Verbal imitation is based on intention understanding

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A B S T R A C T
Using an elicited imitation paradigm, we investigated whether young children imitate the communicative intentions behind speech. Previous research using elicited imitation has shown that children tend to correct ungrammatical sentences. This finding is usually interpreted as evidence that children, like adults, remember and reproduce the gist of linguistic information. In three studies, we tested whether this tendency is also a product of their intention understanding. Replicating and extending previous research by Meltzoff (Meltzoff A. N. (1995). Understanding the intentions of others: Re-enactment of intended acts by 18-month-old children. Developmental Psychology, 31, 838–850), our first two experiments showed that children tend to correct ungrammatical sentences. A critical third experiment showed that children correct ungrammatical sentences only when they believe the model to be an intentional agent. These results complement previous findings from the action domain and strongly support the claim that imitation is based on understanding the intentions of others.

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Imitation is a powerful learning mechanism. From infancy through to adulthood, we acquire many of our most important cognitive and social skills by observing and reproducing the behavior of others. The function of tools, the conventional use of objects, and appropriate social behavior and norms are all learned, partially or entirely, through imitation (Tomasello, 1999a). The cognitive mechanisms underlying this skill have been a topic of considerable debate. Whereas some researchers have argued that imitation is primarily based on direct matching (Iacaboni et al., 1999) or low-level associative processes (Heyes, 2001; Huang, Heyes, & Charman, 2002), others have argued that imitation is also based on an understanding of goals and intentions (Bekkering, Wohlschläger, & Gattis, 2000; Carpenter, Akhtar, & Tomasello, 1998; Carpenter, Call, & Tomasello, 2005; Gattis, Bekkering, & Wohlschläger, 2002;
Meltzoff, 1995). To date, this debate has concentrated almost exclusively on action imitation. In this article we attempt to shed fresh light on the topic by investigating the relatively neglected domain of verbal imitation.

1. Action imitation

There are three main accounts of the cognitive mechanisms underlying action imitation—the direct matching account (Iacaboni et al., 1999), the associationist account (Heyes, 2001), and the intention-based account (Bekkering et al., 2000; Carpenter et al., 1998). Direct matching accounts claim that humans possess an innate imitation mechanism through which visual input from observed actions is matched to proprioceptive feedback from self-produced actions (Meltzoff, 1993). The strongest support for directing matching accounts has come from the discovery of mirror neurons (Iacaboni et al., 1999; Rizzolatti, Fadiga, Fogassi, & Gallese, 2002; Rizzolatti, Fadiga, Gallese, & Fogassi, 1996). These neurons, located in the ventral premotor cortex of the macaque, fire both when a monkey observes an action and when it performs a similar action itself (Rizzolatti et al., 2002). Imaging studies have shown that there is a comparable ‘mirror system’ in humans that could provide a neurological basis for common coding between observed and produced acts (Meltzoff & Decety, 2003). However, the strong formulation of this account is incompatible with results suggesting that imitation is experience dependent, changing both with development (Perra & Gattis, 2008) and with relatively brief training (Gillmeister, Catmur, Liepelt, Brass, & Heyes, 2008).

In contrast to the direct matching account, the associationist account holds that imitation is highly experience dependent (Heyes, 2001). According to this account, imitation results from a series of excitatory vertical links between sensory and motor representations (Bird & Heyes, 2005). These links are generated through concurrent observation and execution of the same actions. This account gains strong support from data showing that mirror system activation can change and even reverse with training (Catmur, Walsh, & Heyes, 2007; Catmur et al., 2008). Moreover, it is compatible with evidence suggesting that non–human animals can be trained to imitate (Heyes, 2001; Mui, Hazelgrove, Pearce, & Heyes, 2008) and with studies demonstrating that adults automatically imitate the gestures and mannerisms of their social partners (Chartrand & van Baaren, 2009). Although associations no doubt play an important role in imitation, they cannot be the whole story: there is a growing body of research suggesting that imitation is a selective, interpretive process based on understanding the goals and intentions of a model.

