Young Children's Understanding of Denial

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Although a fair amount is known about young children's production of negation, little is known about their comprehension. Here, we focus on arguably the most complex basic form, denial, and how young children understand denial, when it is expressed in response to a question with gesture, single word, or sentence. One hundred twenty-six children in 3 age groups (Ms = 1 year 9 months, 2 years 0 months, and 2 years 4 months) witnessed an adult look into 1 of 2 buckets and then, in response to a question about whether the toy was in there, communicate either something positive (positive head nod, "yes," "it is in this bucket") or negative (negative head shake, "No," "It's not in this bucket"). The youngest children did not search differently in response to any of the communicative cues (nor in response to an additional cue using both gesture and single word). Children at 2 years 0 months searched at above-chance levels only in response to the negative word and negative sentence. Children at 2 years 4 months were successful with all 3 types of cues in both positive and negative modalities, with the exception of the positive sentence. Young children thus seem to understand the denial of a statement before they understand its affirmation, and they understand linguistic means of expressing denial before they understand gestural means.

Keywords: negation understanding, denial, language development, gesture

Negation is complex both cognitively (Piaget, 1977) and linguistically (Horn, 2001). The functions of negation range from simple protest through to denial and deception, which requires the understanding of other minds. The same linguistic forms often express a wide range of these functions. Negation is, therefore, a central focus for understanding the relationship between cognitive development and language development, and, from the outset of the modern study of child language acquisition, researchers have investigated when and how young children acquire and use the many and various forms of negation that are conventionalized in natural languages (see Brown, 1973; Wode, 1977, for an early review). In this article, we experimentally test young children's comprehension, in third-party exchanges, of one use of negation, namely, denial. We explore two theoretical positions: the first which sees denial as logically dependent on affirmation; the second focuses on the interaction between the forms that children learn from their input as a function of frequency and saliency and their cognitive readiness to understand a particular function. Although these two positions are not necessarily mutually exclusive, they have rarely been studied together: One starts from logical analysis, whereas the other focuses on the context in which children process the relations between states of the world and the language used to describe them. In testing how children process the expression of affirmation and denial with gestures and utterances, we aim to illuminate the strength and potential relationship between an important aspect of cognitive development and children's communicative understanding.

Studies examining the acquisition of negation reveal that, initially, children express subfunctions, which relate to objects and events occurring in the immediate context (Bloom, 1970; Choi, 1988; Pea, 1980; Tam & Stokes, 2001). These are typically instances that violate the child's perceptual expectation (an object vanishing from view) or conflict with their desires (refusing to eat a certain type of food). These early expressions therefore are motivated by perceptually salient events (rooted in behavioral rather than linguistic comprehension) and do not rely on more abstract reasoning (such as theory of mind, counterfactual thinking, or truth-functional reasoning). On these grounds, denials are widely regarded to be distinct from other subfunctions of negation because of their complexity (Choi, 1988; Heinemann, 1943; Horn, 2001; Pea, 1980; Verhagen, 2005).

In contrast to a number of early acquired negative subfunctions, children's understanding of propositional denials is argued to rely on their ability to handle multiple mental models simultaneously (Hummer, Wimmer, & Antes, 1993; Perner, 1991; Verhagen 2005). It is assumed that the child must construct two conflicting mental models (one corresponding to the true state of affairs and one to the presupposed false state) and then use the negator to select the relevant model (Hummer et al., 1993). In this approach, upon hearing a negative assertion, the child must construct a counterfactual affirmative situation (based on prior experience and deductive logic) enabling them to understand what is true from

what is not true (Kaup, Yaxley, Madden, Zwaan, & Lüdtke, 2007). If this is the case, then by contrast with affirmatives, denials require that children have not only a greater linguistic understanding to process the negator but also a greater understanding of the communicative intentions of others.

Under these assumptions, children's understanding of denial requires that they are able to construct and understand what the affirmative state of affairs is or is alleged to be. A prediction, therefore, is that children would be able to understand the affirmation of a proposition before its negation. This is supported in psycholinguistic studies that indicate that negation reliably increases cognitive load (Bloom, 1970; Guidetti, 2000; Horn, 2001) and slows processing times in adults using statements (Kim, 1985; Pea, 1982; Wason, 1961) and picture-verification tasks (Slobin, 1966). However, a number of factors suggest caution in extending these results to wider situations of affirmation and denial. These experiments largely use statements about visible objects ("This is a cat, This is not a cat: The cat is on the mat, The cat is not on the mat"). Although it may be the case that in this type of study, it is easier to comprehend a correct identification than to deny it, this may be more a result of the experimental setup than of a logical analysis. It may be pragmatically very odd to be looking at a picture, in this instance of a cat, and be asked to process the truth or falsity of a statement that, for instance, it is not a cat. In more pragmatically motivated interactions, it seems possible that there is no necessary priority to comprehending a positive or negative statement, for instance, in conveying information about the location of nonvisible objects, ("It is in the box, It is not in the box"). Thus, the experimental setup and its pragmatics may play a greater role than a logical analysis of the relation between affirmation and denial.

