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DOI:

[10.1016/j.cogdev.2019.100824](https://doi.org/10.1016/j.cogdev.2019.100824)

Document Version

Accepted author manuscript

[Link to publication record in Manchester Research Explorer](#)

Citation for published version (APA):

Domberg, A., Köymen, B., & Tomasello, M. (2019). Young children choose to reason with partners who submit to reason. *Cognitive Development*. <https://doi.org/10.1016/j.cogdev.2019.100824>

Published in:

Cognitive Development

Citing this paper

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Children choose to reason with partners who submit to reason

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Article published in *Cognitive Development*

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Acknowledgements: We would like to thank Carl Bartl, Christian Biermann, Manuel Bohn, Paula Buchholz, Petra Jahn, Georg Keller, Cathal O'Madagain, Benjamin Reimann, Elena Rossi, Heiko Saur, Silvio Tüpke, and Lua for their advice and help in realizing this study.

Abstract

When reasoning with others, the reasons used in an exchange can have varying degrees of quality, irrespective of the facts under discussion. Partners often evaluate one another's evaluation of reasons – one another's reasoning. Can children evaluate their partner's judgment of the quality of reasons independent of objective truth? 5- and 7-year-olds (N=122) chose among two partners for cooperation. In the experimental condition, one acceded to a good reason, the other to a poor reason. In the control condition, each agreed to a different good reason. Crucially, in both conditions, both partners arrived at the wrong conclusion. Results suggested that 7-year-olds, and 5-year-olds to a lesser degree, chose the partner who endorsed the good reason in the experimental condition, but showed no preference for partners in the control condition. Thus, young children distinguish good from poor reasons, even if neither leads to success, and choose partners who do the same.

Keywords: cooperation; reasoning; partner choice

Children choose to reason with partners who submit to reason

A rapidly growing literature characterizes reasoning as a social phenomenon. Mercier and Sperber (2011, 2017) argue that the main function of reasoning is for speakers to generate reasons that persuade group members of a given belief or decision, and for hearers to be critical of reasons when they encounter reasons presented by their partner. Tomasello (2014) further emphasizes the critical role that reasoning plays in collaborative decision-making, where groups need to find a good and justified solution benefiting all group members. In cooperative contexts, where the paramount goal is to come to a correct conclusion, people should submit to good reasons (over trying to win the argument) and prefer to reason with partners who do the same.

Children are vigilant social learners who selectively trust some information sources more than others. Four-year-olds trust accurate informants over inaccurate ones (Birch, Vauthier, & Bloom, 2008; Corriveau & Harris, 2009; Jaswal & Neely, 2006; Koenig & Harris, 2005). When accuracy cannot be verified and children need to attend instead to how informants justify their conclusions, 2- to 3-year-olds trust those who give good reasons for their proposals (e.g., “The dog went this way because I saw it go this way.”) as opposed to circular ones (e.g., “The dog went this way because it went this way.”; Castelain et al., 2018, 2016; Corriveau & Kurkul, 2014; Mercier et al., 2014, 2018). Similarly, Koenig (2012) showed that 4-year-olds trust conclusions that are based on good epistemic grounds such as perceptual access, (e.g., “I looked and I saw an apple in the box.”) more than those based on wishful thinking (e.g., “I like apples. I want there to be apples in the box.”).

However, in these studies, it was often not clear whether the informants were actually right or wrong. A stricter test of children's sensitivity to the quality of reasons would be to investigate whether children still prefer an informant who produces good reasons, when both informants are wrong or have a false belief (e.g., "I saw that there is an apple in the box"—but the apple is no longer there). Moreover, in these studies, children were often asked to choose between individuals who produce reasons, instead of individuals who evaluate these reasons. Children's ability to identify and trust individuals who are able to distinguish good reasons from poor ones is a more advanced skill, because it requires children to not only evaluate the quality of the reasons and detach it from their own beliefs about the truth, but also to evaluate another person's evaluation of reasons.