The intention-based account holds that the mapping between perception and action is cognitively mediated. Behaviors are not replicated as unified motor patterns, but rather are broken down and reconstructed in terms of their goals (Bekkering et al., 2000; Gattis et al., 2002). This account is compatible with a large body of empirical evidence suggesting that both children’s and adults’ imitations systematically deviate from modeled behavior depending on interpretation of the model’s goals and intentions. For example, infants (Carpenter et al., 2005), young children (Bekkering et al., 2000; Gleissner, Meltzoff, & Bekkering, 2000) and adults (Wohlschläger, Bekkering, & Gattis, 2003) imitate the same action differently depending on its perceived goal. Moreover, infants copy intentional actions but not mistakes (Carpenter et al., 1998) or failed attempts (Meltzoff, 1995).

Although many are now convinced by the intention–based account (Carpenter et al., 1998; Carpenter, Call, & Tomasello, 2002; Carpenter et al., 2005; Meltzoff, 1995), some researchers in the associationist tradition maintain that such a rich interpretation of these data is unwarranted (Heyes, 2001). Many of the apparently convincing demonstrations of intention–based imitation can be explained by lower-level processes such as stimulus enhancement (increased attention towards an object as a result of seeing a conspecific interact with it) and emulation (learning the affordances of objects in a demonstration) (Huang et al., 2002; Huang, Heyes, & Charman, 2006) and perceptual salience (Bird, Brindley, Leighton, & Heyes, 2007).

2. Verbal imitation

Compared to the debate surrounding action imitation, there has been relatively little discussion of the mechanisms underlying verbal imitation. Most strikingly, there has been very little discussion of
whether verbal imitation is based on understanding the goals and intentions of a model (for one such discussion, see Tomasello, 1999b). However, there is some evidence suggesting that verbal imitation is cognitively mediated. Research using elicited imitation paradigms has shown that children do not always copy utterances exactly. As they acquire knowledge of their native grammar, they start to correct ungrammatical sentences (Akhtar, 1999; Bohannon, 1975; Love & Parker-Robinson, 1972; Scholes, 1969; Slobin & Welsh, 1973; Weener, 1971). For example, Slobin and Welsh (1973) found that, when their subject was presented with sentences which included ungrammatical repetitions, she would correct them in her imitation (by omitting the repetitions). Similar results were found by Love and Parker-Robinson (1972), who showed that children were more accurate in their imitation of grammatical sentences than ungrammatical sentences. Results such as these have been taken as evidence that children, like adults, remember the gist of linguistic information. When asked to imitate, they use their grammatical knowledge in order to produce a ‘best guess’ about the original form of the sentence. This best guess leads them to produce grammatical sentences in place of the ungrammatical models (Gathercole, Frankish, Pickering, & Peaker, 1999; Hulme, Maughan, & Brown, 1991). According to this account, verbal imitation relies on memory processes and grammatical knowledge, but not on intention understanding (see Tessari & Rumiati, 2004, for a similar view of action imitation).

We propose that the literature on action imitation suggests an alternative and even richer interpretation of these data. As noted above, from infancy, children appear to copy intentional actions but not mistakes (Carpenter et al., 1998) or failed attempts (Meltzoff, 1995). An ungrammatical sentence can be seen as equivalent to a failed attempt to perform an action. Although there is a failure in the surface form of the utterance, it succeeds nonetheless in conveying an intention to the listener. Drawing on this analogy, it is possible that children’s tendency to correct ungrammatical sentences is based not solely on their grammatical knowledge but also on a tendency to copy the perceived intentions behind speech.

3. The present experiments

In the series of studies presented here, we investigated whether verbal imitation is based on understanding the intentions of a speaker. In doing so, we explore whether imitation more generally involves intention understanding or whether it is purely a lower level process based on associative learning.

To address these questions, we drew on Meltzoff’s (1995) behavioral reenactment paradigm. Meltzoff (1995) compared imitation of successful actions to imitation of failed attempts. Infants in a Demonstrate (target) condition observed a model perform a successful action, for example pulling two halves of a toy dumbbell apart. Infants in a second, Demonstrate (intention) condition observed a ‘failed attempt’ to perform the same action; they watched the model’s hands repeatedly slip from the ends of the dumbbell. When offered the opportunity to imitate, infants in both conditions reproduced the goal of the action (pulling the toy apart) in equivalent numbers and did so significantly more often than infants in a control group who observed an irrelevant action on the toy. In other words, infants in the Demonstrate (intention) condition reproduced the intended goal of the action rather than the surface behavior they observed.

