



Pedagogical Cues to Artist's Intention in Young Children's Understanding of Drawings

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Abstract

Three studies investigated the effects of pedagogical cues to artist's referential intention on 2- and 2.5-year-old children's understanding of drawings in a matching task without verbal labels support. Results showed that pedagogical cues, the combination of the artist's eye gaze while she was creating the drawings (non-linguistic cues) and verbal descriptions about her graphic actions (linguistic cues), enabled 2-year-olds to match highly realistic line-drawings with referents. However, 2-year-olds' performance was not influenced to an equal degree by non-linguistic and linguistic cues; verbal scripts appeared to be the critical aspect of pedagogical demonstration even with pre-drawn pictures. By contrast, at 2.5 years of age, children inferred the artist's intention when comprehending drawings in the absence of pedagogical cues. This research illustrates the potential power of pedagogical demonstration to communicate referential intentions in the pictorial symbol domain.

Pedagogical Cues to Artist's Intention in Young Children's Understanding of Drawings

At the beginning of "The Little Prince", Antoine de Saint-Exupéry shares that when he was a child he showed his first drawing to adults, asked them what it was, and received a unanimous answer: A hat. But his drawing was not a picture of a hat. The naïve artist had drawn using an irregular shape, which looked like a hat, a boa constrictor digesting an elephant. Pictorial symbols are made with intentionality; to understand what the symbol's creator intends to represent is crucial for interpreting them. The role of communicative, pedagogical cues as a signal of adult artist's referential intention is the focus of the current research.

Children's understanding of intentions is inherent to many domains, including word learning (Baldwin, 1993) and imitation (Gergely, Bekkering, & Király, 2002; Meltzoff, 1995). For example, children use adult's intentions to guide their inferences when mapping verbal symbols to referent objects from as early as the second year of life (Akhtar & Tomasello, 1996; Baldwin, 1993), indicating they recognize the adult's intention to communicate about the referent (Tomasello, 1999). Csibra and Gergely (2006, 2009) argue that humans have evolved a mechanism for recognizing and capitalizing on communicative actions, and that children have a tendency to take a "pedagogical stance" towards acts of intentional, ostensive communication. Infants are sensitive to cues, such as eye gaze, joint attention and child-directed speech, which distinguish instrumental actions from actions with which an adult intends to communicate information for the child's benefit. That is, they infer not only that information being communicated is relevant, but also that knowledgeable adults communicate information in order to teach them important things

