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Two-year-olds use adults' but not peers' points

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Abstract

In the current study, 24- to 27-month-old children (*N* = 37) used pointing gestures in a cooperative object choice task with either peer or adult partners. When indicating the location of a hidden toy, children pointed equally accurately for adult and peer partners but more often for adult partners. When choosing from one of three hiding places, children used adults' pointing to find a hidden toy significantly more often than they used peers'. In interaction with peers, children's choice behavior was at chance level. These results suggest that toddlers ascribe informative value to adults' but not peers' pointing gestures, and highlight the role of children's social expectations in their communicative development.

RESEARCH HIGHLIGHTS

- Two-year-old children are less likely to use a peer's point in an object choice task despite being able to use an adult's point in the same context. This is first evidence that children at this age can take an interlocutor's age into account when judging testimony.
- First trial analysis suggests that the results reflect expectations that children have acquired prior to testing.
- In addition, we report a new comparison of children's willingness to point for adult and peer partners. We found that while they point (and do so accurately for both), they point more often for adults.

1 | INTRODUCTION

Pre-verbal children possess remarkable skills for communicating with adults. For example, before they speak their first words, they understand points produced by adults in diverse contexts, and when interacting with adults they produce these points themselves to express a variety of communicative and social motives (Tomasello, Carpenter, & Liszkowski, 2007). However, little is known about the extent to which young children are able and motivated to employ their communicative skills in peer interaction.

Since at the age of 2 peer interactions are still mostly nonverbal and restricted to simple give-and-take exchanges or imitation games (Brownell & Carriger, 1990; Eckerman, Davis, & Didow, 1989; Eckerman & Peterman, 2001; Nadel-Brulfert & Baudonniere, 1982; Smiley, 2001), one might expect that 1-year-olds' communicative interactions with peers would also be inhibited. At 18 and 24 months old, peer dyads begin to engage in interactions with several turns of consecutive and alternating communicative acts (Brownell, 1990). During their second year, toddlers also engage in joint attention to explore their environment together (Bakeman & Adamson, 1984; Gunnar, Senior, & Hartup, 1984), and are ready to learn imitatively from age-mates (Hanna & Meltzoff, 1993). Requests for objects via pointing gestures are occasionally met with an appropriate reaction on the side of the receiver (Hay, Caplan, Castle, & Stimson, 1991; Hay, Castle, Davies, Demetriou, & Stimson, 1999; Hepach, Kante, & Tomasello, 2017) and responses to communicative behavior appear increasingly rational (Ross, Lollis, & Elliott, 1982). At 2.5 years of age, peer dyads begin to integrate several turns in early structured conversations (Hay, 2006). However, while children use words fluently with adults before they turn 2 (Tomasello, 1992), interactions

between peers are predominantly nonverbal well into the third year (Eckerman & Didow, 1996; Eckerman & Peterman, 2001) and increase only slowly in richness and complexity (Brenner & Mueller, 1982; Eckerman & Didow, 1996).

These findings testify to the fact that peer interaction provides a challenging testing ground for young children's developing communicative and social skills. Not only is a peer's behavior less structured and predictable than adult behavior (Bakeman & Adamson, 1984), it also lacks the social and pedagogical routines—or 'scaffolding'—that adults contribute to the interaction with children. Such routines might include adjustments in tone of voice and pace, patient and elaborated movements, repetition, and careful monitoring of children's attention. By contrast, interactions with age-mates provide a social context that is highly symmetrical with regard to the motivations and abilities that interlocutors provide. It is a very demanding context for the exercise of their emerging communicative skills.

Pointing, as one of the earliest and most versatile elements of intentional communication, has been studied extensively (Tomasello, 2008; Tomasello et al., 2007). Children as young as 12 months use pointing gestures when produced with communicative intent (Behne, Carpenter, & Tomasello, 2005, Behne, Liszkowski, Carpenter, & Tomasello, 2012). At the same age, they readily point to share interest and direct others' attention towards objects (Liszkowski, Carpenter, Henning, Striano, & Tomasello, 2004) as well as to request and provide information (Kovács, Tauzin, Téglás, Gergely, & Csibra, 2014; Liszkowski, 2005). Thus, it is evident that prior to their first uses of words—and long before they reach 2 years of age—toddlers have extensive experience with the pointing gesture and are highly competent in its use (Behne et al., 2005; Behne et al., 2012; Tomasello, Call, & Gluckman, 1997). Given its importance and early mastery in ontogeny, children might be predicted to provide points and use information from pointing gestures with different groups of interlocutors, making it a promising object of study in the context of peer interaction.

