

Contingency in requests of signing chimpanzees (*Pan troglodytes*)

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Conversational interactions depend on partners making contingent responses. This experiment examined the responses of five chimpanzees (*Pan troglodytes*), Washoe, Moja, Tatu, Dar and Loulis, to four conversational conditions. Following the chimpanzee's request, a human interlocutor either: (1) complied with the request, (2) provided an unrequested item or activity, (3) refused to comply or (4) did not respond to the request. The chimpanzees' responses were contingent on the conversational input of the interlocutor. When their requests were satisfied, the chimpanzees most often ceased signing. However, when their requests were misunderstood, refused or not acknowledged, the chimpanzees repeated and revised. This pattern of responses is comparable to patterns of conversational responses in human children.

Keywords: chimpanzees; American Sign Language; requests; pragmatics; conversation; gesture; communication; *Pan troglodytes*

1. Introduction

Communication depends on the interaction between two speakers or signers. In the give and take of conversation, conversational partners must respond appropriately to the communicative actions of each other. However, communication breakdown between partners is not uncommon and partners must make contingent adjustments in their responses for the conversation to continue (Forrester & Cherington 2009; Schegloff, Jefferson & Sacks 1977). Conversational contingency is evident in behaviors of very young human children and develops gradually and systematically on into adulthood (Wilcox & Webster 1980; Golinkoff 1986; Wootton 1994; King & Gallegos-Santillan 1999; Most 2002). Systematic studies of children's early responses to conversational breakdown shows they initially repeat their original utterance (Gallagher 1977). Later they begin to add more

information by revising the original utterance and adding new words (Brinton, Fujiki, Loeb & Winkler 1986). Researchers have examined this during natural conversations (Garvey 1997; Golinkoff 1993; King & Gallego-Santillan 1999) and in paradigms where the interlocutor presents systematic probes in response to a child's utterance (Brinton, Fujiki, Loeb et al. 1986; Brinton, Fujiki, Winkler, Loeb 1986; Ciocchi & Baran 1998; Most 2002; Wilcox & Webster 1980; Wooton 1994) or request (Marcos 1991; Marcos & Kornhaber-le Chanu 1992).

Conversational interaction is a fundamental characteristic of human face-to-face communication in words and signs and has always been a primary objective of sign language studies of cross-fostered chimpanzees:

At the outset we were quite sure that Washoe could learn to make various signs in order to obtain food, drink, and other things. For the project to be a success, we felt that something more must be developed. We wanted Washoe not only to ask for objects but to answer questions about them and also to ask us questions. We wanted to develop behavior that could be described as conversation.

(R. A. Gardner & Gardner 1969, pp. 2–3)

Ethologists use the procedure called cross-fostering to study the interaction between environmental and genetic factors by having parents of one genetic stock rear the young of a different genetic stock. It seems as if no form of behavior is so fundamental or so distinctively species-specific that it is not deeply sensitive to the effects of early experience (Stamps 2003). In making discoveries about human behaviors, chimpanzees are an obvious first choice for cross-fostering, as they look and act remarkably like human beings and recent research reveals close and deep biological similarities of all kinds (Goodall 1986). In blood chemistry, for example, chimpanzees are not only the closest species to humans, but chimpanzees are closer to humans than chimpanzees are to gorillas or to orangutans (Stanyon, Chiarelli, Gottlieb & Patton 1986; Ruvolo 1994) and 98% of human and chimpanzee DNA shares the same structure (Sibley & Ahlquist 1984; The Chimpanzee Sequencing and Analysis Consortium 2005).

Humans reared the infant chimpanzees, Washoe, Moja, Tatu and Dar, in a cross-fostering laboratory at the University of Nevada-Reno and raised the young chimpanzees as if they were deaf human children. Like human children, the cross-fosterlings wore clothes, used spoons, bowls and highchairs, played games and helped with chores (R.A. Gardner & B.T. Gardner 1989). The human foster families used only American Sign Language (ASL) during everyday activities with the chimpanzees. They encouraged the cross-fosterlings to sign by expanding on fragmentary utterances and asking questions. Under these conditions, the cross-fosterlings acquired the signs of ASL in patterns similar to those

of human children (R.A. Gardner, Gardner & Van Cantfort 1989; B.T. Gardner & Gardner 1994).