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4 about the world: Pedagogical demonstration serves to facilitate the transmission of
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6 culturally important knowledge.
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9 A clear example of the things that children learn from adults directly is the
10 appropriate use of culturally significant symbols, such as photographs, paintings and
11 drawings. Western middle-class adults and children spend considerable time engaged in
12 activities with pictorial artifacts designed to foster, for example, early learning of language
13 (e.g., baby picture books). However, it remains unclear what role the sensitivity to
14 pedagogical cues that is present in infancy might play in young children's initial insight
15 that pictorial symbols represent.
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25 The onset of pictorial comprehension can be placed sometime between 2 and 3
26 years of age, depending on the task. When tested using language-based learning tasks, even
27 1.5-year-old children extended a novel word learned from a depicted novel object to the
28 real object (Ganea, Allen, Butler, Carey, & DeLoache, 2009; Geraghty, Waxman, &
29 Gelman, 2014; Preissler & Carey, 2004). Nevertheless, children's understanding of pictures
30 remains tenuous for some time. Toddlers under the age of 2.5 years have difficulty
31 matching a real-object display with a picture of that display (Harris, Kavanaugh, &
32 Dowson, 1997) and using a picture to locate a toy hidden in a room (DeLoache & Burns,
33 1994; Peralta & Salsa, 2009). Moreover, in studies controlling for the bootstrapping of
34 pictorial comprehension with language, Callaghan (1999, 2000) found that children do not
35 fully understand pictures until 3 years of age: Under this age, children rely on verbal labels
36 to mediate the matching of a drawing with its referent. Young children have trouble using
37 pictures as symbols—even at the same time that they are dealing with linguistic symbols
38 quite effectively—because pictures have a kind of dual status; they are both physical
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4 objects to be grasped and manipulated and they are simultaneously representations of other
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6 objects. DeLoache (1987, 1995) calls this the dual representation problem.
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9 The studies just described are mainly focused on the relation between symbol and
10 referent, age-related changes in pictorial comprehension, and some of the factors that can
11 influence this understanding. Little attention, however, has been given to children's
12 comprehension of the symbolic link between a picture, its referent, and the person who
13 creates the depiction. As a matter of fact, a picture's referent is determined by the intentions
14 of the creator: Intention-monitoring skills seem to be critical to pictorial comprehension
15 (Bloom, 2000; Callaghan & Rochat, 2008; Freeman, 2008). Therefore, in order to
16 effectively map pictures to referents, children must infer the artist's referential intention
17 from a range of social communicative cues that interact in subtle ways.
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30 Although several studies have examined children's sensitivity to referential
31 intention when comprehending drawings (Bloom & Markson, 1998; Browne & Woolley,
32 2001; Gelman & Ebeling, 1998), only two experiments have brought into focus the role of
33 communicative cues, specifically eye gaze direction. Preissler and Bloom (2008) used a
34 word extension task in order to test 2.5-year-olds' understanding of an ambiguous line-
35 drawing (a circle) that looked equally like two unfamiliar objects. In Experiment 1, an
36 experimenter produced the drawing and labeled it using a novel word ("Look! A *spoodle*! I
37 drew a *spoodle*. See the *spoodle*"). When children were required to extend the label from
38 the picture, they generalized the word to the object that the adult artist had been gazing at
39 whilst drawing. In Experiment 2, the experimenter looked at the object without creating the
40 drawing; when she discovered a pre-drawn picture that was hidden behind her, children
41 were less successful at indicating the referent of the new word. According to the authors,
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4 these findings are evidence that direction of gaze influences picture naming when serving
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6 as a cue to artist's intention. This cue, combined with simple labeling, highlights the role of
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8 pictures as representational.
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11 We conducted three studies to further explore how young children infer referential
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13 intention in the pictorial symbol domain from communicative cues. We approached this
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15 question from a novel angle, by examining the potential role of pedagogical cues in a task
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17 where verbal labels are not available. For this purpose, we adapted a drawing-referent
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19 matching task developed by Callaghan (1999). In this task, children had to match five
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21 referent objects with their highly realistic line-drawings and verbal labels did not play a role
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23 because the objects shared a basic-level verbal label. This procedure provides a stringent
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25 test of comprehension; children have to use the drawing as a symbol of a particular item
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27 and the name that may be generated when they see the picture cannot help them match.
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29 Previous studies have found that it is not until 3 years of age that children perform well on
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31 this task (Callaghan, 1999; Callaghan & Rankin, 2002).
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37 In particular, in Study 1A, we asked whether children younger than those tested by
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39 Preissler and Bloom (2008), namely 2-year-olds, would grasp the symbolic nature of
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41 drawings through a pedagogical demonstration in the absence of labeling. To this end, we
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43 conflated two ostensive cues to artist's referential intention, one non-linguistic (eye gaze)
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45 and the other linguistic. Instead of verbal labels, our linguistic cues were very simple
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47 descriptions of how the artist had created the pictures (e.g., "To draw the picture of this toy,
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49 I made a big circle for this ball" or "I made two circles, one for each ball"). We reasoned
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51 that when adults instruct young children in everyday social interactions, they use non-
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53 linguistic cues along with descriptions and explanations that invite children to read the
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4 scenario as a pedagogical situation for the transmission of knowledge and skills (Csibra &
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6 Gergely, 2006, 2009; Tomasello, 1999). Tomasello, Striano, and Rochat (1999) indicated
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8 that adults scaffold children's early symbol use through modeling and verbal scripts.
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10 Similarly, Striano, Tomasello, and Rochat (2001) found that symbolic play increased when
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12 mothers were present, which they attributed to maternal modeling and language used to
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14 encourage children to interact with objects symbolically. As far as research on the pictorial
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16 domain concerns, Braswell and Callanan (2003) showed that mothers and children often
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18 talked about their drawings, and many aspects of these conversations (e.g., discussing
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20 features essential for identifying referents and mother's direct instruction) were related to
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22 changes in children's pictorial representations.
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28 As a consequence, our prediction was that the combination of non-linguistic and
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30 linguistic cues would enable the artist to explicitly demonstrate her referential intent in a
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32 pedagogical manner, for the child's benefit. Undoubtedly, children learn from adults by
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34 unguided observation and overhearing, however, whenever they are directly targeted by
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36 communicative cues, their pattern of learning changes fundamentally (Csibra & Gergely,
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38 2009). Children's sensitivity to pedagogical intent might be guiding their understanding
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40 that the adult artist was carrying out an action with the intention of communicating relevant
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42 information: What she drew and how she made the pictures, highlighting the symbolic link
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44 between artist, drawing and referent. Hence, pedagogical cues might help to trigger an
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46 interpretation that the artist's referential intent was being demonstrated, and this inference
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48 could guide 2-year-olds to match drawings with referents.
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54 Studies 1B and 2 were designed to deepen our understanding of the role of
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56 pedagogical cues in pictorial comprehension. In Study 1B we investigated the effects of
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4 age. We asked whether children just six months older, 2.5-year-olds, were able to solve the
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6 drawing-referent matching task without pedagogical demonstration. In Study 2 we explored
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8 the effects of disentangling non-linguistic from linguistic cues in order to elucidate the role
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10 of each cue to convey referential intention in a pedagogical demonstration.

