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Reasoning during joint decision-making by preschool peers

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ABSTRACT

Reasoning with a peer to make a joint decision involves making a proposal (e.g., "Polar bears go here") and justifying it with relevant facts (e.g., "This is ice") based on common ground assumptions or warrants (e.g., polar bears need ice). Twenty-four dyads of 3- and 5-year-olds built a zoo with toy items that were either *conventional* (e.g., animals, cages) or *unconventional* (e.g., piano). For conventional items, both participants in both age groups used justifications that relied on implicit warrants (e.g., stating only the fact "This is ice", assuming that both partners know that polar bears need ice). For unconventional items, they more often articulated the warrant explicitly, arguably to create the necessary common ground. Five-year-olds made warrants explicit more often, produced more justifications, and reached mutual agreement more often than did 3-year-olds. These results suggest that preschoolers can reason with one another appropriately, specifically in justifying their proposals based on appropriate common ground assumptions.

1. Introduction

Reasoning is often viewed as an individual skill that enables humans to make inferences or arrive at conclusions based on evidence. Mercier and Sperber (2011) propose that this individual skill be called thinking or inferencing and that reasoning—in the narrow sense of "giving reasons"—is a social

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ability whose main function is to produce and evaluate arguments in interpersonal communication. Mercier and Sperber emphasize that when people are arguing to obtain some personal benefits they often are not rational arguers and are prone to certain biases, such as the confirmation bias, in which they selectively favor evidence supporting their beliefs (Nickerson, 1998). However, when people are arguing in order to make a joint decision—and when getting it right benefits both arguers—they may be more motivated to produce and evaluate all arguments "reasonably," which means making the reasons for one's beliefs explicit so that they can be jointly examined (Tomasello, 2014). In such cases, people might reason more effectively than they would reason about a problem alone.

Toulmin (1958) proposed a model of argumentation comprising three essential components: the *claim*, a conclusion that needs to be justified, the *data/fact*, which lays out evidence that supports or refutes the claim, and the *warrant*, a general assumption/knowledge/belief on which the claim and fact are based. For example, two people have made plans to go for a picnic tomorrow. One of them claims *We should cancel our picnic tomorrow* and supports this claim by providing evidence that *There is 90% chance of rain tomorrow*. But why does the fact of rain suggest canceling the picnic? It would not suggest canceling a trip to the mall. What connects this claim with this piece of evidence is the common ground assumption, or warrant, of something like *one cannot have a nice picnic when it is raining* (cascading down into: *we will get wet (because a picnic is outside)*, *we do not like getting wet*, etc.). In some cases such common ground assumptions are based on shared personal experiences between individuals, but in others they are based only on "assumptions that members of the community assume they can take for granted in other members"—what Clark (1996, p. 102) terms *cultural* (or *communal*) *common ground*.

By participating in everyday social and communicative interactions children come to discern the cultural common ground of their community (Clark, 1996; Tomasello, 1999, 2009). Ackerman, Szymanski, and Silver (1990) investigated how children make inferences using cultural common ground. Children were read short vignettes in which a referent was ambiguously presented and children were expected to infer the gender, age, or role (mother, teacher) of the referent from cultural common ground. Kindergarten children had difficulties in making such inferences. This could be due to the complex methodology, which required high verbal ability and hypothetical thinking. In less cognitively demanding situations, however, even preschool children have shown some sensitivity to cultural common ground. Based on a study by Clark, Schreuder, and Buttrick (1983), Liebal, Carpenter, and Tomasello (2013) presented 3- and 5-year-olds a culturally well-known object (e.g. Santa Claus) and a novel object (e.g. a green stuffed character). An adult then entered the room and asked the child, "Who is that?" with a puzzled face and voice. Children of both ages knew she was asking about the novel green character, not Santa Claus, whom everyone knows. In the other condition the adult acted as if she had seen something familiar and then asked "Who is that?" and the children knew it was Santa Claus and not the novel character, again because Santa Claus is familiar to everyone.

In both of these studies of children's understanding of cultural common ground, children interacted with adults. But according to Piaget (1932), peer-to-peer interactions—in which the child is interacting with someone of equal expertise and power—provide a richer context for examining children's reasoning (Kruger, 1993; Kruger & Tomasello, 1986). Studies on children's argumentation with peers have mostly been conducted with adolescents, and peer dyads were asked to discuss scenarios on controversial topics, such as capital punishment, and were explicitly instructed to produce arguments supporting their own view and/or refuting their opponent's view on the topic (Felton & Kuhn, 2001; Kuhn & Udell, 2003, 2007; see also Andersen, Chin, Chang, Waggoner, & Yi, 1997). Arguments were often found to be incomplete and lacked a general conclusion or the general premise/warrant that the conclusion was based on. However, these school-aged children did make the warrant explicit, when the warrant was surprising, confusing, or subject to dispute (Andersen et al., 1997).