As a young adult, Washoe adopted 10-month-old Loulis. To determine whether Loulis would acquire signs without human intervention, all human signing, except for seven signs, WHO, WHAT, WHERE, WHICH, WANT, SIGN, and NAME, was prohibited in his presence. Loulis spent all of his time with Washoe and other signing chimpanzees. He began to sign in seven days and combined signs into phrases in five months. In the 5-year-period of signing restriction Loulis, learned 51 signs (Fouts, Hirsch & Fouts 1982; Fouts, Fouts & Van Cantfort 1989). Like the cross-fostered chimpanzees and human children, Loulis acquired his signs in a conversational setting and later he used his signs in conversations with human caregivers and with the other chimpanzees (R. Fouts 1994).

As adults at the Chimpanzee and Human Communication Institute (CHCI) at Central Washington University in Ellensburg, the chimpanzees have continued to sign spontaneously and interactively about activities, meals, games, and events with each other as well as with human familiars (D. Fouts 1994; Bodamer & Gardner 2002; Jensvold & Gardner 2000; Krause & Fouts 1997). The chimpanzees have daily access to picture books, toys, clothing, and other objects, many of which were part of their lives in Reno and are part of the lives of human children. As in the Reno laboratory, human caregivers continue to ask questions of the chimpanzees and expand on fragmentary utterances.

It is during these ongoing casual conversations that interlocutors explore systematically the chimpanzees' conversational behaviors. These investigations have revealed that at CHCI, as in Reno, the chimpanzees initiate many of their signed interactions with humans (Bodamer & Gardner 2002; Krause & Fouts 1997). The chimpanzees use signs to initiate games and social activities with one another as well as to comment on their environment. They reiterate, adjust, and shift utterances in conversationally appropriate rejoinders (Bodamer & Gardner 2002; Jensvold & Gardner 2000). They also sign to themselves when alone (Bodamer, Fouts, Fouts & Jensvold 1994).

The chimpanzees depend on their caregivers to fulfill many of their needs, and often use signs to request objects and activities of humans. Typical interactions between caregivers and the chimpanzees include games, such as chase and peek-a-boo; activities, such as coloring and looking at books; chores, such as cleaning; and meals (R.S. Fouts, Fouts, Jensvold & Bodamer 1994). The objective of this study was to experimentally manipulate caregiver responses to the chimpanzees' requests and determine if changes in the chimpanzees' signing were contingent on this interlocutor input.

2. Method

2.1 Participants

The five participants in this study were Washoe, Moja, Tatu, Dar, and Loulis at CHCI at Central Washington University in Ellensburg, Washington. Washoe, Moja, Tatu and Dar lived under cross-fostering conditions throughout infancy and early childhood (see R.A. Gardner & Gardner 1989, for review and Table 1).

Washoe arrived in Reno on June 21, 1966, when she was about 10 months old and lived as a cross-fosterling until October 1, 1970 when she left to become the first chimpanzee in the Fouts laboratory in Oklahoma. Moja, Tatu, and Dar each arrived in Reno within a few days of birth. Moja, a female, was born at the Laboratory for Experimental Medicine and Surgery in Primates, New York, on November 18, 1972, and arrived in Reno on the following day. Cross-fostering continued for Moja until winter 1979 when she left for the Fouts laboratory in Oklahoma. In 1980 Washoe and Moja moved to the Fouts laboratory in Ellensburg where the present study took place. Tatu, a female, was born at the Institute for Primate Studies, Oklahoma, on December 30, 1975, and arrived in Reno on January 2, 1976. Dar, a male, was born at Albany Medical College, Holloman AFB, New Mexico, on August 2, 1976, and arrived in Reno on August 6, 1976. Cross-fostering continued for Tatu and Dar until May 1981 when they left to join Washoe and Moja in Ellensburg. Loulis, a male, was born at the Yerkes Regional Primate Research Center, Georgia, on May 10, 1978. Loulis arrived at the Fouts laboratory in Oklahoma on March 24, 1979, where Washoe subsequently adopted him. Loulis moved to Ellensburg with Washoe and Moja in 1980.