11 12 13 **Study 1A**

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15 In this study we asked whether 2-year-old children could capitalize on pedagogical
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17 cues that mark the artist's referential intention to guide their understanding of the symbolic
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19 nature of drawings. Children were assigned to one of two conditions, either the Pedagogical
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21 Cues or No Pedagogical Cues condition. In the Pedagogical Cues condition, children
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23 watched as an experimenter looked at an object and slowly drew it. Afterwards, the
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25 experimenter made her symbolic intent more explicit to the children by verbal descriptions
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27 about how she had created the drawings. In the No Pedagogical Cues condition, children
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29 simply had to relate pre-drawn adult's pictures with their referents. However, when the
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31 experimenter presented the drawings, she explicitly told the children she had drawn some
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33 pictures of the toys. As a consequence, the No Pedagogical Cues condition had an
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35 intentional cue to artist's intention but in the absence of a pedagogical demonstration. We
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37 expected that 2-year-olds would have difficulty solving the matching task without
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39 pedagogical cues. This prediction follows easily from Callaghan's (1999) findings in the
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41 matching task without verbal labels.

42 43 44 **Method**

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47 **Participants.** Thirty-two 2-year-old children (age range: 1;11-2;1) were recruited
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49 from day-care centers in Rosario, a large city of Argentina. Children were from middle-
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51 class families and were randomly assigned to one of the two experimental conditions. There
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were 16 children with an average age of 2;1 years in the Pedagogical Cues condition (seven girls and nine boys), and 16 children with an average age of 2;0 years in the No Pedagogical Cues condition (seven girls and nine boys). Four additional children were excluded due to distraction and non-compliance.

Materials. There was one stimuli set consisted of five objects identical in color (blue): (1) a ball; (2) a ball with small wooden sticks attached; (3) a ball smaller than 1 and 2; (2) two balls joined together; and (5) a wooden stick. The experimenter's line-drawings of the objects were made on blank sheets of A4 paper with a graphite pencil (see Figure 1). Five green boxes (20 x 32 x 11.5 cm) and a cardboard paper bag were also used.

Insert Figure 1 here

Procedure. Children were tested individually in a quiet room of the day-care center they attended by a female experimenter. Each child sat at a small table next to the experimenter. To establish rapport, the session began with a brief warm-up period in which the experimenter chatted with the children about what they had been doing at school that day. When the children appeared to be comfortable, the task began.

Children were first told that they were going to play a game with some toys and boxes. Then, the experimenter presented the objects to the children one at a time. The entire session consisted of two phases: Orientation and test. The experimental conditions differed in the way in which the drawings were presented during the orientation phase.

In the *Pedagogical Cues condition*, the experimenter selected one object and said "I am going to draw a picture of this toy". The experimenter encouraged the children to pay

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4 attention and to watch what she was going to do (“Look!”). She picked up a sheet of paper
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6 and a pencil, placed the object on the table, stared at it for 10s, and drew a picture of the
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8 toy. During this time the children could see what the experimenter was drawing. Once all
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10 drawings were completed, the experimenter took them one by one, matched each picture
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12 with its referent and described her graphic actions: “To draw the picture of this toy, I made
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14 a big circle for this ball” (object 1), “... a circle for this ball and a lot of small lines for
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16 these sticks” (object 2), “... a small circle for this ball” (object 3), “... two circles, one for
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18 each ball” (object 4), and “... a line for this stick” (object 5). Finally, each drawing was
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20 placed in an individual box and the objects were kept in the paper bag. The order of the
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22 drawings was counterbalanced.
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28 Afterwards, the test began. The experimenter said: “You will have to keep each toy
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30 in its corresponding box. You will know where to keep the toys because each box has a
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32 drawing inside”. All the boxes were lined up near the children. The experimenter presented
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34 five trials, one for each object. She gave an object to the children and said “Where are you
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36 going to put this toy?”. If necessary, a more explicit prompt was given (“Where is the
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38 drawing of this toy?”). Once the children placed a toy inside a box, the experimenter
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40 removed it so that the children had to choose each drawing among the five drawings of the
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42 set. The order of presentation of the objects was different from the order in which they were
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44 drawn and was counterbalanced.
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49 In the *No Pedagogical Cues condition*, children had to match pre-drawn
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51 experimenter’s drawings with their referents. In the orientation phase, after presenting the
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53 objects and boxes, the experimenter said “I drew some pictures of the toys”. She introduced
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55 one by one the five drawings; each picture was shown for 10s and then was matched with
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4 their referent. In order to make sure that the children were watching carefully the drawings,
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6 the experimenter said "Look!". Once all the drawings were presented, they were placed in
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8 the individual boxes and the objects were kept in the paper bag.
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11 At the beginning of the test phase, the experimenter explained: "You will have to
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13 keep each toy in its corresponding box. You will know where to keep the toys because each
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15 box has a drawing inside". The same basic procedure as in the Pedagogical Cues condition
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17 was followed.
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21 A second experimenter used a score sheet to record children's choices.
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23 **Results and Discussion**

