Adults’ social cues facilitate young children’s use of signs and symbols

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Abstract

Three experiments investigated the effect of an adult’s social cues on 2- and 3-year-old children’s ability to use a sign or symbol to locate a hidden object. Results showed that an adult’s positive, engaging facial expression facilitated children’s ability to identify the correct referent, particularly for 3-year-olds. A neutral facial expression and the presence of the adult’s hand also facilitated performance, but to a lesser degree than did an engaging facial expression. The effect of the adult’s social cues was greater for relatively unfamiliar signs and symbols (replica or arrow) than it was for a more familiar sign (pointing finger). These findings indicate that non-directional social cues such as facial expression help to convey communicative intent and facilitate children’s comprehension of signs and symbols.

Introduction

The capacity to understand communicative intention is proposed to play a central role in early symbolic development (Bloom, 2000; Bates, Benigni, Bretherton, Camaioni & Volterra 1979; Sabbagh, 1999; Tomasello, Carpenter, Call, Behne & Moll, 2005). Proficiency in the use of signs and symbols requires understanding the sign–referent relation; that is, that a gesture, word, picture or replica refers to and/or stands for a particular referent. Anything can serve as a sign or symbol provided that someone intends that it should serve this function (DeLoache, 1995). And since a given sign or symbol could have multiple referents, children must find an efficient way to make the correct sign–referent mapping. One way is to use the communicator’s referential intent. Children use adults’ intentions to guide their inferences when mapping signs and symbols to referent objects from as early as the second year of life (Baldwin, 1993; Akhtar & Tomasello, 1996), indicating that they recognize that the adult intends to communicate about the referent (Tomasello, 1999; Tomasello & Rakoczy, 2003). Although it is widely agreed that young children are able to make use of intentional inferences, little is currently known about how these inferences arise during a social interaction (Baldwin & Baird, 2001; Sabbagh & Baldwin, 2005). A communicator’s intention is likely to be inferred from a range of social cues, such as her eye gaze or engaging facial expression. The goal of the present research was to examine the influence of some of these social cues on children’s comprehension of signs and symbols.

Previous research investigating the role of social cues in processing signs and symbols has tended to focus on directional joint attention cues such as eye-gaze shifts and head direction that provide spatial information about the target referent (Behne, Carpenter & Tomasello, 2005). Although such social cues directed towards a referent may provide information about communicative intention, head and eye movements that are directional can also trigger an automatic following response towards objects (Hood, Willen & Driver, 1998; Butterworth & Jarrett, 1991), and this may occur independently of inferences about communicative intention (Freire, Eskritt & Lee, 2004). In the present research, we focused on some of the non-directional social cues provided by an adult during a typical adult–child social interaction – the adult’s positive facial expression and her child-directed gaze. These behaviours convey the engaging, affective quality of the adult’s demeanor, and may be powerful indicators of the adult’s intention to help the child by emphasizing that there is something specific to attend to.

We adapted a task developed by Tomasello, Call and Gluckman (1997) to investigate the influence of various social cues on children’s comprehension of signs and symbols. In the original study (Tomasello et al., 1997),...
an experimenter hid a sticker under one of three containers that were concealed by a screen. The screen was then removed and a communicator presented a sign or symbol to the child. She either pointed to the target container, placed a marker (a wooden block) on it, or held up a replica of it in her hand. She did this while adopting a positive, engaging facial expression and maintaining eye contact with the child. Tomasello et al. (1997) proposed that if children appreciated the communicator’s intention to convey the location of the sticker, they would recognize the significance of the sign or symbol for finding it. The 2- to 3-year-old children performed above chance for all three signs. Although children found the replica more difficult to comprehend than the pointing finger, their performance with the replica was significantly better than the performance of non-human primates, a finding that was ascribed to children’s ability to take the adult’s communicative intention into account. Note that the children did not have access to directional joint attention cues such as gaze switching or head turning, as the communicator did not look or turn towards the target container and therefore did not provide directional information about the location of the sticker. Instead, the communicator used a variety of non-verbal gestures and then made ‘every effort through facial gestures to let the child know that she was helping her in the task’, including raised eyebrows and an insistent demeanor, without verbalizing. These results raise the intriguing possibility that non-directional cues alone, such as another’s engaging face, might be critical to conveying communicative intention.

We hypothesized that the communicator’s engaging face might facilitate children’s performance in at least three ways. First, the co-presence of the adult’s face could have a general effect on increasing children’s attention to the task at hand. If this is true, then removing the communicator’s face should be detrimental to performance. Second, the facilitating effect of the adult’s face might interact with other relevant information from the adult’s body or hands. If so, then removing the facial and also the non-facial information should have a further negative effect on performance. And third, we considered that in addition to the co-presence of her face, the communicator’s positive, engaging demeanor might also help children to appreciate her communicative intent. In this case, adopting a neutral facial expression should also be detrimental to performance.

