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3-Year-Old Children Make Relevance Inferences in Indirect Verbal Communication

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Three studies investigated 3-year-old children's ability to determine a speaker's communicative intent when the speaker's overt utterance related to that intent only indirectly. Studies 1 and 2 examined children's comprehension of indirectly stated requests (e.g., "I find Xs good" can imply, in context, a request for X; $N = 32$). Study 3 investigated 3- and 4-year-old children's and adults' ($N = 52$) comprehension of the implications of a speaker responding to an offer by mentioning an action's fulfilled or unfulfilled precondition (e.g., responding to an offer of cereal by stating that we have no milk implies rejection of the cereal). In all studies, 3-year-old children were able to make the relevance inference necessary to integrate utterances meaningfully into the ongoing context.

When children learn a linguistic convention, they infer its meaning by coordinating their own intentions and attention with those of another person in order to make sense of that person's use of the linguistic convention. Such sense making is based on the assumption that the language used in a given situation is somehow "relevant" to that situation (Bruner, 1983; Clark, 1990, 1997; Nelson, 1985; Sperber & Wilson, 1986/1995; Tomasello, 2003). Grice (1989) points out that recipients must always make inferences to recover the speaker's meaning, and Wilson and Sperber (2004, p. 607) claim that "the expectations of relevance raised by an utterance are precise enough … to guide the hearer towards the speaker's meaning." In order to understand the speaker's meaning, the hearer attempts first and foremost to understand her intention ("Why is she behaving as she is?"). Determining intentions in communicative situations requires inferential processes, namely, relevance inferences that enable an understanding of the communicative act's social significance.

Young children's expectations of relevance not only operate in word learning, but also in interpreting utterances that only indirectly give evidence for the speaker's meaning. For example, 3-year-olds understand the intended meaning of indirect requests when they include an imperative component that is immediately interpretable or when the imperative intention is conventionalized (cf. Ervin-Tripp, 1977, p. 168; see also Bucciarelli, Colle, & Bara, 2003; Ervin-Tripp, Strage, Lampert, & Bell, 1987). Thus, indirect requests such as "Could you pass me the salt?" do not need to be interpreted differently in different discourse situations; they are conventionalized requests, and their comprehension is based on the explicit mentioning of the intended act, goal, object, and agent. Indirect communication that is less conventionalized is, not surprisingly, more difficult for children to understand. For example, Elrod (1987) found that when presented with stories that ended either with an indirect request ("It's really cold outside") or a direct request ("Please put on your coat") children younger than 5 years of age could not understand the indirect request.

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Young children have even greater difficulty appropriately understanding indirect communication when the communicative act is something other than an indirect request—for example, a reply to a question (Bucciarelli et al., 2003; de Villiers, de Villiers, Coles-White, & Carpenter, 2009; Loukusa, Leinonen, & Ryder, 2007; Verbuk, 2009; Verbuk & Shultz, 2010). In order to interpret a seemingly irrelevant reply to a question, the reply's content needs to be integrated with the current discourse in a way that makes it relevant. For instance, a child might ask her mother: "May I have a biscuit?" and the mother may reply by saying, "We are having lunch in a couple of minutes." In order to infer what the mother meant to convey with the seemingly irrelevant content of the utterance, the child must assume that she is a rational, cooperative speaker and so would only provide relevant information (Grice, 1989; Sperber & Wilson, 1986/1995). Based on this assumption, the child accesses her world knowledge that eating biscuits now and having lunch in a couple of minutes are incompatible. By asking herself "Why would my mother say something about lunch when I am asking her about biscuits?" the child fills in information from her world knowledge to bridge the gap between her question and the mother's reply. Children can only interpret such indirect replies to questions from 6 years on (Bucciarelli et al., 2003; de Villiers et al., 2009; Loukusa et al., 2007; Verbuk, 2009; Verbuk & Shultz, 2010). For example, in the study by de Villiers et al. (2009), the children were shown pictures and an experimenter read a dialogue between two speakers depicted in the pictures. The dialogue ended with a target sentence that required a relevance inference in order to be understood as a reply to a question. The children in these studies were asked to explain what a speaker meant by uttering the target sentence. De Villiers et al. found that only children aged 6 or older correctly explained the speaker's meaning (cf. Loukusa et al., 2007; Verbuk, 2009; Verbuk & Shultz, 2010).

Given children's early skills with interpreting others' communication, the late development of understanding indirect communication seems surprising. A close look at the methods used in these studies reveals that they use quite complex metapragmatic measures in order to assess children's skills in inferring a speaker's intended meaning from indirect communication. Namely, the children's skills were assessed either through their explicit explanation of a target utterance's meaning or through judgment as to the appropriateness of a target utterance in a particular situation. Previous research demonstrated that metapragmatic judgment in a variety of discourse situations only develops during children's school years (Ackerman, 1981; cf. Adams, 2002; Andersen-Wood & Smith, 1997; Bernicot, Laval, & Chaminaud, 2007) apart from some rather constrained cases that only involve the comprehension of a single relation (cf. Papafragou & Tantalou, 2004). So the fact that children only show skilful interpretation of indirect speech when they are 5 or 6 years old might also be an artifact of the methodologies used rather than a precise measure of the children's skills.

However, even with a simplified methodology, Bucciarelli et al. (2003) found evidence for children's understanding of complex indirect refusals only in children older than 6 years of age. For example, in one condition of this study, children watched a video that showed two characters standing in front of a doll shop. One of the characters asked, "Would you get me that game?" and the other one answered, "We don't have any money." Subsequently, children were shown a choice of four pictures depicting how the story might proceed and were asked to choose the picture that they thought fit best with what the speaker meant. Children below the age of 6 failed to reliably choose the correct picture.