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25 The dependent variable was the number of correct choices; that is, the number of
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27 times the children matched a drawing with its referent on their first attempt (maximum =
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29 5). A Kolmogorov-Smirnov test confirmed the data were normally distributed ($z = .923, p =$
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31 $.361$), allowing the employment of parametric analysis. Preliminary analysis revealed no
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33 effects of gender or trial order in either study reported here, so these variables will not be
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35 discussed further.
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40 Figure 2 shows the results for Study 1A. The children in the No Pedagogical Cues
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42 condition were less successful at using the drawings as symbols ($M = 1.56, SD = 1.09$) than
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44 were the children in the Pedagogical Cues condition ($M = 3.75, SD = 1.13$). The children's
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46 level of correct choices was above chance in the Pedagogical Cues group [$t(15) = 9.77, p <$
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48 $.001$], but not in the No Pedagogical Cues group [$t(15) = 2.05, p = .057$] (chance = .20,
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50 based on the five possible picture-referent matches). An independent-samples t test
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52 confirmed that there was a significant difference between correct choices scores in the two
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4 conditions, $t(30) = 5.57, p < .001$; the effect size for this comparison was large (Cohen's $d =$
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6 2.03).
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11 Insert Figure 2 here
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16 At the level of individual performance, the children's success rate also differed
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18 between conditions: Only 1 of the 16 children (6%) in the No Pedagogical Cues condition
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20 had a correct drawing-referent match on the majority of the trials (four or more of the five
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22 trials), whereas 10 of the 16 children (63%) of the Pedagogical Cues condition met this
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24 criterion ($p = .002$, Fisher's exact test). When children's first choice was incorrect, there
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26 were no spontaneous corrections in either group.
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30 These results support the hypothesis that the combination of non-linguistic and
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32 linguistic cues to artist's referential intention facilitates 2-year-olds' ability to match
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34 drawings with referents. Children appreciate that if an artist stares intently at a ball while
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36 producing an enclosed form and provides verbal descriptions about how she made the
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38 drawing, this pictorial symbol then represents the ball. If this pedagogical context is not
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40 present, performance is below chance even when the artist explicitly tells the children that
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42 she drew the pictures.
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46 Two-year-olds' performance on the No Pedagogical Cues condition is in line with
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48 the one reported by Callaghan (1999) using a similar procedure (47% correct choices). In
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50 fact, in that study, children successfully used drawings as symbols to guide their matching
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52 behavior at age 3 (71% correct choices). Based on previous findings that showed a
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54 relatively rapid progress in children's comprehension of pictures (Callaghan, 2000;
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DeLoache & Burns, 1994; Salsa & Peralta, 2007), we anticipated that 2.5-year-olds would reliably solve the matching task without any pedagogical cues. Study 1B was designed to test this hypothesis.

Study 1B

Method

Participants. Seventeen children with a mean age of 2;6 years were included (range: 2;5-2;7 years; 9 girls and 8 boys).

Materials and procedure. The materials were the same as those used in Study 1A and the experimental session was conducted in exactly the same manner as in the No Pedagogical Cues condition.

Results and Discussion

We first analyzed the data from Study 1B, and then compared these data with the data from the No Pedagogical Cues condition in Study 1A in order to examine age-related changes on children's performance. A Kolmogorov-Smirnov test confirmed that the data were normally distributed ($z = 1.19, p = .114$).

Two-and-a-half-year-olds were very successful in using the drawing-referent relation without pedagogical cues; they scored 86% correct choices ($M = 4.29, SD = 0.77$) and performance was significantly better than chance, $t(16) = 22.94, p < .001$. Of the 17 participants, 14 (82%) met the success criterion (at least four correct choices); the remaining 3 children (18%) had 3 correct picture-referent matches. As in the previous study, there were no spontaneous corrections after incorrect first choices.

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Finally, we compared the success rates in the No Pedagogical Cues conditions in Studies 1A and 1B. The level of performance at 2.5 years of age (86%) was substantially above the 31% achieved by the 2-year-old children, $t(31)= 8.33$, $p<.001$, $d = 2.99$.

Studies 1A and 1B together indicate a rapid developmental progression in young children's performance on the matching task: 2.5-year-olds do not need pedagogical cues to help them make sense of drawings, while 2-year-olds need them to infer the symbolic, communicative function of pictures. A pedagogical communicative context seems to be especially important for 2-year-olds' understanding of drawings. However, the Pedagogical Cues condition of Study 1A involved two very different routes to artist's intention, non-linguistic and linguistic cues. In the next study we explore how 2-year-olds' understanding of drawings is related to both types of cues provided by the symbol creator.

Study 2

In Study 2 we designed two conditions in order to disentangle non-linguistic from linguistic cues to artist's intention in a pedagogical demonstration. In one condition (Non-linguistic Cues) the experimenter stared at each object for 10s and drew them in front of the children. In the other condition (Linguistic Cues) the experimenter showed the children pre-drawn pictures of the objects and described her graphic actions; for example, "To draw the picture of this toy, I made a big circle for this ball" (object 1, see Figure 1). In this condition, children did not see the act of mark making but the artist verbally described her intentional actions for representing the objects.