A further consideration in formulating our hypotheses was that the effect of the communicator’s social cues might vary according to the conceptual difficulty of the sign. Tomasello and colleagues found that a novel sign, such as a miniature replica, was more difficult for 2- to 3-year-old children to understand than a relatively familiar sign such as a pointing finger. A pointing finger not only is familiar to young children but also indicates its referent. Miniature replicas, in contrast, are not automatically related to perceptually similar larger objects. However, such a relation may be socially constructed when a communicator intends that a replica should stand for a particular referent (DeLoache, 1987, 1995). Although adults and older children have experience with symbols and thus may easily recognize novel symbol–referent relations, younger children may be less likely to do so (DeLoache, 1995; Johnson, Younger & Furrer, 2005). The question then is whether a communicator’s social cues might help to clarify this relation for young children. We therefore hypothesized that young children will find the significance of the replica more difficult to grasp than the significance of the pointing finger, and that they will appeal to a communicator’s social cues (when these cues are available) in an attempt to gain information about the adult’s communicative intent.

We investigated the extent to which an adult’s social cues affect 2- and 3-year-olds’ comprehension of three signs: a pointing finger, a replica and an arrow. We replaced the marker in the Tomasello et al. (1997) study with an arrow, because the results for the marker were unclear. There has been surprisingly little work on young children’s comprehension of arrows. Recent findings reveal that arrows, like pointing gestures, trigger an automatic orienting response in adults (Ristic, Friesen & Kingstone, 2002; Tipples, 2002). However, there is reason to believe that arrows may not be as transparent to preschool children (Lee, Eskritt, Symons & Muir, 1998). An arrow shares some properties with a pointing finger (e.g. its indicating function) but also shares other properties with a replica (e.g. it is an object, separate from the communicator). As it was not obvious to us which of these properties would weigh more heavily in children’s ability to interpret an arrow, we did not make specific predictions for performance with the arrow sign.

The procedure in the ‘Engaging Face’ condition was very similar to the procedure used in Tomasello et al. (1997). A sticker was hidden under one of three containers behind a screen. The screen was then removed and the experimenter produced a sign – a pointing finger, an arrow or a replica – while looking continuously at the child with a smiling, animated expression. The child’s task was to find the sticker. Experiments 1 and 2 also included a hidden face condition, in which the sign was presented while the experimenter’s face was out of view, behind a curtain. In Experiment 1, only the experimenter’s face was obscured, whereas in Experiment 2 both her face and her hands were hidden. Experiment 3 included a Neutral face condition, in which the experimenter presented the sign while looking continuously at the child with a neutral, non-smiling expression and a neutral, non-engaging gaze. We also gathered receptive vocabulary data to investigate the possibility that comprehending signs and symbols might be related to symbolic development more generally.
Experiment 1

Method

Participants

Forty-eight participants, aged 29.4 to 47.7 months, were recruited from nursery schools in a rural area of southeast England, a predominantly Caucasian community of mixed social class. Children were randomly assigned to either the Engaging Face or the No Face condition (the mean ages were 38.3 and 37.7 months, respectively) and to receive one of the six possible orders of presentation of the three signs. Boys and girls were equally represented in both conditions.

Materials

The experimental set-up (see Figure 1) resembled a 'puppet theatre' measuring 61 cm × 63.5 cm × 55.8 cm and was constructed of heavy cardboard. A full-length set of opaque curtains was hung at the front of the stage. Another full-length opaque curtain, with a slit cut into the middle, was hung at the back of the stage. These curtains were operated by a pulley system located at the back of the stage. A small peephole was created in the frame of the apparatus above the back curtain. An opaque cardboard pelmet (61 cm wide and 25.4 cm tall) was affixed above the front curtains. In the No Face condition, the pelmet concealed the face of the experimenter, who looked through the peephole above the back curtain to see where children searched for the hidden sticker (see below).

A shallow platform (13 cm × 34 cm) occupied the centre of the stage. The hiding locations – three distinctive cylindrical containers – were placed upon the platform. The three containers were decorated in different colours and patterns and varied in size, measuring: 8.5 cm high, 9 cm in diameter; 10 cm high, 6 cm in diameter; and 7.5 cm high, 8.3 cm in diameter for the containers at the left, centre and right, from the child’s view. The containers were open at one end and attached to the platform, open side down, such that they could be tipped back to reveal the stickers underneath. The spatial position of the containers was fixed. The three replicas were miniature versions of the containers, measuring: 6 cm high, 6 cm in diameter; 5 cm high, 5 cm in diameter; and 6.5 cm high, 4 cm in diameter (corresponding to the containers in the order mentioned above). The arrow was constructed of black cardboard and was 13 cm long and 1.5 cm wide. The arrowhead had a 5.5-cm base. Children searched for a variety of coloured stickers. The receptive vocabulary measure was the British Picture Vocabulary Scale – Second Edition (BPVS-II; Dunn, Dunn, Whetton & Burley, 1997).

Design and procedure

Children were tested in a quiet room in their nursery school by the same female experimenter. The session began with the receptive vocabulary measure, which was administered according to standardized instructions. The hiding game followed immediately.

The puppet theatre was placed on a table, facing the child. The front and back curtains were open. The child was told that he or she would play a game and get to win lots of stickers. The hiding game included a training phase, a pre-test phase and a test phase. For the training phase, the child had to retrieve a sticker from underneath a container. The experimenter fixed the containers onto the platform and demonstrated that they could be tipped back. She then hid a sticker in full view and the child was invited to find it. As soon as the child found the sticker, the pre-test phase began. For the pre-test trials, the child had to find the sticker when it was hidden out of view. The child was told that the experimenter would hide a sticker under one of the containers while the front curtain was closed and that when the curtain opened, the child could look for it. The experimenter closed the front curtain, went behind the stage so that she was not visible to the child, hid the sticker and then opened the curtain. Three pre-test trials were carried out with a sticker hidden under each of the three containers in a randomly pre-determined order. All of the children found the sticker on their first attempt on at least one of the pre-test trials before starting the test phase.

