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Timing of Turn Initiations in Signed Conversations with Cross-Fostered Chimpanzees (*Pan troglodytes*)

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This study examined turn taking by adult and infant cross-fostered chimpanzees in one-on-one signed conversations with a human. The study identified turns as alternating, overlapping, or simultaneous and explored the timing of overlapping turn initiations in detail for both age groups. Adult chimpanzee turn taking was furthermore examined in two conditions; in the first condition the human responded to the chimpanzees with scripted probes and in the second condition the human signed freely. Results showed that the adult chimpanzees engaged in more alternating turns in the scripted condition and more overlapping turns in unscripted condition. In the interactions of the unscripted condition, the adult chimpanzees and the human partner initiated overlapping turns with nearly equal frequency, and the chimpanzees were likely to initiate overlap as the partner completed a turn. In comparable unscripted interactions, the infant chimpanzees initiated significantly more overlap than their partners and initiated overlap randomly throughout the partner's sign. Results suggest that turn taking in the chimpanzees developed with experience.

The orderly give-and-take nature of conversation is integrated early in the developmental process without lessons or textbooks and is one of the most conspicuous characteristics of human conversation (Duncan, 1972; Duncan & Niederehe, 1974; Gratier, 2003; Sacks, Schegloff, & Jefferson, 1974; Stivers et al., 2009; Walker, 1982). Adults engage infants in reciprocal social interactions even before infants acquire speech (Bloom, Russell, & Wassenberg, 1987; Kaye & Fogel, 1980; Snow, 1977). Parents use repetitive touches, words, and games such as peek-a-boo with infants that facilitate involvement in alternating social exchanges. When speaking to infants, parents (often unknowingly) wait for the infant to vocalize and then take a turn at talking when he or she is quiet (Rutter & Durkin, 1987; Schaffer, 1977; Snow, 1977) guiding and modeling an alternating form of interaction that is carried into later language development. Bloom et al. (1987) in fact found that when parents utilize this alternating turn taking pattern, infants' vocalizations become more syllabic or speech like. The timing of children's conversational turn initiations therefore develops within these early social interactions.

Pauses in conversation occur between turns providing a potential opportunity for a switch of speakers. Pauses between turns are often preceded by turn yielding signals such as changes in intonation, loudness, and body tension by speakers (Duncan, 1972) or eye gaze, sign duration, and sign position by signers (Baker, 1977). Speakers also pause within their turns take a breath or hesitate for emphasis or while planning the rest of their statement (Grosjean & Collins, 1979;

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Jaffe & Feldstein, 1970; Walker, 1982). Similarly, within signed turns signers often hold signs in place or take longer to transition between some signs.

Overlapping Turns

Sometimes instead of a pause occurring between two speakers' turns, the second partner begins a turn before the first partner has finished, resulting in overlapping turns. In this report overlap refers to any speaking or signing time shared by conversational partners. Some researchers theoretically distinguished between types of simultaneous speech based on the timing or the intention of the second speaker's turn. For example overlap may be initiated to give brief feedback or backchannel responses, begin an early response, force an interruption, ask for clarification, or compete with the current speaker (Craig & Evans, 1989; Cromdal, 2001; Greenbaum, 1985; Maroni, Gnisci, & Pontecorvo, 2008; McLaughlin, 1984; Peets, 2009). Regardless of the reason for overlapping speech, overlapping turns have the potential to break down conversation if the portion of overlapping speech is so great that neither speaker receives the other partner's message or if the timing of the intrusion is disruptive (Jefferson, 1973; McLaughlin, 1984). The amount of overlap and the timing of the turn initiation are therefore important to the successful continuation of the conversation (Baker, 1977, p. 232; Jefferson, 1973; McLaughlin, 1984) and are the focus of the current study.

Overlap in Signed and Spoken Conversation

In spoken conversation, overlap seems to be more intrusive than in signed conversation. In spoken language adults tend to initiate overlap near the end of a partner's utterance (Jefferson, 1973; McLaughlin, 1984; Zimmerman & West, 1975) or after the primary point of the partner's message had been spoken (McLaughlin, 1984), when little new information is being received, or when the addressee has heard a sufficient amount of the speaker's turn to make a response (Jefferson, 1973). However, Coates and Sutton-Spence (2001) suggest that in sign language overlapping turns indicate active participation rather than disinterest (Ervin-Tripp, 1979) or failure to precisely time turns to avoid overlap as others have claimed (Duncan, 1972; Sacks et al., 1974). Coates and Sutton-Spence (2001) recorded several informal conversations among a group of female and a group of male Deaf[1] signers. The authors found that in casual conversation with friends signers utilize a 'collaborative' speaking floor (Edelsky, 1981), in which overlapping turns are common, rather than a one-at-a-time speaking floor, more common to spoken languages. Coates and Sutton-Spence (2001, p. 521) give many such examples of overlapping signing and after one particular example they discuss the conversational use of overlap:

[1]An upper case D in Deaf is used to denote persons who have hearing loss and culturally identify as Deaf. The lower case d in deaf is used in cases here to denote persons who have some degree of hearing loss or in cases where cultural identity of subjects is unknown.

> *This extract is full of overlap: participants share the floor in complex ways to construct talk jointly…Overlaps involve minimal responses, repetition, as well as more polyphonic (Chafe, 1997) talk…Minimal responses have a particular function when a collaborative floor is in operation…This is because the conversation floor is construed as occupied by all participants, participants have an obligation to signal their continued presence in and acceptance of the shared floor.*

Similarly, Baker (1977) reported that approximately 30% of the conversation between two Deaf adult dyads included overlap. Because the nature of visual language allows signers to overlap in conversation more than speakers (Baker, 1977; Coates & Sutton-Spence, 2001) overlap does not appear to pose such a hindrance to conversation in this modality.

Overlap in Structured Conversation

The amount of overlap also varies according to the social and conversational context. Previous studies suggest that more structured contexts produce less overlap than more casual contexts. For example, in analyses of clinical interviews (Duncan, 1972; Duncan & Neidehere, 1974; Jaffe & Feldstein, 1970), courtroom questionings (Gnisci & Bakeman, 2007), and classroom group interactions (Peets, 2009) observations reveal little overlapping speech between speakers since the settings are often highly structured and social dominance may be unequal among speakers (Cromdal, 2001; West & Zimmerman, 1983). Turn taking is one respect in which dialogue in more structured settings is dissimilar to dialogue among friendly familiar partners (Jaffe & Feldstein, 1970, p.115). In unstructured conversation between friends, power is more likely to be equal and conversation may serve multiple purposes for the relationship beyond the formal exchange of information or ideas. This is not to indicate abundant overlap in casual spoken conversations, but a relative difference in overlap based on context. While both more and less structured contexts of conversation contain overlap, the alternating turn model remains a ubiquitous feature of spoken conversation across many languages (Stivers et al., 2009).

Development of turn taking. Studies of childhood language development suggest that the timing aspect of turn taking improves as children develop. Young children tend to pause for longer periods before responding to a partner than older children and adults (Craig & Evans, 1989; Ervin-Tripp, 1979; Gallagher & Craig, 1982; Garvey & Berninger, 1981; Prinz & Prinz, 1985). On the other hand, older children and adults respond more promptly to a partner, increasing the chance of overlap at the end of a partner's turn as speaker and addressee switch roles. Craig and Evans (1989) reported that children between eight and fourteen years initiated overlapping turns significantly more often within a partner's turn (85%) than at the start of a partner's turn (15%) whereas children between two and four years initiated overlapping turns only slightly more often at the start of a partner's turn (55%) than within a partner's turn (45%). Thus as their pragmatic skills improve, children initiate their overlapping turns more often toward the end of a partner's turn as adults do.

Conversational Skills of Cross-Fostered Chimpanzees

Beginning in 1966, adult human caregivers cross-fostered the chimpanzees (*Pan troglodytes*) Washoe, Moja, Tatu, and Dar in nearly human environments using American Sign Language (ASL) to communicate with them as they would a child (Gardner & Gardner, 1971, 1975, 1989; Gardner & Gardner, 1969, 1974, 1978). At the time, chimpanzees appeared ideal subjects for such studies since early observations by Jane Goodall revealed free-living chimpanzees to be highly social and communicate using a system of vocalizations and nonverbal gestures (see Goodall, 1986 for an in-depth description of chimpanzee communication). The cross-fosterlings signed throughout the day to themselves, their caregivers and each other in many contexts to converse about new things they observed in the environment, people they wanted to see, when it was time for blankets or the potty, and so on (see also Gardner & Gardner, 1971, 1989; R. Gardner & Gardner, 1994). Formal tests provided samples of early vocabulary growth (Gardner & Gardner, 1975, 1989) and showed that the early vocabularies of young chimpanzees share many of the same signs as early vocabularies of children (R. Gardner & Gardner, 1994). B. Gardner and Gardner (1994) also found that in their early phrases Moja, Tatu, and Dar used similar semantic relations in the same developmental sequence as young children (Bloom, Rocissano, & Hood, 1976; Braine, 1976; DeVilliers & DeVilliers, 1986). More recent studies of the adult cross-fostered chimpanzees have focused on pragmatic aspects of conversations between Washoe, Moja, Tatu, and Dar and a human partner. Specifically, Jensvold and Gardner (2000) and Bodamer and Gardner (2002) respectively found that the chimpanzees reply to conversational probes with contingent rejoinders and use reiteration, incorporation, and expansion to maintain topic much like hearing adults and children (Brinton & Fujiki, 1989; Ciocci & Baran, 1998; Garvey, 1975; Halliday & Hassan, 1976; Wilcox & Webster, 1980). Chalcraft and Gardner (2005) found that the cross-fostered chimpanzee, Tatu, used different types of modulated signing to indicate directionality and intensity like Deaf signers.