In this study, therefore, we presented 5- and 7-year-old children with a cooperative game for which they needed a partner. Children observed two candidates together in a problem-solving task, namely, finding a lost paintbrush. Candidates heard together two reasons from two disagreeing informants about where the brush is. Crucially, the candidates were ignorant and the informants had a false belief about the location of the paintbrush. In the experimental condition, one informant produced a good reason based on *eye-witness testimony* ("Check the red box [incorrect location] because I saw it there yesterday"), and the other informant produced a poor reason based on *color preference* ("Check the yellow box [incorrect location] because yellow is my favorite color"). In the control condition, one informant produced the same good reason based on eye-witness testimony for the same incorrect proposal, and the other informant produced another good reason based on *rules* ("Check the yellow box [incorrect location] because we always put it there"). In both conditions, one candidate endorsed the good reason based on eye-

witness testimony and the other endorsed the other reason. We predicted that in the experimental condition, children would choose the candidate who endorsed the good reason over the candidate who endorsed the poor reason; whereas in the control condition, children would choose each candidate equally often, because both candidates endorsed a good reason. We explored if there were any age differences. Although 5-year-olds are good at evaluating reasons (Corriveau & Kurkul, 2014; Mercier et al., 2014) and show false belief understanding (Wellman, Cross, & Watson, 2001; Wimmer & Perner, 1983), 7-year-olds have been observed to be more strategic in their reasoning than 5-year-olds (Domberg, Köymen, & Tomasello, 2018). For instance, 7-year-olds withheld information or reasons more often than 5-year-olds, if these reasons would prevent them from winning a game against their peers. Moreover, 7-year-olds are better able to express why they believe an information source is more trustworthy than are 5-year-olds (Köymen & Tomasello, 2018).

Method

Participants

Sixty-one 5-year-olds ($M = 5;9$, $Range = 5;3-6;2$, 32 girls, 30 in the experimental condition) and 61 7-year-olds ($M = 7;6$, $Range = 7;3-7;9$, 30 girls, 31 in the experimental condition) participated in this study. All children were native German speakers with various socio-economic backgrounds, recruited and tested at urban daycares and schools. Additional 32 5-year-olds could not be included in the analysis, because they gave incorrect responses to false belief questions (24 children), failed to recall one or both reasons after cues (5 children), or refused to choose a partner (3 children). Additional

eight 7-year-olds could not be included in the analysis due to incorrect responses to false belief questions (5 children), failure to recall one or both reasons after cues (2 children), or experimenter error (1 child).

Materials

For the cooperative game, we used an 85 cm × 31 cm laminated background with six panels with different colors, each depicting two sets of footprints leading up to two different animals (see Figure 1). At the beginning, each animal was covered by a cardboard box with a slot, and only its footprints were visible. The child and experimenter had identical chips, depicting a desired item for an animal. They had to infer which animal needs this item, which set of footprints belonged to this animal, and coordinate their decisions by cashing their chips into the same correct box. If correct, the child would win marbles to stack in an upright transparent tube with a finish line. For the partner choice, the story describing the candidates was told using a 15-page booklet (see Appendix for the pictures and the exact narration in English).

Procedure

The procedure was approved by the Research Ethics Committee of (anonymized).

Warm-up phase

Figure 1. The cooperative warm-up game in its initial state (above) and before the picture narration (below); six panels, each with two boxes with a slot, and two tokens. Both tokens depict the same food item (right) and need both to be put into the box of the correct animal for a round to be successful. Panels 1-3 were used in warm-up, the remaining panels were used after the children chose a new partner.

123 For the cooperative game, the experimenter (E) explained to the child (C) the two
 124 were playing a detective game. E and C would have to infer together what animals were
 125 hidden under the two boxes based on their reading of the footprints, and place the two
 126 identical “gifts” (food items printed on each chip, see Figure 1) in the box of the correct
 127 animal. If both E and C placed their chips in the same correct box, C would get two
 128 marbles. For instance, in the first round, E and C’s chips each depicted a glass of honey. E
 129 asked C what animal might be happy about honey (proposed bear, if necessary). Then E
 130 and C decided which set of footprints belonged to the bear. Given that one set of
 131 footprints belonged to a bear, the other to a mouse, E asked where C wanted to put her/his
 132 chip (reliably the box with bear traces) and asked C to put the chip there. E then inserted

his own chip into the same box. They verified together that the animal under that box was a bear and won two marbles.

In the second and third round, the procedure was parallel to the first, except that E acted incompetently. After C entered her/his chip into the correct box, E first asked where he should put his, but upon C's response remained doubtful about the right choice and inserted his chip into the incorrect box, against any protest. After the third round, E pointed out that C seemed to be a much better detective and would need a better partner than E. The child could play the rest of the game (the remaining three panels in Figure 1) with the new partner. E introduced the storybook about the two candidates.

Story phase and partner choice

In the storybook, there were four main characters: two cartoon informants who provide a claim and support it with a reason, and two photographed candidates who evaluate the two informants' reasoning. We depicted the informants with cartoon figures and the candidates with photographs so they were easily distinguishable. The first page (see Appendix for the detailed narration) depicted both candidates side by side. E explained that one was a good detective, just like C, and the other was not, and that C had to pay attention to what these two said in the story in order to know which was the good one.