The test phase was similar to the pre-test phase except that a sign was now also presented. The experimenter closed the front curtains, hid the sticker and then opened the front curtains to reveal the hiding containers as well as the sign or symbol (the point, arrow or replica) and said, ‘Can you find the sticker?’ For the pointing sign, the experimenter held her index finger above the row of containers, pointing down towards the target container. For the arrow sign, she held the arrow.

Figure 1 The experimental set-up used in Experiment 1. The figure shows the presentation of the arrow in the Engaging Face condition.
above the row of containers, pointing down towards the target. For the replica, she held a miniature version of the target in her upturned palm, at the centre of the stage, behind the platform with the containers. The sign or symbol was held in place until the child searched for the sticker.

Half of the children were assigned to the Engaging Face condition and half to the No Face condition. For the Engaging Face condition, the back curtains remained open throughout the testing phase and the front curtains were closed only while the sticker was hidden. When the front curtain opened, the experimenter’s face appeared at the back of the stage. She made eye contact with the child and then used an insistent animated and engaging facial expression. From the instant at which the curtains were opened, the experimenter looked directly at the child. She did not look in the direction of the containers or at the sign she was holding. For the No Face condition, the experimenter closed the back curtains after hiding the sticker. When the front curtains opened, the experimenter’s hand protruded through the slit in the back curtain to present the sign or symbol. Her face remained behind the back curtain and thus could not be seen by the child. In both conditions, the sign or symbol was in place before the experimenter opened the front curtains. Children were allowed to search once on each test trial, and the experimenter recorded the search location. In the No Face condition, the experimenter looked through the small peephole in the apparatus to see where the child searched, while remaining out of the child’s view. The procedure was repeated for two blocks of nine trials. Each block of trials comprised three trials in a row with each sign. The order of presentation of the signs was counterbalanced such that equal numbers of children received each of the six possible orders (e.g. point, arrow, replica). Children received the same order of presentation for the two blocks of trials.

Results
In all three experiments reported here, children were awarded one point for each trial on which they found the hidden sticker, and performance was summed across the six trials for each sign. Preliminary analyses revealed no significant effects involving gender. Therefore we analysed the data collapsed across this variable.

As we tested children across a continuous age range in Experiment 1, we first correlated chronological age with performance for each of the three signs separately. Age was significantly correlated with performance for the replica only, $r = .3$, $p < .04$, suggesting that chronological age might interact with the type of sign to affect performance. To explore this possibility more systematically, we divided the sample at the median age to form a younger group (mean age 34.3 months, range 29.4 to 38.6 months) and an older group (mean age 41.6 months, range 38.7 to 47.7 months). The numbers of children in the Engaging Face and No Face conditions were 10 and 14 for the younger group and 14 and 10 for the older group. The mean chronological ages for the four groups were 34.1, 34.5, 41.2 and 42 months, respectively. We then analysed the data using Age Group as a between-subjects variable.

The left panel of Figure 2 shows the results for Experiment 1. The data were subjected to a 3 (Sign: point, arrow, replica) × 2 (Condition: Engaging Face, No Face) × 2 (Age Group: older, younger) analysis of variance (ANOVA), with Age Group and Condition as between-subjects variables and Sign as a within-subject variable. There were main effects of Condition ($\text{F}(1, 88) = 110.39$, $p < .0001$, $\eta^2_{\text{p}} = .71$) and Age Group ($\text{F}(1, 44) = 5.05$, $p < .05$, $\eta^2_{\text{p}} = .10$), as well as a Sign by Age Group interaction ($\text{F}(2, 88) = 3.46$, $p < .04$, $\eta^2_{\text{p}} = .10$). Performance was significantly better in the Engaging Face condition, and older children outperformed their younger peers. Follow-up pair-wise comparisons revealed no difference between the means for the point and arrow signs, but that both means were significantly greater than the mean for the replica ($p < .0001$). However, although all of the children performed well with the point and the arrow, the older children performed significantly better than the younger children with the replica ($p < .01$). The effect sizes for these comparisons were large, ranging between 0.86 and 2.22 (Cohen’s $d$).

We also compared performance to chance. Chance was set at two, as there were three hiding containers and six trials for each type of sign. The means for the point and the arrow were significantly greater than chance, across age groups and conditions (with the exception of the mean for the younger children in the Engaging Face condition on the point trials, which could not be compared to chance statistically because the children performed without error). However, whereas the younger children’s performance with the replica was not significantly different from chance in either condition, the older children’s performance was significantly better than chance for the Engaging Face condition but not for the No Face condition (all significant $p$s < .002 using one-sample $t$-tests). We also examined the number of children whose performance was significantly better than chance. For each sign, children were categorized as passing or failing according to whether or not they searched correctly on at least 5 of the 6 trials, which is significant by a binomial test when $p < .05$. The results are shown in the top panel of Table 1. Note that in the table, the number of passing children in each subgroup has been converted to a percentage to facilitate comparing performance across groups with discrepant sample sizes. More children passed the task in the Engaging Face condition than in the No Face condition (75% vs. 54%) and in the older group than in the younger group. Furthermore, although the majority of children in both conditions performed very well with the point and the arrow (the range was 71% to 100%), few performed
above chance with the replica. The only exception was that 57% of the older children succeeded with the replica in the Engaging Face condition. Fisher’s exact tests confirmed that there was no difference between the number of younger and older children who were categorized as ‘passing’ either the point or the arrow trials, but that significantly more older children passed the replica trials, $p < .02$.