Interestingly, research on other pragmatic inferences (e.g., scalar implicatures) suggests that with very child-engaging tasks children's skillful and pragmatically appropriate interpretation of utterances can be shown for preschoolers. For example, Pouscoulous, Noveck, Politzer, and Bastide (2007) found that with an act-out task, even 4-year-olds understood quantifiers such as *some* correctly (although they did not yet behave in adult-like ways; cf. Papafragou & Musolino, 2003; Papafragou & Tantalou, 2004). By contrast, previous studies (requiring meta linguistic judgments) found that only 6- to 8-year-olds were able to do this (Guasti et al., 2005; Noveck, 2001; see Katsos, 2009, for a review and Katsos & Bishop, 2011, for an argument against binary judgment tasks). Papafragou and Tantalou (2004) "conclude that the family of judgment tasks, however useful as an initial tool in exploring awareness of SIs, may in fact underestimate preschoolers' ability to compute implicatures 'in the wild'."

The current studies therefore investigated young children's skills in drawing relevance inferences about the meaning of seemingly irrelevant answers in question–answer sequences by employing child-engaging methods. In Studies 1 and 2, indirect communication was very concrete (based on the finding

of de Villiers et al., 2009, that fewer inferential steps made things easier for children). Since previous studies found that children understand the link between an explicitly stated desire for an object and the corresponding object choice (Fawcett & Markson, 2010; Repacholi & Gopnik, 1997; Saylor & Troseth, 2006; Wellman & Bartsch, 1988; Wellman & Woolley, 1990), we used statements about personal likes and dislikes that indirectly conveyed that the experimenter wanted to play with a particular object. In Study 3, we made the inferential leap more similar to the inferences required in previous studies. We used statements about fulfilled or unfulfilled preconditions (analogous to "We have no money") to indirectly convey which object was wanted. We hypothesized that the more interactive and child-friendly nature of the tasks had the potential of demonstrating preschoolers' skills with gap-filling relevance inferences—if indeed children younger than 6 years of age do have such skills.

Study 1

Method

Participants

Sixteen monolingual German-speaking children participated in this study. The mean age of the children was 3;0,0 (range = 2;10,28–3;1,21), with an equal number of boys and girls. Four additional children had to be excluded from the final sample for the following reasons: because of an experimenter error (one child), uncooperativeness (one child), and the child did not meet the baseline criteria (two children). The children's parents had previously agreed to their children participating in studies on children's social-cognitive and language development.

Materials and Design

Children's derivation of relevance inferences was assessed by an object choice task over four within-subjects conditions. The children were engaged in a game in which they took turns with an adult at playing with an apparatus (e.g., a catapult). Playing with the apparatus required objects that were offered by an experimenter (E1). E1 always offered two objects per trial, both of which were familiar to the child and labeled by the experimenter (ball and doll, flower and mouse, watch and toothbrush, mushroom and shuttlecock, polar bear and panda, lion and elephant, giraffe and zebra, meerkat and squirrel, pullover and shoes, boots and cap, trousers and jacket, pear and grapes). The object pairs were fixed and it was established in pretests that both objects of a pair were similarly attractive. E1 proposed giving a particular object from the pair to the second experimenter (E2). E2 responded to E1's proposal in an indirect manner. In the four conditions we varied two factors in a 2 × 2 design: first, whether E2's utterance was consistent with E1's proposal in terms of the surface structure of the utterance (i.e., did she make a statement about the same object or about the other object) and, second, on the level of E2's speaker meaning (i.e., did she intend to play with the same object as the one suggested by E1 or not). The four conditions were thus "same label, same intention," "different label, same intention," "same label, different intention," and "different label, different intention."

The experiment was split into three blocks. In each block, we used a different apparatus (slide, carrousel, catapult, and a pair of wooden blocks for the warm-up with the apparatus). Each block consisted of four trials, with one trial per experimental condition. Thus, overall, each child underwent a total of 12 experimental trials, consisting of 3 trials per condition. The order of conditions within each block and the left–right position of objects were counterbalanced within and across children.

In order to ensure that the children understood the object-choice task, we ran two familiarization trials prior to the experimental trials in which we used two pairs of familiar objects (chair and apple, spoon and clothes peg). In addition to the experimental trials, the children's comprehension of negation was assessed. For the negation comprehension test we used four pairs of toy animals (tiger and donkey, horse and goat, pig and ape, dog and cat) and a piece of cardboard that represented a race course.

Procedure

The children were tested in a separate room at their day cares. Children sat at a table on the right side of their main interlocutor (E1) with the second experimenter (E2) directly across from them. When the child felt comfortable, E1 presented the first two objects of the familiarization trials. This was to familiarize the children with the object choice task. Then the experimental trials followed. At the end of the session, the children's understanding of negation was assessed. All sessions were videotaped.

Familiarization. In order to familiarize the children with the object selection task, E1 introduced two

familiar objects (e.g., a chair and an apple) and asked the child to hand over one of them to E2. Both experimenters and the child played with the object for approximately 30 s. The procedure was repeated for a second pair of objects.

Experimental trials. Each block of four experimental trials was conducted with a different apparatus. E1 first introduced the apparatus assigned to a block of four experimental trials (e.g., the slide) and two familiarization toys. E1 and the child took turns at using the apparatus. E1 used one toy and the child used the other toy. After a while E2 indicated her interest in joining the game. E1 agreed and stowed the two objects away.

She then introduced two new toys to the child, saying for example, "Here I have a lion and an elephant." While putting both objects on the table, centred, approximately 30 cm away from the child, E1 looked straight at the child and invited her to give a specific one to E2, saying for example, "Let's give [E2] the elephant." E1's utterance was identical in all conditions (except for the particular object label). The conditions differed in what E2 said subsequent to E1's proposal. Table 1 summarizes the differences of the four conditions. For example, in the same label, same intention condition, E2 would respond to E1's proposal of the elephant, saying, "I find elephants good" (in German the experimenter said "Ich finde Elefanten gut," which literally means "I find elephants good" and should convey the same level of indirectness between one's personal statement about likes and dislikes of toys and the actual intention to play with the toy as in the German version).

When a child hesitated to select one of the two objects, E1 waited for approximately 10 s and then said to the child: "Should we ask [E2] again? [E2], should [name of the child] give you the elephant?" and E2 responded exactly as before, but with the addition that she held her hand between the two toys. This was repeated until the child made a decision. After the child had handed an object to E2, she responded neutrally, saying, "Thank you" and then played with the object and the apparatus. The child was allowed to play with the remaining object. The procedure was repeated once for each of the four conditions.