Studies testing children's sharing behavior have provided evidence that children can use pointing and reaching gestures with familiar and unfamiliar peers to demand an object from as young as 12 months of age (Hay et al., 1991; Hay et al., 1999; Hepach et al., 2017). Franco, Perucchin, and March (2009) tested the initiation of joint attention via pointing in same-aged peer dyads at 12 and 24 months of age and directly contrasted children's performance in both age groups with an adult condition. Periods of joint attention were produced frequently in both age groups—although more often with adult than with peer partners. While this paradigm did not require children to make any inferences about their partner's communicative goals, the results suggest that at 2 years of age children should be able to direct one another's attention to objects in their periphery.

On the one hand, young children have been shown to prefer adults over peers as informants in a variety of contexts. For example, 2-year-olds are more likely to imitate novel actions from adult demonstrators (Zmyj, Daum, Prinz, & Aschersleben, 2012; cf. Zmyj & Seehagen, 2013). Three-year-olds prefer to learn object-labels (Jaswal & Neely, 2006) and game-rules from adults (Rakoczy, Hamann, Warneken, & Tomasello, 2010), are more likely to conform to an adult over a peer majority (McGuigan & Stevenson, 2016) and copy adults more faithfully in an over-imitation paradigm under matched conditions (McGuigan, Makinson, & Whiten, 2011). On the other hand, preschoolers have been shown to prefer same-age peers as informants, for example, on questions about toys (Vanderborght & Jaswal, 2009), and are able to preserve redundant actions in a transmission chain with peers when they are presented in a playful manner (Nielsen, Cucchiaro, & Mohamedally, 2012). Peers can also serve as an important learning context by providing a zone of proximal development (Vygostky, 1978) making slightly older peers especially salient sources of information (Zmyj & Seehagen, 2013). In addition, pointing is a highly salient ostensive practice (Csibra & Gergely, 2009), and one with which children have a strong tendency to comply (Palmquist, Burns, & Jaswal, 2012).

In this study, we adapted a paradigm previously tested on orangutans (Moore, Call, & Tomasello, 2015) to investigate 2-year-olds' abilities to produce and use information provided by pointing gestures in an object choice task in which a relatively strong relevance inference is required. In this task children not only have to follow a peer's point to a target but also make the pragmatic inference that their interlocutor is knowledgeable, helpful, and intent on providing information that is relevant for them—namely the location of a hidden toy. To our knowledge, this is the first study to directly compare children's ability to provide and use information from points in interaction with peer and adult partners.

In line with previous findings comparing the production of pointing gestures across social contexts (Bakeman and Adamson, 1986; Franco et al., 2009; Ninio, 2016), we hypothesize that children in our task will also be likely to point more frequently for adult as opposed to peer partners. Whether children would also be more likely to use pointing gestures from adults is an open question. While studies comparing learning from peer and adult partners suggests that even very young children would prefer adults as informants, the context of direct ostensive communication is a demanding context for such a bias to appear in. Differences in the usage of pointing gestures from same-aged peer and adult partners would provide the earliest evidence to date that children can take an interlocutor's age into account when judging testimony (cf. Harris & Lane, 2014) and testify to children's active contribution to social learning in communicative contexts (Begus, Gliga & Souhtgate, 2014, 2016; Csibra & Gergely, 2009).

2 | METHOD

2.1 | Participants

A total of 37 children were tested across two conditions. In the peer-peer condition, we tested 12 same-sex dyads of unfamiliar 24- to 27-month-old children (mean age = 25.86 months, *SD* = 0.87 months, range = 23.8–26.91 months; 10 girls, 14 boys). In the child-adult condition, we tested 13 24- to 27-month-olds (mean age = 25.96

months, *SD* = 0.89 months, range = 24.3–26.89 months; 7 girls, 6 boys) in interaction with an adult experimenter.

In addition, 29 further children were tested but not included in the analysis (peer-peer condition, *n* = 22; child-adult condition *n* = 7). These children were excluded due to camera malfunction (*n* = 2), parental interference (*n* = 3), experimenter errors (*n* = 4), and because they failed to finish the warm-up exercise (*n* = 5). We also excluded individuals in the adult-child, or both partners in the peer-peer dyad, if they did not complete at least six out of 12 trials (*n* = 15). Since the peer-peer condition required that both children stay on task for approximately 30 minutes, and since unsettledness in one partner tended to be contagious, the dropout rate in this condition was relatively high (75% of all subjects who dropped out were tested in the peer condition). However, drop-out rates in studies investigating peer interactions are commonly higher in this age group (cf. Endedijk, Cillessen, Cox, Bekkering, & Hunnius, 2015; Franco et al., 2009) than studies testing children individually. Furthermore, we adopted relatively strict inclusion criteria, since we wanted to ensure that the children in the final analyses were generally attentive and had been motivated to engage in several turns of interaction with a peer. Otherwise we risked undermining our findings by comparing children's performance in well-structured adult-child interactions with their performance in short and flaky peer interactions, in which motivation to participate would likely have been harder to sustain.