As infant chimpanzees signing with their caregivers, Washoe, Moja, Tatu, and Dar hesitated between some signs, held some signs, and dropped their hands out of the signing space when finished signing. The cross-fostered chimpanzees take turns as signer and addressee during conversation and overlap with their signing partners (Chalcraft & Gardner, 2005; O'Sullivan & Yeager, 1989; Shaw, 2001; Van Cantfort & Rimpau, 1982). Shaw (2001) found young chimpanzees to be similar to young children in that they showed immature patterns of eye gaze while shifting roles as signer and addressee, and the adult chimpanzees to be similar to human adults in their gaze patterns while shifting conversational roles. Building upon these earlier studies reporting turn taking in cross-fostered chimpanzees, the current study examined infant and adult chimpanzee turns with a human interlocutor in an effort to better understand the timing of their turn initiations.

Objectives

The study's first main objective was to determine what type of turn taking the infant and adult chimpanzees engaged in most frequently with their partners; specifically whether the chimpanzees waited for the partners to complete a turn before beginning (i.e., initiated alternating turns), whether the chimpanzees began a turn while the partner was still signing (i.e., initiated overlapping turns), or whether the chimpanzees began a new turn just as the partner began a new turn (i.e., simultaneous turns). The study's second objective was to determine whether a more structured, planned conversational style resulted in fewer or more overlapping turn initiations by the adult chimpanzees. The study's third main objective was to compare the timing of infant and adult overlapping turn initiations to determine whether the infants initiated turns at the same time, earlier or later in the partner's signing process than did the adults. Because the chimpanzees resemble humans in many other aspects of pragmatic development, based on studies of human turn taking the author predicted that:

1) infant and adult chimpanzees would primarily initiate alternating turns with their partner, however overlapping turns would be common enough for further inspection
2) adult chimpanzees would initiate fewer overlapping turns during the more structured scripted condition than the less structured unscripted condition
3) adult chimpanzees would initiate overlapping turns near the end of the partner's turn
4) infant chimpanzees would initiate overlapping turns near the beginning of the partner's turn and engage in more simultaneous starts than the adults.

Method

Subjects

Subjects of the current study were the four cross-fostered chimpanzees (*Pan troglodytes*), Washoe, Moja, Tatu and Dar. Human caregivers used the signs of ASL to sign with the chimpanzees about daily events such as the food they were preparing, who was coming to visit, favorite colors, household objects, games and friends (Gardner & Gardner, 1971, 1989; Gardner & Gardner, 1969, 1974, 1978). A brief overview of the histories of the chimpanzees appears in Table 1 and further detail of the chimpanzees' upbringing is summarized by Bodamer and Gardner (2002).

Procedure

Turn taking was analyzed from two archived videotape samples of Washoe, Moja, Tatu and Dar as adults and of Tatu and Dar as infants. The samples each contained one-on-one signed interactions between the chimpanzees and a human caregiver.

Adult corpora. Bodamer and Gardner (2002) videotaped signed interactions between a human interlocutor (MDB) and Washoe, Moja, Tatu, or Dar at the Chimpanzee and Human Communication Institute (CHCI) on the campus of Central Washington University in Ellensburg, WA between April, 1992 and April, 1993 for a study of conversation initiation and topic maintenance. At the time of filming the adult corpus, MDB had eight years of experience caring for the chimpanzees and signing in ASL. The chimpanzees lived together in an indoor complex of rooms

and tunnels through which they were able to move freely, interacting with each other and human caregivers.

For Bodamer and Gardner (2002), a chimpanzee initiated the signed interaction of each trial from the TZ; once a chimpanzee signed, MDB responded with a series of two scripted probes. Systematic probes were modeled after studies of deaf and hearing children (e.g., Anselmi, Tomasello, & Acunzo, 1986; Britton & Fujiki, 1989; Britton, Fujiki, & Sonnenberg, 1988). As shown in Table 2, the first probe was always the question WHAT? The second probe contained a second WHAT? question, an on topic question, a denial, or an affirmation. For Bodamer and Gardner the trial ended with the chimpanzee's response to the second probe however, the social interaction did not necessarily end at this point. Instead of abruptly leaving the chimpanzee as soon as the trial was complete, MDB continued to sign with the chimpanzee and the camera continued to film until the interaction ended. This resulted in an unscripted, less structured portion of the interactions which typically continued for several more turns.

The current study included the trial as well as the signing following the trial and consequently chimpanzee behaviors during the scripted and unscripted conversational conditions are analyzed separately. The scripted condition contains the formal trial of Bodamer and Gardner's (2002) study; it began with the chimpanzee's initiating utterance to MDB, included MDB's first and second probes and the chimpanzee's responses to MDB's probes. The unscripted condition began with the first turn after the chimpanzee's response to the second probe and continued until the filmed signing between MDB and the focal chimpanzee ended. The interactions (and therefore unscripted conditions) ended for different reasons. For example, interactions ended when MDB returned to work, MDB left the room to play a physical game such as chase, when another chimpanzee joined the interaction, and so forth.

MDB's responses in the scripted and unscripted conditions ranged from single signs (e.g., WHAT) to longer phrases (e.g., NO CAN'T SORRY NO), thus the opportunity for initiating overlapping turns by the chimpanzees varied from one to many signs in both conditions. Probe 1 always contained the single sign WHAT. In some cases probe 2 responses incorporated one sign such as YES, NO, or SORRY and in other cases probe 2 responses were much longer than one sign in length.

The current sample of adult corpus interactions consists of 40 sessions per chimpanzee, comprised of 10 sessions (5 longest, 5 shortest) from each of the four probe conditions for Bodamer and Gardner (2002). This sample yields approximately 123 min of signed interactions for the four chimpanzees combined. Individually, Dar's sessions resulted in about 23 minutes of interactions, Moja's sessions resulted in about 32 min of interactions, and Washoe and Tatu's sessions each resulted in about 34 min of interactions.

Infant Corpora. Between September, 1979 and August, 1980 B. T. and R. A. Gardner filmed unstructured interactions of Tony McCorkle (TM) signing with 40-month-old Dar, and Martha Gonter (MAG) signing with 48-month-old Tatu in the Reno laboratory (Chalcraft & Gardner, 2005; Rimpau, Gardner, & Gardner, 1989). It should be noted that until the age of about five years, free-living chimpanzees are considered infants given their heavy dependence upon the mother for milk and food, socialization, and care (Goodall, 1986, p. 81). While human children of four to five years old are relatively independent, chimpanzees of the same age are just ending of the infancy stage and are referred to as such in this report. The cross-fosterlings spent from 0700 to 2000 each day of the week with one of a small group of consistent caregivers (Rimpau et al., 1989); TM had been a part of Dar's foster family for 8 months and MAG had been a part of Tatu's foster family for 28 months (Gardner & Gardner, 1989; Gardner, Gardner, & Drumm, 1989). At the time of filming both TM and MAG had extensive signing experience in ASL. The samples of the infant corpora used in the current study include one 23 min interaction for Tatu and two interactions totaling 23 min for Dar. Both samples are taken from a larger body of video filmed over the course of one year and provide a representative sample of conversations between the young chimpanzees and their human caregivers. The conversational samples are similar in duration to other language studies of human adults and children (e.g., Craig & Evans, 1989; Craig & Gallagher, 1982; Craig & Washington, 1986; Garvey & Berninger, 1981; Jaffe & Feldstein, 1970).