According to Csibra and Gergely's (2006, 2009) theory of "natural pedagogy", there is no a theoretical reason for children to prefer non-linguistic to linguistic cues for learning. In fact, eye gaze and child directed-speech are both ostensive cues for infants. To define a

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4 situation as pedagogical, novice learners expect communication to contain shared and
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6 relevant knowledge; this is especially important in opaque contexts where novel artifacts
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8 are shown. In this sense, we reasoned that the Linguistic Cues condition might be a more
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10 effective route to signal pedagogical intent, as the artist explicitly highlighted her
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12 referential intention as well as the link between the drawings and their specific life-
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14 referents. In the Non-linguistic Cues condition, witnessing the artist producing the drawings
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16 might be a cue to intention but not necessarily a pedagogical one. In contrast, if 2-year-olds
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18 would need the combination of non-linguistic and linguistic cues, then performance was
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20 expected to suffer in both conditions.
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24 25 **Method**

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27 **Participants.** A total of 28 2-year-old children (age range: 1;11-2;1 years)
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29 participated in this study. There were 14 children (six girls and eight boys) in the Non-
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31 linguistic Cues condition ($M_{\text{age}} = 2;1$ years) and 14 children (seven girls and seven boys) in
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33 the Linguistic Cues condition ($M_{\text{age}} = 2;1$ years). Two additional children failed to complete
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35 the procedure due to distraction.
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39 **Materials and procedure.** Materials were identical to those used in Study 1A and
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41 1B. The experimental conditions differed in the procedure of the orientation phase. In the
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43 *Non-linguistic Cues condition*, after presenting the objects and boxes, the experimenter said
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45 “I am going to draw pictures of these toys”. She picked up one object and placed it on the
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47 table, stared at it for 10s, and drew a picture of the toy. The experimenter encouraged the
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49 children to pay attention and to watch what she was going to do with each object (“Look!”).
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Once the five drawings were completed, the experimenter matched each drawing with its

referent and put the drawings inside the individual boxes. The objects were kept in the paper bag.

In the *Linguistic Cues condition*, after the materials were presented, the experimenter said "I drew some pictures of the toys". She introduced one by one the five line-drawings of the objects. The experimenter matched each picture with its referent and described her graphic actions in the same way as in the Pedagogical Cues condition of Study 1A: "Look! To draw the picture of this toy, I made a big circle for this ball" (object 1), "... a circle for this ball and a lot of small lines for these sticks" (object 2), "... a small circle for this ball" (object 3), "... two circles, one for each ball" (object 4), and "... a line for this stick" (object 5). Once all the drawings were presented, they were placed in the individual boxes and the objects were kept in the paper bag.

In both conditions, the procedures used in the five trials of the test were the same as those described in the previous study. Table 1 provides a brief overview of the procedures used in the orientation phase of the experimental conditions of Studies 1A and 2 to facilitate interpretation of the results.

Insert Table 1 here

Results and Discussion

We first analyzed the data from Study 2 in isolation before comparing the results from Studies 1A and 2. The results of the Kolmogorov-Smirnov test ($z = 1.11, p = .169$) confirmed that the data were normally distributed.

As is shown in Figure 3, linguistic cues are a privileged route to communicate the creator's referential intention. The children who received verbal descriptions of the artist's drawing actions were more successful in using pictures to assist in the matching task ($M = 3.00$, $SD = 1.77$) than those children who could see what the artist was drawing ($M = 1.64$; $SD = 1.45$). The rate of success of the children in the Linguistic Cues condition was above chance [$t(13) = 4.37$, $p < .01$], but not in the Non-linguistic Cues condition [$t(13) = 1.66$, $p = .120$]. The differences in children's correct choices was significant, $t(26) = 2.33$, $p < .05$, Cohen's $d = .91$

Insert Figure 3 here

We also performed an analysis of individual patterns of responding, assessing the number of children who had four or more correct choices. There was no difference in the number of children fitting this pattern in the two conditions, Fisher's exact test, $p = .209$. However, a closer look at individual performance shows that 6 of the 14 children (43%) of the Linguistic Cues condition met the success criterion. In contrast, only 2 of the 14 children (14%) of the Non-linguistic condition were as successful; in fact, half of the children of this group (7) had only 1 correct choice. After incorrect first choices, there were no spontaneous corrections in either group.

Finally, we carried out a statistical analysis to compare the accuracy of performance by different cues conditions in Studies 1A and 2. A one-way analysis of variance (ANOVA) revealed a significant main effect of condition, $F(3, 56) = 9.57$, $p = .001$, $\eta_p^2 = .34$. According to post hoc tests (Tukey), performance in both the Pedagogical Cues and

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Linguistic Cues conditions was significantly better than that of the No Pedagogical Cues condition ($p < .001$ and $p < .05$, respectively). Pedagogical Cues and Linguistic Cues conditions were also better than Non-linguistic Cues condition ($p = .001$ and $p < .05$). The effect sizes for these comparisons were large, ranging between 0.93 and 2.03 (Cohen's d). Of most importance, no significant differences were found between Pedagogical Cues and Linguistic Cues conditions ($p = .533$), and between Non-linguistic Cues and No Pedagogical Cues conditions ($p = .999$).

To summarize these results, verbal scripts that explicitly highlight the link between artist, drawing and referent appear to be the critical component of the pedagogical cueing support. Two-year-olds' performance is dramatically disrupted if they do not receive any pedagogical cues and is also below chance if they only have the opportunity to watch the artist draw while gazing at the referent. At this age, children use verbal descriptions as a pedagogical demonstration of the artist's intention when they have to match a drawing with its referent.