Further evidence in favor of this interpretation was provided by Meltzoff (1995) in a second experiment in which he compared imitation of a human model to imitation of a mechanical device. A Demonstrate (intention) condition was identical to the one outlined above; infants watched a human model try to pull two halves of the toy dumbbell apart. In a second, Demonstrate (mechanical slippage) condition, infants watched a pair of mechanical pincers perform a similar movement; the two claws repeatedly slipped from the end of the toy. When offered the opportunity to imitate, infants in both conditions reproduced the goal of the action (pulling the toy apart) in equivalent numbers and did so significantly more often than infants in a control group who observed an irrelevant action on the toy. In other words, infants in the Demonstrate (intention) condition reproduced the intended goal of the action rather than the surface behavior they observed.

In the present studies, we combine the logic of Meltzoff’s experiments with an elicited imitation paradigm. In the first two experiments we replicate and extend previous results on elicited imitation showing that children correct ungrammatical sentences. In the critical third experiment we test whether children treat ungrammatical sentences differently when they were spoken by an ‘intentional’ versus a ‘non-intentional’ model. If verbal imitation is based on intention understanding, children
should correct the ungrammatical utterances of the intentional model but repeat the same utterances without modification when they are spoken by the ‘non-intentional’ model.

4. Experiment 1

The purpose of this experiment was to replicate previous research showing that young children correct ungrammatical sentences. Following Slobin and Welsh (1973), we chose to compare children’s imitation of grammatically correct sentences to their imitation of sentences with ungrammatical repetitions. In keeping with previous research on elicited imitation, we chose to test this prediction with 3-year olds.

4.1. Method

4.1.1. Participants

Participants were 20 children (10 female) between the ages of 3–0 and 3–11 years (mean age 3–5). Another two children were excluded due to equipment failure and two for failure to complete the practice trials (defined as failure to respond to three or more consecutive sentences). Children did not have to repeat the practice sentences exactly in order to be included; any response (whether grammatical or ungrammatical) was sufficient for inclusion. Thus, only children too shy to speak at all were excluded. In this and the remaining studies, children were recruited from a database of volunteers, the city’s science museum and local nurseries.

4.1.2. Materials

Five ungrammatical sentences were adopted from the previously mentioned case study by Slobin and Welsh (1973). Each included ungrammatical repetitions, for example ‘I need need the ball’ and ‘Mark fell fell off the horse’. In order to compare performance on these sentences to children’s baseline tendency to copy sentences exactly, five control sentences were generated. These sentences were matched in terms of grammatical complexity rather than sentence length, for example ‘I need the ball’ and ‘Mark fell off the horse’. Ten grammatically correct filler sentences were also created, each containing five words. In order to overcome children’s shyness in speaking to the experimenter, nine practice sentences were generated. The first three sentences contained one word, the next three sentences contained two words, and the final three sentences contained three words (red, boo, door, small mouse, blue car, big dog, he fell down, a brown cat, a big apple).

4.1.3. Design

Test sentences were presented in two random orders. Children heard either the grammatically correct sentences or sentences with grammatical errors in a between-subjects design. The accuracy with which children reproduced the utterances was analyzed.

4.1.4. Procedure

Each child was invited into a quiet room and asked to sit on the floor with the experimenter. After a brief warm-up interaction, the experimenter introduced the copying game by asking “Can you say what I say?” Once the child understood the game, he or she heard and imitated the nine practice sentences followed by the five test sentences. Each test sentence was preceded by two grammatically correct filler sentences. During both practice and test trials children were praised for each response they gave regardless of its correctness. Children were thus reinforced for speaking rather than for offering a particular type of response. If a child refused to repeat a sentence it was presented up to three times. After the third attempt, the experimenter told the child they would try another sentence and the game continued.

4.1.5. Coding

Responses were coded from audiotape. Two coding categories were used: children either copied the sentence exactly or altered the sentence to a grammatically correct form. Twenty percent of the
responses were analyzed by a second coder. Agreement between the two coders was 100%, Cohen’s Kappa = 1.