All children came from a medium-sized German city with a predominantly Caucasian population. They were found via a database of subjects for child development studies to which their parents had voluntarily signed up. None of the partner children had previously met. Groupings of the children were made solely on the basis of age, sex and availability.

During the test phase, parents were asked to fill in both a questionnaire on their children's experiences with similar-age peers and the FRAKIS-K language development questionnaire (Szagun, Stumper, & Schramm, 2009). Questionnaire data revealed that subjects spent an average of 34.55 hours per week in the presence of peers defined as children not more than one year older or younger than themselves (*SD* = 15.02, range 5–80; peer condition: mean = 34 hours, *SD* = 17.02, range = 5–80; adult condition: mean = 35.6 hours, *SD* = 9.8, range = 7–45). This difference is not significant when tested with a Mann-Whitney U test (U = 123, *p* = .95). Within their family, children spent an average of 12.34 hours per week with peers (*SD* = 19.63, range 0–70; peer condition: mean = 9.86 hours, *SD* = 16.02, range = 0–65; adult condition: mean = 14.82 hours, *SD* = 25.05, range = 0–70). Also, this difference is not significant when tested with a Mann-Whitney U test (U = 123, *p* = .95).

On a 5-point Lickert scale (with 5 being the most positive rating) parents indicated that their children felt generally comfortable around unfamiliar peers (average = 4.2, *SD* = 0.72, range 3–5; peer condition: average = 4, *SD* = 0.6, range = 3–5; adult condition: average = 4.33, *SD* = 0.85, range = 3–5) and that they were very interested in another peer's activities (average = 4.41, *SD* = 0.73, range 3–5; peer condition: 4.45, *SD* = 0.72, range = 3–5; adult condition: 4.33, *SD* = 0.75, range 3–5). All children were indicated to have peer playmates. Parents' scores for their children's verbal competence indicated a normal distribution of abilities across conditions with only 10.81% of children (peer 12.5%, adult 7.69%) scoring below the age-norms for active vocabulary identified by the FRAKIS-K.

2.2 | Materials and procedure

Upon entering the lab, children were invited into a warm-up room to be familiarized with both experimenters (henceforth E1 and E2). Interactions involved playing with a doll's house or pretend feeding animals depending on the children's interest. Parents would be in the room watching or reading. During this warm-up phase, abundant toys were provided to minimize negative experiences within dyads.

Following this, children were led into the test room and invited to take a seat at the table with the materials. All subjects were introduced to a hiding game in which E1 would hide toys for them under one of three cups on a board. Children learned that they could retrieve the toy once the board was shifted to their side of the table. During two familiarization trials, the toys were hidden in plain sight and both partners took turns in retrieving them from underneath the cups. Parents were asked to sit behind their children, to keep them settled, but not to interfere with the study.

2.2.1 | Peer interaction

In the test trials, children took turns in the searching game. At the onset of a trial, the board was placed closer to the child whose turn it was to retrieve the ball (hereafter: searcher) but remained out of her reach. After E2 placed a visual occluder in front of the searcher, the E1 called the attention of the other child (hereafter: pointer) and then hid the ball ostensively under one of the three cups (Figure 1a). He then emphasized to the pointer both that it was the searcher's turn to retrieve the ball, and that the searcher was unable to see where the ball was hidden. As soon as E2 removed the visual occluder, E1 addressed both children with the phrase, "Let's see if you can find the ball together!" As soon as the pointer indicated to the searcher where the ball was hidden, the board with the cups was shifted over to the searcher in order for her to make a choice (Figure 1b). If the pointer didn't provide a cue for the searcher within a 5-second interval, the E1 drew the pointer's attention to the task using a series of verbal prompts. Trials without interaction were terminated after four verbal prompts (2 × "See A, B doesn't know where the ball is!"; 2 × "A, can you help B find the ball?"). Both children were non-differentially rewarded with balls after each trial in order to keep their attention. The roles of the pointer and searcher were switched every three trials, for 12 trials in total. Subjects had to complete at least three trials in each role in order for a dyad to be included in the analysis.

2.2.2 | Adult–child interaction

To allow for a comparison of adult–child and peer–peer interaction, a second condition was run in which individual children interacted with a female experimenter (E2) in a matched procedure. In adult–child interaction, children always took the role of the pointer in the first three trials so as not to provide them with a model solution in the initial phase of the session. When taking the role of the searcher, E2 would first look at the cups and then attend to her partner after the removal of the occluder. Her choice was always compliant with the child's pointing behavior when the child pointed. When the child did not point, she chose an empty cup. In the role of the pointer, E2 pointed reliably after the removal of the occluder for a period of approximately 4 seconds and always pointed to the actual hiding place of the toy. To ensure that her points did not carry more information than children's points in the peer condition, E2's pointing behavior was modeled on children's pointing in terms of its physical dimensions. To counteract any salience effect that might result from her greater body size, she was seated lower than the children, so that both interlocutors were at eye-level, and she rested her forearm on a central point on the edge of the table so that she was effectively pointing only with her forearm. During a pointing event, E2 would smile and alternate her gaze between the referent and the addressee but remain completely silent.