Table 1
Biographical information of chimpanzee subjects

Subject	Date of birth	Place of birth	Gardner laboratory Reno, NV	Institute for Primate Studies, Norman, OK	CHCI Ellensburg, WA	Age at time of video taping	
						Adult corpus	Infant corpus
Washoe	1965[a]	Africa	6/66 – 10/70	10/70 – 9/80	9/80 – present	26 years	--
Moja	11/18/72	LEMSIP, NY	11/72 – 12/79	12/79 – 9/80	9/80 – 6/02	19 years	--
Tatu	12/30/75	Norman, OK	1/76 – 5/81	---	5/81 – present	16 years	48 mos
Dar	8/2/76	Holloman Air Force Base, TX	8/76 – 5/81	---	5/81 – present	14 years	40 mos

[a]Washoe was wild caught in Africa; her DOB is estimated

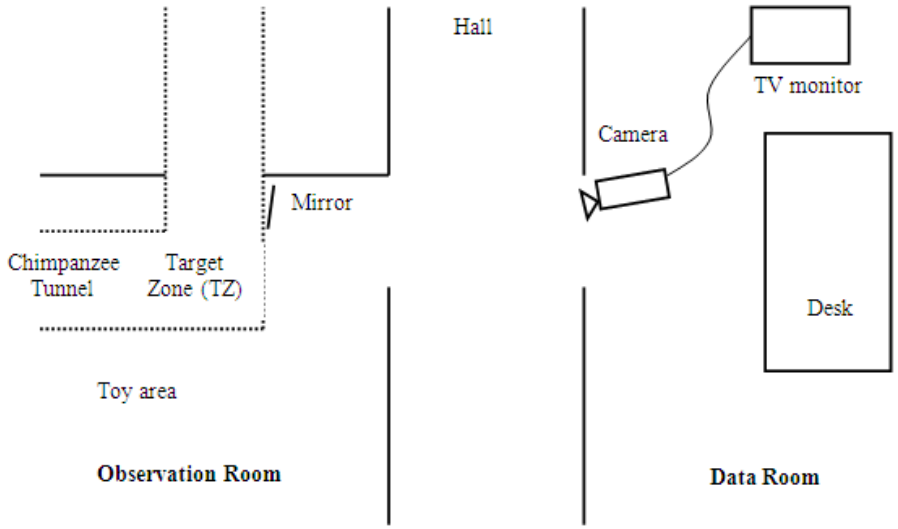

Figure 1. Floor plan showing arrangement of participants and apparatus in Adult corpora.

Table 2
Example trials of each second probe condition in adult corpus.

	Second probe condition			
	WHAT	On topic question	Affirmative	Denial
Example Session:	Dar (Trial 2.02)	Dar (Trial 1.09)	Tatu (Trial 3.03)	Tatu (Trial 3.02)
Chimpanzee	CHASE	TOOTHBRUSH	CHEESE CHEESE	COFFEE
Human Probe 1 (Scripted)	WHAT?	WHAT?	WHAT?	WHAT?
Chimpanzee	TOOTHBRUSH	TOOTHBRUSH	COFFEE DRINK	DRINK COFFEE COFFEE
Human Probe 2 (Scripted)	WHAT?	WHAT TOOTHBRUSH?	YES	NO CAN'T SORRY
Chimpanzee	TOOTHBRUSH	TOOTHBRUSH DAR SWALLOW	DRINK	CHEESE YOU DRINK DRINK
Human (Unscripted)	TOOTHBRUSH WHO?	WHERE TOOTHBRUSH?	YES COFFEE WHERE LOOK?	WHAT DRINK?

In the interactions between Dar and TM, the two sit on a couch in the chimpanzee playroom. TM is wearing a hat and later brings out a soda, both of which become topics of conversation. In the interaction between Tatu and MAG, the two sit on the floor in the chimpanzee playroom. MAG has brought her lunch and shares it with Tatu during the course of filming. In both cases, the chimpanzee and interlocutor engage in signing about whatever is close at hand and topics such as clothes, toys, sharing, whose turn it is to take a bite or sip of a food item, interesting scratches or bruises, and so forth. Some of the interlocutor utterances are short, containing only one sign while others contain 8 signs or more. The opportunity for the chimpanzees to initiate overlapping turns again varied widely as was characteristic of daily unstructured, unscripted social time between the chimpanzees and their caregivers.

Agreement. The author served as the primary transcriber for all transcriptions except sign gloss. Since most of the video corpora used in the study had already been transcribed for previous studies (Bodamer & Gardner, 2002; Shaw, 2001) the author served as the secondary transcriber for sign gloss. Seven second transcribers participated in the transcription process and independently recorded beginning times of signs, end times of signs, presence of transitions, beginning times of transitions, or end times of transitions. All second transcribers had at least one year experience signing with ASL and caring for the chimpanzees. At least 20% of the signed interactions for each corpus for each chimpanzee and human signer were sampled for agreement. Prior to videotape transcription, a time code of hours:minutes:seconds.tenths (hh:mm:ss.0) was burned onto each videotape to ensure consistency in transcription across viewing sessions. Using frame-by-frame analysis to record transcriptions to the tenth of a second (0.10 s) transcribers were said to agree if the transcription times fell within one tenth of a second of each other. Transcriptions recorded within 2 or more 0.10 s were marked as a disagreement. For example, if transcriber 1 marked the end of a sign at 01:11:59.3 and transcriber 2 marked the end of the sign at 01:11:59.2 or 01:11:59.4 then the transcriptions of that time were marked as an agreement. If transcriber 2 marked the end of the sign at 01:11:59.5 or 01:11:59.1 (or further from 01:11:59.3) the transcriptions of that time were marked as a disagreement. Because of the window of agreement, interobserver reliability was assessed using a percent agreement of total observations. A minimum criterion of 85% agreement between transcribers was met or exceeded for each behavior with the range of actual agreement between 85% and 100%. Ranges of agreement for specific transcription tasks are reported below and a complete list of agreement per transcription task can be found in Appendix D of Davis (2007). These levels of agreement are within the range of those for language studies with children (e.g., Craig & Evans, 1989; Craig & Gallagher, 1982; Elias & Broerse, 1996; Mohay, 1982; Spackman, Fujiki, & Brinton, 2006; Snow, 1972). Disagreements were discussed between transcribers to assign final judgments.

Videotape Transcription

In the current study turns are composed of pauses and segments of signing by one or both signers; segments are composed of consecutive individual signs and transitions of one signer bound by pauses. Table 3 provides definitions of signs, pauses, segments, and other terms relevant to the videotape transcription. The following section describes how transcribers viewed videotapes to identify the beginning and end times of signs and transitions and how a computer program then identified turn boundaries.

Signs. Transcribers first viewed videotapes to record sign gloss by playing the portion of videotape forward and backward, using the jog/shuttle feature of the VCR; transcribers were encouraged to replay the video as many times as they chose. Gloss transcribers used the PCM[2] system and an ASL dictionary (e.g., Stokoe, Casterline, & Croneberg, 1965) for transcriptions resulting in independent lists of chimpanzee and human glosses in the order of their appearance. In this report, capital letters indicate English glosses for ASL signs and transcriptions appear in word-for-sign English. Transcribers then viewed videotapes again to record beginnings and ends of signs to one tenth of a second (0.10 s). In the sample conversation of the Appendix signs can be identified by dark gray shading. For the chimpanzees and human interlocutors (transcribed independently) presence of

[2]PCM refers to the Place, Configuration and Movement of the signing hand; a PCM defines a sign. Gardner, Gardner, and Nichols (1989) Table 3.2 provides a thorough PCM description of the signs in the chimpanzees' early vocabularies. At CHCI, Washoe, Moja, Tatu and Dar continued to add signs to their vocabularies, and observers continued to use the PCM system to describe each new sign (Fouts, 1993). Transcribers used these resources as necessary to identify reliable chimpanzee signs.

sign agreement ranged from 88% to 96%, sign gloss from 88% to 98%, beginning time of sign from 90% to 97%, and end time of sign from 85% to 96%.

Table 3
Definitions

Signing Code	Description
Sign	ASL sign as defined by PCM (Stokoe et al., 1965)
Transition	Continuous hand movement between sign and pause or between two signs
• pause – sign (p-s) • sign – pause (s-p) • sign – sign (s-s)	• Transition from pause to sign beginning a segment • Transition from sign to pause ending a segment • Transition from sign to sign within a segment
Pause	0.10 s or more without sign or transition by a signer
• Mutual pause	• 0.10 s or more without sign or transition by either signer
Segment	Stream of one or more signs by one signer connected by transition and bound on either side by pause
Turn	Series of segment(s) and pause(s) bound on either side by mutual pause
Overlap	0.10 s or more of simultaneous signing or transition by the two signers

Transitions. In the process of signing there must be hand movement or transition (Boyes-Braem, 1999; Coulter, 1990; Green, 1984; Grosjean, 1979) between pause and sign. Three categories of transition were defined for the current study: from pause to the first sign in a segment (p-s), from the last sign in a segment to pause (s-p), and from sign to sign (s-s) within a segment (see Table 3). Pauses were identified as periods of 0.10 s or more where a signer's hands were relaxed out of the signing space[3] or engaged in a non-sign act such as scratching. A signer's continual movement of transition and sign between pauses resulted in signing segments. Transitions can be identified by light gray shading in the sample transcript of the Appendix.