A series of related-sample $t$-tests, one for each sign, revealed that performance did not change significantly across the two trial blocks. Finally, there were no significant correlations between the receptive vocabulary age-equivalent scores and performance for any of the signs. We therefore omitted the BPVS-II (Dunn et al., 1997) from Experiments 2 and 3.

**Discussion**

The results of Experiment 1 support the hypothesis that the presence of a positive, engaging face facilitates young children’s ability to grasp the intended function of a sign or symbol. When the communicator’s engaging face was not visible, performance declined significantly for all three signs. Even so, the level of performance for the point and the arrow was still very good in both
conditions, and the majority of children performed above chance. However, as predicted, children found the replica far more challenging. Younger children’s performance was not significantly better than chance in either condition, and only one younger child performed above chance. Older children performed above chance in the Engaging Face condition but not in the No Face condition. These results replicate Tomasello et al.’s (1997) findings with the point and the replica and demonstrate that the presence of the adult’s face facilitates children’s comprehension of novel signs.

Although the absence of the adult’s face detrimentally affected performance for all three signs, children performed at above-chance levels for the point and the arrow even with the adult’s face removed. The results for the pointing sign are not surprising, given that pointing is familiar to young children – they can comprehend its indicating relation to a referent object by as early as 12 months of age (Butterworth, 1995; Woodward & Guajardo, 2002). Although the current results suggest that comprehending the arrow was well within children’s conceptual grasp (even in the No Face condition), an alternative interpretation warrants consideration. Specifically, we wondered whether seeing the arrow in the experimenter’s hand provided an important visual cue to children, physically linking the sign to the experimenter and thus to her communicative intent. Indeed, there is evidence that a human hand may be a powerful cue to an adult’s intention. Guajardo and Woodward (2004) found that children as young as seven months of age attribute intent to an action carried out by a bare human hand, but not to the same action carried out by the same hand when the hand is sheathed in a glove. In the current experiment, the presence of the hand in the No Face condition might have been sufficient to buffer the effects of removing the engaging face and explain why children performed so well with the arrow even in the No Face condition. The buffering effect of the experimenter’s hand may not have been as effective for the replica, for which detecting the symbol–referent relation was clearly more challenging.

In Experiment 2, we investigated the contribution of the experimenter’s hand, over and above the contribution of her engaging face, to children’s ability to find the sticker. A new group of children was tested with the same three signs in the same two conditions as used in Experiment 1 but with one change to the procedure: instead of being held in the experimenter’s hand, the arrow and the replica were suspended from the stage apparatus. Although the role of the hand was relevant only to the arrow and replica, all three signs were included in Experiment 2 in order to keep the procedure uniform across the two experiments. Only 3-year-old children were tested in Experiment 2, as the younger children’s performance for the replica in Experiment 1 was already very low, even with the experimenter’s engaging face and her hand present. The data from Experiment 2 were then compared with the data from the same-aged children who participated in Experiment 1.

**Experiment 2**

**Method**

**Participants**

Twenty-eight new 3-year-olds (12 girls, 16 boys) were recruited from nursery schools in the northeast of England. Participants were predominantly Caucasian and middle class. Children were randomly assigned to either the Engaging Face, No Hand condition or to the No Face, No Hand condition and to receive one of the six possible orders of presentation of the three signs. The mean chronological ages were 40.6 months (range 36 to 46 months) and 41.1 months (range 38 to 46 months) in the two conditions, respectively.

**Materials and procedure**

The materials for Experiment 2 were the same as the materials used for the hiding game in Experiment 1, with two additions. For the presentation of the arrow, a horizontal bar extending across the width of the stage was mounted directly above the platform with the hiding containers. The height of the bar was such that it was concealed by the pelmet and not visible to the child when the apparatus was viewed from the front. The arrow was suspended from the bar pointing down towards the target container. For the presentation of the replica, a small shelf was positioned in the same approximate location as the slit in the back curtain (which was used in the No Face condition). The shelf was supported by a stick the experimenter held under the table top. The replica was placed on the shelf. Thus, children could not see the experimenter’s hand during the presentation of the arrow and the replica, in either condition. In all other respects, the procedure in Experiment 2 was the same as the procedure in Experiment 1. A different female experimenter tested the children in Experiment 2.

**Results**

The middle panel of Figure 2 shows the results for Experiment 2. We first analysed the data from the two conditions in Experiment 2 only, and then compared the data from Experiment 2 with the data from the corresponding age group in Experiment 1.

**Experiment 2**

The data were subjected to a 2 (Condition: Engaging Face, No Hand; No Face, No Hand) × 3 (Sign: point, arrow, replica) ANOVA. The results revealed main effects of Sign (F(2, 52) = 23.9, p < .0001, ηp² = .48) and
Condition \( F(1, 26) = 211.5, p < .0001, \eta^2_p = .89 \), and a Sign by Condition interaction \( F(2, 52) = 8.2, p < .001, \eta^2_p = .24 \). Performance for the point was significantly better than performance for the arrow and for the replica \( (p < .0001) \), which were not significantly different from one another. Follow-up analyses revealed that children performed significantly better in the Engaging Face, No Hand condition than in the No Face, No Hand condition for the arrow and the replica (both \( p < .0001 \), but not for the point). The effect sizes for these comparisons were large (Cohen’s \( d = 3.12 \) and 2.13 for the arrow and the replica, respectively).