Table 1
Name of the Four Within-Subjects Conditions in Studies 1 and 2 and an Example per Condition of E2's Response to E1's Proposal of the Elephant

Name of the condition	E2 utterance
Same label, same intention	"I find elephants good."
Different label, same intention	"I don't find lions good."
Different label, different intention	"I find lions good."
Same label, different intention	"I don't find elephants good."

The procedure was repeated for two further blocks. Thus, in total, the children participated in 12 trials in three blocks, with each block containing 1 trial per condition.

Negation comprehension. After the experimental trials the children's comprehension of negation was assessed. This was done in order to make sure that the children correctly understood the negation particle *not* that was required in half of the experimental trials. Those children who did not succeed in two of the three trials of this assessment were excluded from the final sample.

Familiarizing the children with the procedure, E1 showed them two toy animals performing a race (e.g., a tiger and a donkey). E1 told them that the toy that crossed the finish line first would be the winner. E1 moved the toy animals along the race course and said: "And the winner is—the tiger." The children were then asked to push the winner over the finish line. After this familiarization period, the children were required to extract information from E1's utterance and to push the appropriate winner of a race (e.g., a dog or a cat) over the finish line: for example, "And the winner is—NOT the dog." The procedure was repeated for a total number of three trials.

Coding and Reliability

For the experimental trials, an object was judged as chosen if the child gave it to E2, held it in her direction, or pushed it toward her. For the negation comprehension trials, objects were judged as chosen if the child pushed one object over the finish line, performed another action with one of the toys (e.g., galloping them over the table) or named one object in answer to E1's statement. Children were excluded from analyses in the main study if they were unable to choose the correct object in at least two out of three trials (two children). An independent, blind coder coded a random sample of four children. Intercoder agreement was 100% for both the experimental trials and the negation comprehension test.

Results

Preliminary analyses revealed neither gender nor any order effects. As described in the Procedure section, we repeated some of the trials if the child

failed to choose any object in that trial. Hesitation by itself could mean that the children were not capable of solving the task. Excluding repeated trials had no effect on any of the statistical analyses presented here, and this is therefore not reported.

For statistical analyses, the dependent variable was how often children chose the correct object (that E2 wanted to play with) in each of the four conditions. One-sample *t* tests revealed that the children chose the correct object significantly above chance in the conditions in which E2's intention matched E1's proposal: same label, same intention ($M = 0.96$, $SD = 0.11$), $t(15) = 16.28$, $p < .001$; different label, same intention ($M = 0.83$, $SD = 0.24$), $t(15) = 5.48$, $p < .001$, chance 50%. When E2 indirectly expressed an intention which was different to E1's proposal, the children's object choice did not exceed chance level (same label, different intention: $M = 0.50$, $SD = 0.44$; different label, different intention: $M = 0.58$, $SD = 0.38$).

In a second analysis, the children's object selection was compared across conditions in a 2 (label) × 2 (intention) repeated measures analysis of variance (ANOVA). A main effect of intention indicates that the children found it easier to understand E2's indirectly expressed preference for an object more often when E2 wanted the same object that E1 had suggested than when E2's utterance indirectly conveyed an intention that was different to E1's proposal, $F(15, 1) = 16.48$, $p = 0.001$, $\eta^2 = 0.52$. No main effect was found for the factor label. This indicates that the utterance's surface structure (whether E2 used the same or a different label as E1) did not have an impact on the children's interpretation of her utterance and reference resolution. Finally, no interaction between label use and intention was indicated.

In an additional analysis, we addressed the question of whether children followed a very simple heuristic and ignored E1's proposal when interpreting E2's utterance. Such a simple heuristic would be that they would, upon hearing "I find X good" hand "X" to E2, independently of what E1 had said. For instance, the utterances of the same label, same intention condition ("I find elephants good") and the different label, different intention condition ("I find lions good") both have the same surface structure and should therefore yield the same pattern of object selection if the children ignored E1's previous proposal. A paired-samples *t* test, however, revealed a significant difference between these two conditions, $t(15) = 3.92$, $p = .001$. This difference must therefore be due to E1's proposal and the children's difficulty in deciding on one object when both experimenters gave contradictory instructions. Similarly, the same label, different intention condition ("I don't find elephants good") and the different label, same intention condition ("I don't find lions good") also differ significantly from one another, $t(15) = 3.31$, $p = .005$, although, once again, no difference would have been expected if the children only processed the surface structure of E2's utterances.

Discussion

Study 1 demonstrated that 3-year-old children are able to draw relevance inferences in order to bridge the gap between a person's statement of general likes and dislikes and her current desire to play with an object. That is, the children successfully inferred E2's speaker meaning by answering the question of why E2 would say something about her personal preferences concerning a certain kind of objects and judged it relevant to their object choice. Thus, they gave E2 the elephant when she indirectly asked for that object (saying that she found elephants good or lions not good). Since in those cases E2's intended object matched E1's proposal, one could argue that the children did not make an inference about E2's intention but rather simply followed E1's instructions.

Those things are not as easy as simply following either E1's or E2's utterance is shown by the conditions where E2 expresses an intention different to E1's proposal. Here, the children did not merely rely on E1's proposal in their object selection (they did not always give the elephant) or on the surface structure of E2's utterance alone (they did not always give the lion). That the children's object selection in those different intention conditions is at chance levels shows that they correctly inferred E2's speaker meaning (they made the relevance inference required to interpret the utterance as a request for an object other than the one proposed by E1) but also that they could not totally overcome E1's proposal.

Taken together, all analyses show that the children did not follow a simple strategy but rather tried to integrate both experimenters' instructions. Interestingly, the results reveal that the children were experiencing some difficulties when E1 and E2 contradicted each other (understood, for instance, as "Give her the elephant" and "Don't give me the elephant"). Therefore, in a second study we removed the conflict with a slight change in the procedure. In Study 2, E1 asked E2 whether she would like to be handed a certain object (e.g., "E2, should [name of the child] give you the elephant?"). We assumed that the children would expect a yes or no answer from E2. However, E2 again stated only her like or dislike of certain kinds of objects in the same way as

in Study 1. Thus, the inference in Study 2 is the same as in Study 1 but the conflict between the utterances of the experimenters is removed.