The informants had been painting with a brush, then they put the brush into one of the two boxes (left unclear in the narration). After the informants left the room, a thief stole the brush. From this point forward, the thief with the brush sticking out of his bag was permanently visible next to the storybook. Next day, the two candidates entered the

Figure 2. The key section of the narration. Characters and situation are introduced until including (a). Informants give a reason each for searching a box (b, c). In the experimental condition, the good is paired with a poor reason, in the control with another good one. Candidates each endorse one of the informants (d, e). All facts are summarized (g) and the partner choice is given (h). From (a) through (f), children's false belief understanding is probed to exclude spontaneous ascriptions of knowledge.

room to do some painting but could not find the brush. The informants reappeared to help them out (see Fig. 2a).

At this point, the first false-belief question ("FB 0" in Fig. 2a) was introduced, which concerned the two informants collectively ("Do these two know where the brush really is?"), to make sure that children do not attribute knowledge to the informants. Incorrect responses to this first question were corrected to establish the norm that answers should be guided by information from the story, and not, e.g., guessing or inventing. Any incorrect responses to any of the remaining five false belief questions led to exclusion from the analyses.

One informant proposed to search in one box and the other informant in the other box. One informant gave a good reason, namely eye-witness testimony: "because that is where we put the brush yesterday, and that is also where I last saw it" (followed by false belief question 1 "Does [the informant] really now where the brush is?", Fig. 2b). In the

experimental condition, the other informant gave a poor reason based on color preference:

“because [color of this box] is my favorite color, and I like that color the most” (Fig. 2c).

In the control condition, this other informant gave another good reason based on rules:

“because that is where we always put the brush, and that’s where it also belongs”. In both conditions, this statement was followed by false belief question 2 (Fig. 2c).

Next, one candidate endorsed the good reason based on eye-witness testimony. E asked C to recall this reason (memory question), followed by false belief question 3 about this candidate (“But does [this candidate] know where the brush really is?”; Fig. 2d). The other candidate endorsed the other reason based on color preference/rules. E asked C the same memory question about this reason, and false belief question 4 (Fig. 2e). Children who responded incorrectly or not at all to either of the two memory questions (34 children, 27.9%), received clues towards the correct answer. For the eye-witness testimony, the clue was that it was about the previous day; for the rule-based reason, that it was something that is always the case, and for the color preference-based reason, the question whether the informant disliked the color. All but seven children gave the correct response after the clues (these seven were excluded from the analyses). Then, given a page showing all five characters including the thief (Fig. 2f), E asked the final, collective false belief question 5: “If you look at these five guys, which of them is the only one who knows where the brush really is?”

On a summary page (Fig. 2g) with the pairs of boxes, informants, and candidates arranged such that they reflected who was related to whom and what in the story, E repeated the informants’ and candidates’ statements to aid children’s memory. E then asked C (Fig. 2h): “Which of these two [point to the candidates] is the better detective for

our game?” Upon C’s pointing or naming, E asked why. After that, E explained that neither of the candidates was able to make it to the school/daycare, so C finished the game with E and won the reward. The sessions lasted about 15 minutes and were video-recorded. Throughout the story, we counterbalanced the color of the boxes, look of the informants, look of the candidates, and the presentation order of the two reasons.

For eight children, there were minor experimenter errors that did not lead to exclusion, however. Five children did not receive the first non-critical false belief question, which just reminded children not to guess. Two children were told (instead of asked) about the first informant’s false belief. One final child was told (instead of asked) about both informants’ and one candidate’s false belief, but her explanation of her choice was very detailed so we were ensured that she understood the story and the character’s false belief (“Because he rather responded to what happened last. You can’t just go after your favorite color ...”). These eight children answered all of the remaining questions correctly.

Besides children’s partner choices, we coded their justifications for their choice. Our main interest was whether they mentioned the quality of the reason endorsed by that partner. Responses thus fell into three categories:

- *elaborate*: children made reference to the reason, identifying the critical difference between options with regard to the quality of the reasons and/or false belief of the informants/candidates (e.g., “Because the favorite color has nothing to do with it”, “Because he said that’s where they last saw it”);

- *simple*: children only referred to the candidate/informant/box, without any reference to the reasons (e.g., “Because he listened to him [the informant]”, “Because they looked in the red box”);
- *none*: children gave irrelevant responses or no response (e.g., “Because blue is my favorite color”).

A second rater coded 32 of the 122 responses to the request for explanation, and the agreement was $\kappa = .83$.