Denial is also related to deception in that children who attempt to lie about a situation or action must be able to understand the relationship between the fact that the event actually took place and their subsequent denial of it. This, of course, adds a significant affective dimension to the potentially more neutral situation in which children are denying a proposition in which they have little or no investment. Research suggests that, in experimental settings, children can only be trained to make false statements from age 2 years 7 months (Ahern, Lyon, & Quas, 2011), and even then they show a strong "yes" bias, tending to answer *yes* to questions of the type "Did you see an X?" whether or not this was the case. Other studies show 2- to 3-year-olds exhibit a "yes" bias to a range of yes–no questions, attributed to social pressures, a lack of pragmatic understanding, and failure to inhibit a dominant response strategy, perhaps because parents rarely ask questions requiring a no response (Moriguchi, Okanda, & Itakura, 2008; Okanda & Itakura, 2010). Experimental studies on deception show that it is not until around age 3 years 0 months that children start to show the ability to lie systematically (Polak & Harris, 1999; Talwar & Lee, 2002). However, these studies focused on children's development of the ability to deceive rather than on either their comprehension of deception by others or of nonaffectively loaded denial and affirmation. In the present study, we focus on comprehension of denial and affirmation in nondeceptive situations to address the two issues of whether, in this case, comprehension comes before production and whether removing the affective dimension of lying makes denial easier to understand.

The second major feature of our investigation is the order in which children comprehend the forms with which the different functions of denial and affirmation are expressed. In production, young children first express negation gesturally, as they begin to refuse or reject things from their parents using either idiosyncratic gestures such as pushing things away or more conventional gestures such as nods and side-to-side head shakes, which start to be used around the age of 1 year 1 month (Pea, 1980). These forms account for the majority of a child's agreement and refusal messages until the ages of 1 year 3 months–1 year 5 months when they start to produce negation in verbal form as single words (Fenson et al., 1994; Guidetti, 2005; Horn, 2001; Pea, 1980). In the single-word period, children typically produce the most frequently used negative markers in their surrounding input, for example, in English, *no* and *not* (Bloom, 1970; Choi, 1988; Pea, 1980). These markers are the first to be combined within multiword constructions until more specialized markers (in English, *n't*, as in *can't*) replace them (Cameron-Faulkner, Lieven, & Theakston, 2007). Thus in production, the earliest expressions of negation are gestural, followed by single words and, finally, by the use of more sophisticated multiword phrases (e.g., "I don't want it, I can't do it").

In her cross-linguistic analysis of negation, Choi (1988) argued that the acquisition of denials marked a new developmental phase where children's cognitive and linguistic development enabled them to map subfunctions of negation in a more adultlike manner. As such, she theorized that the acquisition of denials marked a time when children were making more fine-grained analyses of the form-function mappings in their linguistic input. Denials therefore are widely regarded to be one of the last major negative subfunctions to be expressed in production. Initially, children produce denials with the verbal markers *no* or *not* (Choi, 1988; Pea, 1980) and are only able to deny propositions after they can reject actions and comment on nonexistence (Choi, 1988). Production studies show that children begin to produce *no* and *not* responses from the age of 1 year 7 months–2 years 1 month (Choi, 1988; Pea, 1980). However, it is not until age 2 years 4 months–2 years 7 months that children are able to use them with a consistent mapping of their discourse function (Hummer et al., 1993; Pea, 1980). Few studies have examined the acquisition of affirmation. Results from observational studies show that children begin to produce yes responses from age 1 year 7 months (Fensen et al., 1994) and begin to understand their semantic function in question answering around the age of 2 years 0 months–2 years 3 months (Choi, 1991). There is also very little research on the use and frequency of nonverbal markers in children's early denials. However, studies have revealed that children rarely use head gestures to deny their parents' propositions but do use them occasionally to express agreement (Fusaro, Harris, & Pan, 2012; Pea, 1980). Once they can produce full sentences, the function of denial is most often expressed by English-speaking children using *not* and its many variations (e.g., "It isn't!") (Bloom, 1970; Cameron-Faulkner et al., 2007; Choi, 1988; Guidetti, 2005; Pea, 1980). We tentatively summarize these results as follows: (a) It seems that head gestures are rarely used for denial but occasionally used for affirmation; (b) although *yes* affirmative responses to questions comes before *no* responses, at an early stage these may show a bias for the children to say "yes" independently of the accuracy of the answer; and (c) children tend

to express denial in full phrases once they have the capability to do so.

However, note that all these results refer to production in naturalistic observational data rather than children's comprehension, and this is true of the majority of previous studies (Bloom, 1970; Cameron-Faulkner et al., 2007; Choi, 1988; Pea, 1980; Tam & Stokes, 2001; Vaidyanathan, 1991). The study of denial is particularly problematic using this type of methodology, as the pragmatic situations required to motivate the child to produce denial responses may occur infrequently. This problem is exemplified in Bloom (1970) where contrived conditions had to be set up in order to elicit a denial response from the subject, Gia. As we have already noted, children also have a tendency at these ages to agree with adults, which may bias observations (Bloom, 1970; Guidetti, 2000, 2005; Okanda & Itakura, 2010).

There are only two experimental studies of denial that attempt to systematically elicit negative forms from young children. The first by Pea (1982) had adults make statements that were incorrect (e.g., "The dog is on the mat"), and English-speaking children age 1 year 9 months–3 years 0 months had the opportunity to deny and/or correct them. Children were first able to do this only after their second birthdays. The second study by Hummer et al. (1993) showed German-speaking children (age 1 year 1 month–2 years 7 months) pictures and then asked them questions, including the right and wrong labels, for example, "Is this a dog?" when showing a picture of a cat. If children said "no," they were given credit for denial. Children typically began to use these denials from around 1 year 8 months and used them with more consistency around 2 years 4 months.