To mark the boundaries of p-s transitions, transcribers identified the first 0.10 s of movement in the transition from pause to sign which marks the beginning of a p-s transition. The 0.10 s just before the sign begins marks the end of the p-s transition. The example in the Appendix shows a p-s transition before Dar's sign TOOTHBRUSH with light gray shading from 22:57.9 to 22:58.1. To mark the boundaries of s-p transitions, transcribers identified the end of the last sign in a segment then identified the last 0.10 s of movement in the transition from sign to pause. The first 0.10 s after the last sign in the segment marks the beginning of an s-p transition and the last 0.10 s of movement before the pause marks the end of an s-p transition. Again, the first segment in the Appendix shows an s-p transition after Dar's sign TOOTHBRUSH with light gray shading from 22:58.4 to 22:58.5. For time between the end of one sign and the beginning of the next sign transcribers judged whether there was at least 0.10 s of pause. When transcribers could not detect at least one 0.10 s of pause, they marked the time between the signs as s-s transition. Pauses of at least 0.10 s divided the signing stream into segments and thus, transcription of s-s transition or pause between each pair of signs resulted in a series of segments and pauses. For example, in the Appendix light gray shading indicates a transition between MDB's signs NO and TOOTHBRUSH. Transcribers recorded pause between the next set of his adjacent signs TOOTHBRUSH and CHASE. Transcribers recorded transition between CHASE and WHO, and a pause between WHO and CHASE. In this example, transcription of s-s transitions resulted in MDB's three segments, NO TOOTHBRUSH, CHASE WHO, and CHASE. For the chimpanzee and human interlocutors agreement for presence of s-s transition ranged from 90% to100%, presence of p-s transition from 93% to 100%, begin time of

[3]The signing space is the area in which most signs are made and encompasses the head, torso, and arms, usually stopping at the waist (Battison, 1978; Bellugi, 1972).

p-s transition from 86% to 99%, presence of s-p transition from 87% to 97%, and end time of s-p transition from 87% to 100%.

Turns. A computer program designed by the author for the current study using Visual Basic 3.0 made judgments of turn beginnings and endings. Based on the videotape transcriptions, the author entered a code for Pause (N), Signing (S), or Transition (T) for each 0.10 s of each interaction for each signer into an MS Access 6.0 database. Using this raw data, the program generated additional descriptors indicating the type of transition, when a signer initiated overlap, which signer initiated overlap, duration of overlap, and a body of other information describing each signed interaction to the 0.10 s. The computer program utilized this information and the study's definitions of turn types (Table 4) to mark turn beginnings and endings.

For the current study all turns begin with the first 0.10 s of signing by one signer and all turns end at the last 0.10 s of mutual pause (see Table 3) or after 1.5 s of mutual pause indicating no response (Craig & Evans, 1989; Shaw, 2001). Turn boundaries and segment boundaries for the sample transcript are presented in the Appendix. Turns were identified as a function of pauses in the signing stream and were categorized as alternating, overlapping, or simultaneous (see Table 4). Alternating turns occur when one signer signs while the other pauses, as in the turns beginning at 22:57.9 and 22:59.1 in the Appendix. Here Dar signs TOOTHBRUSH and there is a 0.5-s pause before MDB responds with another alternating turn NO TOOTHBRUSH. Overlapping turns occur when both signers sign at the same time as in the turn beginning at 23:05.3 of the Appendix. Here MDB signs CHASE WHO? and before his segment is complete, Dar responds CHASE overlapping the end of MDB's WHO sign. Likewise, before Dar finishes his segment CHASE, MDB overlaps Dar accepting the request to chase by repeating CHASE and then they proceed to play the game. Simultaneous turns occur when both signers begin signing simultaneously. In one example, Moja requests CLOTHES at 55:53.4, the same 0.10 s that MDB begins the question DON'T UNDERSTAND, WHO? in response to her previous request.

Table 4
Turn types

Turn type	Description	Number of signers	Number of segments
Alternating	Chimpanzee remains in a pause while the human signs one or more segments	One	One or more
Overlapping	Chimpanzee begins new segment while human is signing	Two	Two or more
Simultaneous	Chimpanzee and human begin new segments during the same 0.10 s	Two	Two or more

Results

Adult Corpora

In the adult corpora the chimpanzees engaged in either more alternating or overlapping turns according to the conversational condition. In the scripted condition, where the human interlocutor responded with scripted probes, alternating turns occurred more often than overlapping turns for each chimpanzee as seen in Table 5, but the difference was significant only for Dar, $\chi^2(1, 127) = 11.98$, $p = 0.001$. However, in the unscripted condition where the interlocutor responded freely, for Washoe, Moja, and Tatu overlapping turns appeared three to four times as often as alternating turns. For Dar, overlapping turns appeared about twice as often as alternating turns. As can be seen in Table 5 this difference was significant for Washoe, Moja, Tatu, and Dar. Simultaneous turns rarely appeared

and were therefore discarded from further analyses. The remaining adult corpora results focus on analyses of overlapping turns.

Table 5
Comparisons of chimpanzee turns initiated during each condition

	Turn Type					
Corpus, Condition	Alternating	Overlapping	Simultaneous	χ^2	*df*	*p*
Adult, Scripted						
Washoe	75	60	1	1.67	1	> 0.05
Moja	72	58	5	1.51	1	> 0.05
Tatu	61	53	4	0.56	1	> 0.05
Dar	83	44	1	11.98	1	= 0.001
Adult, Unscripted						
Washoe	19	78	3	35.89	1	< 0.001
Moja	28	91	4	33.53	1	< 0.001
Tatu	22	114	1	62.24	1	< 0.001
Dar	59	103	3	11.95	1	< 0.001
Infant						
Tatu	23	84	1	34.78	1	< 0.001
Dar	29	80	3	23.86	1	< 0.001

Note: Chi Squares compare Alternating and Overlapping turns only. Due to the low frequency of simultaneous turns, they are excluded from analyses.

Relative overlap within turn. Overlapping turns typically include time wherein both signers alternate signing back and forth as well as time wherein both signers sign at the same time as shown in the overlapping turn beginning at 23:05.3 of the Appendix. Results in Table 6 show that the amount of actual overlapping signing within overlapping turns was relatively small (12-17%) in the scripted condition, but in the unscripted condition accounted for up to half of (28-51%) the total time in overlapping turns for three of the four chimpanzees. Thus the amount of overlapping turns as well as the amount of overlapping signing per turn was increased in the less structured unscripted condition. In order to assess whether these instances of overlap were particularly long, duration of overlap was examined.

Mean durations of overlap from several previous studies of spoken and signed conversation (see Table 7) show that overlap tends to last longer in signed conversations than in spoken conversations. The duration of each instance of overlap in the current study was calculated based on a consecutive series of 0.10 s cells during which both chimpanzee and human were signing or transitioning. The mean durations of overlap recorded for the chimpanzees and human partner in the scripted condition are shorter than the 1.5-s mean reported for adult signers by Baker (1977) and more similar to the 0.3 to 0.7 s range reported for adult speakers

in unscripted conversation (Jaffe & Feldstein, 1970; Lennes & Anttila, 2002). Although human data available for comparison are extremely limited, in the unscripted condition the mean durations of overlap of .81 to 1.69 s were more similar to Baker's results with Deaf adult signers in unscripted conversation.

Table 6
Distribution of time within overlapping turns.

Condition	Alternating signing (Chimpanzee/Human)	Overlapping signing	Mutual pause
Adult Scripted			
Washoe	79% (69/10)	12%	9%
Moja	75% (64/11)	15%	10%
Tatu	78% (71/7)	14%	8%
Dar	65% (49/16)	17%	18%
Adult Unscripted			
Washoe	45% (20/25)	45%	9%
Moja	42% (24/18)	51%	7%
Tatu	41% (21/20)	51%	8%
Dar	58% (20/38)	28%	14%
Infant			
Tatu	48% (17/31)	35%	17%
Dar	45% (25/20)	45%	10%

Table 7
Comparison of overlap duration in the current study and human adult conversations.

Sample	Condition	Subjects	Mean (s)	Range (s)
Adult corpora				
	Scripted	Washoe	0.68	0.1 – 2.1
		Moja	0.86	0.1 – 2.1
		Tatu	0.88	0.1 – 1.9
		Dar	0.59	0.1 – 2.2
	Unscripted	Washoe	1.23	0.1 – 4.9
		Moja	1.49	0.1 – 10.6
		Tatu	1.69	0.1 – 8.4
		Dar	0.81	0.1 – 3.6
Infant corpora				
		Tatu	1.3	0.1 – 6.0
		Dar	1.6	0.1 – 7.5
Baker (1977)		Signing adults	1.5	NA – 4.3
Jaffe & Feldstein (1970)		Speaking adults	< 0.5	--
Lennes & Anttila (2002)		Speaking adults	--	0.3 – 0.7

Overlap initiators. Unplanned post-hoc analyses revealed an unexpected difference in the scripted and unscripted conditions of the adult corpus regarding which signer, chimpanzee or human, initiated more overlap. In the scripted condition Washoe, Moja, and Dar each initiated more overlapping segments than MDB. This difference was significant for Washoe, χ^2 (1, 59) = 3.81, $p = 0.05$, and Dar, $\chi^2(1, 49) = 7.37$, $p < 0.01$, but not Moja, $\chi^2(1, 57) = 2.12$, $p > 0.05$. Tatu initiated about the same number of overlapping segments as MDB, χ^2 (1, 65) = 0.02, $p > 0.05$. In the unscripted condition Tatu initiated significantly fewer, $\chi^2(1, 300) = 7.05$, $p < 0.01$, and Dar initiated significantly more, $\chi^2(1, 183) = 17.75$, $p < 0.001$, overlapping segments than MDB. Washoe and Moja each initiated a similar number of overlapping segments to MDB (for Washoe, $\chi^2(1, 211) = 0.12$, $p > 0.05$; for Moja, $\chi^2(1, 276) = 1.44$, $p > 0.05$. Thus in the adult sample, no clear pattern was apparent to indicate that the chimpanzees or human initiated more overlapping turns than the other.