At CHCI all five chimpanzees had daily access to 2,133 m² of outdoor and indoor living space. Fencing always separated caregivers from the chimpanzees.

Table 1. Biographical information for chimpanzee participants

	Washoe	Moja	Tatu	Dar	Loulis
Birth date	10/65 (est.)	11/18/72	12/30/75	8/2/76	5/5/78
Univ. of Nevada ^a	1966–70	1972–79	1975–81	1976–81	n/a
Univ. of Oklahoma ^b	1970–1980	1979–1980	n/a	n/a	1979–1980
Central Washington Univ. ^c	1980–2007	1980–2002	1981–present	1981–present	1980–present

^a Cross-fostered, exposed to ASL only.

^b Exposed to ASL and spoken English.

^c Exposed to ASL and spoken English until 6/86; thereafter exposed to ASL primarily.

Caregivers used ASL in all interactions with the chimpanzees. The chimpanzees initiated many of these signed interactions and sometimes requested objects and food.

2.2 Interlocutor

The first author (LL) served as the interlocutor for each of the trials. At the time of data collection, she had had one year of experience caring for and interacting with this group of chimpanzees and one year of experience communicating in ASL.

2.3 List of potential requests

The daily activity of the chimpanzees contained a wide spectrum of events. A master list of potential requests was created before data collection began. Three of the chimpanzees' longtime caregivers compiled a list of 18 object signs or action signs that the chimpanzees often requested. Examples of objects were blanket and book and examples of actions were chase and groom. Then, nine other longtime caregivers ranked each chimpanzee's preference for each object or action (after R.A. Gardner, Gardner & Drumm 1989). The five objects or actions that were ranked as the least preferred for each chimpanzee were those offered during the misunderstand condition, described below.

2.4 Procedure

Interactions between the chimpanzees and interlocutor occurred between 0800 and 1700, within areas typically designated for chimpanzee-human interaction. Although ASL was virtually the only language that the human members of their foster families used in the Gardner laboratory, Washoe, Moja, Tatu, Dar and Loulis often heard spoken English at CHCI and understood spoken English to some extent (Bodamer, Fouts & Fouts 1987; Shaw 1989). To avoid the possibility that a verbal announcement of the upcoming condition might prompt the chimpanzee as well as the interlocutor, trial conditions were randomly ordered and posted on a piece of paper out of the chimpanzees' view at the beginning of each data collection session.

On experimental days, the interlocutor entered the chimpanzee-human interaction area with a camera operator and waited for a chimpanzee to initiate a conversation. A trial began when the chimpanzee signed for an object on the list of potential requests. GIMME and THERE could also begin a trial if the referent of the sign was visible and was included on the list. The interlocutor then responded to the chimpanzee's request with a probe from one of four conditions, described below. Trials concluded either after the chimpanzee signed in response or after

approximately 30 seconds. Each chimpanzee participated in 10 trials under each of the four conditions, yielding a total of 200 trials, with a maximum of 5 trials per chimpanzee per day. A camera operator video recorded the entire trial and was instructed to refrain from interacting with the chimpanzees during data collection sessions. Videotaping was a regular aspect of the chimpanzees' daily life.