Much less is known about young children's comprehension of denial in early development. One possibility is that comprehension follows the order in which markers appear in production. If so, we might expect children to comprehend denial and affirmation earliest with conventional nonverbal gestures, followed by single words and then, finally, multiword utterances. We know that, in general, children use negative gestures before the associated verbal markers (Fenson et al., 1994). But relatively little is known about how this pattern of acquisition relates to the use of these forms in the language children hear. It is unclear whether the raw frequency of a marker is the determinant of acquisition, independent of its function, or whether other factors, such as the uniqueness of the mapping between form and function, are also, or more, important. The problem is that there are many different ways to express any given function linguistically in a given language, and any particular marker can be used to express a range of different functions. But some of these form-function mappings are more tightly associated than others. Early negative gestures are typically used for rejection, not denial (Pea, 1980), and thus, although head shakes can be used to express denial, they may not be initially learned together. Another possibility is that tone of voice may well accompany negative gestures, and these may be heard with different frequencies and become associated with different functions in complex ways (e.g., Cameron-Faulkner et al., 2007). Thus, the fact is that a proposition may be denied with a shake of the head, the word *no* (in the appropriate linguistic context), or with a full sentence including the word *not*. And all of these negative forms are heard by the child with different frequencies and different degrees of association between form and function (e.g., *no* is used for more other functions than *not*).

A second possibility is that denial is initially expressed by generalizing from previously learned negative linguistic markers (Bloom, 1970). This could suggest that *no* would be comprehended earliest and best for denying propositions because children understand its general negative function: *No* is also typically acquired early around age 1 year 3 months (Fenson et al., 1994; Pea, 1980). However, as for the head shake gesture, *no* is used in so many different functions that its use in any given context could easily be indeterminate. Finally, although *not* would seem to be more difficult because it is typically embedded in full clauses of some kind, *not* is nevertheless the prototypical form of denial, and it is likely children have heard more denials of propositions in this form than in other forms. Perhaps, then, *not* will be the earliest and best understood marker of denial. Issues of how children map form to function are central to this proposal: They may have learned a particular form but only in relation to a particular function, either because this is the most frequent mapping in the input or because they are not yet cognitively ready to understand the function being expressed. In the present study, we test children's comprehension of each type of marker separately: head gestures, single words, and multiword utterances.

There is one recent study of children's emerging comprehension of gestural affirmations (head nods) and denials (head shakes) in a nonaffective context. Fusaro and Harris (2013) presented children age 1 year 8 months and 2 years 0 months with questions and statements concerning the identity or location of a novel object. In the location condition, an experimenter produced either two statements ("It's in here") or two questions ("Is it in here?") while referring to each of two possible boxes (locations) containing a hidden object in turn. A second experimenter produced a head nod in response to one statement or question and a head shake in response to the other. Children were then required to pick the correct location. At 1 year 8 months, children were generally unable to pick the correct location, although there was some indication that they were able to use the gestural cues to identify the correct location in response to questions. By 2 years 0 months, children were able to use gestural cues in response to both questions and statements, performing significantly above chance. However, it is important to note that as children received both head nods and head shakes on each trial, it is impossible to determine which of these cues they were sensitive to, and whether this changed with age. It is also impossible to compare the children's performance on gestural cues against other verbal markers.

In the present study, therefore, we attempted to determine what young children understand about denial and how this changes in the early stages of communicative development. Children were required to comprehend the communicative function of a yes–no question used in a third-person exchange and to use their past experience of where an experimenter had looked during a trial as a means to judge the experimenter's response to the question. Children's understanding of third-party interactions emerges around 1 year 2 months. At this time, they are able to understand the function of gaze direction and pointing in a hiding game between two adults (Gräfenhain, Behne, Carpenter, & Tomasello, 2009). By 1 year 6 months, children can reliably use these cues in isolation and are able to use their past experience of an interactant, without social engagement, to understand their focus of attention (Moll & Tomasello, 2007). The youngest children in our study were age 1 year 8 months, so the question is whether adding a

linguistic component to the third-party exchange makes understanding this exchange more or less difficult. The linguistic exchange consisted of a yes–no question by one experimenter (who was assisting the child to find the object) and an answer from the second experimenter, which, if correctly interpreted, would guide the child to the correct solution. On the one hand, two studies have shown that children can learn words from third-party exchanges by 1 year 6 months (Akhtar, 2005; Gampe, Liebal, & Tomasello, 2012), and one could argue that actually learning a new word from third-party observation is more challenging than simple comprehension of the types of exchange that occur in our experiment. On the other hand, in purely linguistic terms, although yes–no questions are typically the first question types that children learn to respond to (from 1 year 3 months; Ervin-Tripp, 1970), it is not until around 2 years 0 months–2 years 3 months that they begin to respond in a semantically appropriate manner (Choi, 1991; Steffensen, 1978). Thus, we might predict that the youngest children would indeed have difficulty with interpreting the third-party linguistic exchange, and, therefore, neither the type of response nor whether it was in the affirmative or negative would make any difference to their success on the task.