4.2. Results

Mann–Whitney comparisons revealed that children were significantly more likely to copy exactly the grammatical as opposed to ungrammatical sentences ($U = 1.5, p < .001$, two-tailed). Moreover, they were significantly more likely to alter the ungrammatical sentences to a grammatically correct form ($U = 15.0, p < .01$, two-tailed). Children corrected the ungrammatical sentences either by dropping the repeated words, substituting the repeated words, or adding additional words to the sentences. For example, when presented the ungrammatical sentence ‘I need need the ball’ some children simply omitted the meaningless repetition of “need”, while others chose to add additional words, for example “I do need the ball”. These results replicate the results of previous elicited imitation studies and suggest that children correct sentences with ungrammatical repetitions.

5. Experiment 2

We interpreted the data from Experiment 1 as evidence that children correct ungrammatical sentences and therefore may be guided by the perceived intentions behind speech. However, an alternative interpretation of the data is that children failed to notice the ungrammatical repetitions (Slobin & Welsh, 1973). In Experiment 2, we asked another sample of 3-year olds to imitate sentences that contained either grammatical repetitions or ungrammatical repetitions. We predicted that if children fail to notice repetitions, they should omit repetitions from both the grammatical and ungrammatical sentences. However, if children correct ungrammatical sentences, they should omit only ungrammatical repetitions.

5.1. Method

5.1.1. Participants

Participants were 20 children (14 female) between the ages of 3–0 and 3–11 (mean age 3–6). Another two children were excluded for failing to complete the practice trials. As in Experiment 1, children were not expected to repeat the practice trials exactly; they were excluded only if they failed to offer three consecutive responses on the practice trials (regardless of whether those responses were grammatical or ungrammatical).

5.1.2. Materials

Eight test sentences were constructed. Four of these sentences contained grammatical repetitions, e.g. ‘Sam was a big big cat’, and four contained ungrammatical repetitions, e.g., ‘The cat was too big big for the chair’. The nine practice sentences, as well as eight grammatically correct filler sentences, were taken from Experiment 1.

5.1.3. Design

As in Experiment 1, children heard either grammatically correct sentences or sentences with grammatical errors in a between-subjects design.

5.1.4. Procedure

The instructions, practice trials, and testing procedure were identical to those used in Experiment 1.

5.1.5. Coding

Responses were coded from an audiotape into the same categories as Experiment 1. A child either repeated the sentence exactly or altered the sentence to a grammatically correct form. Twenty percent
of the dataset was analyzed by a second coder. Agreement between the two coders was 100%, Cohen’s Kappa = 1.

5.2. Results

Mann–Whitney comparisons revealed that children were significantly more likely to copy exactly sentences with grammatical as opposed to ungrammatical repetitions (U = 7.0, p < .001, two-tailed). Moreover, they were significantly more likely to alter sentences with ungrammatical repetitions to a grammatically correct form (U = 6.0, p < .001, two-tailed). These results demonstrate that children’s tendency to correct ungrammatical sentences was not due to a failure to notice repetitions. This conclusion is consistent with a large body of work suggesting that children of this age correct ungrammatical sentences more generally (Vinther, 2002).

6. Experiment 3

This experiment provided the critical test of our hypothesis. We compared imitation of ungrammatical sentences delivered by an apparently ‘intentional’ agent to imitation of the same sentences delivered by a ‘non-intentional’ agent (following Meltzoff, 1995). If children’s tendency to correct ungrammatical sentences is based solely on their grammatical knowledge and memory constraints, they should correct both the ‘intentional’ and the ‘non-intentional’ model. However, if children imitate the intentions behind speech, they should correct only the ‘intentional’ model.

6.1. Method

6.1.1. Participants

Participants were 20 children (10 female) between the ages of 3–0 and 3–10 (mean age 3–5). Another three children were excluded for failing to complete the practice trials and one for parental interference during the test phase.