Performance was significantly better than chance for all three signs in the Engaging Face, No Hand condition \( (p < .0001) \). In the No Face, No Hand condition, performance was significantly better than chance for the point \( (p < .0001) \) and the arrow \( (p < .04) \), but not for the replica. The middle panel of Table 1 shows the percentage of children who were classified as ‘passing’ the task. The results are consistent with the pattern of results for the group means. There was no difference between the two conditions in the success rate for the pointing sign \( (93\% \text{ vs. } 86\%) \), but significantly more children succeeded in the Engaging Face, No Hand condition than in the No Face, No Hand condition for both the arrow \( (93\% \text{ vs. } 0\% \); Fisher’s test, \( p < .001 \)) and the replica \( (57\% \text{ vs. } 7\%; \text{ Fisher’s test, } p < .02) \) signs. Finally, related-sample \( t \)-tests showed that performance improved significantly across trial blocks for the replica \( (p < .03) \), but not for the point or the arrow.

Comparisons between Experiment 1 and Experiment 2

To investigate the contribution of the engaging face together with the contribution of the experimenter’s hand, the data from the older children in Experiment 1 were compared with the data from Experiment 2. The critical comparisons were between the Engaging Face (with hand) condition in Experiment 1 and the Engaging Face, No Hand condition in Experiment 2, and between the No Face (with hand) condition in Experiment 1 and the No Face, No Hand condition in Experiment 2. Each comparison was analysed with an ANOVA. A 2 (Condition: Engaging Face (with hand); Engaging Face, No Hand) \( \times 3 \) (Sign: point, arrow, replica) ANOVA revealed only the predicted main effect of Sign \( F(2, 52) = 12.26, p < .0001, \eta^2_p = .32 \). There was no difference between the means for the point and the arrow; however, the means for both signs were significantly higher than the mean for the replica \( (p < .004) \). These results indicate that in the presence of an engaging face, removal of the experimenter’s hand had no impact on performance for the arrow or for the replica.

A parallel ANOVA conducted on the data from the two No Face conditions (with and without hand) revealed a main effect of Condition, \( F(1, 22) = 18.94, p < .0001, \eta^2_p = .46; \text{ Sign, } F(2, 44) = 37.49, p < .0001, \eta^2_p = .63; \text{ and a Condition by Sign interaction, } F(2, 44) = 4.04, p < .02, \eta^2_p = .17 \). Performance was significantly better for the pointing sign compared with the two other signs and for the arrow compared with the replica \( (\text{all } p < .0001) \). Further analysis investigating the effect of condition for each sign revealed no effect of condition for either the point or the replica but a strong effect for the arrow, with superior performance in the No Face (with hand) condition \( (p < .001; \text{ Cohen’s } d = 1.72) \). Thus, when the experimenter’s face was not visible to children, removal of her hand was uniquely detrimental to performance with the arrow.

Comparing the performance of individual children across the two experiments once again yielded a pattern consistent with the results based on the group means (see Table 1). The percentage of successful older children in Experiment 1 and the percentage of successful children in Experiment 2 were similar in the two Engaging Face conditions and also in the two No Face conditions for the point \( (100\% \text{ vs. } 93\% \text{ and } 90\% \text{ vs. } 86\%) \) and for the replica \( (57\% \text{ vs. } 57\% \text{ and } 0\% \text{ vs. } 7\%) \). For the arrow, the percentage of successful children was very high in the two Engaging Face conditions \( (93\%) \). However, whereas most of the children also succeeded in the No Face (with hand) condition \( (90\%) \), not one child performed above chance in the No Face, No Hand condition, \( p < .0001 \) (all analyses based on Fisher’s exact tests carried out on the number of successful children).

In sum, the results for Experiments 1 and 2 indicate a significant effect of an engaging face, with or without the hand present, for all three signs. Furthermore, the results support the notion that removal of the hand, in addition to the engaging face, is detrimental to comprehending the arrow.

Discussion

The results from Experiment 2 provide further evidence that the presence of an engaging face is an important social cue that helps children to appreciate the intended function of a sign or symbol. The absence of an engaging face had a significant negative impact on performance when the arrow and the replica were presented without the experimenter’s hand, just as it did in Experiment 1 when the hand was present. The results also indicate that the experimenter’s hand helped children to detect the significance of the arrow. Even though performance with the arrow was significantly above chance when both the experimenter’s engaging face and her hand were removed, performance was worse in this condition than when only the engaging face was removed. Our results for the arrow are in keeping with findings from previous work showing that 3-year-old children who were asked to identify an object that a person desired did not benefit from the presence of an arrow pointing to the target object (Lee et al., 1998). Children had no difficulty with
this task when the person pointed to the object. But note that the arrow was merely co-present with the communicator and that she did not hold the arrow in her hand. The authors suggested that since a pointing finger, but not an arrow, is inherent in the communicator this might help children to link the pointing finger, but not the arrow, to her mental state. A similar effect may have held in the present experiments. Even in the No Face conditions in Experiments 1 and 2, it is likely that children inferred that the disembodied finger was attached to the experimenter and therefore associated it with her communicative intent. In contrast, arrows are usually not physically linked to the person who is intending to communicate with them. Thus, the relation between arrow and communicator must be inferred. We suggest that having the experimenter hold the arrow in her hand rendered the presentation of the arrow more similar to a pointing finger and thus helped children to draw this inference. That children did not benefit from the experimenter’s hand when her face was absent to interpret the replica is probably a result of the greater cognitive demands of detecting the ‘stand for’ relation between a replica and its corresponding referent object. Only the experimenter’s insistent, engaging face might suffice in this regard.