In summary, we tested children's comprehension at three different ages, from 1 year 8 months to 2 years 6 months, in a third-party paradigm in which they had to determine the truth of a proposition by observing one adult questioning another adult about the location of a hidden object (e.g., E1: "Is it in the X?"; E2: "No"). To test the difference between affirmation and denial, the second experimenter sometimes responded with a negative response, and sometimes with an affirmative response. To investigate which form children understood earliest, denial and affirmation were tested in three between-subjects conditions (gesture "head shake/nod," single-word utterance: "no/yes," or proposition: "It's not/it is in the X," respectively). These particular age ranges were chosen because of the results obtained in previous elicitation studies (Hummer et al., 1993; Pea, 1982). They also cover the period when, according to naturalistic studies, denials begin to emerge in children's productions (Choi, 1988; Pea, 1980) and the period during which children begin to answer yes–no questions with semantically appropriate marking (Choi, 1991).

From a purely logical analysis, the prediction would be that affirmation should be understood before denial; however, as argued above, this may depend on the precise pragmatics of the experimental situation. In terms of comprehension of the type of utterance, the simplest prediction is that this would follow the general order of production found for affirmations and negations: gestures before single words, followed by multiword utterances. However, as argued above, the order of acquisition may reflect specific form-function mappings and their distribution in the input to children.

Method

Participants

One hundred twenty-six monolingual English-speaking children participated. Children were recruited from the Child Study Centre database at the University of Manchester. Parents were provided with full information about the study and gave written consent before their child participated in the study. There were three age groups, referred to as Group 1 (age 1 year 8 months–1 year 10 months), Group 2 (age 2 years 0 months–2 years 2 months), and Group 3 (age 2 years 4 months–2 years 6 months), respectively, each containing 42 participants (Group 1: $M = 1$ year 9.01 months, 20 boys; Group 2: $M = 2$ years 0.20 months, 19 boys; Group 3: $M = 2$ years 4.23 months, 22 boys).

In addition, 22 participants (eight age 1 year 8 months–1 year 10 months; five age 2 years 0 months–2 years 2 months; nine age 2 years 4 months–2 years 6 months) were tested but were excluded from the study after they showed a 100% side bias to a specific location. A further 53 participants began the testing phase but failed to complete 75% of the trials. Of these participants, six were age 2 years 4 months–2 years 6 months, 17 were age 2 years 0 months–2 years 2 months, and 27 were age 1 year 8 months–1 year 10 months. Throughout the testing phase, seven trials were excluded (across the entire sample), as children may have been influenced by their caretaker or required that a question be repeated more than twice.

Materials and Design

Children were asked to play a "hiding game" where they could find a number of wooden blocks. These blocks were made desirable: They could be inserted into a box (the plink machine) that made a noise. Each block could be hidden in one of two locations (a house and a bucket), both of which were opaque (preventing the child from seeing inside them) and had a hole in the back enabling a block to be placed inside without the child's knowledge. Each container was also fitted with a cover (a roof and lid), allowing the child and experimenter to look inside. In order to keep the location of the block a secret, each container was kept behind a barrier until the child was given the opportunity to search.

Children were divided into one of three between-subjects conditions: gesture, single word, or proposition. Each child then received 12 test trials with two within-subject conditions (four trials in each). The within-subject measure was an alternating polarity (positive, negative) given in response to a yes–no question ("Is it in the house/bucket?").

The location of the hidden block was counterbalanced, allowing it to appear equally in each of the two locations (the house and bucket). In addition, the order of trials was manipulated so that, although random, the location of the box and polarity of the trial were never repeated more than twice in a row. Table 1 illustrates the design of the study.

Procedure

Testing took part in a Child Study Centre. Before attempting the test phase, each child was presented with a warm-up and training

Table 1
Experimental Design

Response type: Within-subjects variable	Mode of communication: Between-groups variable		
	Gesture	Single word	Sentence (Proposition)
Positive	Head nod	"Yes"	"It's in the bucket"
Negative	Head shake	"No"	"It's not in the bucket"

phase. The intention of this was to familiarize them with the experimental procedure, ensuring they understood what would be expected of them when testing began.

The warm-up and training phases served as a chance for the children to bond with E1 and to see themselves and E1 as a "team." This was important, as it would make the child more involved with the question and response procedure, guiding his or her attention to what E1 (and they themselves by association) was asking, and what E2 was affirming or denying. In the warm-up phase, each child was introduced to the first experimenter (E1), who immediately showed him or her the "plink machine" and demonstrated how to use it. After playing with four blocks, the child was told that the second experimenter (E2) had more blocks but that he "likes to hide them."

In the training phase, participants began to play a simplified form of the experimental procedure. The phase consisted of four trials that were rigged to ensure that the child was both successful and unsuccessful in attaining a block (every participant was successful in the first and third trials and unsuccessful in the second and fourth). E2 began by pulling the house and bucket behind a barrier obscuring them from the view of E1 and the child. He would then either insert a block into both of the two containers or leave them both empty. Both the house and the bucket would then be pushed from behind the barrier (one to each side), and the child would then be allowed to choose which one he or she thought the block was in. It was stressed to the child that he or she could only pick one box per trial and that if he or she did not find a block, then he or she would not be able to use the plink machine (encouraging attention). If the child was unwilling to pick a box on the first trial, E1 would help him or her choose. If E1 helped the child, E1 would also help on the subsequent failure trial to avoid any damage to the child's confidence. On the rare occasions when children failed to pick a box on the fourth trial, the game was terminated, and the child excluded from the analysis. After every selection, the child was shown whether or not there was a block in the other location. This required E2 to secretly remove (for success trials) or insert (for failure trials) a block in the second location. After the four training trials, the child was then told by E1 that to get a block every time, E1 would need to ask E2 questions about where the block was. The main point of the training phase was to establish an expectation within the child that they could not be successful 100% of the time purely by guessing.