Most previous studies of younger children's production of arguments and justifications have examined spontaneous peer interactions (Cobb-Moore, Danby, & Farrell, 2008; Eisenberg & Garvey, 1981; Goetz & Shatz, 1999; Kyratzis, Ross, & Koymen, 2010; Phinney, 1986; Stein & Albro, 2001; Orsolini, 1993; Zadunaisky-Ehrlich & Blum-Kulka, 2010), and most of these studies have focused on conflict-motivated justifications. Eisenberg and Garvey (1981) found that when preschoolers provided reasons for their opposition, the conflicts were more likely to be terminated. Phinney (1986) observed that with age children were more likely to provide justifications for their oppositions. Some studies also showed that children use justifications to elaborate on the ideas of their interlocutors in a validating

way or to expand their own ideas (Goetz & Shatz, 1999; Kyratzis et al., 2010). Goetz and Shatz (1999) found that when pairs of 8- and 11-year-olds made joint decisions they used justifications for their oppositions and for expanding earlier suggestions, often by appealing to facts (e.g., pointing out that an object could not be assigned to a location because it had already been previously assigned).

Although young children's reasoning has been investigated in various contexts such as spontaneous peer interactions (Eisenberg & Garvey, 1981; Kyratzis et al., 2010), preschoolers' social reasoning in relation to common ground they share with their interlocutors has not been investigated. Nor have these studies addressed how young children's justification or argumentation changes developmentally (but see Phinney, 1986). To document developmental changes, one needs a more controlled setting in which children of different ages interact with peers in similar circumstances and toward the same end. In the present study, therefore, we created an experimental setting in which 3- and 5-year-old German-speaking dyads were asked to build a zoo together and jointly decide where each item goes. Because German preschoolers are familiar with zoos, they could rely on this knowledge as cultural common ground. Each dyad had a set of items of two kinds: (a) conventional items that one would expect in a zoo (animals, cages, and visitors) and (b) unconventional items that one would not expect in a zoo (e.g., a piano or a washing machine).

Inspired by Toulmin's concepts (1958)—*claim*, *fact*, and *warrant*—we sought to identify the elements of children's reasoning and argumentation. We mainly investigated whether there were any age-related changes in the way children provided reasons for their joint decisions with their peers—more specifically how often children justified their proposals with reasons, whether they explicitly stated a warrant, and how they resolved the reasoning episodes or arrived at joint decisions. We predicted that for conventional items children would not explicitly state the warrant because they share this common knowledge with their peers. But for unconventional items children would make the warrant explicit because they need to create common ground assumptions before their proposal makes sense, as Andersen et al. (1997) observed with school-aged children. Furthermore, we predicted that at age 3, children would overall be less likely to make the warrant explicit because they would assume that the partner knows what they know, due to their limited perspective-taking skills. Finally, we investigated what kinds of joint decisions children reached and then analyzed whether the discussion ended with a mutual agreement or with one child imposing a proposal on the other (forced resolution). We expected that 5-year-olds would mutually agree on a joint-decision more than 3-year-olds, regardless of the conventionality of the item, because they would be better at recognizing the perspective of their partners and incorporating both perspectives into their joint decisions.

2. Method

2.1. Participants

Twenty-eight 3-year-olds (mean age 3–11, range 3-5–3-11), and 24 5-year-olds (mean age 5–9, range 5-2–5-11) participated in this study. They were grouped into same-sex dyads who knew each other, on the basis of the recommendation of their teachers. Two 3-year-old dyads did not want to finish the game and their data were excluded. In the final analysis there were 24 dyads, 12 3-year-old dyads and 12 5-year-old dyads (six male and six female dyads in each age group). All children were monolingual native German speakers of various socioeconomic backgrounds.

2.2. Materials

There were two sets of materials. Set 1 materials, used in the warm-up phase, consisted of items to play house. There were 12 items to be placed in a dollhouse with four empty rooms. Eight of these items stereotypically belonged to certain rooms in a house (a couch, two beds, a fireplace, an oven, a fridge, a toilet, and a bathtub). Four of the items (a clock, a lamp, a table, and a chair) could be placed almost anywhere in a house.

Set 2 materials, used in the testing phase, consisted of items to build a toy zoo. There was a 90×120 cm green cloth, which served as the ground of the zoo. On the cloth, certain landmarks of a zoo were highlighted: walkways marked in brown, a sand-floor, a lake, a water hole, and an ice area.

Table 1
Set 2 materials: conventional and unconventional zoo items in their respective bags.

	Conventional items	Unconventional items
Bag 1	1 Buffalo	2 Ladders
	2 Elephants	1 Skateboard
	2 Lions	
	2 Monkeys	
	A polar bear with a baby polar bear	
	1 Snake	
	2 Tigers	
Bag 2	2 Black cages	
	2 Blue cages	
	1 Transparent cage	
	1 Orange cage	
	1 Yellow cage	
Bag 3	1 Building	1 Box
	1 Bush	1 Candle holder
	1 Tree	1 Piano
	1 Tunnel	1 Toilet
	4 Visitors	1 TV
		1 Washing machine

There were 35 items to be placed in the zoo, which were presented in 3 bags. The first bag had 14 items, the second seven items, and the third 14 items. Items were: (a) 26 conventional items, such as animals, cages, or visitors that one would expect in a zoo; (b) nine unconventional items (distributed into two bags), that one would not necessarily expect in a zoo, such as a skateboard, a piano, or a washing machine (see Table 1 for a complete list of items).

2.3. Procedure

The study took place in a quiet room of a kindergarten in a mid-size German city. Each dyad played the house game first in the warm-up phase and the zoo game next in the testing phase. All sessions were videotaped. Although sessions varied in length, the full procedure lasted approximately 45 min.