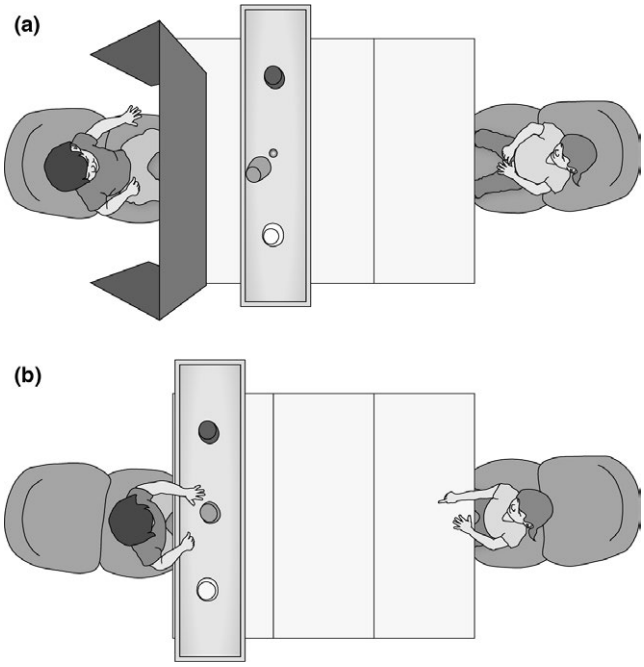

FIGURE 1 Experimental set-up. During the hiding phase (a) only the searcher can see where the ball is placed. In the test phase (b) the board is shifted over to the searcher as soon as the pointer provides a cue for the partner

2.3 | Coding and reliability

Sessions were videotaped with two cameras focused on participants' faces, and a ceiling-mounted camera for coding children's pointing and choice behavior. Video material was coded using the software INTERACT (Mangold International GmbH, Arnstorf).

Children's pointing behavior was coded for its target (cups 1–3; other) and the recipient's attentiveness (attentive, inattentive). In order for pointing events to be submitted to the analysis of production, points had to clearly identify one of the three cups. The first cup that a child lifted in a given trial was counted as her choice. Children's choice behavior was coded for its target and whether it was in compliance with a cue provided by the pointer. If subjects were inattentive during pointing events, their choice was not analyzed.

Frequency of children's pointing was coded in both conditions. In addition, a dyad's performance in a given trial was categorized by whether or not the pointer's point was accurate, and whether or not the recipient's choice was compliant with the pointing gesture.

Our final dataset included 243 trials. Eleven trials were not run, because children became restless during the final trials of some sessions. Forty-six further trials were excluded from the final analysis because children were inattentive to the experimenter's verbal prompts (N = 19), or interfered with the procedure (N = 9), because their parents interfered (N = 10), or because of experimenter errors (N = 8).

Inter-observer agreement was tested on eight sessions (12 subjects, 32% of the data) that were equally distributed across conditions and sexes. Reliability coding was conducted in two steps. First, the second coder was naïve with regard to the actual hiding place of the toy and coded the children's and experimenter's pointing, choice and verbal behavior separately for each session. In a second step, the second coder was informed about the manipulation and was asked to assess whether the pointer referred to the cup with the hidden toy and whether the searcher acted in accordance with the cue provided by the pointer using one of five predefined categories ((i) correct point – compliant choice, (ii) incorrect point – compliant choice, (iii) correct point – noncompliant choice, (iv) incorrect point – noncompliant choice, (v) no choice).

In order to assess inter-rater reliability, Cohen's kappa and correlations were computed. Agreement was excellent for the referent of the point (kappa = .91), subject's choice (kappa = 1) and trial categorization (kappa = .97). Agreement for recipient's attentiveness was very good (kappa = .76), agreement on type of point (finger point vs. whole-hand point) (kappa = .69) and vocalizations accompanying the pointing gesture (with vs. without vocalization) (kappa = .62) was good. Correlations for the number of points observed in a given trial (rho 0.89, $p < .001$) and their duration (rho 0.81, $p < .0001$) were highly significant.

2.4 | Analysis

We used generalized linear mixed models (GLMM; Baayen, 2008) with binomial error structure and logit link function to compare the likelihood with which children pointed and used information provided by pointing gestures between conditions. Since we were primarily interested in the effect of our experimental manipulation,

condition (peer, adult) was included as a fixed effect. Sex and trial number were entered as further fixed effects to be controlled for. An interaction of condition and sex was added. Prior to the analysis, trial number was *z*-transformed to a mean of zero and a standard deviation of one to ensure model convergence. Dyad and subject were included as random effects. Furthermore, we added trial number as a random slope within dyad and subject as well as the correlation of the slopes and random intercepts.