Study 2

Method

Participants

Sixteen monolingual German-speaking children participated in this study: Nine of them were girls and seven were boys. The mean age of the children was 3;0,7 (range = 2;10,11–3;1,26). Five additional children had to be excluded from analyses because of experimenter error (two children) or because they did not meet baseline criteria (three children).

Materials and Design

We used the same materials and followed the same design as in Study 1.

Procedure

We used exactly the same procedure as in Study 1 except that in the experimental trials E1's proposal was changed to a question (rather than using a demand as in Study 1). Specifically, while E1 placed a pair of objects on the table for the object choice task she asked E2, for example, "[E2], should [name of the child] give you the elephant?" E2 answered in exactly the same way as in Study 1.

Coding and Reliability

We used the same coding criteria as in Study 1. An independent, blind coder coded a random sample of four children. Intercoder agreement was 100%.

Results

As in Study 1, we measured how often children selected the correct object, that is, the object E2 requested indirectly in each of the four conditions. Again, the exclusion of those trials in which the children failed to choose one object immediately (and were therefore asked repeatedly) had no effect on any of the statistical analyses presented here and is, therefore, not reported. Preliminary analyses revealed neither gender differences nor any effects that the order of conditions might have had on the children. (Children were included only if they successfully comprehended negation in at least two out of three trials.)

One-sample t tests revealed that the children chose the correct object significantly above chance in all conditions: same label, same intention ($M = 0.98$, $SD = 0.08$), $t(15) = 23.24$, $p < .001$; different label, same intention ($M = 0.86$, $SD = 0.21$), $t(15) = 6.79$, $p < .001$; same label, different intention ($M = 0.75$, $SD = 0.38$), $t(15) = 2.66$, $p = .018$; different label, different intention ($M = 0.83$, $SD = 0.27$), $t(15) = 4.88$, $p < .001$, chance 50%.

Furthermore, the children's object selection was analyzed in a 2 (label) × 2 (intention) repeated measures ANOVA. A marginal main effect of intention indicates that the children tended to select the correct object more often when E2 wanted the same object that E1 had suggested than when E2's utterance indirectly conveyed an intention different to E1's proposal, $F(15, 1) = 3.88$, $p = .068$, $\eta^2 = 0.21$. As in Study 1, no main effect for the utterance's surface structure (whether E2 used the same or a different label to E1) was found. An interaction of label use and intention indicates that the children were less likely to choose the correct object compared to the other conditions when E2 said that she did not find the object E1 had proposed good. Note however, that children's correct object choice is at higher levels in the disagreement conditions in Study 2 as compared to Study 1.

As in Study 1 we tested for whether children relied on simple heuristics rather than relevance inferences. A paired-samples t test revealed a significant difference, $t(15) = 2.40$, $p = .03$, between the same label, same intention condition ("I find elephants good") and the different label, different intention condition ("I find lions good"), indicating that children did not rely solely on E2's utterance and ignore E1's. For the same label, different intention condition ("I don't find elephants good") and the different label, same intention condition ("I don't find lions good"), however, no such difference was found.

In another analysis we compared the children's selection of the correct object in each of the four conditions across Study 1 and Study 2 using independent-samples t tests. In both studies, E2's utterances were the same in each condition, but E1's proposal was either a demand (Study 1) or a question (Study 2). Differences between the same conditions across studies should indicate the influence of E1's proposal type on the children's object choice. We found a marginally significant difference in the same label, different intention condition ("I don't find elephants good") between studies, $t(30) = -1.74$, $p = .093$, and a significant difference in the different label, different intention condition ("I find lions good") between studies, $t(20) = -2.15$,

$p = .04$. Again, "I find lions good" should be equally easy to understand if the children ignored E1's previous proposal concerning the elephant, independent of whether she used a demand or a question to express this proposal. The results indicate that the children's object selection was not merely based on E2's utterance alone but that they rather integrated both experimenters' utterances into the ongoing discourse.

Discussion

In Study 2, children integrated E2's seemingly irrelevant utterance into the discourse in all conditions by making a relevance inference. In particular, children inferred that a statement such as "I find elephants good" might mean either yes or no in relation to a suggestion made by another person. That is, led by the situational demand that they should give one object to E2 and not being biased towards one object by E1's utterance, 3-year-old children understood E2's utterance as an indirect reply relating to the object choice.

Although it could be argued that phrasing E1's proposal as a question increased the relevance of E2's utterance (since an answer was to be expected and the utterance was therefore relevant per se), the content of the utterance, which expresses the speaker's meaning, still had to be related to the discourse context. In many contexts, "I find X good" does not mean, "I want to play with X right now" (think of an exhibition displaying pictures of elephants where someone says: "I find elephants good"). Thus, the children had to infer this relation within the current situation. Indeed, when E1 proposed the elephant and E2 indirectly rejected this proposal by saying "I don't find elephants good" or "I find lions good," 3-year-old children (who may have expected E2 to say "yes" or "no" directly), reestablished relevance by making necessary inferences. They came to the conclusion that E2's intention was for them to give the object that was not proposed by E1.

The significant interaction found for children's success with the relevance inferences in Study 2 might be interesting for an understanding of the cognitive processes that influence children's performance with relevance inferences. This interaction suggests that the children found it a bit more difficult to infer E2's intended meaning when E2 simply refused the object that E1 had proposed (saying "I don't find elephants good" when the elephant was suggested). This condition requires two inferences: First, E2's utterance is relevant to the game and if E2 does not like an object then she probably does not want to play with it (relevance inference), and second, that one should therefore choose the other available object (exclusion inference). The children's mastery of each of these inferences is demonstrated in the negation posttest (exclusion inference) and in the other conditions of the main study that also required a relevance inference. Also, many studies have shown that infants are able to exclude an object in a two-way disambiguation task in word learning, even when facts about the objects are used for disambiguation (Diesendruck, 2005; Diesendruck & Markson, 2001; Grassmann, Stracke, & Tomasello, 2009). Moreover, children never had problems choosing the correct object when E2 expressed her dislike for the alternative object ("I don't find lions good" when the elephant was proposed), presumably because this utterance refers the children back to the object that E1 had previously suggested, whereas "I don't find elephants good" leaves them with no clue as to which object to choose. Therefore, the difficulty seems to be the combined effort of integrating the seemingly irrelevant content of the utterance into the discourse context and making the exclusion inference.