In the warm-up phase, the dyad was first presented the house with four empty rooms and eight pieces of furniture stereotypically belonging to specific rooms. These eight items were lined up next to the house in the following order: couch, two beds, fireplace, oven, fridge, toilet, and bathtub. The experimenter (E) introduced the house game: "Today we will play two games. The first is the house game. Look, this house has four empty rooms. And here is the furniture. I will go first and place the couch here." E took the two beds and gave each child one and asked them to place the beds somewhere in the house. Then she asked, "Why do you put them in the same/different room/s?" If the children provided a reason for their decisions, E repeated it. If not, she provided a reason herself such as "because this is the bedroom." These questions were posed to encourage children to provide reasons for their actions later in the testing phase. Then E presented the rules of the game: "For each piece of furniture you have to decide together, where it goes. And remember all of them have to go somewhere in the house. You should tell each other when and why you place the items. Now it is your turn to set up the house with the remaining furniture." E stayed in the room during this time. After these eight items were placed in the house, E asked the children to give reasons for their choices three times: "Why did you put the X there?", "And you put the Y there because. . .?", and "And you put the Z there so that. . .?" E repeated children's explanations and if they did not provide explanations, she provided explanations herself. Then E presented the four ambiguous items (a clock, a lamp, a table, and a chair) and asked children to decide together about where to place these items. After the children placed each item, E asked, "You put it in the X-room, why?" Again, E repeated the reasons children provided for their decisions. As earlier, if the children provided reasons, E repeated the reason; if not, she provided reasons herself, such as "because you need a lamp to read in the bedroom". Since none of these items was "unconventional" in a house setting, the primes for producing justifications did not bias children to produce arguments about facts or warrants.

In the testing phase, E introduced the zoo game: "Now we will play the zoo game. This is where the zoo is (points to the green cloth). And the brown stripes are the visitor walkways, because visitors walk on walkways through the zoo, right? And here we have a water hole, an ice area, a lake, and a sand-floor. Here in the first bag are different animals, for example a lion and an elephant (showed lion and elephant). Here in the second bag are some cages (showed big and small cage). Here in the third bag are some trees and an office for the workers. You have to decide together where and why you place things, like in the house game. You start with the first bag. You need to place all the items in the first bag before you move to the second. And you need to place all the items in the second bag before you move to the third. I will begin. Here is the entrance. Where shall we put it? Why?". As earlier, if children provided reasons, E repeated the reason; if not, she provided reasons herself. Then E left the room until the children had placed all the items. She re-entered the room only if the dyad moved to the next bag before finishing the previous one.

2.4. Coding and reliability

The conversations during the zoo game were transcribed verbatim. Each line in a transcript depicted an utterance, which could be a word, an incomplete sentence, a simple sentence or a complex sentence within an intonation contour.

We divided each transcript from each dyad into segments in which children are discussing an item (e.g. a lion) or a group of items (e.g., a cage and a monkey) and coded whether the item was "conventional" or "unconventional." If a group of items included an unconventional item (e.g. a person and a piano), it was coded as "unconventional". For each item, we identified "reasoning episodes". A reasoning episode was defined as a segment of the transcript that had a proposal about the placement of one item followed by a justification for that proposal or a subsequent proposal about the same item. A reasoning episode could have the following components: (a) proposals, (b) justifications for proposals, and (c) agreements/disagreements with the proposals or the justifications. All of these components could be produced by a single child or both children in a dyad. We did not distinguish between speakers within a dyad. Even if a single child produced all these components, these utterances were publicly addressed to a peer (who might object) so the social/interactional nature of reasoning was still at play.

(a) A proposal was defined as a suggestion about where to place an item. Proposals could be explicit or implicit. Explicit proposals were actions, which were explicitly described such as 'Or we put them [: the monkeys] next to the polar bears.' Implicit proposals were nonverbal actions or incomplete descriptions of the actions such as a placement of an item as one child says 'Here.'

(b) A justification was an utterance that offered reasons for or against a proposal. These could be about the warrant, the fact, or both. Justifications based on a warrant explicitly stated the assumption in the cultural common ground and usually revealed generic information. For instance, one child justified the proposal of putting the polar bears in the ice area with a generic statement, 'Only the polar bears like to be on the ice.' Warrants could also be in the form of made-up/pretend assumptions. For instance, to justify the placement of the washing machine next to the lions and tigers, a child introduced a pretend warrant: 'For the tigers and lions, so that they can wash their coats'. Justifications based on facts provided evidence supporting or refuting the proposal with an implicit/unstated warrant. For instance, when a child placed a small cage on a gorilla, the child provided factual information about the gorilla: 'It [: the gorilla] is too big,' based on the implicit warrant that the cages must be bigger than the animals they detain. Some justifications could be based on both warrant and fact simultaneously. For instance, a child justified the proposal of placing the buffalo next to the bush by saying, 'They [: buffalos] do eat that [: bush],' referring to the fact that there is bush for buffalos to eat and to the warrant that buffalos eat bush.

Some utterances functioned as both proposals and justifications. These were treated as instances of both. For instance, a child proposed to put the little tiger next to the big tiger by saying, 'That [: little tiger] belongs next to mama tiger.'

(c) Agreements/disagreements were utterances that expressed consent or non-consent to a proposal or reasons supporting the proposal without offering a justification, such as 'Yes' or 'No.'