Throughout this article, transcribed glosses of signs appear in all capital letters. Signed utterances are transcribed into word-for-sign English because more interpretive translations would add words and affixes which lack signed equivalents either in the vocabularies of the chimpanzees or in ASL more broadly. This mode of transcription makes the utterances appear to be in a crude or pidgin dialect, but the reader should keep in mind the fact that equally literal word-for-word transcriptions between, say, Russian or Japanese and English appear equally crude. In transcriptions, an "x" following a gloss indicates immediate reiteration of that sign. A slash (/) indicates an utterance boundary (see B.T. Gardner & R.A. Gardner 1994, p. 230).

Conditions. There were four conditions of interlocutor probes in this study: comply, misunderstand, refuse and unresponsive. The probe in the comply condition was when the interlocutor offered the chimpanzee the requested object or performed the requested action. Requested objects were readily available in a nearby area, but often not visible to the chimpanzees. For example, if Tatu requested MASK, the interlocutor would enter the adjacent enrichment room and return to Tatu with a mask. If the chimpanzee requested gum, toothbrushes, snacks, or other items, the interlocutor offered the item to all of the chimpanzees regardless of whether they had participated in a trial. This was in accordance with laboratory protocols that when caregivers offer food, objects, and activities, all of the chimpanzees should be allowed to partake.

The probe in the misunderstand condition was when the interlocutor offered an object or activity that was not part of the initial request. For example, if Tatu requested MASK, the interlocutor would enter the adjacent enrichment room and return to Tatu with a brush. The interlocutor used a list of objects to determine which requests were candidates for misunderstand trials and what objects to offer in the misunderstand condition. The interlocutor only presented a probe to utterances that contained a sign for an object or action that was on the list for that chimpanzee.

The probe in the refuse condition was when the interlocutor refused to comply with the chimpanzee's request, with signs such as CAN'T. For example, if Tatu requested MASK, the interlocutor would respond by signing SORRY CAN'T. The refusals in this condition were like the refusals that typically occur in interactions between caregivers and their charges, be they children (Marcos & Bernicot 1994) or chimpanzees.

The probe in the unresponsive condition was when the interlocutor made no signed response to the chimpanzee's request, but continued to face the chimpanzee.

For example, if Tatu requested MASK, the interlocutor refrained from responding and ignored the request.

Transcription. A transcriber recorded the times that the chimpanzee signed utterances occurred, the time of the interlocutor's probe, the condition of the interlocutor's probe, and the gloss of the signs. For all times, the transcriber recorded the onset of signs from the videotape. This was done to locate trials on the videotape and to provide times for subsequent classification of responses. The transcriber assigned glosses to each sign in each chimpanzee utterance for every trial using the PCM (place, configuration, movement) system. The PCM system (B.T. Gardner, Gardner & Nichols 1989) is a description of how a sign is formed using the place where the sign is made, the configuration of the hand, and the movement of the hand. Next, for the time after the probe, the transcriber assigned the gloss of the chimpanzee's utterance that occurred in response to each probe or if the chimpanzee did not sign, a description of the action.

Classification of responses. An experimenter classified each chimpanzee's response by comparing it to the chimpanzee's initial request.

Repetition. In a repetition, the signs in the chimpanzee's response were the same as the signs in the chimpanzee's initial request. An example of a repetition is:

Trial #1

0:31:17 Tatu: TOOTHBRUSHx/

0:31:38 LL: Offers Tatu a glove

0:32:07 Tatu: TOOTHBRUSHx/

Revision. In a revision, the signs in the chimpanzee's response contained more or fewer signs than the chimpanzee's initial request, or the response contained completely different signs than the initial request. Some examples of revisions are:

Trial #140

0:31:56 Moja: FOODx GUMx/

0:32:16 LL: Gives Moja a string

0:32:18 Moja: FOOD THERE GUM/

Trial #48

1:37:25 Washoe: GIMMEx TOOTHBRUSHx/

1:37:44 LL: Offers Washoe a hammer

1:37:58 Washoe: TOOTHBRUSHx HURRYx/

Trial #33

1:19:24 Tatu: TOOTHBRUSHx/

1:19:58 LL: Offers Tatu a ball

1:20:28 Tatu: MASKx/

Nonsign. In a nonsign response, the chimpanzee failed to sign within 30 s after the probe (Brinton, Fujiki, Loeb & Winkler 1986, p. 377) as determined by the time appearing on the transcripts.