Even though the current study demonstrated much earlier skillful interpretation of seemingly irrelevant utterances than previous research, the relevance inference drawn here was fairly simple compared to many others in adult linguistic communication. In this study children simply needed to know that people's generic statements of preferences about classes of objects have implications for what they might want in the current situation. More common conversational inferences require knowing facts about the world that are fairly far removed from the immediate situation (e.g., that one cannot have a doll from a store window unless one purchases it, and to purchase it one must have money). Such inferences are based on preconditions for taking the appropriate action and are similar to the ones used in previous studies on relevance implicature comprehension (de Villiers et al., 2009; Verbuk & Shultz, 2010). We therefore investigated such inferences in a third study, again using an object choice paradigm.

Study 3

Method

Participants

Forty monolingual German-speaking children of two age groups participated in this study. The

mean age of the younger children was 3;0,2 (range = 2;10,10–3;1,19) with an equal number of boys and girls. The mean age of the older children was 3;11,26 (range = 3;10,2–4;1,12) with 9 boys and 11 girls in this age group. Eight additional children had to be excluded from the final sample because of experimenter error (two 3-year-olds, and two 4-year-olds), or uncooperativeness or inattentiveness (four 3-year-olds). Children's parents had previously agreed to their children participating in studies on children's social-cognitive and language development.

Additionally, 10 German-speaking adults participated in this study. The mean age was 31 years (range = 21–40 years) with equal numbers of female and male participants.

Materials and Design

The children's derivation of relevance inferences based on precondition was assessed by an object choice task in two within-subjects conditions—a precondition fulfilled condition and a precondition unfulfilled condition. Children were presented with a puppet theater and two characters (Anna and Becky) were introduced. The characters were played by a second experimenter (E2). In the sections relevant to the study, the first experimenter (E1) presented the child with pairs of objects; all of them were familiar to the child and labeled by E1 several times (cereal and roll, car and tram, board game and jigsaw puzzle, paint-in picture and ball, cat and dog, apple and orange juice, melon and grapes, toothbrush and comb). The object pairs were fixed and it was established in pretests with a different sample of children that both objects of a pair were similarly attractive. The same pretest assessed whether the children associated a particular item with that object's use. For instance, the experimenter asked the children what they would need if they wanted to eat cereal. We measured spontaneous and prompted labelings of object-related items (in the cereal example this would be milk) and chose those objects that were proven to be strongly associated with the particular item.

Having presented the object pairs, E1 asked the puppets which of the objects they would like to perform an action with and indicated that the child should give one object after the puppet's answer. We called the object which the puppet's answers indirectly referred to the target object. The target object was the same for all children in the respective trials. The utterances were designed so as not to include the label of the target object or the alternative object. Rather, E2 stated something about the use of an item related to the target object, which conveyed that the precondition for using that target object was either fulfilled or unfulfilled. The relation between target object and the precondition item and the consequences of the precondition statement had to be inferred by the child. Depending on the children's object choice, additional material was used to perform the required action (see the Appendix for a list of E2's utterances and the additional material). The children underwent a total of eight trials (four trials per condition). The order of conditions, the left–right position of objects and whether the target object was labeled first or second were counterbalanced within and across children. To familiarize the child with the situation, we played a puzzle game prior to the experimental trials, where both puppets interacted naturally with the child.

Procedure

The children were tested in a separate room in their day-care centres. They sat at a table with E1 to their right and the second experimenter (E2) half-visible behind a puppet theatre that was directly across the table. A puzzle was prepositioned on the table and E1 invited the child to put in the pieces. During the familiarization phase, the puppets were introduced and interacted with the child. Then the experimental trials followed. All sessions were videotaped.

Familiarization. The children completed the puzzle until they were left with five missing pieces. At that point, E1 called to Anna (the first puppet) for help. Anna presented three opaque containers on a tray and told the child that she would help her find the missing pieces. E1 then asked Anna for a particular piece on behalf of the child (e.g., "The cow is still missing. Do you know where the cow is?"). Anna answered: "The cow is in the red cup" (silver pot and blue box) and moved the tray over to the child. The child lifted one container; if she chose the wrong one the experimenters intervened and Anna repeated her utterance. This was done to ensure that the children paid attention to the puppet's utterances. When the child had retrieved the pieces from the three containers, Becky (the second puppet) was introduced and she asked the child for one of the missing pieces that E1 had surreptitiously placed on the table. This was done to ensure that the children complied with a direct request from the puppets. Having filled in all the pieces, E1 cleared away the jigsaw puzzle and told the child that they would watch a puppet show where Anna

and Becky would demonstrate their daily routine. The children were told that they might be asked to hand over required objects to the puppets but that E1 would explain this to them in time.

Experimental trials. Beginning the puppet theater performance, the puppets Anna and Becky entered the stage telling the child that they had just got up and were tired but hungry. Anna stated: "I'm really hungry, I'd like to have breakfast." Becky said: "But what do we have for breakfast?" both looking expectantly in the direction of E1 and the child. Then E1 presented two objects, holding them alternately in front of the child while labeling them both ("Look, [name of the child], here I have cereal and a roll. You can hand over one of those to the puppets. I'll ask them which one they'd like to have."). E1 asked the puppets: "Do you want the cereal or the roll?" again showing them alternately to the puppets. The puppets looked at each other briefly, then in the direction of the child, and then Anna expressed the fact that the precondition for using one of the objects was either fulfilled or unfulfilled. In the precondition fulfilled condition, Anna said: "I bought milk," whereas in the precondition unfulfilled condition she said: "The milk is all gone." The utterances were spoken by E2, who was partly concealed behind the curtain. Her eyes, however, were visible and she looked straight at the child throughout the utterance and the subsequent object choice phase. After the puppet's statement, E1 placed both objects on a tray and moved the tray in front of the child. During the whole phase of object selection, no additional material (apart from the two objects of choice) was present "on stage" and neither the puppets nor the experimenters would look in the direction of the objects the child could choose from.