We further coded each reasoning episode for the explicitness of the warrant. If all the justifications in an episode were about facts, that episode was coded as an episode with an implicit warrant; if not,

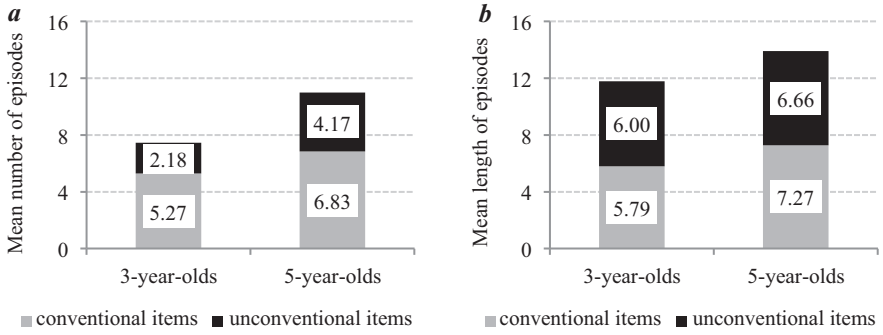

Fig. 1. The mean number of reasoning episodes and the mean length of reasoning episodes across age groups and the conventionality of the items.

the episodes were coded as episodes with explicit warrants. Episodes with explicit warrants included at least one justification, which was about the warrant or about both the warrant and fact.

Next, we coded each reasoning episode for the type of resolution. If both children agreed on a proposal by explicitly saying yes, the episode was coded as having an "agreed resolution." If one child decided on his/her own about the placement of an item, the episode was coded as having a "forced resolution." If children stopped talking about the item without a resolution and moved on to another item, the episode was coded as having "no resolution."

A second coder coded 25% of the transcripts, three dyads from each age group. We first examined whether the two coders identified the same lines as part of reasoning episodes; of 1426 lines from the transcripts agreement was $\kappa = .82$ (92%). Within reasoning episodes identified by both coders (507 lines and 51 episodes), agreement was $\kappa = .67$ (85%) for identification of proposals, $\kappa = .72$ (87%) for identification of justifications, $\kappa = .62$ (71%) for kind of justification, and $\kappa = .85$ (98%) for identification of agreements/disagreements. Within the 51 episodes identified by both coders, agreement was $\kappa = .79$ (94%) for explicitness of the warrant and $\kappa = .75$ (84%) for resolution type.

3. Results

3.1. Quantitative analyses

There were a total of 214 reasoning episodes, which ranged from 0 to 26 episodes per dyad. One 3-year-old dyad did not have any reasoning episodes and was excluded from analyses. There were a total of 442 justifications (20% of them were based on facts, 20% on warrants, and 60% on both).

The length of each reasoning episode was calculated by summing the number of lines in the transcript that were coded as proposal, justification, and agreement/disagreement. Some lines had both proposals and justifications. These lines were counted once. The length of reasoning episodes ranged from 1 to 31 lines.

There were no age differences in number of reasoning episodes ($U = 45.5$, $p = .22$, $r = .08$,[1] see Fig. 1a) or the mean length of the reasoning episodes ($U = 60$, $p = .73$, $r = .01$, see Fig. 1b). However, 5-year-olds produced marginally more justifications than did 3-year-olds ($U = 38$, $p = .09$, $r = .15$; see Fig. 2). Then we carried out two analyses to investigate whether (1) explicitness of the warrant, and (2) type of resolution differed across the age groups and the conventionality of item, which the reasoning episode was about. There were no gender differences so gender was dropped from the statistical analyses for parsimony.

3.1.1. Explicitness of the warrant

We tested whether the explicit mention of the warrant differed across age groups and conventionality of the items, using a Generalized Linear Mixed Model (GLMM). The response variable was a binary

[1] The effect sizes for the Mann–Whitney *U*-tests were calculated from the corresponding parametric test, a *t*-test.

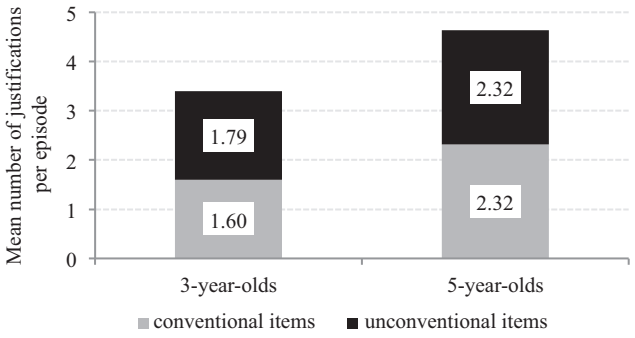

Fig. 2. The mean number of justifications per episode across the age groups and the conventionality of the item.

