasks in counterbalanced order, ensuring that children were told each version exactly once during the study.

2.1.3 Procedure and Materials

All tasks were displayed with MS Powerpoint on a 15.6” laptop. The laptop stood on a low table facing the children, who sat on a small chair about 20 inches away from the screen. The investigator sat next to the child and operated the laptop.

2.1.3.1 Identity, Attribution and Memory Control tasks

All four tasks were embedded into short stories told by the investigator. Throughout the stories children were asked comprehension questions to ensure they were following the plot. Protagonists and story objects were represented on screen by animated pictures of Playmobil® people, animals and objects. All tasks were available in four versions (fire station, bakery, police station and hospital), which were identical in structure. In the following, all stories will be described using the example of the fire station version.

**Identity condition (ID).** The first scene of the fire station identity task showed a dog standing next to a fire station. Both the dog and the fire station were pointed out to the child.

Q1: Where is the dog? [point to the dog]

Then a man entered the scene dressed in plain clothes. He was introduced as “the fire fighter”.

Q2: Who is this? [the fire fighter]

The fire fighter then entered the fire station and was no longer visible. Next, a boy called Peter walked into the scene carrying a bag, which, as children were told, somebody else had lost.

Q3: Where is the bag? [point to the bag]

After Peter asked the dog whose bag it was, the dog said that it belonged to Mr Mueller.

Q4: Whose bag is it? [Mr Mueller’s]

Peter then asked the dog where Mr Mueller was. The dog answered that he was in the fire station and gave Peter the identity information, “Mr Mueller is the fire fighter”. So Peter walked up to the fire station and rang the bell. The door opened and Peter saw two men in plain clothes standing in the doorway – one of them being the fire fighter introduced earlier in the story. Children were then asked the critical question, “Whose bag is it?” to assess whether they had correctly understood the identity information and thus knew the bag belonged to the fire fighter. If children answered verbally with “Mr Mueller” or “the fire fighter”, they were asked to point to one of the two men in the doorway.

**Memory Control condition (MC).** The Memory Control condition was identical to the Identity condition up to Q3. After Q3 neither the proper name (Mr Mueller) nor the identity information was given. Instead, after Peter asked the dog whose bag it was, the

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1 German original: „Wem gehört die Tasche?“
dog replied that the bag belonged to the fire fighter, whereupon Peter walked up to the fire station and rang the bell. The story then ended with the same two men standing in the doorway and the same critical question was asked as in the identity condition.

The purpose of the Memory Control condition was to ensure children remembered which of the pictured men was the fire fighter introduced earlier in the story.

**Attribution condition (ATT).** Unlike in the Identity condition the fire fighter was not mentioned or shown at the beginning. Moreover, the dog gave attributive information, “Mr Mueller is fire fighter,” instead of the identity information “Mr Mueller is the fire fighter,” given in the identity condition. Thus children did not have to process any identity information in the attribute control condition. To clarify which of the two men in the doorway was the fire fighter, one of them, Mr Mueller, was dressed as a fire fighter, while the other one wore plain clothes. Children had to draw a very similar inference as in the Identity condition. In the attribute condition they had to infer from (a) Mr Mueller is fire fighter and (b) one of the two men in the doorway is a fire fighter, that (c) Mr Mueller is that man in the doorway. Whereas in the identity condition the inference went from (a) Mr Mueller is the fire fighter (introduced earlier) and (b) one of the two men in the doorway is that fire fighter, that (c) Mr Mueller is that man in the doorway. Thus, the condition controlled whether children’s possible difficulties with the Identity condition were due to problems processing identity information and not to difficulties drawing inferences, understanding the story, or the critical test questions.

### 2.1.3.2 False Belief tasks

Similar to the Identity tasks, the two False Belief tasks were also presented as animated stories featuring Playmobil® people, animals, and objects on the computer with the text spoken by the investigator. Throughout these stories memory questions checked whether children had understood the essential story facts and could still remember them at the end. Both stories had the same structure; only different characters (Maxi versus Lisa) and objects were used. At the beginning of the story with Maxi the screen showed a room with a blue and a green cabinet. Then Maxi entered the scene from the left carrying a ball. Children were told that Maxi was thirsty and wanted to get himself a drink. Thus he put the ball into the blue cabinet and disappeared off the scene to the right. The investigator explained that he had gone into the kitchen and that he had closed the door behind him.

**Q1:** Where did Maxi put the ball? [blue cabinet]

Next, Maxi’s sister Lena entered the scene from the left. She found the ball in the blue cabinet, took it out, and put it into the green cabinet. Then she left the scene in the direction she had come from.

**Q2:** Where is the ball now? [green cabinet]

**Q3:** Who put it there? [Lena / his sister]

**Q4:** Did Maxi see that? [no]

**Q5:** Where did Maxi put the ball in the beginning? [blue cabinet]

After Lena had left, Maxi came back from the kitchen and wanted to play with his ball again. The critical prediction question “Where will Maxi look for the ball first?” [blue cabinet] tested children’s ability to make a behavioural prediction based on false belief.

2 German original: “Herr Müller ist Feuerwehrmann.”
Maxi then opened the blue cabinet and realised that it was empty. The investigator then asked the critical explanation question “Why did Maxi look for the ball in the blue cabinet?” to assess children’s ability to explain an erroneous action due to a false belief. In the Lisa task, the boy called Maxi was replaced by a girl called Lisa, the ball by a teddy bear, the blue cabinet by a red basket, the green cabinet by a yellow basket, Maxi’s sister Lena by Lisa’s brother Tom and thirst by hunger. In all other respects plot and questions remained the same.

2.1.3.4 Verbal Intelligence Test (K-ABC)
To assess whether correlations between tasks were influenced by differences in verbal intelligence, the vocabulary subtest of the Kaufman-Assessment Battery for Children K-ABC (31) was conducted. The test measures the ability to correctly name depicted items and describes children’s verbal abilities.

2.2 Results
The results showed good performance in the memory (96% correct) as well as the attribution control conditions (88%) and there was no reliable difference (McNemar’s test, p > .10). In fact, 86% gave correct answers in both conditions as opposed to only 50% in the two identity conditions. This difference was considerably larger for the younger than the older children (Figure 2b). The difference between control conditions and identity conditions diminished significantly with age (linear-by-linear $\chi^2 (1) = 6.51$, $p = .011$). Children’s ability to make correct predictions in both false belief tasks was somewhat lower (37%) than in the two identity conditions, which is probably due to the fact that children who do not yet understand identity statements are likely to guess—the lucky ones twice correct—while on the false belief task they apply a wrong theory leading to systematically wrong answers (32).

Using a more sensitive measure to tap individual differences we correlated children’s number of correct answers on the identity questions (0, 1, 2) with their number of correct predictions and correct explanations on the two false belief tasks (range: 0 to 4). The results (right half of Table 1) show in addition to Study 1 that the partial correlation between false belief and identity understanding remains highly significant even after taking age and verbal intelligence into account. This shows that the developmental relationship between understanding identity and false belief cannot be reduced to general facility with language but is more specific. We checked the reliability of this result with the strict pass criterion used for Figure 2b with logistic regression. After introducing age and KABC-scores in the model passing the identity conditions accounted for a significant improvement in predicting passing the false belief tasks: $p = .015$. 


References and Notes


18. Materials and methods are available as supporting material on Science Online.


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