6.1.2. Materials

The recording included the 4 ungrammatical test sentences from Experiment 2, along with the 8 grammatically correct filler sentences and 6 of the practice sentences. The ‘non-intentional’ agent was a green and yellow cardboard box, approximately 8 in. tall. The tape recorder was concealed on a small shelf at the back of the box. The ‘intentional’ agent was a green and yellow soft toy frog, also 8 in. tall. The tape recorder was concealed in a small rucksack on the toy’s back. In order to ensure that the sound quality was held constant across conditions, the speakers were always left uncovered. Fig. 1 presents photographs of each agent.

6.1.3. Design

Children heard the recording delivered by either the intentional or the non-intentional model in a between-subjects design. Manipulation of perceived intentionality was based on research demonstrating that when either of two critical cues are present, children will attribute intentionality to an inanimate object. First, children attribute intentionality to an inanimate object if it engages in a contingent interaction with them. For example, Johnson, Slaughter, and Carey (1998) showed 12-month olds an inanimate object (a furry brown object about the size of a beach ball) that either bleeped in response to infants’ babbling or bleeped at random intervals. Infants were significantly more likely to follow the gaze of the inanimate object when its actions were contingent upon theirs. Second, children will attribute intentionality to an object if it has features resembling a face; infants in the same Johnson et al. (1998) study were significantly more likely to follow the gaze of the inanimate object if it had facial features (see also Johnson, Booth, & O’Hearn, 2001). Consequently, we manipulated the perceived intentionality of the model in two ways, first by altering its physical appearance and second by altering the nature of children’s interaction with the toy. Whereas the toy frog had a face, the box had similar features arranged in a non-face-like configuration. Whereas the frog engaged
Fig. 1. Stimuli from Experiment 3. The left-hand panel shows the ‘non-intentional’ model, a cardboard box. The right-hand panel shows the ‘intentional’ model, a soft toy frog that engaged in a contingent social interaction with the children.

in a contingent social interaction with the child prior to speaking the test sentences, the box did not.

6.1.4. Procedure

In both conditions the copying game was introduced by having children complete the first three practice sentences with the experimenter, after which the model was introduced. The nature of this introduction varied by condition; in the non-intentional condition the experimenter introduced the model by saying “Now look at this. This is just a box, and boxes can’t really speak, can they? But if I press these buttons I can make it sound like the box is speaking. Can you say what the box says?” In the intentional condition, the experimenter introduced the model by saying “This is my friend Froggie. Can you wave to him? [child waves then Froggie waves] Froggie would really like to play this game with you. Can you say what Froggie says?” Once the child agreed, the experimenter told the child that Froggie was really excited.

The child then heard the final six practice sentences, followed by the four ungrammatical test sentences. Each of the ungrammatical test sentences were preceded by two grammatically correct filler sentences. Once the child repeated a sentence, the experimenter played the next sentence. During both the practice sentences and the test phase, children were praised by the experimenter after each response they gave, regardless of whether they produced a grammatically correct sentence or not. In this experiment, test sentences were presented only once. If a child failed to respond on the first presentation, the sentence was not repeated.

6.1.5. Coding

Twenty percent of the dataset was analyzed by a second coder who was blind to experimental condition. Agreement between the two coders was 94%, Cohen’s Kappa = .881.

6.2. Results

Fig. 2 shows the mean number of times children produced exact copies versus corrections in response to the intentional and non-intentional models. Mann–Whitney comparisons revealed that children were significantly more likely to exactly copy the box than the frog ($U = 16, p < .01$, two-tailed). Moreover, they were significantly more likely to correct the frog than the box ($U = 23, p < .05$, two-tailed).

A possible objection to these results is that children could have been paying more attention in one of the conditions. Although we made every effort to make the frog and the box as visually similar
as possible, the nature of our manipulation meant that there were visual dissimilarities between the two models. Thus, despite the fact that children heard an identical recording of the ungrammatical sentences in the two conditions, it is possible that children may have found either the frog or the box more interesting. The inclusion of grammatically correct filler sentences allowed us to test for this possibility. If children were paying more attention in one of the conditions, they should have been more accurate in repeating the filler sentences in that condition. However, a Mann–Whitney test revealed no significant difference between the two conditions ($U = 37, p = .35$, two-tailed).