In the experimental phase, E1 and the child sat in front of E2. After hiding the block and positioning the containers, E2 would sit equidistant between them and look at the child and E1. E1 would then ask E2 a question, "Is it in the . . . ." during which E2 looked at both the child and E1 and then proceeded to look in the corresponding location. After E2 returned to his position equidistant between the two locations, E1 would then repeat the question, focusing the child's attention toward E2. E2 would only respond (gesturally or verbally according to condition, see Table 1) once he and the child made eye contact to make sure (especially in the gesture condition) that the child was paying attention. E2's facial expressions were kept to a minimum when responding, and particular effort was made to make sure that any conflicting or contributing communications were absent. Most children understood the task and spontaneously went to search in one of the two locations once E2 had given his response. However, if the child failed to move toward either location, E2 encouraged the child to

search for the hidden block in one of the two locations by pointing to both locations simultaneously and asking, "Where is it? Is it in the house or the bucket?" or by pointing first to the house saying, "Is it in the house?" then immediately pointing to the bucket saying, "Is it in the bucket?"—these questions were then repeated in reverse order to avoid highlighting one or other location. If children were successful, they were able to insert the block into the plink box before returning to sit with E1 in preparation for the next trial. The child's caregiver was present in the room during the entire game. Caregivers sat either away from the child and E1 or a little way behind the child and E1. Caregivers were instructed not to try to help their child or give hints. On the rare occasions when caregivers provided a hint, these trials were excluded.

Coding and Reliability

Participants' choices were recorded by both experimenters while the experiment was being conducted, according to whether the child looked in the same location as E2 had looked to find the block. This was the correct location in positive trials, and the incorrect location in negative trials. In addition, there were two video cameras, one filming the child and one filming E2, which enabled postexperiment verification of any coding discrepancies. Primarily, the use of video allowed postassessment of the child's attention during testing along with the ability to scrutinize E2's facial expressions and gestures. Each trial was coded by the two experimenters with 99.8% concordance ratings across the experiment. Any anomalous data points were discussed by both experimenters after consulting the video data and were altered accordingly.

Results

Children's responses were measured in relation to where the second experimenter had looked during the question and response procedure. As a result, searches were successful in the positive condition if children searched in the location where E2 had looked and successful in the negative condition if children searched in the opposite location to where E2 had looked. Thus, ceiling performance would be 1.0 for positive markers and 0.0 for negative markers. The rationale for using the location where E2 looked as the dependent variable (rather than searches in the correct location) was because we were concerned that children might show a bias to look where E2 looked, irrespective of his response (a kind of "yes bias" to agree with the experimenter). To test whether this was in fact the case, we included a neutral condition in which E2 gave responses that were designed to be uninformative (shoulder shrug, "maybe" and "I don't know" in the gesture, single-word and proposition modalities, respectively). We intended to compare performance in the positive and negative conditions against this baseline to establish whether children were able to use the information provided by E2 to deviate from any observed response bias. As there could be no search behavior that could meaningfully be labeled *correct* in response to neutral cues, searching in the same location as E2 formed the point of comparison. However, as it turned out, children did not treat the neutral cues as "neutral," especially in the case of the words and propositions. As a result, the neutral condition was removed from the analysis, and a baseline chance performance of .5 was adopted. Figure 1 shows the
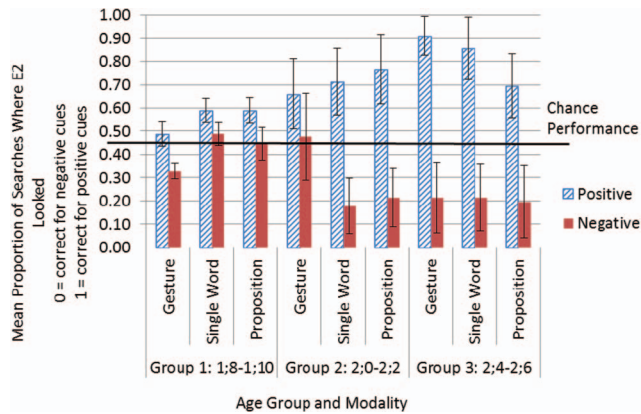
Figure 1. Mean proportion of responses in which children searched where the experimenter looked as a function of age, mode of response, and polarity of response. E2 = second experimenter. The error bars represent the 95% confidence intervals for the data. See the online article for the color version of this figure.

proportion of responses in each condition in which the children searched where E2 had looked. Prior to carrying out our analysis, an arcsine transformation was performed as the data were proportional.

Our first analysis aimed to identify the age when children began to comprehend specific communicative markers. A series of one sample t tests was used to compare children's search behaviors with a baseline of .5, representing what would be a chance performance (i.e., a child searching equally in the location where E2 had or had not looked regardless of response). Due to the number of comparisons, the significance threshold was adjusted using the Bonferroni correction.