To establish the significance of the full model (Forstmeier & Schielzeth, 2011), we used a likelihood ratio test (Dobson, 2002), comparing its deviance with that of a null model that comprised all factors of the full model (described above) except for condition and the interaction of sex and condition. All GLMM analyses reported below share this full and null model structure. Model stability was assessed by excluding subjects and dyads one at a time from the data and comparing the estimates derived with the values obtained from the model based on the complete data set. We calculated variance inflation factors to test for collinearity among predictors using the function vif of the R-package car (Fox & Weisberg, 2011) applied to a standard linear model excluding the random effects. In all of the models reported below, we found no evidence for influential cases or for collinearity.

For additional support of our findings, we ran Mann-Whitney U tests comparing conditions. To test whether children's choice behavior was above chance when deciding between the three possible hiding places, we ran two-tailed one-sample *t* tests for each condition separately with the chance level set to 1/3.

3 | RESULTS

3.1 | Production of pointing gestures

3.1.1 | Frequency

Children pointed in 80.2% of trials in which they interacted with adults and 58.4% of trials in which they pointed for peers (Figure 2). Overall, 20 out of 24 subjects (83.3%) provided some information for their peers, and 12 out of 13 subjects (92.3%) provided some information for adult partners. Participants in the adult condition provided an average of 5.69 trials (N = 13; range = 4–6, median = 6). In the peer condition, participants provided an average of 4.25 trials (N = 24; range = 3–6, median = 4).

In order to test whether children were more likely to provide information for adults or for peers, we analyzed the probability that the subject pointed in a trial. The full-null model comparison found a significant effect of condition (χ^2 = 7.16, df = 2, p = .028). Furthermore, we found no evidence of a significant interaction between condition and sex (Estimate = 2.98, SE = 3.31, z = 0.9, p = .367). After this interaction was dropped from the analysis, we found that children were more likely to point in the adult condition (Estimate = −4.15, SE = 1.86; z = −2.24; p = .025). In addition, a Mann-Whitney U test comparing the proportion of trials in which subjects pointed indicated a significant difference across conditions (peer N = 24; adult N = 13; U = 96; p = .05).

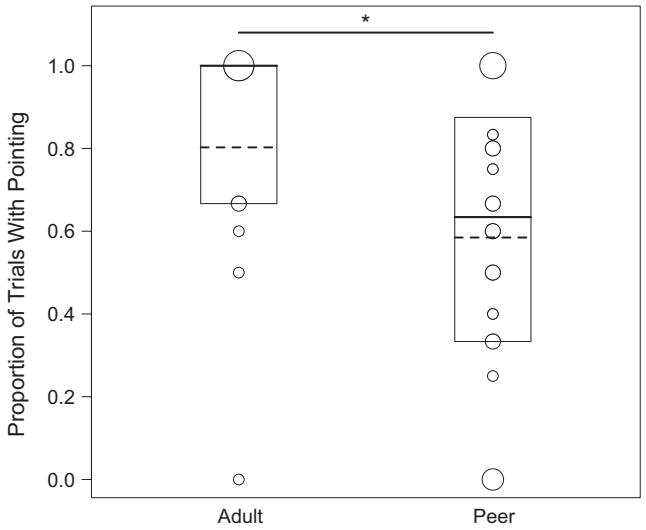

FIGURE 2 Proportion of trials with pointing per condition. Larger bubbles represent more subjects with a given proportion. Boxes indicate 25th, 50th and 75th percentiles. Dashed lines indicate means. * indicates statistically significant difference (p < .05)

As outlined above, children in the adult condition always started with a set of production trials so as not to provide them with a model solution to the production task. Since partners swapped roles every three trials, children here might still have benefited from seeing their adult partner point when entering the second set of production trials. To investigate an effect of in-test learning weighing differently on both conditions, we created a subsample comprising only the first three trials from each condition. Here, children pointed in 74.4% of trials when faced with an adult partner and in only 37.9% of cases when interacting with an age-mate. A Mann-Whitney U test comparing the proportion of trials with pointing in this subset yielded a significant difference across conditions (peer N = 11; adult N = 13; U = 105; p = .04).

3.1.2 | Accuracy

Children's points were also largely accurate (peer: 80%; adult: 93.8%). A comparison of the full and null models revealed no effect of condition on the accuracy of points (χ^2 = 0.4; df = 2; p > .250). This finding was corroborated by a Mann-Whiney U test revealing no significant difference between conditions (peer N = 20; adult N = 12; U = 93; p = .235). Hence, children were equally likely to point to the correct target in both conditions.