Results

As Figure 3 shows, in the experimental condition, 70% of the 5-year-olds and 87% of the 7-year-olds chose the candidate who endorsed the good reason based on eye-witness testimony; whereas in the control condition, this was the case with 35% of the 5-year-olds and 57% of the 7-year-olds. In both age groups, the number of children who chose the candidate endorsing the good reason based on eye-witness testimony was significantly higher in the experimental condition than in the control condition ($\chi^2 (1, N = 61) = 5.97, p = .015$ for 5-year-olds, and $\chi^2 (1, N = 61) = 5.59, p = .018$ for 7-year-olds).

227 We also compared the number of children who chose the candidate endorsing the
 228 good reason based on eye-witness testimony to chance in each condition using binomial
 229 tests. In the experimental condition, children in both age groups chose this candidate
 230 significantly above chance (5-year-olds: $p = .043$, 7-year-olds: $p < .001$), whereas in the
 231 control condition, their choice of this candidate was at chance level (5-year-olds: $p = .150$,
 232 7-year-olds: $p = .585$).

Figure 3. Proportion of children who chose the partners that endorse the reason based on eye-witness testimony. Asterisks indicate significance levels for participant groups that differ from chance in a binomial test ($*p < .05$; $***p < .001$). The dashed line indicates the chance level.

Figure 4. Children's explanations for their choice of candidates that endorsed the reasons based on eye-witness testimony, color preference, or rule.

Also, Figure 4 shows that in both conditions, 7-year-olds more often produced elaborate explanations for their choice that referred to the relevant reason than did 5-year-olds. This age difference was significant ($\chi^2(1, N = 122) = 7.48, p = .006$).

Discussion

Our general findings were very clear. In the experimental condition, 7-year-olds chose the candidate who endorsed the good reason over the candidate who endorsed the poor reason, and in the control condition, where both candidates endorsed good reasons, children chose both partners equally frequently. Five-year-olds, to the extent that they could overcome the task demands (e.g., information tracking, false belief of the characters), showed a similar pattern but much less reliably due to high dropout rates. Crucially in both conditions, both candidates arrived at the wrong decision. Thus, our study shows that children are able to evaluate the quality of reasons, and choose a partner based on how well he/she responds to good (versus poor) reasons.

Our study specifically rules out that children, if they selected the supporter of the good reason, did so based on the assumption that this person is more knowledgeable or simply right. Through the false belief questions, we made sure that children knew that neither candidate knew better. Moreover, the control condition rules out the alternative interpretation that children's choice of the candidate endorsing the good reason based on eye-witness testimony in the experimental condition was due to an enduring belief that the brush was still in the indicated box. If this were the case, children would have preferred this candidate in the control condition as well.

One criticism for our findings would be that children in the experimental condition did not evaluate the quality of the reasons or distinguished between good and poor reasons, but simply distinguished between relevant and irrelevant information. However, the bad reason ("yellow is my favorite color") is relevant to the proposal ("check the yellow box") and to the task (choosing a box). If the informants had no information about where the brush was and were taking a guess, saying "choose the yellow box, because yellow is my favorite color" would not be irrelevant and in fact be a fine reason. Thus, in our experimental condition children are evaluating whether the reason based on eye-witness testimony is "better" or more "valid" than the reason based on color preference. Another criticism would be the similarity in the wording of the two good reasons in the control condition ("that is where I saw it yesterday" vs. "that is where we always put it") and that children did not notice the difference between the two good reasons. We ensured that children distinguished the two good reasons through memory questions ("do you remember what the reason for the red/yellow box was?"), and only those children who answered these questions correctly were included in the analysis.

When explaining their choice, 7-year-olds more often than 5-year-olds produced explanations that referred to the relevant reason. This is in line with the finding that at school age children start to produce more complex reasons for their decisions (Domberg et al., 2018; Köymen & Tomasello, 2018). It should be noted that explanations categorized as “simple” (e.g., “Because he agreed with X”) were ambiguous in terms of what guided children’s decision, but these explanations were, in a way, optimally informative. Research on children’s use of common ground supports this view (Köymen, Mammen, & Tomasello, 2016; Mammen, Köymen, & Tomasello, 2018). That is, since the experimenter knew the story, children might have assumed some common ground with him and thought that it was obvious to the experimenter that the candidate who agreed with one informant was better than the other candidate.