The results show that children's search behaviors in Group 1 (1 year 9 months) were not significantly different from chance in any of the response conditions. As a result, we would argue that children were unable to comprehend the function of any response marker at this young age. In Group 2 (2 years 0 months), the t test indicated that children's scores were significantly different from chance for both single-word, $t(13) = 4.929$, $p < .001$, and propositional, $t(13) = 4.251$, $p = .001$, response markers. However, children's search behaviors did not differ from chance in the negative gesture condition, nor with any of the three positive response markers. In Group 3 (2 years 4 months), the results indicated that, for negative markers, children were able to understand the function of the gestural, $t(13) = 3.957$, $p = .002$; single word, $t(13) = 4.009$, $p = .001$; and propositional, $t(13) = 3.569$, $p = .003$, responses. With positive markers, children's scores were also significantly different from chance for gesture, $t(13) = 8.093$, $p < .001$; and single word, $t(13) = 5.446$, $p < .001$, responses. However, even these oldest children's scores were not significantly different from chance for positive propositional response markers. Table 2 summarizes when children began to comprehend each marker relative to chance performance.

Next, we analyzed the children's performance within each age group to understand whether certain modes of response markers (gesture, single word, proposition) were easier for children to understand than others.[1] An analysis was not performed on the scores of children in Group 1 (1 year 9 months), as none of the

response markers altered children's search behaviors significantly from chance. Two one-way analyses of variance (ANOVAs) were carried out, one for each polarity, to investigate the effect of modality within the second and third age groups. These analyses largely supported our earlier findings. In Group 2 (2 years 0 months), there was a significant effect of modality for negative markers, $F(2, 39) = 4.185$, $p = .023$ (gesture .48; single word .18; proposition .20), but not for positive markers, $F(2, 39) = .583$, $p = .563$ (gesture .66; single word .71; proposition .77). For negative markers, there was a significant difference between the gesture and single-word conditions ($p = .034$) and a difference approaching significance between the gesture and proposition conditions ($p = .079$). These differences reinforce our previous finding that children were unable to understand the function of head shakes in Group 2 as their understanding of the gestural response was significantly worse (or approaching significance) than the verbal response markers. In Group 3 (2 years 4 months), the analysis revealed a significant effect of modality for positive, $F(2, 39) = 3.709$, $p = .034$ (gesture .91; single word .86; proposition .70), but not for negative markers, $F(2, 39) = .009$, $p = .992$ (gesture .21; single word .21; proposition .20). For positive markers, there was a significant difference between the gesture and proposition conditions ($p = .045$), but not between the gesture and single-word, or single-word and proposition conditions. Thus, although the oldest group's performance was significantly different from chance on positive single-word markers, but not on propositions, their performance on the two verbal markers did not differ significantly.

Overall, the results from our analysis of modality show that verbal markers had an initial advantage when communicating the negative function of denial in the context of this study. This does not appear to be the case for positive markers of affirmation, which were more readily understood in a gestural form, but at a later stage of development.

In our final analysis, we investigated the differences between each age group after splitting the data set by modality to determine whether the developmental trajectory was the same for each type of marker.[2] Three one-way ANOVAs were calculated for each polarity to investigate the effect of age on comprehension of gesture, single-word, and proposition cues, respectively. For gestural cues, the analysis revealed a significant effect of age for both positive, $F(2, 39) = 9.311$, $p < .001$, and negative markers, $F(2, 39) = 3.301$, $p = .047$. For the positive *head nod* (Group 1 = .49, Group 2 = .66, Group 3 = .91), there were significant differences between Groups 1 and 3 ($p < .001$) and Groups 2 and 3 ($p = .021$). Similarly, for the negative *head shake* (Group 1 = .33, Group 2 = .48, Group 3 = .21), there was a significant difference between Groups 2 and 3 ($p = .043$). Overall, the results reveal a clear shift in children's comprehension occurring in the oldest age group. This reinforces our earlier finding that only the oldest children (2 years 4 months) were able to interpret the gestural cues differently from chance. For negative single-word cues (Group 1 = .49, Group 2 = .18, Group 3 = .21), there was an effect of age, $F(2, 39) = 5.137$, $p = .009$, with significant differences between

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[1] Post hoc pairwise comparisons were performed using the Bonferroni correction.

[2] Post hoc pairwise comparisons were performed using the Bonferroni correction.

Table 2
Summary of Comparisons to Chance Performance

	Gesture		Single word		Proposition	
Age group	Positive	Negative	Positive	Negative	Positive	Negative
1 year 8 months–1 year 10 months	X	X	X	X	X	X
2 years 0 months–2 years 2 months	X	X	X	✓	X	✓
2 years 4 months–2 years 6 months	✓	✓	✓	✓	X	✓

Groups 1 and 2 ($p = .016$) and Groups 1 and 3 ($p = .032$). This supports our previous findings that revealed that the single word *no* is acquired earlier in development in comparison to the gestural head shake. For positive single-word markers, a significant effect of age was found, $F(2, 39) = 4.36$, $p = .020$ (Group 1 = .59, Group 2 = .71, Group 3 = .86). However, unlike the negative single-word marker, the analysis only revealed a significant difference between Groups 1 and 3 ($p = .016$). Thus, the acquisition of positive single-word markers showed a more gradual developmental progression, where only the oldest children were able to understand the function the marker was performing. For propositions, performance does not change significantly with age for either positive, $F(2, 39) = 1.153$, $p = .326$, or negative markers, $F(2, 39) = 2.501$, $p = .095$. For positive cues, this reflects the finding that none of the age groups successfully comprehended the positive proposition cue "*It's in the . . . .*" In the case of the negative cue, "*It's not in the . . .,*" the results show that although the oldest two groups were able to comprehend the proposition marker significantly differently from chance, their performance in comparison to the youngest group was only approaching significance.