Finally, children's pointing gestures were index-finger points in 98% of cases (peer condition: 99%; adult condition: 96%). Pointing gestures were accompanied by vocalizations in 78.8% of cases (peer condition: 81.1%; adult condition: 76.05%).

3.2 | Choice behavior

For the analysis of children's choice behavior, participants' responses were recoded as compliant or noncompliant with their partner's pointing gesture. We only included trials in which children pointed

for an attentive partner and compared the probability of a subject making a compliant choice between conditions. One child in the adult-child condition was excluded from this analysis as she ostentatiously refused to make compliant choices in all trials and was apparently playing a game of her own. This never happened in the peer condition. Including this child in the analyses did not alter the significance of any of the reported effects (cf. Supplementary Material). In the final sample, participants in the adult condition had an average of 5.1 trials (N = 12; range = 3–6, median = 5). In the peer condition, participants had an average of 2.85 trials (N = 20; range = 1–6, median = 3).

We used one-sample t tests to check whether children were significantly better than chance at making pointing-compliant choices. In the peer condition, subjects made compliant choices in 38% of trial (Figure 3). As a group, this performance was not above chance (chance = 33%; t = 0.59; df = 19; p = .56). By contrast, children made compliant choices in 76% of trials when reacting to an adult pointer and were significantly above chance (chance = 33%; t = 5.62; df = 11, p < .001).

Comparing the likelihood of children making compliant choices in both experimental groups, we found the full model was significantly better than the null model at describing variation in the response (χ^2 = 9.31; df = 2; p < .01). The interaction of condition and sex was not found to be significant and so was dropped from the model (Estimate = 0.67; SE = 1.11; z = 0.61; p = .545). The final model revealed condition to have a significant effect (Estimate = −1.81; SE = 0.56; z = −3.24; p < .01). The estimate indicates that subjects were less likely to show a compliant response in the peer condition. The result was further supported by a Mann-Whitney U test comparing performance across conditions (peer N = 20; adult N = 12; U = 45, p = .003).

There are two ways in which the frequency and accuracy of production could have influenced children's choice behavior in the peer condition. First, peers did not point in all trials consecutively, which might have caused their partner to lose interest in them. Second, in one-third of the cases in which children complied with their partner's point, the pointer was inaccurate and so children followed a point to an empty cup. This may have caused them to lose faith in the accuracy of peer points. We think it unlikely that these factors undermine the finding that 2-year-olds do not use points provided by peers. First of all, our analysis included only trials in which the searcher attended to the pointer's gesture. Thus, even if children became less attentive over time, this would not explain their failure to use pointing gestures to which they were clearly attending. Furthermore, the effect of condition yielded by the GLMM is unlikely to be driven by in-test learning as the random effects structure of our model controls for variation in the response resulting from testing in multiple consecutive trials.

To further explore possible effects of children's inaccuracy on our finding, we analyzed a subset of the choice data in the peer condition in which we excluded trials that might have been affected by incorrect points. If a child followed a peer's point to an empty cup, all consecutive trials of this subject were excluded regardless of their being compliant or non-compliant responses. This reduces the peer data set from 57 trials to a subset of 42 trials (73.7%). Here, children made compliant choices in 45.3% as opposed to 38% of cases found in the full data set, suggesting that experience of incorrect points did not make them less likely to trust their partners. As before, children's performance in this analysis was not statistically different from chance (chance = 33%; t = 1.24; df = 19; p = .23). Furthermore, we created a subset of the data from the peer condition including only participants whose partner consistently provided accurate points. This reduces the number of participants from 20 to 15. In this subsample, children made compliant choices in 31.1% of cases and as a group did not perform above chance level (chance = 33%; t = −0.23; df = 14; p = .83).

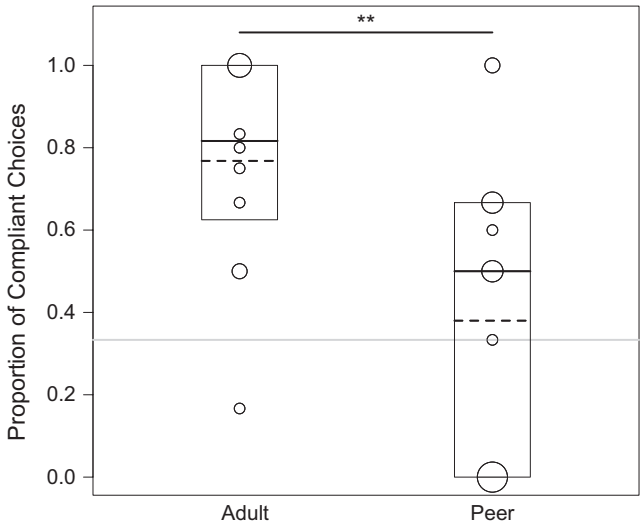

FIGURE 3 Proportion of compliant choices per condition. Larger bubbles represent more subjects with a given proportion. Boxes indicate 25th, 50th and 75th percentiles. Dashed lines indicate means. The grey line demarcates chance level (1/3). * indicates statistically significant difference (p < .01)