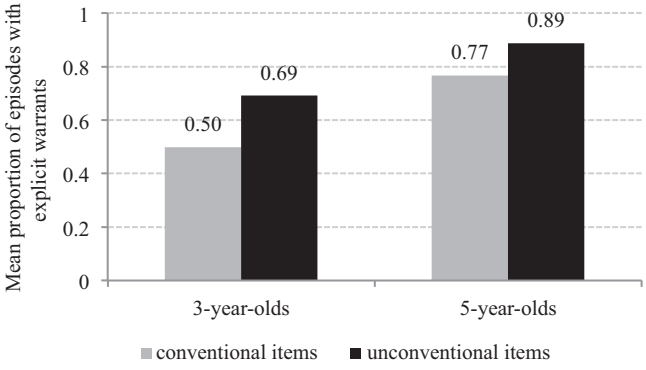

Fig. 3. The mean proportion of episodes in which the warrants are explicitly stated while discussing the placement of conventional and unconventional items.

measure: explicit warrant vs. implicit warrant in each episode. The full model included the predictor of age group (3- vs. 5-year-old), the conventionality of the item (conventional vs. unconventional), and their interaction, the random factor of dyad ($N = 23$) and the random slope of conventionality and dyad. The null model included the random factor and the random slope. The full model improved the fit as compared to the null model ($\chi^2 = 10.44$, df = 3, $p = .02$). Because the interaction between age group and conventionality of item was not significant, this interaction term was dropped from the model to assess the main effects. In this reduced model, the significant main effect of age indicated that 5-year-olds made the warrant explicit more than did 3-year-olds ($z = -2.52$, $p = .01$). The significant main effect of conventionality indicated that when the episode was about an unconventional item, both 3- and 5-year-olds made the warrant explicit; but when the item was conventional, they relied on the implicit warrant ($z = -1.96$, $p = .049$; see Fig. 3).[2]

3.1.2. Type of resolution

To compare the resolution type in each episode across age groups and conventionality of item, we only included the cases with "agreed resolution" and "forced resolution", using a GLMM. We excluded the 32 episodes (15%) with "no resolution" as it was not clear whether the children agreed or not. Hence, this analyses was run with 182 reasoning episodes. Almost half of these (95 episodes) ended with agreed resolution, and the other half (87 episodes) with forced resolution. The response variable

[2] One 5-year-old dyad had only one reasoning episode about a conventional item. In a more conservative analysis, we reran the analyses without this dyad so that we have multiple observations of reasoning episodes for each dyad. In this analysis, the results remained the same, except that the main effect of conventionality was slightly weaker ($z = -1.89$, $p = .059$).

was a binary measure of resolution: agreed resolution vs. forced resolution for each episode. The full model included the predictors of age group (3- vs. 5-year-old), the conventionality of the item (conventional vs. unconventional), and their interaction, the number of justifications, the random factor of dyad ($N = 23$) and the random slope of conventionality and dyad. The null model included the random factor and the random slope. The full model improved the fit as compared to the null model ($\chi^2 = 9.49$, df = 4, $p = .049$). Because the interaction between age group and conventionality of item was not significant, this interaction term was dropped from the model to assess main effects. This reduced model indicated the main effect of number of justifications: a reasoning episode with more justifications was more likely to end with an agreed resolution than with a forced resolution ($z = 2.18$, $p = .03$). The main effects of age group and conventionality were not significant.[3] Because 5-year-olds already produced more justifications than 3-year-olds, the age difference could be masked when both predictors (age group and number of justifications) were included in the model. Since we had specific predictions about the age difference regardless of the conventionality of the item, we performed a Mann–Whitney *U*-test with age as the predictor and the response variable as the proportion of reasoning episodes with agreed resolution to the total number of episodes. This analysis revealed a marginally significant age difference: the reasoning episodes of 5-year-olds ended with agreed resolution more often ($M = .64$) than that of 3-year-olds ($M = .44$; $U = 35.5$, $p = .06$, $r = .17$).

3.2. Qualitative analyses

The following examples illustrate some differences in the way 3- and 5-year-olds justified proposals. To make our coding more transparent, we flagged proposals with "»", justifications with "**>**" (bolded), and agreements/disagreements with "*".

As the quantitative analyses suggested (Fig. 3), when the item was conventional, both 3- and 5-year-olds tended to justify proposals by highlighting the facts and relying on implicit warrants. Example 1 shows an episode in which two 3-year-old boys discuss the proposal about a tiger, a conventional item.

Example 1[4] (Paul and Mark: 3-year-old boys; item: tiger-conventional)

	1	Mark:	A tiger.
»	2	Paul:	Then I put it here [: lake].
>	**3**	**Mark:**	**That is a lake [[contradicting]].**
*	4	Paul:	No.
*	5	Mark:	Yes.

In line 2, Paul proposes to put the tiger in the lake. Then Mark objects to this proposal by highlighting the fact that it is a lake (line 3). This justification is based on the implicit warrant that tigers do not live in water. After this point Mark and Paul continue to disagree. The episode ends with the tiger left in the lake without a resolution.

The next example shows how 3-year-old girls provided justifications about what to do with the ladder, an unconventional item, as they made the warrant explicit.

Example 2 (Ute and Pia: 3-year-old girls; item: ladder-unconventional)

»	1		[[Pia puts the little tiger on the ladder at the entrance.]]
	2	Ute:	No not high up here you little lion.
>	**3**		**That [: ladder] is for people.**
>	**4**		**Animals do not come up this high.**
>	**5**	**Pia:**	**Only the monkeys.**

Ute and Pia place the ladder by the entrance of the zoo. In line 1 Pia makes an implicit proposal by placing the little tiger on the ladder. Ute objects to this proposal by explicitly stating the warrant that ladders are for people not for animals (lines 3–4). In line 5, Pia agrees with this warrant, but amends the warrant with an exception that monkeys are the only animals that can climb up high on a ladder.