The main finding in Experiments 1 and 2 is that a communicator’s engaging face plays an important role in helping children to grasp the significance of a sign or symbol. In Experiment 3, we investigated the contribution of the experimenter’s insistent, positive facial expression over and above her physical co-presence and eye contact, cues that were available simultaneously with her engaging demeanor in Experiments 1 and 2. A new group of children was tested using the same procedures as in Experiment 2, with the exception that, instead of a positive, engaging facial expression, the experimenter adopted a neutral, non-smiling expression with natural eye contact that was not insistent or animated in quality (i.e. eyes were not widened nor were eyebrows raised). As in the Engaging Face condition in Experiment 2, she maintained eye contact while the child searched for the sticker. At no time did she look in the direction of the target container or at the sign. The children were tested by the same female experimenter who tested the children in Experiment 2.

Results
The far right panel of Figure 2 shows the results for Experiment 3. We first analysed the data from Experiment 3 in isolation before comparing the results from Experiments 2 and 3.

Experiment 3
A repeated-measures ANOVA revealed a significant effect of Sign ($F(2, 26) = 7.33$, $p < .003$, $\eta_p^2 = .36$). Pairwise comparisons showed that performance with the point sign was not significantly better than performance with the arrow, and that performance with the arrow did not exceed performance with the replica. However, performance for the point sign was significantly better than performance with the replica ($p < .004$). The mean level of performance for all three signs was significantly better than chance ($ps < .0001$ for the point and the arrow and $p < .04$ for the replica). The bottom panel of Table 2 shows the percentage of children who searched correctly on at least 5/6 trials. More children succeeded with the point (71%) than with the arrow (43%), and only a few children succeeded with the replica (14%). However, in keeping with the pattern of results for the group means, the only significant difference was between the point and the replica ($p < .03$; McNemar’s test). Finally, performance improved significantly across the two trial blocks for the arrow ($p < .01$), but not for either the point or the replica (related-sample $t$-tests).
Comparison between Experiments 2 and 3

To investigate the contribution of the experimenter’s engaging facial expression over and above the co-presence of her face and/or eye contact, the data from Experiment 3 were analysed together with the data from Experiment 2. A 3 (Condition: Engaging Face, No Hand; No Face, No Hand; Neutral Face, No Hand) × 3 (Sign: point, arrow, replica) ANOVA revealed significant main effects of Sign, \( F(2, 78) = 20.1, \ p < .0001, \eta^2_p = .43 \), and Condition, \( F(2, 39) = 74.1, \ p < .0001, \eta^2_p = .79 \), and a Condition by Sign interaction, \( F(4, 78) = 3.7, \ p < .01, \eta^2_p = .16 \). Post hoc tests revealed that the mean for the point was significantly better than the mean for the arrow, \( p < .0001 \), which was significantly better than the mean for the replica, \( p < .01 \). And performance in the Engaging Face, No Hand condition was significantly better than performance in the Neutral Face, No Hand condition, which in turn was significantly better than performance in the No Face, No Hand condition, \( ps < .0001 \) (Tukey). The effect sizes for the latter comparisons were large (Cohen’s \( d = 2.41 \) and 1.90, respectively). Further analyses of the interaction showed that, whereas there was no effect of condition for the pointing finger, the means in the Neutral Face, No Hand condition were between, and significantly different from, the means for both the Engaging Face, No Hand and the No Face, No No hand conditions for the arrow \( (ps < .03 \) and .001; effect sizes 0.88 and 1.38, Cohen’s \( d \) and for the replica \( (ps < .003 \) and .05; effect sizes 1.26 and 0.78, Cohen’s \( d \)).

Finally, we compared the success rates in the three conditions in Experiments 2 and 3 (see the middle and bottom panels of Table 1). Separate chi-square analyses for each sign revealed significant effects of condition for the arrow and the replica only, \( \chi^2(2) = 24.41, \ p < .0001 \) and \( \chi^2(2) = 10.59, \ p < .0005 \), respectively. Follow-up tests showed that, for the arrow, significantly more children succeeded in the Engaging Face, No Hand condition than in the Neutral Face, No Hand condition \( (p < .02) \), which in turn had more successful children than the No Face, No Hand condition \( (p < .02) \). For the replica, the number of successful children was significantly higher in the Engaging Face, No Hand condition than in the Neutral Face, No Hand condition \( (p < .05) \), but there was no difference between the Neutral Face, No Hand and the No Face, No Hand conditions (all results based on Fisher’s exact tests).

Discussion

The results from the analyses of the group means in Experiment 3 indicate that even a neutral facial expression facilitates children’s comprehension of an arrow and a replica. Performance with the neutral facial expression was worse than with the engaging facial expression but significantly better than when the experimenter’s face was out of view. As the adult in the present research did not alternate her gaze between the child and the target container, the results show that by three years of age children can use non-directional cues, such as the experimenter’s face, to help them make sense of signs and symbols.