General Discussion

The current work adds to the burgeoning literature addressing children's understanding that pictorial symbols are situated in the context of a creator who assigns meaning and a user who interprets that meaning: Understanding communicative intentions and understanding symbols are two cognitive abilities that are believed to develop interdependently (Callaghan & Rochat, 2008; Freeman, 2008; Tomasello, 1999). Creator's intention is likely to be inferred from a range of varied cues that interact in subtle ways. The aim of the present research was to investigate the contribution of artist's pedagogical cues to referential intention in young children's comprehension of highly realistic line-

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4 drawings. Thus, these studies shed some light on the social mechanisms through which
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6 children come to understand that pictorial symbols represent.
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9 We began with the question of whether 2-year-old children could understand the
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11 symbolic function of drawings through a pedagogical demonstration of the artist's
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13 referential intention. In the Pedagogical Cues condition of Study 1A, children received non-
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15 linguistic and linguistic cues, the artist's eye gaze while she was creating the pictures and
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17 verbal scripts about her graphic actions. Without either of these cues, as in the No
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19 Pedagogical Cues condition, children's performance was at chance. These findings confirm
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21 that for 2-year-olds graphic marks do not have inherent meaning by sole virtue of the
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23 perceptual similarities to their referents (Callaghan, 1999; DeLoache & Burns, 1994), but
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25 they can use these marks as symbols if the artist explicitly demonstrates the intent to
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27 symbolize in a pedagogical manner, combining non-linguistic cues with descriptions and
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29 explanations. Importantly, in contrast with previous studies (Preissler & Bloom, 2008), this
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31 occurred in a task in which verbal labels were controlled. We adapted Callaghan's (1999,
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33 2000) methodology to investigate pictorial comprehension when children were unable to
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35 generate a unique label for each symbol. Hence, our results show that 2-year-olds use
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37 pedagogical cues to assign referential identities to pictures that have not been verbally
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39 labelled.
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46 We also investigated the effects of disentangling non-linguistic from linguistic cues,
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48 and a striking pattern of results emerged in Study 2. Two-year-olds were able to use
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50 drawings as symbols if the artist provided verbal cues to intention, even when they could
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52 not see the trace of the drawing as it emerged. Therefore, a privileged route towards
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pictorial comprehension seems to be the artist confirming her intention to represent by verbal descriptions of how she created the pictures.

Our results are consistent with other studies that emphasize the importance of adult social and linguistic interaction in symbolic competency. The work of Tomasello and colleagues (Striano, Tomasello, & Rochat, 2001; Tomasello, Striano, & Rochat, 1999), for example, suggests that adults provide support for many of children's earliest symbolic actions, either by directly modeling symbolic actions or by providing verbal scripts. Similarly, when 2.5-year-olds were exposed to an adult producing and then using pictorial symbols, children's use of others' drawings and the production of their own graphic representations improved (Callaghan & Rankin, 2002). Troseth, Saylor, and Archer (2006) found that learning that a person on video was a social partner who could share relevant information eliminated the typical deficiencies in 2-year-olds' acquisition and use of information from video. Nevertheless, the research we present here advances our understanding of symbolic development by elucidating the nature of the communicative cues that fundamentally underpin drawing-referent relations in a pedagogical demonstration. As Csibra and Gergely (2006, 2009) have pointed out, pedagogical cues may be especially useful in the service of reasoning about symbolic artifacts.

Verbal scripts were the crucial aspect of the pedagogical demonstration in Study 2. How might verbal descriptions have helped children to make the correct drawing-referent mapping? One possibility is that a non-linguistic cue such as eye gaze while the artist was creating the pictures may allow 2-year-olds to identify the act of drawing as communicative. But this communicative cue itself, despite being a cue to intention, did not specify *what* was being communicated. We consider that linguistic cues may not have only