To summarize, our analyses of age effects show somewhat different developmental sequences for positive and negative markers. Children appear to acquire positive markers relatively late in our three age groups, with no significant differences observed between Groups 1 (1 year 9 months) and 2 (2 years 0 months) for any modality. In contrast, a significant difference was observed between Groups 1 (1 year 9 months) and 2 (2 years 0 months) for the single-word cue in the negative condition, suggesting an earlier mapping of its form and function. When combined with the overall findings, the results show that children are able to understand the function of negative verbal responses from an earlier age and are only later able to understand the function of head gestures and responses in the positive single-word condition.[3]

Discussion

The aim of the present study was to examine the acquisition of children's understanding of affirmations and denials in third-party interactions. The results revealed that the youngest group of children at 1 year 9 months did not succeed in processing any of the response cues, irrespective of polarity or mode of presentation. At 2 years 0 months, children began to show an understanding of certain cues. However, this was limited to verbal negative responses ("No" and "It's not in the X"). Finally, the results from children at 2 years 4 months showed that they were capable of processing each type of marker, verbal or gestural, in order to find the location of a hidden object, with the exception of the affirmative propositional cue ("*It's in the bucket/house*"). In terms of the

tentative predictions outlined at the end of the introduction, the two major findings are that affirmation does not precede denial as would be predicted by a logical analysis and that, for denial, comprehension of single words and multiword utterances preceded comprehension of gestures on their own.

There are two possible reasons for the failure of the youngest group in all conditions. The first is that they may fail to process the answers to the yes–no questions put by the experimenter. Although children can certainly answer yes–no questions in dyadic exchanges by this age, both Ervin-Tripp (1970) and Choi (1991) suggested that they do not do so fully appropriately until around 2 years 0 months. In these studies, the children were able to produce both positive and negative markers (fulfilling the conversational requirements) but unable to associate the semantic function of each marker until the age of 2 years 0 months–2 years 3 months.

The second possibility is that the youngest group was not yet able to fully process third-party linguistic exchanges per se. The issue of what children can learn from overhearing conversations between others is important, because there is enormous variation in the amount of dyadic talk in which children are involved (Hart & Risley, 1995). We should first note that the situation in our experiment was not that of purely overhearing an exchange between two other people. The children were encouraged to form part of a team with the first experimenter and were highly motivated to find the block so that they could use it in the plink machine. In other words, the exchange mattered to them. We know that children age 1 year 3 months can interpret gaze direction between two adults, though, of course, this is probably considerably more straightforward than understanding an exchange involving yes–no questions and answers. We also know that children age 1 year 6 months can learn words from overhearing exchanges (Akhtar, 2005; Gampe et al., 2012). It is an interesting issue as to whether this is less or more complex than interpreting the meaning of *yes* or *no* in a third-party exchange. Finally, Fusaro and Harris (2013) have shown that children age 2 years 0 months, but not 1 year 8 months, are able to interpret a combination of gestural head nods and head shakes to infer the identity or location of an object. Our tentative conclusion is that it is not the third-party exchange in and of itself that is presenting the major problem to the youngest children, but indeed understanding the relationship of the second experimenter's reply to the first experimenter's question. To our knowledge, ours is the first study that isolates the precise cues

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[3] To test whether the youngest children were particularly confused by exposure to single cues in isolation, we also tested a further group of fourteen 1 year 9 month-year-olds on a combined gesture + single-word cue, which might be more natural (head nod + yes, and head shake + no). Their performance on these combined cues was also not significantly different from chance ($M = .55$ in both conditions).

children can use in a third-party exchange to interpret a fact about the world, and how this changes with development.

A somewhat surprising result was that the verbal cues were the first to significantly alter children's searching behavior. Because children's first use of negation occurs prior to their use of verbal language (Bloom, 1970; Guidetti, 2005; Pea, 1980), we might expect that the comprehension of gestures would emerge first or alongside children's comprehension of verbal utterances. However, children at 2 years 0 months were significantly more successful when provided with the single response ("No") and propositional utterance ("It's not in the X") than with a negative head shake. Children's comprehension of the gesture condition (a head shake) was at chance level and was found to be significantly less informative than children's comprehension of single-word utterances ("No"). In addition, despite this comprehension of verbal markers in the negative condition, children only began to show a significant understanding of positive cues at 2 years 4 months. Here, it was their performance on affirmative gestures and single-word utterances that showed reliable understanding, but they were unable to perform consistently when presented with the positive propositional cue ("*It's in the X*").

There are a number of possible reasons for these results. In the case of denials, we would expect that gestures are unlikely to occur in the absence of accompanying utterances (e.g., "No") in normal interactions. As a result, children may initially require multiple cues, rather than just an isolated gesture. Exploring the ways in which combining gestural and verbal cues may aid children in interpreting these types of exchanges is an important area for further research.