The results from Experiment 3 also provide further evidence that the extent to which children rely upon the available social cues varies with the nature of the sign. There was no effect of the experimenter’s face for the familiar, indicating sign of a pointing finger, possibly as a result of ceiling effects. The arrow sign was somewhat less transparent to children. Even though performance was above chance for the arrow sign when the experimenter’s face was removed, children still benefited from the experimenter’s neutral facial expression and even more so from her engaging facial expression. The results for the replica were even less robust. The group mean was significantly above chance for the engaging and neutral face, but not when the face was removed. And the mean for the neutral face was significantly lower than that with the engaging face, but higher than that with the face removed. But note that, unlike the case for the arrow, the benefit of the neutral face for the replica did not accrue to the majority of the children. More children succeeded with the replica with the Engaging Face, compared to with the Neutral Face, but the numbers of successful children in the Neutral and No Face conditions did not differ. Taken together, these findings suggest that the more conceptually complex the sign or symbol is, the more children may appeal to the experimenter’s face.

General discussion

The aim of the present research was to investigate the contribution of adults’ social cues to children’s comprehension of signs and symbols. The results showed that an engaging facial expression facilitates 2- to 3-year-old children’s ability to grasp the significance of a pointing sign, an arrow and a replica. Moreover, our findings indicate that the adult’s insistent, positive demeanor contributes to performance beyond the effects of the physical co-presence of her face and/or eye contact and the presence of her hand. These cues of neutral facial expression, eye contact and hand also contribute to performance, but not as much as does the adult’s engaging face. This suggests that, even if children rapidly integrate information from multiple social cues in their every-day social experiences (as is likely), they may benefit from an engaging facial expression more than from other simultaneously available cues.

The results from the present work also support our suggestion that the facilitating effect of an adult’s engaging face may vary with the relative difficulty of comprehending the sign. Children’s ability to comprehend the pointing finger was very good across age groups and conditions. This is not surprising, given
that the onset of comprehending and producing pointing is already emerging by the end of the first year (Schaffer, 1984; Butterworth, 1995) and thus that children would have substantial experience with pointing by two to three years of age. In contrast, ability to comprehend the arrow was affected by the adult’s engaging demeanor. It was also affected by other more subtle cues such as by seeing the arrow in the adult’s hand and by the presence of the adult’s face even with a neutral expression. These findings contribute to other evidence suggesting that an arrow may be less transparent to children than a pointing finger (Lee et al., 1998). For the replica, children performed best when the adult adopted an engaging facial expression. They performed significantly worse when the adult adopted a neutral facial expression, and when the adult’s face was removed their performance dropped to chance. Unlike the case for the arrow, seeing the replica in the experimenter’s hand did not attenuate the effect of removing her engaging face. Thus, social cues may not all share the same level of importance for the comprehension of all types of signs. Children may come to rely less on the social support provided by an adult with experience of various signs and with greater cognitive maturity. This notion is consistent with evidence showing an age-related decrease in the amount of instruction children require to infer that information obtained from a scale model of a room can be used to find a hidden object in the actual room (Peralta de Mendoza, DeLoache & Anderson, 1999).

It is important to consider alternative explanations for the present pattern of findings. Another interpretation is that children were distracted by the unnatural social situation created in the Neutral and No Face conditions. However, we suggest that this is unlikely. Performance was excellent and robust (even for the youngest children) in what was arguably the most unnatural context – that of the disembodied pointing finger. Indeed, we were surprised that the children were not even somewhat distracted by the isolated human finger and that they did not actively search for the person attached to the finger in the No Face conditions. It also seems possible that children might have interpreted the experimenter’s unusual demeanor in the Neutral Face condition to indicate that something strange was afoot (i.e. that they were being tricked). This might have led children deliberately to avoid the target location. But their relatively good performance in the Neutral Face condition, especially with the point, suggests that this was not the case. Finally, anecdotal evidence indicated that the children in these conditions did not appear more distracted or less motivated to search than the children in the more natural Engaging Face conditions.

Another alternative explanation could be that the experimenter conveyed cues to the children (whether consciously or unconsciously) as to the location of the sticker. However, there are several reasons why this is also unlikely. We aimed specifically to explore the contribution of non-directional social cues and thus took great care to ensure careful administration of the procedures. First, even though experimenter cueing was not possible in the No Face conditions, the pattern of findings in these conditions alone is compelling (better performance for the point than for the arrow and replica, and an effect of the hand for the arrow). Second, cues provided by the experimenter could not account for the age effect that obtained in Experiment 1. We first tested children across a continuous age range and only divided the sample into a younger and older group after completion of the data collection and during the statistical analyses. Therefore, the experimenter could not have known which of the many children in the middle of the age range would eventually be allocated to the younger or the older group. Third, it also seems unlikely that the experimenter provided cues to children in the Neutral and Engaging Face conditions as she would have had to keep many factors in mind in order for those cues to be effective: the order of the signs to use for each child; which sign to produce on a given trial; where to hide the sticker; the experimental condition; which block of trials she was currently administering, and so forth. Her responses would have had to vary systematically according to the age, condition, and type of sign in order to explain our overall pattern of results. And finally, our findings in the Engaging Face conditions are consistent with Tomasello et al.’s (1997) findings for the point and the replica using the same paradigm and procedure. Moreover, our results for the relation between age and the type of sign are in line with the results from studies using very different tasks to investigate sign/symbol understanding (see, for example, Butterworth, 1995, for comprehending a pointing finger; Lee et al., 1998, for comprehending an arrow; and DeLoache, 1987, 1995, for the ability to use a replica).