Timing of overlap initiations. The timing of chimpanzee overlap initiations were analyzed in relation to the partner's segment and also in relation to the partner's specific overlapped sign within the segment.

Segments. A signer can initiate overlap during one of four divisions of the partner's segment: at the beginning of the partner's segment during the pause to sign transition (p-s), during a sign, between signs during a sign to sign transition (s-s), or as the partner finishes a segment during a sign to pause transition (s-p). Table 8 presents chi-square analyses showing that all four chimpanzees initiated more overlapping segments than statistically expected during s-p transitions and fewer overlapping segments than statistically expected during p-s transitions based on what time and opportunity alone explain. Since signing typically takes longer than transitioning, the overlap for each division of the signing stream was expected to be unequal. Therefore in the chi square analyses expected frequencies of initiations were mathematically adjusted for the different proportion of time that the interlocutor spent in each of the four segment divisions with each chimpanzee. Pair-wise comparisons for each chimpanzee showed no significant difference between the number of initiations during signs and s-s transitions, thus these two divisions of the signing stream were pooled for the remaining adult analyses. Table 8 shows that in the scripted condition at the beginning of MDB's segments where Washoe is expected to initiate at least 9 overlapping segments during p-s transitions, she initiated just four overlapping segments. Alternatively, at the end of MDB's segments, where Washoe is expected to initiate at least 9 overlapping segments during s-p transitions, she initiated 20 overlapping segments. While the pattern of initiations was consistent for all four chimpanzees in the scripted condition these differences were significant for Washoe ($p < 0.001$) and Dar ($p < 0.001$), but not for Tatu ($p = 0.17$) or Moja ($p = 0.13$). In the unscripted condition these differences were significant for Washoe ($p < 0.01$), Tatu ($p = .04$) and Dar ($p < 0.001$) and approached significance for Moja ($p = 0.06$).

Signs. The time of overlap initiation during a given sign, T_i, was the midpoint of that tenth of a second during which the chimpanzee began the overlap. For example, if MDB's total sign duration was seven tenths of a second (0.7 s) and Moja began signing during the fourth tenth of a second, then T_i equals 0.4-0.05, or 0.35 s. In the formula $S_c = (T_i / T_t)\ 100$, S_c represents the percentage of MDB's sign

that was complete at the point of initiation and is calculated by dividing T_i by the total duration of the overlapped sign, T_t, and multiplying by 100. Continuing with the same example, if T_i equals 0.35 s and T_t equals 0.7 s, then S_c = (0.35/0.7)100, or 50%, indicating that the chimpanzee initiated overlap when MDB's sign was half complete. An S_c value greater than 50% indicates that the chimpanzee initiated overlap in the latter half of MDB's sign. As shown in Figure 2, each of the four adult chimpanzees initiated most overlapping segments during the latter half of MDB's signs in both conditions,.

As the duration of MDB's sign increased Washoe, Moja, Tatu, and Dar initiated overlap later in the sign. Pearson's product moment correlations showed significant relationships between the point of chimpanzee initiation, T_i, in MDB's overlapped signs and the duration of MDB's overlapped signs, T_t. In the scripted condition for Washoe (N = 37) $r = 0.62$, $p < 0.001$, Moja (N = 34) $r = 0.53$, $p < 0.001$, Tatu (N = 32) $r = 0.63$, $p < 0.001$, and Dar (N = 34) $r = 0.47$, $p = 0.005$. Likewise, in the unscripted condition for Washoe (N = 108) $r = 0.61$, $p < 0.001$, for Moja (N = 119) $r = 0.72$, $p < 0.001$, for Tatu (N = 127) $r = 0.66$, $p < 0.001$, and for Dar (N = 120) $r = 0.79$, $p < 0.001$. Thus, for Moja and Dar, this relationship was again stronger in the unscripted condition than in the scripted condition.

Table 8
Comparison of overlap initiations during MDB's p-s transitions, signing[4], and s-p transitions in adult corpora.

		Segment division					
Condition	Subject	p-s transition	signing	s-p transition	χ^2	*df*	*p*
Scripted							
	Washoe	4 (9.07)	13 (18.68)	20 (9.24)	17.09	2	< 0.001
	Moja	4 (8.97)	18 (16.19)	12 (8.84)	4.08	2	0.13
	Tatu	4 (8.12)	16 (15.38)	12 (8.51)	3.55	2	0.17
	Dar	3 (9.45)	4 (15.37)	27 (9.18)	47.44	2	< 0.001
Unscripted							
	Washoe	2 (12.45)	86 (82.89)	20 (12.66)	13.14	2	< 0.01
	Moja	5 (13.10)	100 (93.07)	14 (12.83)	5.63	2	0.06
	Tatu	6 (12.64)	102 (101.45)	19 (12.92)	6.35	2	0.04
	Dar	3 (16.48)	94 (87.69)	23 (15.82)	14.74	2	< 0.001

Note: Expected frequencies, shown in parentheses, are adjusted for the amount of time human partner spent in each segment division.

[4] The difference between s-s transitions and signs was insignificant, thus these two divisions are pooled as signing for this analysis.

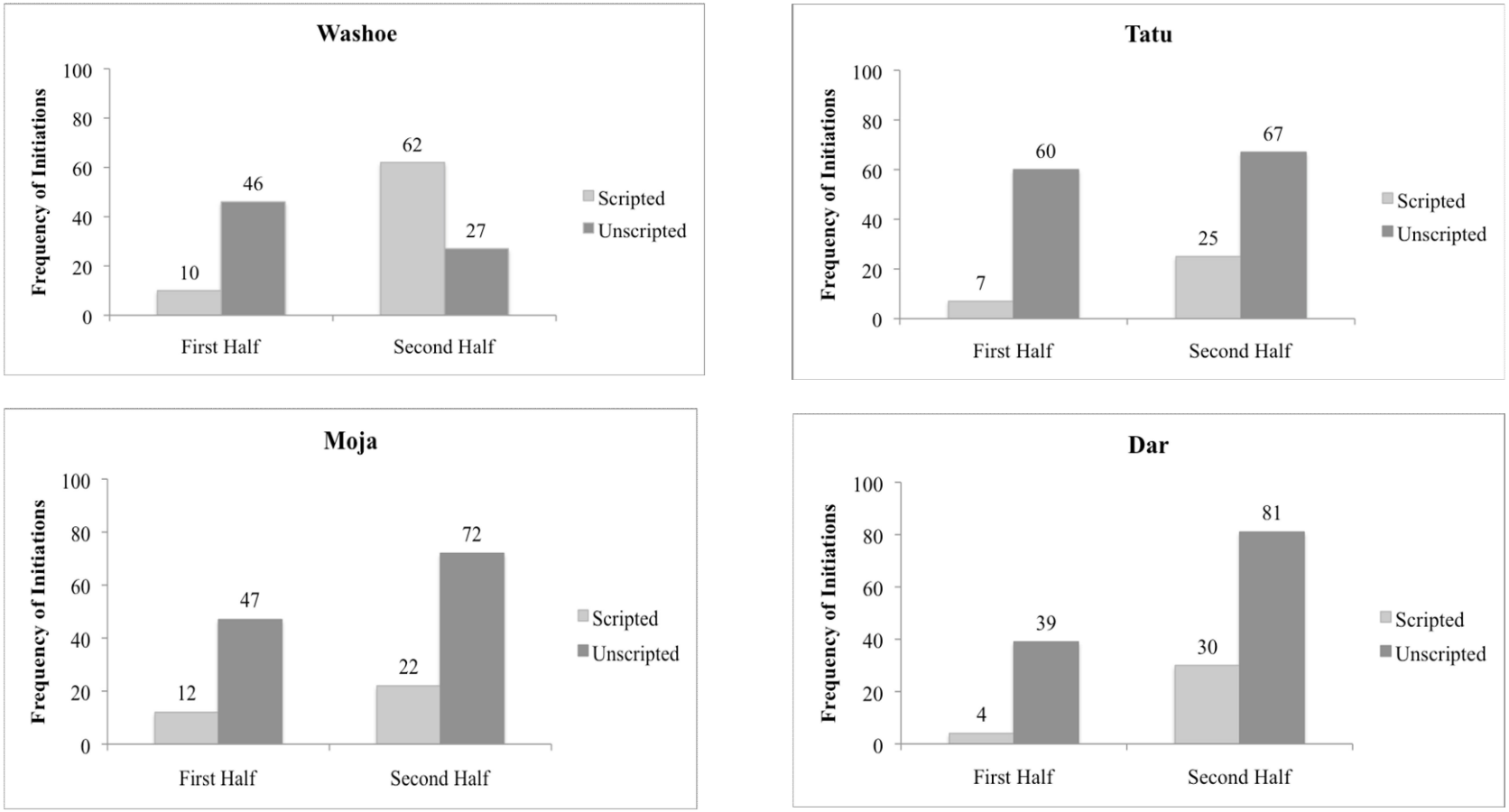

Figure 2. Number of chimpanzee overlap initiations during first or second half of human's signs in adult corpora.