A second, not mutually exclusive possibility may be that gestures are less common in a naturalistic interaction within pragmatic situations of denial. Children may well understand these gestures in other contexts that are less "metacognitive" (e.g., a refusal or agreement to a request), but fail to do so in these situations if their input rarely exemplifies them. The fact that scores in the gesture and single-word affirmative condition went in the same direction for the two older groups (i.e., both not different from chance at 2 years 0 months and both significantly different from chance at 2 years 4 months) may relate to the relative frequency with which adults use positive and negative gestures and positive and negative single-word utterances in the input. For instance, positive gestures may be used as frequently to children as negative gestures in this context, whereas single-word denial utterances may be more frequent than single-word affirmations. In addition, as suggested by a reviewer, there may be a number of different versions of affirmative single-word responses: "yes," "yeah," "yep" by contrast with a simple "no." There is clearly an urgent need for a corpus analysis using video data before we can decide between these alternatives. Nonetheless, these results do suggest that there may be differences in the ways that adults choose to express these pragmatic functions.

As far as the difference in understanding negation in single words and propositions is concerned, we outlined two possible hypotheses. On the one hand, the single word *no* may be more easily understood because it is presumably more salient and, other things being equal, more easily processed than a multiword utterance. It is also commonly used to respond to questions and is the first verbal negative marker that children acquire (Hummer et al., 1993; Pea, 1980, 1982). Children also use *no* polysemously to

express a variety of negative functions, suggesting that it is fairly synonymous with a child's early representation of negation (Bloom, 1970; Choi, 1988; Pea, 1980).

On the other hand, utterances with *not* have been found to be the most frequent form of negation in the input at these ages and the most frequent when expressing denials (Cameron-Faulkner, 2002). These frequency effects should result in a high "transparency" between the typical form and function of denials, which would make *not* easier for children to comprehend in this type of context (Choi, 1988). Observational studies have also revealed that the acquisition of denial marks a new developmental phase in which children begin to acquire new functions with new negative forms (which more closely resemble adultlike uses in the input, i.e., *not*) (Choi, 1988). This would suggest that it is acquired separately to other functions and would be the most prominent form for this function in the input. The results, however, revealed that children at 2 years 0 months did equally well on both types of response: single word and proposition. This was also the case for children in the older group at 2 years 4 months. As a result, we are unable to differentiate these alternatives: Clearly, by around 2 years 0 months, the presence of either negator is enough to guide the children to the correct solution.

However, the acquisition of positive cues showed a different pattern of development. Only the children in the oldest group showed a significant understanding of positive cues. Unlike the pattern found with negative utterances, comprehension was limited to gestural and single-word cues with children who received affirmative multiword utterances showing no significant deviation in their searching behavior, in comparison to chance. Unlike the negative proposition, the affirmative proposition contains no specific marker of affirmation, and this may well be the reason for children's difficulty in processing it. Again, had cues been combined using an explicit affirmative marker (e.g., "*Yes, it's in the X*"), this might have helped the children.

The first markers to elicit any significant change in the study were negative rather than affirmative. This runs counter to the philosophical arguments of asymmetricalists who assume that "affirmation is epistemologically prior" to propositional negation (Horn, 2001, p. 46). As negation has been previously found to increase the complexity of statement verification (Kim, 1985; Pea, 1982; Wason, 1961), one might have predicted that children would learn the function of positive markers first. This might also be expected from observational studies, which reveal that children's affirmative multiword utterances are typically more sophisticated and more complex than their negative utterances (Bloom, 1970; Pea, 1980). However, the finding that comprehension emerges first for negative utterances may not be too surprising, despite the inference being more complex in logical terms than understanding an affirmative statement. As noted above, children understand the pragmatic requirements of yes–no questions by the age of 1 year 3 months–1 year 5 months, but do not answer them appropriately until the age of 2 years 0 months–2 years 3 months. Choi (1991) also noted that the process of mapping each marker's function was not symmetrical for each polarity. Children often answered affirmatively by naming the events/objects in question (e.g., "Is this a bee?" "Bee"), despite using more explicit markers (*no* and *not*) to negate. This observation has also been made in a number of studies (Akiyama, 1985; Bloom, 1970; Hummer et al., 1993; Pea, 1982) and has been taken as an indication that a child's ability to map the

semantic function of "minimal forms, particularly affirmations" like *yes* often lags behind negative markers (Choi, 1991, p. 412).

Previous studies (Cameron-Faulkner et al., 2007; Choi, 1988; Pea, 1980) have revealed that a child's ability to map the form/function of negative markers is affected by his or her input. The early emergence of verbal markers of negation may therefore result from children not receiving positive markers for the function of proposition affirmation at the same frequency as they do negative markers for the function of proposition denial. It may also be possible that the pragmatic situations that elicit such responses occur more frequently for denials. As a result, negative markers may feature more frequently than positive markers. This may also explain the differences between which modes of communication emerged first for each polarity. Although the affirmation of propositions may be simpler from a logical standpoint, the denial of propositions has a stronger impetus in the natural discourse in which young children typically engage. From the point of view of developmental theory, this emphasizes the importance of extending a purely logical analysis of cognitive categories and relations to one that takes children's actual experience of language and interaction into account. However, it would also be important to explore this conclusion further by providing an overt marker in the affirmative condition. This is done most naturally in English using stress: "*It IS in the bucket*" (after all). German would even allow us to do this with a separate word: "*Es ist DOCH in der Kiste*" (Schmerse, Lieven, & Tomasello, 2014).

We conclude that children comprehend negation in general from early in the second year, and, based on their discourse interactions, they come to comprehend the negation of propositions by denial, in particular, by soon after their second birthdays, beginning with the linguistic forms that express such denials most often and most saliently.

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