Reliability. Two other observers independently scored separate, randomly selected samples of 20% of the videotaped interactions for identification of the chimpanzee participant, the time that the chimpanzee initiated the request, the experimental condition, the glosses of the chimpanzees' signed utterances, and the classification of the chimpanzees' responses. Table 2 summarizes the reliability for each measure.

2.5 Statistical analysis

Using Fisher's exact tests of independence (FET), we analyzed five 3×4 contingency tables, one for each chimpanzee, to determine if the distribution of response types was contingent on the conditions. The FET is often used in situations where the more familiar chi-square test would be inappropriate due to expected cell values. A p-value of less than .05 revealed that one or more cells in a table had a frequency significantly greater or less than we would if the pattern of responses was essentially the same across conditions. To determine which cells had these unusual high or low frequencies, we examined the adjusted Pearson residual (APR) for each cell. The APR is the difference between the observed cell frequency and the frequency expected by chance, based on the row and column totals, divided by a standard error. Thus, it is essentially a z-score, and is interpreted similarly (Haberman 1973; Agresti 2002). Next, we conducted

Table 2. Interobserver reliability

Measure	Percent agreement
Identification of chimpanzee	95
Chimpanzee utterance time	95.5
Probe time	95
Probe condition	90
<i>Chimpanzee glosses</i>	
Washoe	100
Moja	94
Tatu	82
Dar	85
Loulis	95
Classification of responses	87.5

a test of heterogeneity (Sheskin 2004), using the chi-square statistic, to determine if the distribution of response types among the four conditions differed by chimpanzee.

3. Results

For each chimpanzee, there were 10 trials in each of the four conditions, yielding a total of 40 responses per chimpanzee. The 3×4 FET tests indicated that for four of the five chimpanzees the distribution of response types differed significantly across the four conditions, Washoe, $p < .001$, Tatu, $p < .001$, Dar, $p = .002$, Loulis, $p = .03$. There was no evidence that Moja's response types differed across the conditions, $p = .28$, FET. Table 3 shows the distribution of responses.

Systematic differences in non-signing contributed to the significance of the omnibus tests. Each chimpanzee ceased signing in the comply condition significantly more often than would be expected given the null hypothesis, Washoe, $APR = 3.7$, $p < .001$, Tatu, $APR = 5.90$, $p < .001$, Dar, $APR = 3.70$, $p < .001$, and Loulis, $APR = 2.51$, $p = .01$. Figure 1 illustrates the observed and expected values from the APR in each cell of the tables, for each chimpanzee. Asterisks indicate cells that contribute significantly to the omnibus effect.

In the comply condition, Washoe, Tatu, and Dar used revisions significantly less often than expected, Washoe, $APR = -2.01$, $p = .04$, Tatu, $APR = -2.53$, $p = .01$, and Dar, $APR = -2.25$, $p = .02$. Also in the comply condition Loulis exhibited less repetition than would be expected as indicated, $APR = -2.68$, $p = .007$. Finally, in the unresponsive condition Washoe used significantly more repetition than would be expected, $APR = 3.65$, $p < .001$.

Table 3 summarizes the test of heterogeneity. A chi-square statistic was calculated for each chimpanzee individually, with the associated degrees of freedom ($df = 6$ in each case). We summed these individual chi-square values (summed $\chi^2 = 103.78$), and the individual degrees of freedom (summed $df = 30$). Then we calculated a pooled chi-square statistic (pooled $\chi^2 = 68.13$) and a pooled degrees of freedom (pooled $df = 6$) using the observations from all of the chimpanzees, collectively. Finally, we subtracted the summed chi-square values and the summed degrees of freedom from the pooled chi-square values and pooled degrees of freedom, respectively. The resulting differences yielded a chi-square statistic of 35.65 with 24 degrees of freedom, which is non-significant, $p = .06$, indicating no significant differences between participants in the pattern of their responses over the conditions.