Infant Corpora

In the infant corpora overlapping turns occurred significantly more often than alternating turns for each chimpanzee (see Table 5). For infant Tatu, $\chi^2(1, 135) = 34.78$, $p > 0.001$ and for infant Dar, $\chi^2(1, 130) = 23.86$, $p > 0.001$. In one interaction for example, after MAG had shared her lunch with Tatu, she used the opportunity to sign about brushing teeth, a common part of the daily routine. MAG and Tatu overlapped each other several times in the conversation as shown in Figure 3. As in the adult conversations, simultaneous turns were rare and were discarded from further analyses.

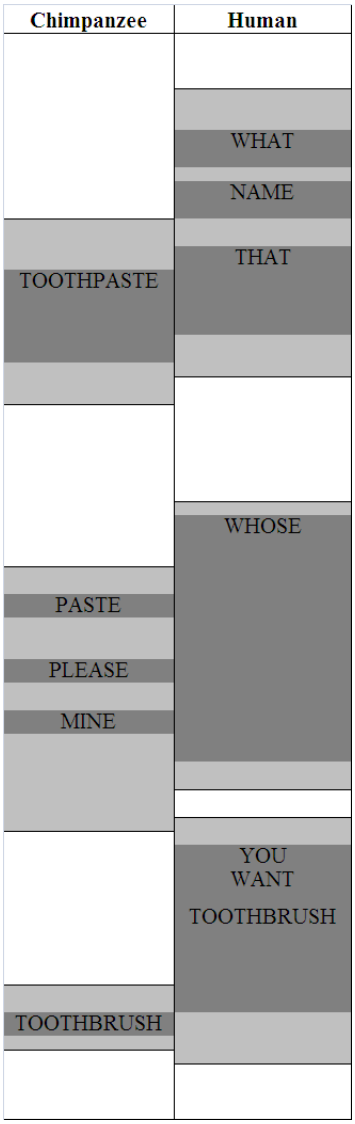

Figure 3. Example of overlapping turns in Tatu's infant corpus. Light shading indicates transition and dark shading indicates sign.

Relative overlap within turn. As described previously, overlapping turns typically include time wherein both signers alternate signing back and forth as well as time wherein both signers sign at the same time. In the infant corpus overlapping signing within the overlapping turns accounted for 35% and 45% of the overlapping turns by Tatu and Dar respectively (Table 6). Alternating signing accounted for 45% and 48% of the overlapping turns by Dar and Tatu respectively. These figures are within the range of that recorded in the similar unscripted condition of the adult corpus.

Overlap initiators. Unlike the pattern shown by the adults, unplanned post-hoc analyses showed that infant Tatu (N = 96) initiated over twice as many overlapping segments as her partner MAG (N = 39), $\chi^2(1, 135) = 24.07$, $p < 0.001$. Infant Dar (N = 102) initiated almost one and a half times the overlapping segments as his partner TM (N = 69), $\chi^2(1, 171) = 6.37$, $p < 0.01$.

Timing of overlap initiations. Contrary to the initial predictions for the study, both infant chimpanzees initiated fewer rather than more overlaps than statistically expected at the beginning of segments and during p-s transitions and initiated more overlaps than statistically expected during the partners' signs. For infant Tatu, $\chi^2(3, 96) = 9.49$, $p = 0.023$, and for infant Dar, $\chi^2(3, 102) = 23.84$, $p < 0.001$. During s-p transitions that occur at the end of segments, infant Tatu initiated fewer overlaps than statistically expected and infant Dar initiated more overlaps than statistically expected. These results indicate that in the timing of his initiations within the partner's segment, infant Dar behaved more similarly to the adult chimpanzees than did infant Tatu.

The infant chimpanzees initiated overlapping segments throughout MAG and TM's signs. In the timing of overlap initiations during the partner's signs infant Tatu was more similar to the adult chimpanzees than infant Dar. For example in one portion of the visit between TM and Dar, TM asks Dar who makes the sound like the 'tweet tweet' of a bird. Infant Dar gives a variety of incorrect answers including CAT and his own name. TM responds YOU KNOW, NOT CAT and midway (0.4 s of 0.8 s) into TM's sign NOT, Dar begins an unusually long p-s transition lasting 1.5 s to respond with a 0.2-s duration COW. This type of extended p-s transition for such a brief sign was rarely seen in the adult corpora.

As the duration of the partner's sign increased, infant Tatu and Dar both initiated overlap later in the sign; for Tatu (N = 96) $r = 0.71$, $p < 0.001$ and for Dar (N = 102) $r = 0.65$, $p < 0.001$. The mean duration of overlap between Tatu and MAG was 1.3 s and between Dar and TM was 1.6 s, both of which were similar to the overlap durations recorded in the unscripted adult condition (see Table 7).

Developmental Comparisons of Overlapping Turns

Since all interactions in the infant corpora were unscripted, the adult data discussed in this section includes only data from the unscripted condition.

Overlap initiations. As adults, Tatu and Dar each initiated more overlapping segments with MDB than they did as infants with their respective human partners. For Tatu, $\chi^2(1, 223) = 5.53$, $p = 0.02$, and for Dar, $\chi^2(1, 222) = 1.96$, $p > 0.05$. This finding resembles human children who increase the amount of overlap as they develop (Craig & Evans; 1989; Garvey & Berninger, 1981).

Presumably longer gaps between turns and less overlap by younger children may be due to the longer time required to formulate responses.

Timing of overlap initiations within a partner's segment and sign. While as adults the chimpanzees initiated more overlap, their timing of overlap initiations was also more sophisticated. Tatu and Dar each initiated overlap at different divisions within the partner's segments as infants and adults. These differences were significant for Tatu, $\chi^2(3, 223) = 13.4$, $p < 0.01$, and for Dar, $\chi^2(3, 222) = 35.5$, $p < 0.001$. Pair-wise comparisons reveal that as adults both Tatu and Dar waited until later in the partner's segments and initiated significantly more overlap at the end of the segments during s-p transitions than they did as infants (for Tatu, $\chi^2(1, 24) = 4.79$, $p < 0.05$; for Dar, $\chi^2(1, 33) = 4.15$, $p < 0.05$). As adults and as infants Tatu and Dar also initiated significantly fewer overlaps than statistically expected at the beginning of the partner's segments during p-s transitions (for Tatu, $\chi^2(1, 10) = 6.05$, $p < 0.01$; for Dar, $\chi^2(1, 7) = 28.86$, $p < 0.001$).

The analysis of overlap initiations in regard to individual signs showed the developmental difference that as infants Tatu and Dar used little distinction in the timing of their overlap initiations but as adults timed initiations in a consistent pattern. Both infant Tatu and Dar initiated overlap with almost equal frequency during the first and second half of the partner's signs, but as adults they each initiated overlap during the second half of the partner's sign more frequently than the first half (Fig. 4).

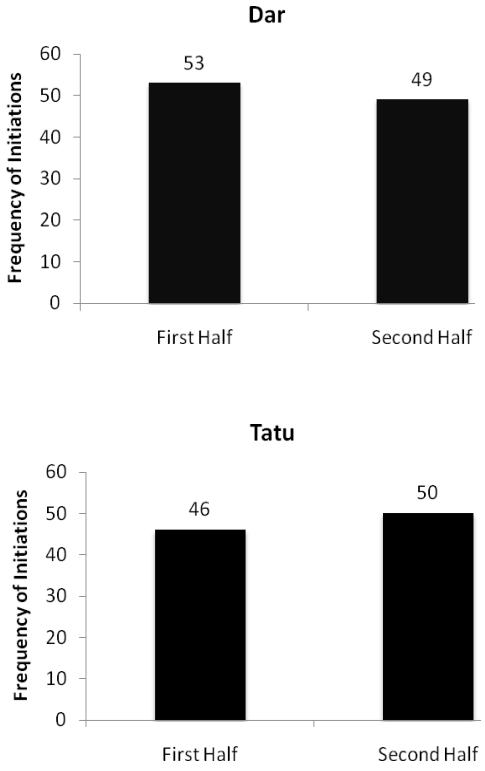

Figure 4. Chimpanzee overlap initiations during first and second half of humans' signs in infant corpora.