We therefore suggest that neither the unnaturalness of the social situation in the Neutral and No Face conditions, nor experimenter cueing is likely to account for our overall pattern of results, and that an explanation that appeals to the presence and engaging nature of the experimenter’s face seems more tenable.

Indeed, the sticker task used in these experiments could be considered a strong test of young children’s sensitivity to social cues and their role in comprehending signs and symbols, as children received only minimal instructions. For example, we did not tell children that the communicator was there to help them, nor did we explicitly point out the correspondence between, for example, the replica and its referent. The children had to draw these inferences themselves. That children clearly comprehended the pointing finger, were generally very good at using the arrow (in the Engaging Face conditions and the No Face, with hand conditions) and that the older children could also use the replica (in the Engaging Face conditions) shows not only that children at this age benefit from the availability of social cues, but also that they comprehend the specific information each of the
signs aims to convey (follow the trajectory of the point and the arrow, look for the thing that matches the replica).

How might the adult’s social cues have helped children to understand this specific information? One possibility is that the adult’s social cues conveyed her communicative intent, which in turn encouraged the child to ‘see through the sign’. More specifically, adults may mediate children’s understanding of the symbolic function of an object by helping them to take a dual stance to it – to see it both as an object and as an indicator or as a representation of something else. Research on children’s pretend use of objects suggests that adults may facilitate children’s ability to interpret objects in terms of multiple functions (Lillard & Witherington, 2004; Rakoczy, Tomasello & Striano, 2005). Perhaps when an adult is not available to highlight some purpose for a sign, children will simply treat the sign as an object and nothing more. Seeing the adult’s insistent face may encourage children to look beyond the object, to see it as an indicator (as with the arrow) or as a representation of something other than itself (in the case of the replica), and to recognize that it is its indicating or representational status that is critical in a given situation. Although indicating signs such as an arrow are easier for children because they directly refer to their referent, the demands of appreciating their dual function may be similar to the demands of the replica, especially in the absence of social cues.

Although adults might help young children to appreciate that objects have a dual status, it is not clear whether the social cues in this experiment actually affected children’s ability to take a dual stance or whether children already had this ability and the social cues helped them to see the intended function of the sign. In other words, although it could be that the understanding of communicative intent allows children to comprehend the sign, it remains possible that it is the comprehension of the sign (or perhaps just a readiness to comprehend it) that allows children to detect when and how to take account of an adult’s social cues when inferring her communicative intent. Our results point to the latter view. Children appeared to depend more on social cues when the sign was relatively unfamiliar and perhaps more cognitively demanding, and the older children were more likely to profit from these cues than the younger ones. For example, in Experiment 1, only the older children benefited from the available social cues when presented with the replica. And in Experiment 2, removing the hand had an effect on performance for the arrow but not for the replica, a sign that was already far more challenging for children. If children were indeed relying on social cues to indicate whether it was appropriate to treat the object symbolically, then the adult’s engaging, positive facial expression with raised eyebrows and smile might have facilitated this less obvious interpretation. The possibility that social cues might actually help children to acquire knowledge is nonetheless intriguing, and we would argue that it warrants further consideration. If this were true, one might expect performance to improve across the two blocks of trials. Our findings provide some evidence that sign learning might be affected by the nature of the sign and perhaps also by the particular social cues available. Performance improved significantly across trial blocks for the arrow in Experiment 3 and for the replica in Experiment 2. As the effect of learning was not the main focus of the present series of experiments, however, children received a fairly limited number of trials. Further research using a larger number of trials is needed to test systematically the interesting possibility that sign learning might be affected by the presence of different social cues.

Understanding communicative intention and understanding symbols are two abilities that are believed to be uniquely human and that are considered to develop interdependently (Bates et al., 1979; Tomasello, 1999). Yet we still know relatively little about the developmental nature of this interdependence (Sabbagh & Baldwin, 2005). The present work sheds some light on the link between these two domains; however, further research is needed to understand this link more fully. Although the development of communicative intention may be developmentally connected to symbolic understanding, we know that these abilities can also function independently. Children are sensitive to social cues and will be aware of others’ communicative intentions in a range of situations. Gergely and colleagues (Csibra & Gergeley, 2006; Gergely, Egyed & Király, 2007) propose that human infants are adapted to acquire knowledge from the pedagogical approaches of others: they have an inbuilt social learning capacity that leads them automatically to orient towards an adult for instruction. It could be that specific ostensive social cues of eye contact and positive expression may help to trigger an interpretation that an adult intends to show the child new information. Although it is likely that these cues help to focus children’s attention to the task and may further enhance their motivation, we propose that the critical effect of an engaging partner is to highlight both his or her communication and his or her intention, and hence that the child becomes aware that the adult is intending to communicate something in particular. By this view, we would expect to find the facilitating effect of adults’ social cues in other cognitive domains. Such findings would add an interesting new dimension to thinking about the role of more experienced peers in propelling cognitive development.

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References


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