Finally, we also tested children's performance in their first search trial. For this analysis, we only considered the first trial in which a searcher reacted to a point produced by either a peer or an adult partner. Here, children made compliant choices in 40% of cases with a peer partner. As a group, this performance was not statistically different from chance (chance = 33%; t = 0.59; df = 19; p = .56). When reacting to an adult point for the first time in the study, children chose the correct cup in 75% of cases and were significantly better than chance as a group (chance = 33%; t = 3.19; df = 11; p = .009). A Mann-Whitney test comparing only first trial performance across peer and adult groups tended towards significance (peer N = 20; adult N = 12; U = 162, p-value = .062).

4 | DISCUSSION

Results show that in the current study, 2-year-olds are significantly more likely to point for adult as opposed to peer partners. To the extent that our adult experimenter was a generally more attentive

interlocutor than most peers, this result might be attributable to differences in in-test experience. However, the finding is also in line with studies reporting infants and toddlers to point at lower rates for peers than for adults (Bakeman & Adamson, 1984; Franco et al., 2009; Ninio, 2016). A possible explanation for such differences is that infants might point first and foremost to share interest and attention (Tomasello et al., 2007) or to request information (Begus & Southgate, 2012; Kovács et al., 2014) making caregivers and competent informants privileged addressees of early pointing gestures. By contrast, age-mates can neither help infants gain access to nor provide them with information about possible referents (cf. Ninio, 2016; Southgate, Van Maanen, & Csibra, 2007). By consistently making more rewarding experiences with caregivers, infants and toddlers might generally come to prefer adult interlocutors in most contexts. Nevertheless, in cases where participants pointed in our task, these gestures might not necessarily have served an interrogative function as the pointers themselves already knew about the hiding place of the toy and probably were aware of their partner's ignorance. After all, the 2-year-olds in our study pointed for their peer partners in more than half of all trials. To the extent that their gestures can be described as genuinely informative (cf. Liszkowski, 2005), our data indicate that 2-year-olds are generally capable of informing both peer and adult partners in a cooperative coordination problem. Hence, we provide further evidence that toddlers put their prosocial motivations to work with both adult and peer interaction partners (cf. Hay et al., 1999; Hepach et al., 2017; Ulber, Hamann, & Tomasello, 2015).

Analyzing children's search behavior, we found no evidence that 2-year-olds use informative pointing gestures provided by age-mates. That is, while children pointed for peers, their age-matched partners did not make choices compliant with their peers' gesture and as a group were not significantly better than chance in the object choice task. In contrast, children used adults' points more often than would be predicted by chance. This finding is present from the first trial onwards, suggesting that it is not the result of within-test learning. Furthermore, children were significantly less likely to use information provided by an age-mate than by the adult experimenter when directly comparing conditions.

Children's competent performance when interacting with an adult experimenter under matched conditions illustrates that they are able to solve the task in which they were tested. In that case, it needs to be explained why they did not use the information they were provided with in the peer condition. One possibility is that the difference in use of pointing gestures can be explained by systematic differences in the pointing behavior that children witnessed in the different conditions. Arguably, adult points could have been more salient than children's points, and, hence, were easier to interpret. While this is possible, we do not think it likely, since E2's pointing was carefully modeled on the tested children's pointing. Furthermore, in 81.1% of cases the peers' points were accompanied by vocalizations (e.g. "Here!" "There it is!")—providing extra information about the location of the toy. Such vocalizations are a salient display of the sender's confidence in the information provided and to which young children might already be sensitive. It is therefore striking that children should ignore peers' points even in the presence of this extra information. Since our adult partner remained silent throughout the experiment, it seems unlikely that differences in the use of pointing gestures are explained by differences in the production of communicative behavior by the pointing partners.

It may be that children were more motivated to interact with adult partners than peer partners. This is possible since the adult experimenter was, in general, a more reliable partner than were child peers. For example, in every trial E2 pointed reliably after the removal of the visual occluder. By contrast, peers would sometimes be restless and inattentive, and would fail to produce points. However, this does not explain why children were less willing to use the points that peers did produce. Furthermore, an additional analysis showing that in the peer condition children are at chance even in their first search trial suggests that the differences might not result from differences in in-test experience.