There was one limitation of our study however. Despite showing the same pattern as 7-year-olds, 5-year-olds did have difficulty with the task. Our story was indeed a long story with five characters and required children to keep track of these characters’ knowledge states, etc. Twenty-four 5-year-olds, who could not be included in the analyses, answered at least one false belief question incorrectly and thus attributed knowledge to one of the four characters. This high rate of incorrect responses to false belief questions by 5-year-olds is surprising given the literature on false belief understanding (Wellman et al., 2001). One potential explanation for this could be that when children answered five false-belief questions in which the correct answer was always “no”, they might have found it pragmatically odd to answer “no” to all questions and switched some of their answers to “yes”. Moreover, children faced a non-standard

false belief task with high memory load that was not designed to measure false belief abilities but to safeguard our interpretation of the findings.

Future research could use simpler stories (perhaps with live actors) to investigate how reliably 5-year-olds can evaluate other people's reasoning. Also, it would be worth investigating whether social factors such as politeness, expertise, social status, group membership would contribute to children's evaluation how others respond to good and bad reasons, particularly in naturalistic settings. Children, even adults, might be prone to social pressures and might occasionally favor bad reasoners over good reasoners in some contexts.

To conclude, by age 7, children can reliably evaluate other people's reasoning and reliably distinguish between speakers who submit to "reason" and those who do not. They distinguish good reasons from poor ones, even if neither reason leads to a correct solution, and prefer those partners who do the same.

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Appendix: The story book and narration given on each page

363

364

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366

367

Page 1. Here is a little story. At the end you can pick a new partner. One of these two: Blue Boris [point at BB] or Green Gustav [point at GG]. You need to pay attention, because one of them is a real good detective, just like you, and the other one is not. So listen well to what these two say.

1

368

369

Page 2. There are two other children, Mützen-Max [point at MM] and Blonde Ben [point at BB] and they met yesterday to paint together.

2

370

371

Page 3. They grabbed the brush and painted everything they could get their hands on.

372

373

Page 4. Mützen-Max and Blonde Ben tidied up the brush into the box and then went out the door.

3

374

375

Page 5. But at night, the thief came. He stole the brush from the box and ran off.

376

Page 6. [E unfolds the extra leaflet that from now on remains visible to the side of the booklet.] The thief now has the brush in his bag. And the two boys, Mützen-Max and Blonde Ben, didn't notice it.

6

377

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382

Page 7. And these two guys here, remember them?

Free response

4

383

384

Blue Boris and Green Gustav met this morning and they also wanted to paint. And what's missing?

385

Response: the brush

386

387

Right. And no one knows where it is. So the two pondered: Where can we find the brush?

388

389

Page 8. But they were lucky. Mützen-Max and Blonde Ben appeared again and said: Guys, we will help you find the brush.

5

390

391

False belief probe (1): Although, do they know where the brush really is?

392

Negative response, otherwise correction.

393

Page 9. Mützen-Max said:

394

395

396

397

Good reason (both conditions):

Check the red box,

because that is where we put the brush yesterday,

and that's also where I last saw it.

7

8

398

399

False belief probe (2): But does Mützen-Max know where the brush really is?

400

Negative response, otherwise drop.

401

Page 10. And Blonde Ben said:

9

402 *Poor reason (experimental condition):*

403 Check the yellow box,
404 because yellow is my favorite color,
405 and I like that color the most.

406 *Other good reason (control condition):*

407 Check the yellow box,
408 because that's where we always put the brush,
409 and that's where it also belongs.

410 **False belief probe (3):** But does Blonde Ben know where the
411 brush really is?

412 Negative response, otherwise drop.

413 **Page 11.** Next, Blue Boris said:

414 I think the idea with the red box is good!

415 **Memory question:** [name], do you remember what the reason
416 for the red box was?

417 Correct response: reproduce reason; give cues if hesitant,
418 correct if false.

419 **False belief probe (4):** But does Blue Boris know where the
420 brush really is?

421 Negative response, otherwise drop.

422 **Page 12.** And Green Gustav said:

423 I think the idea with the yellow box is good!

424 **Memory question:** [name], do you remember what the reason
425 for the yellow box was?

426 Correct response: reproduce reason; give cues if hesitant,
427 correct if false.

428 **False belief probe (5):** But does Green Gustav know where
429 the brush really is?

430 Negative response, otherwise drop.

431 **Page 13.** And now I have a question for you.

432 **False belief probe (6):** Which of these guys is the only one
433 who knows where the brush really is?

434 Correct response: the thief; drop if false.

435 **Page 14.** So Mützen-Max thinks it's in the red box because he last saw it
436 there, and Blue Boris thinks that's a good clue. And Blonde Ben thinks
437 it's in the yellow box because [he likes yellow/it belongs there], and
438 Green Gustav thinks that's a good clue.

439 **Page 15.** If you think hard about what these two said, which one is the
440 better detective for our game?