[3] In the more conservative analysis without the dyad that only had one reasoning episode about a conventional item, the results remained the same, except that the comparison between the full model and the null model revealed a marginally significant improvement ($\chi^2 = 9.37$, df = 4, $p = .053$).

[4] The conversations were in German. To make the transcript more reader-friendly we only report the English translations.

Then they move to the next item without publicly expressing their agreement to the resolution; thus, the episode ends with "no resolution."

The quantitative analyses also suggested that 5-year-olds stated the warrant explicitly more than 3-year-olds did regardless of the conventionality of the item. Moreover, 5-year-olds provided more justifications and their discussions more often ended with agreed resolution. The following example shows how two 5-year-old girls justify and compare two proposals for where to place the elephant, a conventional item.

Example 3 (Anja and Gabi: 5-year-old girls; item: elephant-conventional)

»	1	Anja:	Certainly in the sand, right?
»>	**2**	**Gabi:**	**No it lives in water.**
>	**3**		**I know where all animals live.**
	4	Anja:	Me too.
	5	Gabi:	That,
	6		We can . . .
»>	**7**	**Anja:**	**It can (live) on sand or in water.**
>	**8**	**Gabi:**	**Because it gets clean feet there.**
>	**9**	**Anja:**	**But that's not real [: water].**
*	10	Gabi:	No.
»	11	Anja:	Or next to the polar bears.
*	12	Gabi:	No.
»	13		Then we put it here [: sand floor].
>	**14**		**Because it has more space here.**
*	15	Anja:	*Uh-huh* [: yes].

Anja proposes to place the elephant on the sand (line 1). Gabi objects to this proposal through appealing to the warrant that elephants live in water (line 2). Anja acknowledges Gabi's proposal by stating that the elephant can live on sand or in water. Then in line 8, Gabi justifies her proposal of placing the elephant in the water by highlighting the fact that the elephant would have clean feet if it were in water. However, Anja challenges the implicit warrant that there is in fact water (line 9). Gabi agrees with Anja and provides another reason why the sand area is better for the elephant by pointing out the elephant would have more space there (line 14). The episode ends with the elephant on the sand (agreed resolution). Consequently, each girl had a different proposal for the elephant. They evaluated each proposal carefully and provided many justifications about the warrants (lines 2 and 7) and the facts, such as having clean feet if it is placed in water (line 8). Eventually they mutually agreed on the placement.

Example 4 shows how two 5-year-old boys provide reasons about where to place a skateboard, an unconventional item. The episode shows how they make the warrant explicit and check the facts in the light of this newly introduced warrant.

Example 4 (Leo and Max: 5-year-old boys; item: skateboard-unconventional)

»	1	Leo:	Hey Max, there can be a "No skateboarding" sign.
>	**2**		**Because one can jump high**
	3		**and somehow xxx in monkey or bull cage.**
>	**4**	**Max:**	**Because otherwise one can enter an open animal cage.**
	5		To the snake.
>	**6**		**It is especially protected because it is a poisonous snake.**
	7		Right?
*	8	Leo:	Yes xxx.
>	**9**	**Max:**	**And furthermore, the gorillas are not protected.**
>	**10**		**And yet they eat meat.**
>	**11**		**But it is not a problem with those [: gorillas].**
>	**12**		**The tigers are covered.**
>	**13**		**Fortunately lions are covered too.**
>	**14**		**But the gorillas** . . .
»	**15**		**There we better put "No skateboarding" sign.**

Leo first proposes to place a "No skateboarding"-sign. He justifies this proposal by explaining the consequences of riding a skateboard in a zoo and marks the warrant explicitly (lines 2–3): one might jump high and fall into a cage (line 1). Although Max elaborates on Leo's proposal by reformulating

the warrant in line 4, Max provides evidence against this warrant and shows that dangerous animals like snakes are in cages with roofs so that nobody could fall in (line 6), and thus, the sign would not be necessary. Then Max seeks the evidence for the necessity of the "No skateboarding" sign between the lines 9–14 and checks which cages have roofs. Max identifies gorillas as dangerous animals and invokes the explicit warrant that they eat meat (line 10); thus he concludes that they need a "No skateboarding" sign (line 15), and Leo agrees.

4. Discussion

Overall, children of both ages in this study were competent reasoners. They supported their proposals for joint decisions by stating some relevant evidence or fact(s). Moreover, they also discriminated instances when the warrant connecting fact and proposal could be safely assumed to be part of their cultural common ground and when it needed to be explicitly stated. Specifically, children of both ages created common ground beliefs before trying to justify the placement of unconventional items (e.g., that riding a skateboard in a zoo might land one in a dangerous animal's cage if it has no roof) in a way that they did not need to do for conventional items (since, for these, cultural common ground could be assumed). For both age groups, the conventionality of the items only mattered for making the warrant explicit. Once children made the warrant explicit and secured the commitment of their partner to this new and unfamiliar warrant about an unconventional item, the pattern of the rest of the argumentation (e.g., resolution type) resembled the discussions about conventional items.