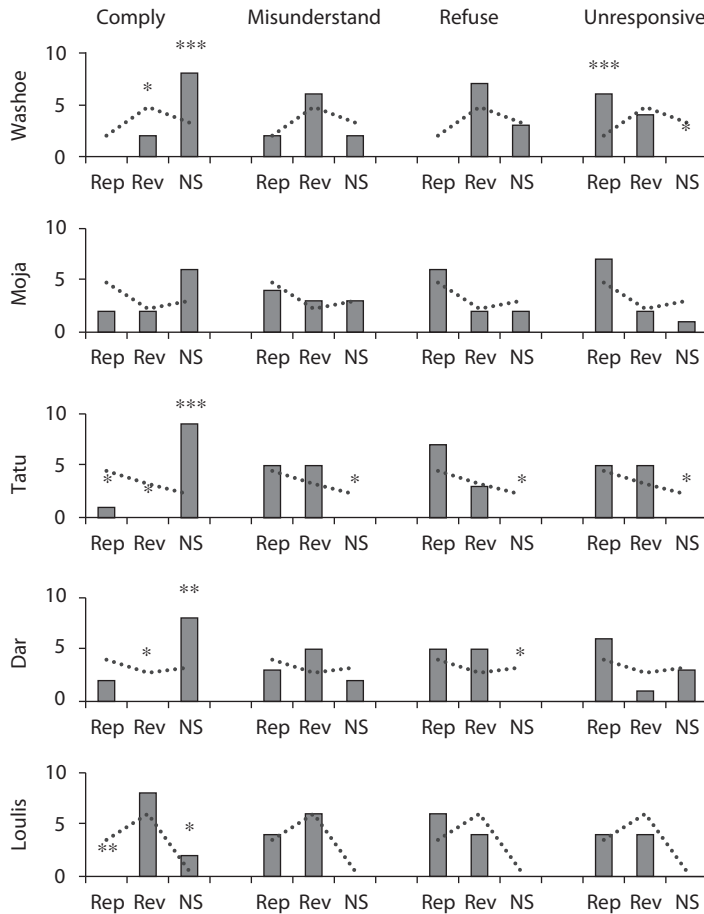


Figure 1. Frequency of responses in each condition for each chimpanzee
Rep = Repetition. Rev = Revision. NS = Nonsign
Grey bars indicate observed frequencies. Dotted line indicates expected frequencies. Asterisks indicate significantly under- or over-represented observed frequencies. * Indicates statistical significance at the .05 level. ** Indicates statistical significance at the .01 level. *** Indicates statistical significance at the .001 level.

4. Discussion

Effective face-to-face interactions between communicators requires partners to make adjustments to keep the conversational ball in the air. Human children and adults make adjustments contingent on their conversational partners (Gallagher 1977; Wilcox & Webster 1980; Golinkoff 1986; Brinton, Fujiki, Loeb &

Table 3. A test of heterogeneity of the frequency of response types across conditions for the five chimpanzees

Chimpanzee	Condition	Response type			χ^2	df
		Rep	Rev	NS		
Washoe	Comply	0	2	8	25.80	6
	Misunderstand	2	6	2		
	Refuse	0	7	3		
	Unresponsive	6	4	0		
Moja	Comply	2	2	6	8.11	6
	Misunderstand	4	3	3		
	Refuse	6	2	2		
	Unresponsive	7	2	1		
Tatu	Comply	1	0	9	36.38	6
	Misunderstand	5	5	0		
	Refuse	7	3	0		
	Unresponsive	5	5	0		
Dar	Comply	2	0	8	20.74	6
	Misunderstand	3	5	2		
	Refuse	5	5	0		
	Unresponsive	6	1	3		
Loulis	Comply	0	8	2	12.76	6
	Misunderstand	4	6	0		
	Refuse	6	4	0		
	Unresponsive	4	6	0		
Sum of χ^2		103.78 ^a			30	
Pooled χ^2	Comply	5	12	33	68.13	6
	Misunderstand	18	25	7		
	Refuse	24	21	5		
	Unresponsive	28	18	4		
Test of heterogeneity (sum of χ^2 - pooled χ^2) 35.65 24 p = .06						