Whenever a child hesitated in selecting one of the two objects E1 waited approximately 15 s before saying to the child: "Which one will you give to the puppets?" If they still did not choose an object, the trial was repeated exactly as before. After the child had handed an object to the puppets, they proceeded with the puppet show and began performing the action corresponding to the object the child had given to them (e.g., they "ate" the roll or "poured the cereals" into a bowl). In addition, the children were engaged to join the play (e.g., to feed the puppets with the spoon). Seven trials followed (see the Appendix for a list of objects and utterances) until the puppets finally declared that they were tired and were going to bed and the first experimenter told the child that the puppet theater was finished.

Coding and Reliability

For the experimental trials, an object was coded as chosen if the child gave it to E2, held it in her direction, or pushed it toward her. Four trials (of four different children) had to be excluded from the analysis because the children did not choose an object (one trial) or because of experimenter error (three trials). An independent, blind coder coded a random sample of four children. Intercoder agreement was 100%.

Results

For statistical analyses, the dependent variable was how often children chose the correct object (i.e., the target object if the precondition for using this object was fulfilled, and the alternative object if the precondition for using the target object was unfulfilled) in each of the conditions (see Table 2). Preliminary analyses revealed neither gender differences nor order effects.

One-sample t tests revealed that 3-year-old children chose the correct, alternative, object significantly above chance when the speaker conveyed that the precondition for using the target object was unfulfilled ($M = 0.73$, $SD = 0.20$), $t(19) = 5.11$, $p < .001$. However, when the speaker indirectly stated that the precondition for using the target object was fulfilled, children chose this object at chance level ($M = 0.58$, $SD = 0.28$). Four-year-olds chose the correct object significantly above chance in both conditions: precondition unfulfilled ($M = 0.65$, $SD = 0.32$), $t(19) = 2.18$, $p = .042$; precondition fulfilled ($M = 0.62$, $SD = 0.23$), $t(19) = 2.23$, $p = .038$. This tendency was even more pronounced among the adults: precondition unfulfilled ($M = 0.93$, $SD = 0.12$), $t(9) = 11.13$, $p < .001$; precondition fulfilled ($M = 1.00$, $SD = 0.00$).

Paired-samples t tests affirm these findings: For 3-year-olds the difference between the two conditions is significant, $t(19) = -2.197$, $p = .041$. We found no significant difference between the two conditions for the 4-year-olds, $t(19) = -.402$, $p = .692$, and the adults, $t(9) = 1.964$, $p = .081$.

Table 2
Mean Proportion of the Children's Correct Object Selection According to the Conditions in Study 3

Participants	Precondition fulfilled	Precondition unfulfilled
3-year-olds	$M = 0.58$, $SD = 0.28$	$M = 0.73$, $SD = 0.20$
4-year-olds	$M = 0.62$, $SD = 0.23$	$M = 0.65$, $SD = 0.32$
Adults	$M = 1.00$, $SD = 0$	$M = 0.93$, $SD = 0.12$

Discussion

In this study, we found that 3-year-old children make relevance inferences on the speaker's meaning when the content of the speaker's utterance is fairly far removed from the current discourse context. When the speaker conveyed that the precondition for using an object was unfulfilled, thereby indirectly excluding one object from the object choice, the children chose the alternative object. Three-year-olds, however, failed to perform above chance in the precondition fulfilled condition. We suggest that this finding is due to the restrictedness of the actual discourse rather than the inferential abilities of young children.

Given that young children infer a speaker's intention when learning the meaning of a word, they should be able to use the exact same abilities when interpreting more complex utterances. In both discourse situations, the hearer has to contemplate the communicator's communicative, social, and referential intention. But Quine's (1960) famous "Gavagai" example shows that inferring the meaning of a word requires the additional usage of situational or contextual factors, world knowledge, and common ground to narrow down the number of possible meanings. We think the same is true for inferring the meaning of whole utterances. They give rise to a potentially infinite number of inferences on the speaker's possible meaning and hearers have to use world knowledge, common ground and other situational factors to constrain the interpretation space. The more knowledge the hearer has about the situation the easier this will be.

The precondition unfulfilled condition in Study 3 provides more constraining factors than the precondition fulfilled condition since the puppet's utterances indirectly exclude one object from the object choice. Moreover, when using indirect requests, speakers generally have the tendency to mention aversive conditions (Ervin-Tripp, 1977), thereby addressing the obstacle that has to be removed in order to fulfil the request (Clark, 1996; Francik & Clark, 1985; Gibbs, 1986). When the children heard the utterance that conveyed that the target object could not be used due to an unfulfilled precondition, they simply tried to remove this obstacle by choosing the alternative object. The combination of earlier discourse experiences and indirectly expressed exclusion of an object made the 3-year-old children's object choice in the precondition unfulfilled condition more straightforward. By contrast, the utterances of the precondition fulfilled condition are more difficult since they do not provide hints that constrain the object choice and they are not in line with previous discourse experiences. Additionally, we presume that 3-year-olds but not 4-year-olds might have a problem accessing their world knowledge in the precondition fulfilled condition and that they were therefore choosing at chance levels. It is probable that the 3-year-old children only became aware of the relation between, for example, the milk and cereals because a problem with the milk was presented in the precondition unfulfilled condition. The 3-year-old children may only then have started to think about how to solve this problem, whereas in the fulfilled condition children did not need to make such an assessment. Four-year-olds, however, may have stronger world knowledge and thus access the relation between target object and precondition item more easily.

We argue that in both conditions participants engaged in the same inferential process taking the following factors into account:

1. Situational factors: They were asked to choose one of two objects to give it to the puppets.
2. Puppet's utterance: Since the puppet said something directed at the child, the child knew that the utterance was made for her benefit (cooperative principle of communication). And she knew that now it was her turn to figure out the speaker's meaning. In order to answer the question about the speaker's social goal ("What does she want me to do?"), the child made a relevance inference ("How is [not] having X relevant to the question under discussion?"). Thus, choosing one object over the other is first of all tied to the existence of an utterance telling us about the (non)existence of such constraints. Without the utterance there would be no basis for an inference in Study 3.
3. Then the child had to use her world knowledge to figure out the relation between the utterance and the object choice. Importantly, the correct object choice was always and in both conditions tied to world knowledge. If I were not to know that (generally) dice are used with board games but not with puzzles, I would be unable to interpret the utterance, "I do have a die" as a request for playing the board game. The same is true for "I don't have a die" as a request to play the puzzle.