These data show that in some respects Tatu and Dar at 40 and 48 months behaved in similar ways as they did when adults, and in other respects less maturely. The observed differences in behavior indicate that, with development, the adult chimpanzees attended to the partner's overall segment by waiting to initiate overlap toward the end of the segments. Furthermore, the adults waited to initiate overlap until later in the sign when it is more likely that the sign is held or repeated, thus minimizing potential lost content due to simultaneous signing.

Discussion

The current study examined alternating and overlapping turns by infant and adult chimpanzees in conversation with a human interlocutor, when the chimpanzees timed the initiations of their overlapping turns, and how scripted and unscripted conditions affected turn taking.

In the scripted condition as predicted the adult chimpanzees primarily signed back and forth with the interlocutor using alternating turns, but in the unscripted condition the chimpanzees initiated significantly more overlapping than alternating turns. The sample conversations here with infant chimpanzees Dar and Tatu were filmed in unscripted informal contexts. Accordingly, the infant chimpanzees, like the adults also initiated more overlapping than alternating turns. The structured context of the scripted condition was more similar to an interview than a casual conversation among friends. The results indicated that the more structured context impacted the back and forth nature of the turn taking. Many studies of discourse use a structured interview or series of probe questions for experimental control and these conversational situations are useful and often necessary to identify contingent responses by subjects. One limitation of these procedures however is the generalizability from the more structured setting to a less structured setting. Just as grammar, vocabulary, and social formalities are altered by the discourse partner and social context (Brown & Ford, 1961; Ervin-Tripp, 1969; Homzie, Kotsonis, & Toris, 1981) turn taking appears also to be altered by the structured aspect of the conversational context. For the adults the type of turns and amount of overlap varied with condition, but the timing of their overlap initiations remained consistent across both conditions. The infants however randomly initiated overlapping turns throughout the partner's turns instead of waiting until later in the partner's sign or segment as did the adults.

Comparing chimpanzee and human overlap. An important though unexpected result of the current study is the proportional amount of overlapping segments initiated by the chimpanzees and human interlocutors. The study's focus was on chimpanzee (not human) behavior, however giving perspective to the amount of overlap initiations allows us to assess whether the chimpanzees initiated more or less overlap than their partner.

Terrace, Petitto, Sanders, and Bever (1979) heavily criticized the signed productions of the chimpanzees Nim and Washoe. Both chimpanzees were taught signs of ASL although their upbringings differed significantly. A brief example of difference between the two ape language projects is that Nim was driven to a university classroom from his home to receive training three to five times per week

(Terrace et al., 1979, Note 16). Washoe's cross-fostering, described earlier, took place in an environment much like a Deaf home with members of her foster family. Extensive details of the projects and early research findings are published in Terrace (1979), Terrace et al. (1979), and R. Gardner and Gardner (1969, 1974, 1994). A criticism of Terrace et al.'s relevant to the current study's findings was that both Nim and Washoe engaged in more interruption than human children. They report that Nim signed simultaneously with his partner in 71% of his utterances. This is clearly a majority of the conversation, however comparisons or conclusion based on this figure alone are speculative since the authors did not distinguish between definitions of overlap and interruption and did not include their methods for sign transcription. According to Terrace et al. (1979) any simultaneous signing by the chimpanzee was considered interruption and assumed inappropriate stating that "Such interruptions detract from *true conversation* [italics mine] since they result in discourse that is simultaneous rather than successive" (p. 897). The authors neglected to consider the then recent finding that 30% of adult ASL conversations contained overlap (Baker, 1977). Their claim would of course mean that Baker's data from adult signers did not represent true conversation either.

Edelsky's (1981) notion of a collaborative floor had not been published at the time of Terrace et al.'s 1979 article and Sack, Schegloff, and Jefferson's (1974) model proposing no gaps between turns and no overlaps of turns was heavily cited in papers on turn exchanges during discourse. Since specific data on Nim's interruptions are not provided, the timing of his turn initiations cannot be evaluated. The authors report that Nim was the initiator of 70% of the overlap leaving 30% to be human initiated. Unfortunately, a different explanation was used for Nim's interruptions than his human partner's. The authors state "When the teacher interrupted one of Nim's utterances it was generally the case that Nim had just interrupted the teacher and the teacher was in effect asserting his or her right to hold the floor" (p. 897). The lack of statistical analysis of the turn initiations do not allow valid comparisons of Nim and his partner's overlap initiations. Another concern raised by the previous quote is the concept of single ownership of the speaking floor. This is a common notion in turn taking literature (Coates & Sutton-Spence, 2001; Cromdal, 2001; Duncan, 1972; Duncan & Niederehe, 1974; Jaffe & Feldstein, 1970; West & Zimmerman, 1983) however, without independent inter-rater reliability on which one speaker possesses the speaking floor at any given time in a conversation, which is largely lacking on the literature, claims of a particular speaker's rights to the floor are better off suspended.

In the current study, both humans and adult chimpanzees initiated overlapping turns and there were many examples of volleying segments of both signers initiating overlap for several exchanges in succession. The proportion of chimpanzee and human initiations here provides evidence that the scripted nature of conversation increased the amount of chimpanzee initiated overlap in comparison to human initiated overlap, but that in the unscripted condition chimpanzee and human overlap initiations were very similar. However, as infants the chimpanzees clearly initiated proportionally more overlap than their partners. The results suggest that conversational experience also influences how often a signer initiates overlapping turns. As new data in human speech and sign expand

our understanding of simultaneous contributions to conversation (Baker, 1977; Coates & Sutton-Spence, 2001; Cromdal, 2001; Peets, 2009) the context, linguistic modality, and developmental stage must be considered prior to evaluating the appropriateness (or inappropriateness) of overlapping turns in any given sample of discourse.

Timing of Turn Initiations

Results of the current study support the hypothesis that, at least in signed conversations, the collaborative floor is common (Baker, 1977; Coates & Sutton-Spence, 2001). Sacks et al.'s (1974) frequently cited theory that advanced conversation should have 'no gaps' between turns and 'no overlap' of turns fails to be supported by such records of actual spoken (Cromdal, 2001; Jefferson, 1973; Wennerstrom & Seigel, 2003) and signed conversations among adults (Baker, 1977; Coates & Sutton-Spence, 2001) and chimpanzees in the current and previous studies (O'Sullivan & Yeager, 1989; Shaw, 2001). The chimpanzee initiated overlap observed here appears non-intrusive as evidenced by the frequent pattern of turn exchanges where the partners sign back and forth in a series of segments containing overlap without a break in the conversation. The interactions in the signed context of the current study allowed for both partners to contribute to the conversation at the same time but for short durations at a time. Overlap in spoken languages is less likely to be sustained for the same duration as in signed conversation. However, further study of conversation in casual contexts would be especially helpful for comparisons of the effect of modality on the proportional use of collaborative or alternating models of turn taking.

Initiation Cues

When responding to their partners, the adult chimpanzees initiated overlapping turns at nonrandom places within the partner's turns. The results show that the adult chimpanzees, but not the infant chimpanzees, initiated overlap consistently later in a partner's turns and especially during s-p transitions, after the last sign of the segment was completed and as the partner's hands moved toward a relaxed position. In the current study, s-p transitions are included as part of the signing process and so a turn initiation during this time was considered overlap. It could be argued that the nature of these overlaps differs from overlap during a sign 'proper' and should not be considered overlap at all. Analyses of overlap initiations during sign versus transition would provide additional detail of this type of smooth sign exchange where one signer begins as the other finishes his or her segment. At this time however, no data on human p-s, s-s, or s-p transitions in signed conversations are available to allow for such cross-species comparisons.

Whether the initiation occurred during a sign or during a s-p transition, this later timing suggests that the adults are initiating responses once they have received the majority of the information in their partner's turn or at least enough information to begin their response. In ASL, once a sign is formed, repetition or holding is often used to modulate the sign (Bellugi & Fischer, 1972; Coulter, 1990; Klima & Bellugi, 1979). Observations of Deaf conversations indicate that signers

also slow their signing at the ends of turns; this change in signing rate is thought to be one signal to the addressee to begin his or her response (Baker, 1977; Mesch, 2000; Wilbur & Petitto, 1981). In addition, signs at the end of signers' turns or phrases are typically longer (Coulter, 1990; Grosjean, 1979; Liddell, 1978; Wilbur, 1999) and larger (Wilbur, 1999) than signs made earlier in the utterance and are often raised or held in the signing space (Baker, 1977). The longer a sign continues, the less new semantic information is introduced. For example, the sign HAPPY is signed with open hands facing the signer brushing upwards on the chest. Repeated or enlarged movement and facial expression can alter the meaning to very happy or ecstatic. However, after the initial PCM is made, the partner has seen the most basic form of the sign and can offer a related response. Likewise, signers may raise (Baker, 1977; Bellugi & Fischer, 1972) or hold a sign with a questioning facial expression (Baker, 1977) to ask a question. Once the movement has been made and is subsequently held, theoretically the partner should initiate a response. A period of time during which a sign is lengthened serves to enhance meaning and or supply specificity to the message even though the most basic meaning of a sign is conveyed with the first formation of the sign. This characteristic of visual language allows for a period of time during which overlap by the partner is not disruptive to incoming content.