These results show that as early as age 3, children are able to tailor their reasons based on the knowledge state of their interlocutors or the common ground knowledge that they share with their interlocutors. That is, even 3-year-olds are sensitive to what kinds of information they can take for granted (e.g., while discussing conventional items) or what kinds of information they need to explicitly state such as the warrant (e.g., while discussing unconventional items), while reasoning with a peer to reach a joint decision. Thus, our findings are in line with the account that long before ages 4–5 when children pass false-belief tasks (Wellman, Cross, & Watson, 2001), they are able to track others' goals, intentions, desires, and knowledge states when the actions are situated in less abstract social contexts (Buttelmann, Carpenter, & Tomasello, 2009; Repacholi & Gopnik, 1997; Tomasello & Haberl, 2003).

Furthermore, our study demonstrates this sensitivity to common ground with production data (how children actually *produce* reasons), which is mostly investigated through comprehension studies (Liebal et al., 2013; Matthews, Lieven, & Tomasello, 2010). Considering how cognitively demanding it is to produce a reasonable argument based on common ground assumptions, compared to simply disambiguating an utterance, the performance of the 3-year-olds is especially informative.

Interestingly as well, children also seemed to understand that warrants were more powerful if they were generic facts that applied to all animals of the type. Thus, many of children's explicit warrants were in the form of generic statements such as 'Gorillas eat meat' or 'Only the polar bears like to be on ice.' A large proportion of children's earliest generic statements are about animals (Brandone & Gelman, 2013; Gelman, Goetz, Sarnecka, & Flukes, 2008; Pappas & Gelman, 1998); thus, our zoo setting may have been an especially facilitative context for children's use of these kinds of generic statements as justifications.

Despite the similarities between 3- and 5-year-olds, there were also some age differences in the ways children provided justifications for joint decisions. Compared to 3-year-olds, 5-year-olds produced more justifications and were more likely to make the warrant explicit in the reasoning episodes. Moreover, a reasoning episode with high number of justifications was more likely to end with an agreed resolution, which was mostly observed in the discussions of 5-year-olds, although these age differences were marginally significant. Due to their superior cognitive and verbal skills, 5-year-olds overall made more careful and complete analyses of the situation, through which they challenged the warrant and the evidence behind each proposal before they reached mutual agreement, incorporating the perspective of their peer.

Beyond differences in cognitive and verbal skills, these age differences may also suggest that 5-year-olds appreciated the social nature of reasoning more than did 3-year olds. Five-year-olds not only produced arguments based on the appropriate common ground assumptions shared with their peers, as the 3-year-olds did, but they were also better at convincing their peer to agree with their

arguments. It could be that the 5-year-olds produced more, and possibly better, arguments convincing their peers, whereas the 3-year-olds either could not convince their peers or did not necessarily care to convince their peers, and therefore relied on forced resolutions. In addition, in terms of evaluating arguments, 5-year-olds were perhaps more open to the possibility that their partner's proposals could sometimes be better than their own proposals and were better at distinguishing good arguments from poor ones, compared to 3-year-olds. In short, children's social reasoning seems to improve between ages 3 and 5. By age 3, children start taking into account what common knowledge they have with their interlocutors in constructing and producing arguments. By age 5, they may start working on the reception or the evaluation of their own arguments by their interlocutors. This is in line with the recent findings that at age 5, children become concerned with social evaluation or how others evaluate them (Engelmann, Over, Herrmann, & Tomasello, 2013; Mercier, 2011).

To conclude, the present results provide further evidence that preschool children are not, as Piaget and others assumed, totally egocentric thinkers and reasoners. They are able to present and discuss arguments while making joint decisions with their peers. Our results also support the view that reasoning is indeed a social skill (Mercier, 2011; Mercier & Sperber, 2011), which children often practice in their spontaneous interactions. While interacting with equals in their peer interactions, children devised creative solutions, without being constrained by adult expertise and power. Peer interactions thus provide children a rich context to practice their social, cognitive, and linguistic skills.

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References

Ackerman, B. P., Szymanski, J., & Silver, D. (1990). Children's use of the common ground in interpreting ambiguous referential utterances. *Developmental Psychology*, *26*, 234–245. http://dx.doi.org/10.1037/0012-1649.26.2.234

Andersen, R., Chin, C., Chang, J., Waggoner, M., & Yi, H. (1997). On the logical integrity of children's arguments. *Cognition and Instruction*, *15*, 135–167. http://dx.doi.org/10.1207/s1532690xci1502_1

Brandone, A. C., & Gelman, S. A. (2013). Generic language use reveals domain differences in young children's expectations about animal and artifact categories. *Cognitive Development*, *28*, 63–75. http://dx.doi.org/10.1016/j.cogdev.2012.09.002

Buttelmann, D., Carpenter, M., & Tomasello, M. (2009). Eighteen-month-old infants show false belief understanding in an active helping paradigm. *Cognition*, *112*, 337–342. http://dx.doi.org/10.1016/j.cognition.2009.05.006

Clark, H. H. (1996). *Using language*. New York: Cambridge University Press.