Another possibility is that children lost faith in peer partners, because their points were less accurate. There is evidence that infants and toddlers are sensitive to the reliability of an interlocutor at 14 and 16 months of age (cf. Begus & Southgate, 2012; Chow, Poulin-Dubois, & Lewis, 2008), and this might potentially have influenced subsequent performance. However, since our analysis included trial number as a random slope within dyad and subject, we controlled for variance arising from effects of learning or fatigue.

Furthermore, ignoring testimony—even if it contradicts their own first-hand experience—is still difficult for 2- and 3-year-old children as it requires the inhibition of a response that would be perfectly appropriate under normal circumstances (Jaswal et al., 2014). In the absence of conflicting evidence, 3-year-olds trust previously inaccurate informants in an object-labeling task (Vanderbilt, Heyman, & Liu, 2011) and even follow the advice of a communicator who is labeled as a "big liar" despite receiving continuous feedback by the experimenter (Mascaro & Sperber, 2009). It is especially difficult for children not to follow pointing gestures in standard object choice paradigms as informative pointing gestures are generally not only produced with clear communicative intent (Heyman, Sritanyaratana, & Vanderbilt, 2013) but also have a veridical history (Palmquist et al., 2012). For example, 3-year-olds are unable to ignore a clearly ignorant pointer's gesture directly conflicting with a reliable gesture from a knowledgeable communicator when presented simultaneously (Palmquist, Burns, & Jaswal, 2012; Palmquist & Jaswal, 2012). They also appear unable to ignore pointing gestures to one of two containers even if these points are constantly misleading in several consecutive trials (Couillard & Woodward, 1999). It is therefore unlikely that children of the age that we tested would have been sensitive to their partner's reliability in the test. Additional analyses of children's first search trials show that they are above chance using the pointing gestures of an adult but that they are at chance with an age-mate from the beginning. This is further evidence that our main finding is unlikely to reflect in-test learning. As a result, we suggest that children entered the experimental set-up with differing expectations about the reliability of their interlocutor in the first place.

To the extent that the pointing gestures children observed in the peer condition were salient and unambiguous, the findings reported here raise the possibility that children value or interpret the same information differently when it is provided by peers and adults. One explanation for this is that while they value adults as reliable sources of knowledge, this expectation does not generalize to children of their own age. Were this true, they may distrust information provided by their peers. An alternative explanation could be that children might interpret peers' points as requests (cf. Begus & Southgate, 2012; Kovács et al., 2014) and adults' points as genuinely informative. However, both explanations amount to 2-year-olds not ascribing informative value to pointing gestures from peers.

If our findings are explained by children's pre-test expectations, such expectations might have two sources. First, they may be the result of a biologically evolved heuristic for learning from others. Alternatively, children's expectations may be acquired. Toddlers' interactions with adult or peer partners are qualitatively different. The experience children have in interaction with adults and peers will in turn shape their social expectations and motivations and might make other peers less attractive partners for interaction. Since in most contexts adults are more reliable sources of knowledge than are young children, an acquired bias against peers as sources of knowledge might serve as an adaptive learning heuristic—even though, in the current study, it caused them to miss out.

Further studies should also explore when and why children sometimes prefer to use information provided by peers over adults (VanderBorght & Jaswal, 2009). One possibility is that young children differentiate between cases where adults are more likely to have objective knowledge, and cases where peers' subjective preferences may more closely match their own. The extent to which young children develop an increasingly elaborate and differentiated attitude towards the informative value and learning affordances of interactions with partners of various ages could be a very fruitful field of investigation.

While the data presented here were taken only from trials in which participants were attentive to one another, we cannot exclude the possibility that the different results between conditions can be explained by differences in the way that children attend to adults and peers. For example, it may be that children were attentive to their age-matched partners, but inattentive to the gestures that they produced. However, if attentional differences arose because children have different expectations about the informational payoff of attending to individuals of different ages, this would be in line with our preferred interpretation of the data. That is, if children were less attentive to the gestures produced by their peers than by adults, this may be because they did not expect to learn from these gestures in the same way. Future studies should address this possibility by employing eye-tracking techniques to look for possible qualitative differences in children's attention to age-mates and adults.

This is the first study to compare adult-child and peer-peer communication in a context in which a partner's communicative intentions must be both inferred and evaluated. It adds to a growing literature contrasting infants' and toddlers' behavior with adults and age-mates under controlled experimental conditions. While infants and toddlers have been shown to imitate novel actions more from adult partners (Zmyj et al., 2012), to copy adults more faithfully in over-imitation (McGuigan et al., 2011) and are more likely to adress adults with pointing gestures (Franco et al., 2009), this study is the first to suggest that 2-year-olds also use testimony from pointing gestures differently when provided by peer and adult partners. Further work in this line of research will help us to better understand what children contribute to adult–child interactions in terms of specific motivations and expectations for social learning and, thereby, provide a new perspective on why the infant–caregiver relationship is so conducive to social learning.

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SUPPORTING INFORMATION

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