The above mentioned points 1 to 3 present the inferential process children have to go through in both conditions. Supposedly, this process becomes

more apparent (and thus easier to notice) in the precondition fulfilled condition. Namely, the interpretation space is less constrained in this condition, and the hearer is thus left with more options as to how to interpret the speaker's meaning. Therefore, it might seem as if *only* in the precondition fulfilled condition the hearer needs to (consciously) think about and infer the speaker's communicative intention. However, we suggest that hearers do not have to *consciously* reason about the speaker's utterance as being for their benefit—rather, this is simply the prerequisite of all communication as described in Grice's cooperative principle and the (subconscious) impulse underlying the comprehension of every communicative act. Thus, the hearer's recognition of the speaker's communicative intention (on whichever level of consciousness) triggers the inference process and licenses the cognitive effort of making relevance inferences on the speaker's meaning. It might be that in some rather difficult (i.e., unconstrained) cases we become aware of that inferential process but that does not mean it is not there all along.

General Discussion

Overall, the results of the current set of three studies suggest that at 3 to 4 years of age children are able to derive relevance inferences and make sense of an utterance that uses indirect communicative means. Specifically, in Studies 1 and 2, we assessed children's inferential abilities when interpreting utterances that required only a few inferential steps, whereas in Study 3, more complex inferences were used that were similar to the ones employed in previous research.

A listener's ability to infer what should be done about the information provided by the speaker includes assessing the situation and also comprehending the speaker's goal-directed, intentional actions. The most important skill required for such an inferential process is intention reading. Research over the past two decades has demonstrated that intention reading based on someone's perceived goals is a social-cognitive skill that develops early on (Hamlin, Hallinan, & Woodward, 2008; Meltzoff, 1995, 2007; Woodward, 2009). For example, in pointing and word-learning studies children as young as 14–18 months of age have been shown to engage in intention reading and context-sensitive interpretation of gestural communication. Specifically, infants interpreted pointing gestures differently when the experimenter's communicative intent differed (e.g., because of recently shared experiences; cf. Liebal, Behne, Carpenter, & Tomasello, 2009). Similarly, young children are more likely to learn new words for objects the speaker intended to refer to, not merely the first object encountered (Baldwin, 1991; Tomasello, Strosberg, & Akhtar, 1996). Thus, even when only speaking a few words themselves, infants understand speakers as goal-directed communicators, which in turn enables them to engage in inferences about the goals and intentions in both verbal and nonverbal behavior (Carpenter, Akhtar, & Tomasello, 1998; Carpenter, Nagell, & Tomasello, 1998; Tomasello, 2001). Given these early skills with intention reading, one can be quite sure that the children in the studies presented here applied comparable skills as well.

In contrast, de Villiers et al. (2009) argued that children's computation of relevance implicatures is based not on mere intention reading but on full-fledged mastering of theory-of-mind abilities. However, our findings that even 3-year-olds mastered relevance inferences suggest that it is not an understanding of beliefs but rather an understanding of intentions that is the prerequisite of inferring a speaker's meaning in indirect and ambiguous communicative situations.

In order to infer a communicator's intentions, recipients need to engage in joint attention with her. That is, both discourse partners need to have the same idea of what they are communicating about and that they are mutually sharing their experiences. The ability to engage in joint attention also develops very early on in life. Liszkowski, Carpenter, Henning, Striano, and Tomasello (2004) showed that 12-month-old infants actively try to establish joint attention with an adult in order to share their interests and emotions about an ongoing novel event.

Another skill that is needed when interpreting a speaker's utterance is to be able to acknowledge the personal, situational and cultural common ground between a speaker and a hearer. Importantly, when the communication partners know that they mutually know something through shared cultural or situational experience, they also know that they do not need to express a corresponding piece of knowledge explicitly, but rather build communication on top of that (Clark, 1996; Tomasello, 2008). The ability to do so is, again, something that develops rather early on: By 14 months of age, infants already know what they and another person have experienced together and interpret the person's pointing gestures or emotional reactions differently (Liebal et al., 2009; Moll, Koring, Carpenter, &

Tomasello, 2006; Moll, Richter, Carpenter, & Tomasello, 2008; Tomasello & Haberl, 2003). Thus, in sum, we can expect the children in our studies to be capable of all this: establishing joint attention, reading intentions, and using shared common ground as the basis of communication and its interpretation.

Finally, in order to make sense of indirect verbal communication, hearers often need a good deal of world knowledge in order to bridge the gap between two utterances and to infer the speaker's social goal. As argued in the discussion of Study 3, the more solid and better established the required knowledge, the easier the inference will be for the hearer. It is, however, very important to keep in mind that even when it seems that the hearer "merely" has to use a well-established piece of world knowledge in order to make a connection between the speaker's utterance and her social goal, this is still an inference about a speaker's meaning, based on the hearer's perception of the speaker's utterance and her communicative intention.

Just as in everyday interaction, the difficulty and complexity of the relevance inferences required also differed in the three studies reported here. Most interesting is our finding that 3- to 4-year-olds made relevance inferences in Study 3's rather complex task (which was similar to the ones employed in previous research), as previous studies found that only children aged 6 years or older were able to make inferences in such circumstances (Bucciarelli et al., 2003; de Villiers et al., 2009; Loukusa et al., 2007; Verbuk & Shultz, 2010). This apparent difference in findings might be due to the fact that earlier studies used methods requiring metapragmatic abilities, while our tasks did not. The difficulty of tasks used in earlier studies is particularly apparent in a study by Bernicot et al. (2007). In this study, pragmatic comprehension abilities (choosing an appropriate picture depicting the intended meaning of a storyboard) as well as children's metapragmatic explanation abilities (explain your choice) were assessed in 6- to 10-year-old children. Strikingly, it was found that although even the 6-year-olds were capable of deriving relevance inferences, even the 10-year-olds could not explain their choice. Thus, it is not surprising that children younger than 6 years of age have been found to fail to demonstrate reliable understanding of relevance inferences when metareasoning was required. This point is further supported by the fact that when testing children's inferential abilities in another domain of pragmatic inferences, namely, scalar implicatures, Pouscoulous et al. (2007) and Papafragou and Tantalou (2004) found that using an act-out paradigm enhanced children's performance with such inferences as compared to earlier studies that used metapragmatic methods (Guasti et al., 2005; Noveck, 2001). Thus, previous results about relevance inference skills in indirect verbal communication might as well be an artifact of the methodologies used rather than a precise measure of the children's skills.