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4 helped to focus children's attention to the communicative partner, but also have served as a
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6 key factor to activate a pedagogical interpretation of the situation, whereby leading children
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8 to become aware of the artist's intended transmission of relevant information in order to
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10 relate her drawings with their specific life-referents. In other words, verbal scripts invited
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12 children to read the scenario as a pedagogical demonstration of the symbolic network
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14 between the artist, the pictures and their referents. Watching the adult make the drawings
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16 was not a crucial component of the pedagogical context, at least at this point of
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18 development.
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23 More broadly, evidence of language mediating children's symbolic comprehension
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25 comes from work by Callaghan (2000) and Homer and Nelson (2009). Homer and Nelson
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27 claim that language provides a social context for representation and that it scaffolds
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29 behavior and thought (Vygotsky, 1978). For these authors, language mediates symbolic
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31 representation by helping children to take a dual stance to pictures— to see them both as
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33 physical objects and as representations of something else (DeLoache, 1987, 1995).
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35 Nevertheless, all these prior studies were focused on the impact of verbal labels. In our
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37 studies, verbal descriptions of the artist's graphic actions appear to be another way in which
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39 language may support young children's symbolic understanding. In future studies it would
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41 be interesting to directly test the contribution of labels and descriptions of graphic actions
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43 in pictorial comprehension.
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49 Our findings do not allow us to pinpoint extra factors that could make 2-year-olds
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51 more sensitive to linguistic cues than non-linguistic ones. The experimenter's voice,
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53 intonation and verbal expression when explaining how she made the drawings could also
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55 help children to recognize that information being communicated was relevant to
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4 subsequently match the pictures with their referents. Thus, further research is needed to
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6 isolate these possible effects from the impact of verbal scripts.
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9 Additionally, the current data reveal an interesting developmental difference.
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11 Whereas 2-year-olds benefit from pedagogical cueing, 2.5-year-olds infer the artist's
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13 intention without any pedagogical cues (Study 1B). Two-and-a-half-year-olds' performance
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15 on the matching task evolutionarily complements the findings reported by Callaghan (1999)
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17 with 2- and 3-year-old children. Besides, the shift we have found between 2 and 2.5 years
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19 of age coincides with the well documented relatively rapid progress in children's
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21 comprehension of picture-referent relations (Callaghan, 2000; DeLoache & Burns, 1994;
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23 Salsa & Peralta, 2007).
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28 However, Study 1B shows a different pattern of results to that observed in Preissler
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30 and Bloom's (2008) study, in which eye gaze direction was an effective cue to intention for
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32 2.5-year-olds. What is the reason for this divergence? We can provide an answer by taking
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34 into account the nature of the drawings used in both studies. In the experiments of Preissler
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36 and Bloom (2008), the same shape (a circle) could represent either the referent object or a
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38 distracter object. As abstract pictures relate to referents only by virtue of referential intent,
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40 2.5-year-olds would need some ostensive cues to understand these types of drawings: Eye
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42 gaze direction while the artist was drawing and labeling ("A *spoodle!* I drew a *spoodle*"). In
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44 the current studies, we used highly realistic line-drawings; shape-based similarity seems to
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46 be sufficient to confer symbolic meaning at this age with a less salient cue to intention ("I
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48 drew some pictures of the toys").
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54 When looked at together, these studies suggest that children can make an inference
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56 about what pictures represent from an interplay between communicative cues and cues
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4 inherent to the symbol. They can do this by 2 years when the creator's intention is directly
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6 given in a pedagogical context, showing an implicit knowledge of the artist-picture relation.
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9 Close to their third birthday, children seem to be progressing towards a more accessible
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11 knowledge of this relation: They only need support watching an adult draw and label the
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13 depicted objects with abstract drawings, in which there are not perceptual cues of intention.
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15 However, these are only the first steps towards an explicit knowledge of the artist-picture
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17 link. For example, children's view of drawings includes a consideration of the attributes of
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19 the artist (age, sentience, affective style, and emotional state) beginning around 5 years of
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21 age (Callaghan & Rochat, 2003).
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25 To summarize, even at an age at which children have considerable difficulty using
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27 drawings as symbols, the present findings indicate that 2-year-olds tune into pedagogical
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29 cues, particularly linguistic cues, when they attempt to infer what an artist meant to draw.
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31 Prior research has found that pedagogical demonstrations serve as a gateway to imitation
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33 (Brugger, Lariviere, Mumme, & Bushnell, 2007; Southgate, Chevallier, & Csibra, 2009),
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35 inductive generalization (Butler & Markman, 2012) and children's transmission of
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37 culturally relevant information to others (Vredenburg, Kushnir, & Casasola, 2014). Our
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39 studies are the first to show that pedagogical demonstration seems to be a powerful tool for
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41 communicating referential intention when children engage with others who are using
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43 pictorial symbols.
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49 When an artist creates a picture, however, his or her intention might not only be
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51 referential. For example, the artist may want to convey certain emotions or induce a
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53 specific effect on the observer (expressive intention), tell a story (narrative intention) or
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55 produce a composition of shapes and colors that has a decorative purpose (aesthetic
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CUES TO ARTIST’S INTENTION

intention). Further addressing the facilitating effect of pedagogical cues to these different dimensions of intention is the challenge for future research on children’s pictorial comprehension.

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Table 1

Summary of the procedures used in the orientation phase of the task in Studies 1A and 2

	Study 1A		Study 2	
	PC	NPC	NLC	LC
The artist looked at the objects and slowly drew them	X		X	
The drawings were pre-made		X		X
The artist described her graphic actions	X			X
The artist matched each drawing with its referent	X	X	X	X

Note. PC = Pedagogical Cues; NPC = No Pedagogical Cues; NLC = Non-linguistic Cues;