Note. Rep = Repetition. Rev = Revision. NS = Nonsign.

^a Difference in summation due to rounding.

Winkler 1986; Wootton 1994; King & Gallegos-Santillan 1999; Most 2002). This experiment systematically examined conversational contingency in the responses of five chimpanzees, Washoe, Moja, Tatu, Dar and Loulis, that occurred during typical interactions with a human interlocutor. The data indicate that the chimpanzees' responses were contingent on the interlocutor's input; their responses varied systematically in relation to the experimental conditions. This was statistically significant for all of the chimpanzees except for Moja. The test of heterogeneity indicated that the chimpanzees did not differ significantly in the patterns of their responses.

In the comply condition the compliant behavior of the interlocutor eliminated the necessity of further conversation, because the object request had been satisfied and no breakdown in the conversation occurred. Nonsign was the chimpanzees' most frequent response in the comply condition, but was generally limited in the other three conditions. Human children also tend to withhold responses when their requests have been satisfied (Wootton 1994; Shwe & Markman 2001). Captive orangutans (Cartmill & Byrne 2007) and chimpanzees (Leavens, Russell & Hopkins 2005) also withhold responses after a request is satisfied.

In contrast, in the misunderstand condition supplying an unrequested object demonstrated that the interlocutor perceived the request, but that communication failed as to the specific referent. In this study, the chimpanzees both repeated and revised their original utterances in the misunderstand condition. Beginning at about the age of 12 months, children repeat their initial requests when given an unrequested object (Wootton 1994). Older human children demonstrate a high proportion of revisions, but fewer repetitions when presented with an unrequested object (Marcos & Kornhaber-le-Chanu 1992) and in analogous conversational breakdowns (Wilcox & Webster 1980; Shwe & Markman 2001). Non-signing orangutans (Cartmill & Byrne 2007) and chimpanzees (Leavens et al. 2005) also repeat and add different gestures when an interlocutor provides an unrequested object.

In unresponsive conditions, there is no indication that the interlocutor perceived the request. The chimpanzees tended to repeat their initial request when the interlocutor refused to comply. Marcos and colleagues (Marcos 1991; Marcos & Verba 1997) examined the responses of young children when an interlocutor failed to respond to the request. The children persisted in their original request and, less often, revised their request or completely changed referents.

In the refuse condition, the interlocutors demonstrate that they perceive the request but do not comply. Children have a higher level of non-response to refusals than requests for clarification or compliance (Marcos & Bernicot 1994; Marcos & Verba 1997). In an earlier study with this same group of chimpanzees,

the chimpanzees did not respond to interlocutor refusals (Jensvold & Gardner 2000). However, in this study, as in a second earlier study of this group (Bodamer & Gardner 2002), the chimpanzees tended to repeat or revise in response to refusals. Each of these studies with this group of chimpanzees had a single interlocutor, who was different for each study. Yet each of the interlocutors was familiar to the chimpanzees and had a standing relationship with some history of interactions. In past interactions, some individuals may have shown a propensity to be more easily swayed from a refusal. Thus the differences in the chimpanzees' responses to refusals across the studies may be a result of the differences in the history of the relationship with the interlocutor in each study. The potential effects of interlocutor relationship to the chimpanzees raises questions for future research.