7. General discussion

In three experiments we investigated whether verbal imitation is based on intention understanding. To do so, we applied the logic of a well-known action imitation paradigm to the verbal domain. Meltzoff (1995) compared imitation of successful actions to imitation of failed attempts and found that, whereas infants copy successful actions exactly, they tend to correct failed attempts. In our first two experiments we replicated and extended previous results by showing an analogous pattern of results in the verbal domain. Whereas children copied grammatical sentences exactly, they tended to correct ungrammatical sentences. This held true even when both the grammatical and ungrammatical sentences contained repeated words.

Experiment 3 provided the critical test of our hypothesis. Again the paradigm was analogous to one used in the action domain. Meltzoff (1995) compared imitation of unsuccessful actions delivered by an intentional agent (a human model) to the same actions delivered by a non-intentional agent (a pair of mechanical pincers). Results showed that whereas infants tended to correct the failed attempts of the human model, they copied the same actions exactly when performed by the pair of mechanical pincers. Meltzoff interpreted this as evidence that infants attributed an intention to the human model but not to the mechanical device. In Experiment 3, we compared imitation of unsuccessful (i.e., ungrammatical) utterances delivered by an intentional agent and a non-intentional agent. Children in both conditions heard the same audio-recording of four ungrammatical sentences. The variation between conditions was the perceived intentionality of the model—either an inanimate cardboard box the experimenter could make ‘talk’ or a toy frog that engaged in a contingent social interaction with child and experimenter (Johnson et al., 1998). Consistent with the intention-based hypothesis, children tended to correct the utterances of the apparently intentional frog but repeat the utterances of the non-intentional box exactly.

At first glance it seems possible to argue that, rather than being indicative of intention understanding, the results of Experiment 3 could be explained in terms of differential attention in the two
conditions. Perhaps children paid more attention to either the frog or the box and varied their copying behavior accordingly. However, if children were paying more attention in one condition than the other, they should have performed differently not only on the ungrammatical test sentences but also on the grammatically correct filler sentences. Instead, they were equally accurate in the two conditions.

A great deal of research has shown that children correct ungrammatical sentences of various forms (Akhtar, 1999; Bohannon, 1975; Love & Parker-Robinson, 1972; Scholes, 1969; Slobin & Welsh, 1973; Vinther, 2002; Weener, 1971). The standard interpretation of these findings is that children remember the gist of linguistic information. When asked to imitate, they use their grammatical knowledge in order to produce a best guess about the original form of the sentence, leading them to correct ungrammatical sentences. According to this interpretation, verbal imitation relies on memory processes and grammatical knowledge, but not on intention understanding. The results of Experiment 3 provide support for the claim that, although memory limitations may influence sentence reproduction, children’s understanding of the intentionality of the speaker also plays a role. Children interpret ungrammatical repetitions as failed attempts and use their grammatical knowledge in order to accurately reproduce the perceived intentions behind the utterances. Interpretation of past results using elicited imitation paradigms ought to be re-evaluated in light of these results.

The results of Experiment 3 are also inconsistent with claims that associative learning alone can explain verbal imitation. These accounts predict that the perceived intentionality of a model should not affect children’s copying behavior. Although associative accounts explain a great deal of data on imitation (e.g., Catmur et al., 2008), they cannot explain the differences in children’s imitation of the intentional and non-intentional models in Experiment 3. These results, however, can be easily explained by the claim that children attributed intentions to one of the models but not to the other.

The present studies also contribute to our understanding of imitation more generally. Despite many convincing demonstrations of intention-based imitation, several individual studies have been criticized for confounding intention-based imitation with lower level processes. To take just one example, Meltzoff’s (1995) behavioral re-enactment paradigm has been criticized for confounding intention-based imitation with stimulus enhancement and emulation (Huang et al., 2002, 2006). Huang et al. (2002) showed that, when these two factors were controlled for, infants who observed a failed attempt were no more likely to produce the target action than infants in a control condition (see Meltzoff, 2007 for an alternative viewpoint). When the data from our studies are combined with studies from the action domain (e.g., Bekkering et al., 2000; Carpenter et al., 1998; Gergely, Bekkering, & Király, 2002), they provide strong support for the claim that intention-understanding plays an integral role in imitation, thus posing a serious challenge to those who claim that associative learning alone can explain imitation.

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