LC = Linguistic Cues

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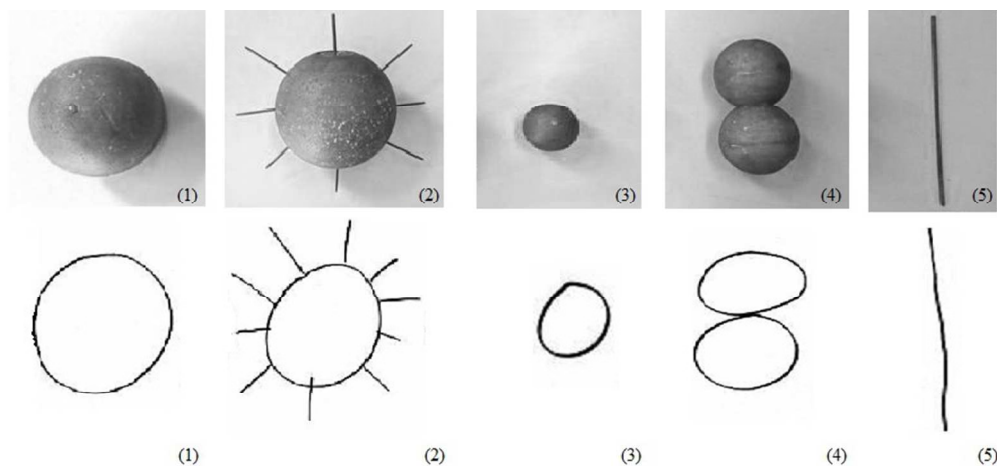


Figure 1. Objects and sample experimenter's line-drawings used in these studies.
234x112mm (96 x 96 DPI)

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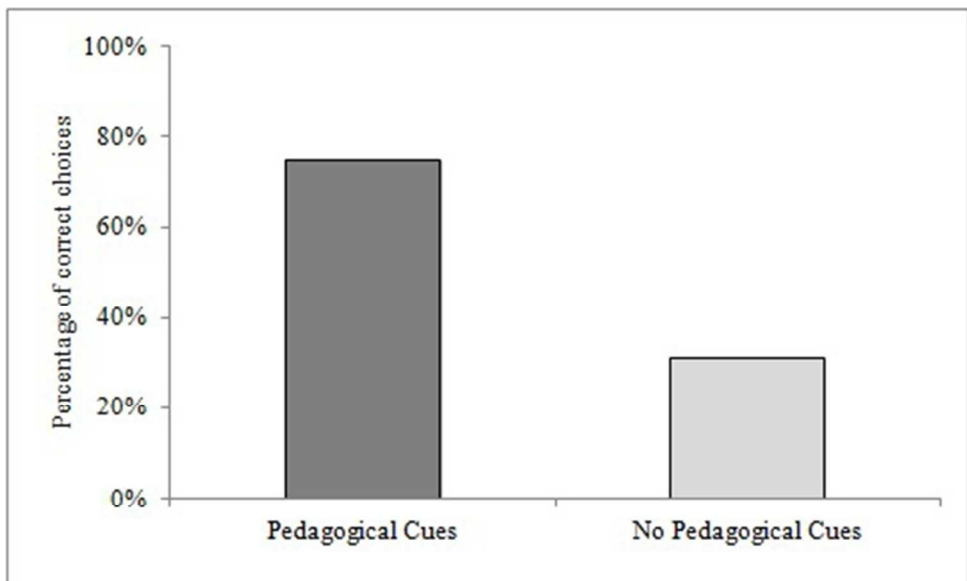


Figure 2. Percentage of correct choices in Study 1A.
128x78mm (96 x 96 DPI)

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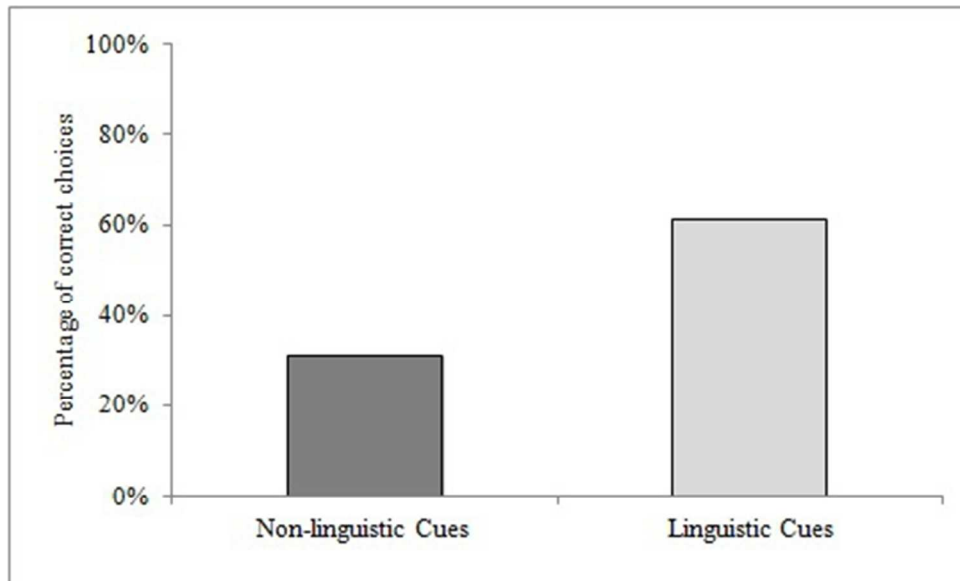


Figure 3. Percentage of correct choices in Study 2.
129x78mm (96 x 96 DPI)