Repetitions provide no new information to the interlocutor. Repetitions are used often by younger children (Brinton, Fujiki, Winkler et al. 1986; Brinton, Fujiki, Loeb et al. 1986; Wilcox & Webster 1980) in response to requests for clarification such as the question "What?" Also children repeat in response to misunderstandings (Shwe & Markman 2001). Like human children, the chimpanzees repeated their initial request more often in the refuse and unresponsive conditions than in either of the other conditions. For example:

Trial #182

0:34:05 Washoe: HUG x/

LL: No response

0:34:07 Washoe: HUG x/

Jensvold and Gardner (2000) asked the chimpanzees a series of general questions, "Huh?" "What?" and "I don't understand," and the chimpanzees sometimes repeated their previous utterance. In these conversations repetition served to clarify or emphasize something that the interlocutor may have missed. Repetition in the refusal and unresponsive conditions may serve the same function.

In revisions, also termed modifications, addition, deletion, or substitution of words or signs changed the original message (Halle, Brady & Drasgow 2004). Older children use revision more than younger children in requests for clarification. (Brinton, Fujiki, Winkler et al. 1986; Brinton, Fujiki, Loeb et al. 1986). As described by Halle et al. (2004):

Whereas both repetitions and modifications can be effective from the child's point of view... modifications have been viewed as important indicators of children's development in perspective-taking skills needed for conversation. Modifications have obvious practical advantages as well. If a child's communication is not successful, then producing an alternative communication act that matches environmental conditions and partner behavior would seem to have adaptive value. (p. 45)

Revisions require persistence and elaboration which are indicators of intentionality (Bates Benigni, Bretherton, Camaioni & Volterra 1979; Golinkoff 1986, 1993). Golinkoff stated that these behaviors in young children “indeed reveal an understanding ... of the mind of another” (p. 203). Adjusting responses to conversational partners is part of the shared negotiation and give-and-take of conversation. The chimpanzees in this study used revisions often when the interlocutor misunderstood the request, for example:

Trial #140
 0:34:05 Moja: EATx GUMx/
 LL: Gives Moja string
 0:34:07 Moja: EAT THAT GUM/

If revisions are indicators of intentionality in human children, then the same can be said for chimpanzees.

The conversations examined in this article were videorecorded at CHCI where the chimpanzees continued to sign spontaneously and interactively with each other as well as with human familiars (D. Fouts 1994; Jensvold & Gardner 2000; Bodamer & Gardner 2002). During the daily interactions between caregivers and chimpanzees, utterances of many types of communicative intention occur. For example the chimpanzees sign to comment on their environment (R.S. Fouts 1975; R.S. Fouts & Mills 1997; R.A. Gardner & Gardner 1989, p. 23; Jensvold & Gardner 2000) and they initiate many of their signed interactions with humans (B.T. Gardner, Gardner & Nichols 1989; Bodamer & Gardner 2002). This study systematically introduced probes only to the chimpanzees' requests, not to the many other types of communicative acts that occurred each day, thus they represent a small subset of chimpanzees' output, just as formal experimental tests of human children that introduce probes after requests represent only a small fraction of the daily output of children (Marcos & Verba 1997; Marcos & Bernicot; 1994; Marcos 1991).

Systematic variations in input from a familiar conversational partner resulted in systematic variations in the responses of five chimpanzees. Under the conditions of the cross-fostering environment, interlocutors treated Washoe, Moja, Tatu, and Dar as conversational partners. Interactive sign language had always been an integral part of their daily lives, beginning at an infantile level and rising to gradually more sophisticated levels as they matured. Loulis' only conversational partners during the 5-year signing restriction were the other chimpanzees. At the end of the restriction, the humans included Loulis in the signed conversations. In this study Loulis adjusted his responses to the interlocutor like the cross-fostered chimpanzees. The responses of the chimpanzees resembled the conversational responses of human children in similar studies.

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Jason Wallin received a B.A. in Psychology, a B.A. in Anthropology, and B.S. in Primate Behavior & Ecology. His research covers the gestural communication of human children, including children with autism, and non-human primates.

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