The tasks used in the current studies simplified matters for children in the following ways: First, inferring another person's intentions is cognitively expensive. We suppose that if the task is relevant to the child, that is, if she is involved in a game and gains something, she wants to make the effort to choose the correct object and uses her intention-reading skills and whatever knowledge that helps her. Second, since in our studies children actively took part in a game, we think that it was easier for them to establish joint attention and common ground compared to other paradigms in which they were required to judge utterances from a third person's perspective. Third, concerning Study 3, we think that using discourse situations and objects that were suited to the children's world knowledge improved their perception of common ground and therefore made it easier for them to choose the object the speaker wanted to have. Most importantly, in our studies the children and the experimenter formed some interpersonal common ground in their joint activity. Specifically, they played a game together that required the child to choose between two objects. Experiencing an utterance within this interaction with established common ground, children could not help but interpret their interlocutor's utterance as a hint for the activity at hand—their object choice.

In all the studies presented in this article, children had to infer another person's desire for a certain object or activity. One could thus argue that our study does not show anything new as compared to other studies showing that children as young as 14 months understand that people tend to engage with objects they prefer as opposed to objects they dislike (Repacholi & Gopnik, 1997; see also Fawcett & Markson, 2010; Saylor & Troseth, 2006; Wellman & Bartsch, 1988; Wellman & Woolley, 1990). The (important) difference is that the inference in the current studies goes some steps further: Whereas the experimenter in the study by Repacholi and Gopnik (1997) expressed her like or dislike of an object directly (she tasted food and showed her disgust or happiness using facial emotional expressions), the experimenter in our set of studies never looked at one of the objects directly

and never used any facial expressions. Thus, in our studies liking and disliking were expressed indirectly using verbal statements that were seemingly irrelevant to the ongoing discourse. In Studies 1 and 2, the experimenter only hinted at her desire using some rather general piece of information about an object category. In Study 3 the experimenter did not even use the lexical expression for her desired object. Therefore, in this study, children depended on the experimenter's utterance that indirectly described her preferred object choice and they had to relate that utterance to the ongoing interaction. All in all, we think the difference between our studies and the one by Repacholi and Gopnik lies in the degree of directness of the connection between the desired object and the piece of information children received from the experimenter in order to infer that desire.

Since the role of previous experiences concerning the comprehension of desire as well as the role of general world knowledge is so important in our studies, one could argue that children use these skills as a kind of short-cut to come to an appropriate decision concerning their object choice: They hear something about likes and dislikes, about preconditions being fulfilled or unfulfilled, and assume from their knowledge which object is more likely to be requested. But to assume something here is indeed to make a relevance inference that is primarily based on children's motivation to understand the speaker's social goal, which in turn is triggered by their recognition of the speaker's communicative intention. Why else should the speaker say something if not to help the children with their object choice? Had she not said anything, no inference would have followed. The argument that the children in our studies indeed had to engage in inferential communication and were able to do so is supported by previous research showing that the most basic inferential abilities can even be seen in 1-year-olds' prelinguistic comprehension of the pointing gesture. For example, in the context of a hiding–finding game, if an adult points to a bucket in front of a 14-month-old infant, they not only follow the pointing gesture to the bucket, but they also understand that the pointing gesture was made for their benefit and thus make the inference that this bucket must be somehow relevant to their search for the hidden toy (Behne, Carpenter, & Tomasello, 2005). Just as in the current studies, they must ask themselves why the adult is choosing to communicate with them in this way in this situation. In the studies presented here the inference is, arguably, complicated by the fact that the utterance itself has an interpretation, which the child must in some sense "overcome" to derive the appropriate relevance inference—whereas this is not the case with the pointing gesture. Thus, our findings on the one hand show that infants use the very same resources to derive relevance inferences in non-verbal and verbal communication. But on the other hand we suggest that making relevance inferences with language requires additional skills beyond those used by infants when making relevance inferences to interpret pointing gestures.

Overall, then, the results presented here contribute to a growing body of literature that supports the notion that young children understand more about the communication process (even when indirect verbal means are used) than was previously believed. Even prelinguistically, children make very simple relevance inferences, and their ability to integrate their comprehension of an utterance with real-world knowledge and their understanding of the speaker's goals and intended meaning in a particular situation develops fairly quickly. Our studies show that by 3 years of age children can make fairly large inferential leaps in communicative situations if they understand the overall situation well enough.

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Appendix

List of Utterances, Objects, and Additional Material Used in Study 3

Action	Target object	Alternative object	Precondition fulfilled	Precondition unfulfilled	Additional material
Breakfast	Cereal	Roll	I bought milk.	The milk is all gone.	Bowl, spoon
Go to day-care	Car	Tram	The booster seat is there.	The booster seat is at grandma's.	—
Play	Board game	Jigsaw puzzle	I've got a die.	I don't have a die.	Dice, figures
Play	Paint-in picture	Ball	The crayon's tip has been sharpened.	The crayon's tip is broken off.	Crayons, felt pen
Nursing pets	Dog	Cat	I've got a leash.	The leash is torn.	Leash, rope, feeding dish
Dinner	Orange juice	Apple	The cups are clean.	The cups are dirty.	Cup
Dinner	Melon	Grapes	I've got a knife.	I don't have a knife.	Knife
Go to bed	Toothbrush	Comb	The toothpaste is in the bathroom.	The toothpaste is all gone.	—