Clark, H. H., Schreuder, R., & Buttrick, S. (1983). Common ground and the understanding of demonstrative reference. *Journal of Verbal Learning and Verbal Behavior*, *22*, 245–258. http://dx.doi.org/10.1016/S0022-5371(83)90189-5

Cobb-Moore, C., Danby, S., & Farrell, A. (2008). 'I told you so': Justification used in disputes in young children's interactions in an early childhood classroom. *Discourse Studies*, *10*, 595–614. http://dx.doi.org/10.1177/1461445608094214

Eisenberg, A. R., & Garvey, C. (1981). Children's use of verbal strategies in resolving conflicts. *Discourse Processes*, *4*, 149–170. http://dx.doi.org/10.1080/01638538109544512

Engelmann, J., Over, H., Herrmann, E., & Tomasello, M. (2013). Young children care more about their reputation with ingroup members and potential reciprocators. *Developmental Science*, *16*, 952–958. http://dx.doi.org/10.1111/desc.12086

Felton, M., & Kuhn, D. (2001). The development of argumentative discourse skills. *Discourse Processes*, *32*, 135–153. http://dx.doi.org/10.1080/0163853X.2001.9651595

Gelman, S. A., Goetz, P. J., Sarnecka, B. S., & Flukes, J. (2008). Generic language in parent–child conversations. *Language Learning and Development*, *4*, 1–31. http://dx.doi.org/10.1080/15475440701542625

Goetz, P. J., & Shatz, M. (1999). When and how peers give reasons: Justifications in the talk of middle school children. *Journal of Child Language*, *26*, 721–748.

Kuhn, D., & Udell, W. (2003). The development of argument skills. *Child Development*, *74*, 1245–1260. http://dx.doi.org/10.1111/1467-8624.00605

Kuhn, D., & Udell, W. (2007). Coordinating own and other perspectives in argument. *Thinking and Reasoning*, *13*, 90–104. http://dx.doi.org/10.1080/13546780600625447

Kruger, A. C. (1993). Peer collaboration: Conflict, cooperation, or both? *Social Development*, *2*, 165–182. http://dx.doi.org/10.1111/j.1467-9507.1993.tb00012.x

Kruger, A. C., & Tomasello, M. (1986). Transactive discussions with peers and adults. *Developmental Psychology*, *22*, 681–685. http://dx.doi.org/10.1037/0012-1649.22.5.681

Kyratzis, A., Ross, T. S., & Koymen, S. B. (2010). Validating justifications in preschool girls' and boys' friendship group talk: Implications for linguistic and socio-cognitive development. *Journal of Child Language*, *37*, 115–144. http://dx.doi.org/10.1017/S0305000908009069

Liebal, K., Carpenter, M., & Tomasello, M. (2013). Young children's understanding of cultural common ground. *British Journal of Developmental Psychology*, *31*, 88–96. http://dx.doi.org/10.1111/j.2044-835X.2012.02080.x
Matthews, D., Lieven, E., & Tomasello, M. (2010). What's in a manner of speaking? Children' sensitivity to partner-specific referential precedents. *Developmental Psychology*, *46*, 749–760. http://dx.doi.org/10.1037/a0019657
Mercier, H. (2011). Reasoning serves argumentation in children. *Cognitive Development*, *26*, 177–191. http://dx.doi.org/10.1016/j.cogdev.2010.12.001
Mercier, H., & Sperber, D. (2011). Why do humans reason? Arguments for an argumentative theory. *Behavioral and Brain Sciences*, *34*, 57–74. http://dx.doi.org/10.1017/S0140525X10000968
Nickerson, R. S. (1998). Confirmation bias: A ubiquitos phenomenon in many guises. *Review of General Psychology*, *2*, 175–220, doi:10.1.1.93.4839.
Orsolini, M. (1993). Dwarfs do not shoot: An analysis of children's justifications. *Cognition and Instruction*, *11*, 281–297. http://dx.doi.org/10.1080/07370008.1993.9649026
Pappas, A., & Gelman, S. A. (1998). Generic noun phrases in mother-child conversations. *Journal of Child Language*, *25*, 19–33.
Piaget, J. (1932). *The moral judgment of the child*. London: Free Press.
Phinney, J. S. (1986). The structure of 5-year-olds' verbal quarrels with peers and siblings. *The Journal of Genetic Psychology*, *147*, 47–60. http://dx.doi.org/10.1080/00221325.1986.9914479
Repacholi, B. M., & Gopnik, A. (1997). Early reasoning about desires: Evidence from 14- and 18-month-olds. *Developmental Psychology*, *33*, 12–21. http://dx.doi.org/10.1037/0012-1649.33.1.12
Stein, N. L., & Albro, E. R. (2001). The origins and nature of arguments: Studies in conflict understanding, emotion, and negotiation. *Discourse Processes*, *32*, 113–133. http://dx.doi.org/10.1080/0163853X.2001.9651594
Tomasello, M. (1999). *The cultural origins of human cognition*. Cambridge, MA: Harvard University Press.
Tomasello, M. (2009). *Why we cooperate*. Cambridge, MA: MIT Press.
Tomasello, M. (2014). *A natural history of human thinking*. Cambridge, MA: Harvard University Press.
Tomasello, M., & Haberl, K. (2003). Understanding attention: 12- and 18- month-olds know what's new for other persons. *Developmental Psychology*, *39*, 906–912. http://dx.doi.org/10.1037/0012-1649.39.5.906
Toulmin, S. E. (1958). *The uses of argument*. Cambridge: Cambridge University Press.
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. http://dx.doi.org/10.1111/1467-8624.00304
Zadunaisky-Ehrlich, S., & Blum-Kulka, S. (2010). Peer talk as a 'double opportunity space': The case of argumentative discourse. *Discourse & Society*, *21*, 211–233. http://dx.doi.org/10.1177/0957926509353847