Under comparable unscripted conditions the infant chimpanzees but not the adults initiated more overlap than their partners and initiated overlaps with nearly the same frequency during the first and second half of the partner's signs suggesting that overlapping turns are less collaborative and less well timed by younger signers and therefore likely develop with conversational experience. One limitation of the current study is that by using archived samples of conversation, different humans served as interlocutors with the adult and infant chimpanzees. While this could account for differences among the adult and infant data, it is unlikely since infant Tatu and Dar signed with two different caregivers but responded similarly in regard to the timing of their overlap initiations (i.e., random). Tatu and Dar's turn taking behaviors as infant chimpanzees varied in other respects (e.g., who initiated more overlap with their partner) which may be due to the different interlocutors or simple individual differences. Individual differences were also apparent for the adult chimpanzees which interacted with the same interlocutor.

Another more likely explanation of differences between the adult and infant chimpanzee behavior is that, since it is not possible to accurately guess how long a partner will continue a sign, the latter half of the partner's turns must contain cues such as s-p transitions and shifting gaze toward the addressee that together signal experienced signers when to initiate a response to their partner, much like Duncan (1972) and Duncan and Niederehe's (1974) turn yielding signals in spoken conversation. The current results suggest that the adult chimpanzees observed some of these cues yet the infant chimpanzees at 40 and 48 months had not yet acquired this skill. The scope of the current study did not include an analysis of possible interlocutor cues. Further research is necessary to determine what specific cues are provided to facilitate such turn taking and which cues are most salient. For example future studies could examine the human partner's signs for changes in sign rate, duration, and position throughout the turn

which may provide insight into partner cues that signal the chimpanzees when to initiate a turn.

Measures of Turn Taking

Transcribers identified one of three main types of signing behavior (signing, transitioning, or pause) for every 0.10 s in an effort to distinguish between pause and transition as well as between transition and sign. The final transcripts therefore distinguish mutual pauses from individual pauses allowing for identification of conversational turns and segments within an individual's turns. Such specific units of transcription allow for more precise analysis of turn initiations than line by line or minute by minute transcriptions (e.g., Craig & Washington, 1986; Cromdal, 2001; Gallagher & Craig, 1982; Jefferson, 1973; Maroni, Gnisci, & Pontecorvo, 2008; Prinz & Prinz, 1981) which allow for more gross estimates of turn initiations.

Despite the time consuming nature of the method, this level of transcription combined with computer based turn identification yielded highly reliable and detailed transcripts. Such detailed transcriptions of human conversation would allow researchers to make reliable, comprehensive and quantifiable comparisons of turn taking across and within species and across conversational contexts. Many studies of human dialogue suggest variation in turn taking as a function of modality (Coates & Sutton-Spence, 2001), age (Gallagher & Craig, 1982), culture (Greenbaum, 1985), language impairments (Craig & Evans, 1989), gender (ten Bosch, Oostdijk, & Boves, 2005) and atypical social or language skills (Dollaghan, 1987; Peets, 2009). However the lack of consistency in methodology currently restricts our understanding of the degrees and types of variation in turn taking across these populations and contexts. Detailed transcripts of the timing of human turn initiations using a consistent methodology would provide the opportunity for more precise comparisons of this clearly rich and varied aspect of discourse.

Summary

Washoe, Moja, Tatu, and Dar were reared in a human like environment and were able to observe signed conversations of adults around them and join in conversation as they chose. Unlike household pets, in the cross-fostering environment the chimpanzees were treated much like children. They were signed to as Deaf children are; they participated in signing games and had new signs modeled within the context of daily conversation. From early infancy turn taking in play and conversation was an integral part of their upbringing as it is for most humans. A common characteristic of free-living chimpanzee behavior is to engage in social interactions such as grooming and play where partners participate cooperatively (Arnold & Whiten, 2003; Goodall, 1986), thus turn taking in one-on-one conversations by the chimpanzees is a likely result given their cross-fostered rearing history and biologically social nature.

Casual conversations among friends are often messy; they include stops and starts, incomplete sentences, fillers like 'um', and alternating and overlapping

turns. Likewise the chimpanzee-human conversations in the current study are characterized by back and forth turn exchanges, sometimes alternating, sometimes overlapping, and occasionally including simultaneous starts. The current study supports previous findings with humans that and the amount of structure in a conversation influences the proportion of alternating and overlapping turns (e.g., Baker, 1977; Coates & Sutton-Spence, 2001; Jaffe & Feldstein, 1970), that experience is an important factor in the timing of turn taking (e.g., Craig & Evans, 1989; Ervin-Tripp, 1979; Gallagher & Craig, 1982), and expands these areas of the literature to cross-fostered chimpanzees. Previous studies established that cross-fostered chimpanzees follow the same patterns of vocabulary and phrase development (B. Gardner & Gardner, 1989, 1994; Gardner & Gardner, 1974, 1978) and exhibit many of the same pragmatic behaviors as human children and adults (Bodamer & Gardner, 2002; Chalcraft & Gardner, 2005; Jensvold & Gardner, 2000; Shaw, 2001). The current study adds to the continually growing body of evidence that cross-fostered chimpanzees develop more sophisticated pragmatic skills with experience.

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Appendix

Partial Transcription Showing Turn Boundaries, Segment Boundaries and Signing Codes

Shaded blocks indicate segments of signing, and white blocks indicate pauses between segments. Light shading within the segment indicates transition and dark shading within the segment indicates sign. Signing codes: A = Alternating Signing, O = Overlapping Signing, and MP = Mutual Pause. In Segment Boundaries, C= Chimpanzee and H = Human.

TIME	CHIMPANZEE	HUMAN	TURN BOUNDARIES	CODE	SEGMENT BOUNDARIES
22:57.8				MP	
22:57.9			Begin Alternating Turn	A	Begin C Segment
22:58.0				A	
22:58.1				A	
22:58.2	Toothbrush			A	
22:58.3				A	
22:58.4				A	
22:58.5				A	End C Segment
22:58.6				MP	
22:58.7				MP	
22:58.8				MP	
22:58.9				MP	
22:59.0			End Alternating Turn	MP	
22:59.1			Begin Alternating Turn	A	Begin H Segment
22:59.2				A	
22:59.3				A	
22:59.4				A	
22:59.5		No		A	
22:59.6				A	
22:59.7				A	
22:59.8				A	
22:59.9				A	
23:00.0				A	
23:00.1		Toothbrush		A	
23:00.2				A	
23:00.3				A	
23:00.4				A	
23:00.5				A	
23:00.6				A	End H Segment
23:00.7				MP	
23:00.8				MP	
23:00.9				MP	
23:01.0				MP	

23:01.1				MP	
23:01.2				MP	
23:01.3				MP	
23:01.4				MP	
23:01.5				MP	
23:01.6				MP	
23:01.7				MP	
23:01.8				MP	
23:01.9				MP	
23:02.0				MP	
23:02.1			End Alternating Turn	MP	
23:02.2				MP	
23:02.3				MP	
23:02.4				MP	
23:02.5				MP	
23:02.6				MP	
23:02.7				MP	
23:02.8				MP	
23:02.9				MP	
23:03.0				MP	
23:03.1				MP	
23:03.2				MP	
23:03.3				MP	
23:03.4				MP	
23:03.5				MP	
23:03.6				MP	
23:03.7				MP	
23:03.8				MP	
23:03.9				MP	
23:04.0				MP	
23:04.1				MP	
23:04.2			Begin Alternating Turn	A	Begin C Segment
23:04.3				A	
23:04.4				A	
23:04.5				A	
23:04.6				A	
23:04.7	Chase			A	
23:04.8				A	
23:04.9				A	End C Segment
23:05.0				MP	
23:05.1				MP	
23:05.2			End Alternating Turn	MP	
23:05.3			Begin Overlapping Turn	A	Begin H Segment
23:05.4				A	
23:05.5				A	

23:05.6				A	
23:05.7				A	
23:05.8				A	
23:05.9		Chase		A	
23:06.0				A	
23:06.1				A	
23:06.2				A	
23:06.3		Who		A	
23:06.4				A	
23:06.5				A	
23:06.6				A	
23:06.7				A	
23:06.8				O	Begin C Segment
23:06.9				O	
23:07.0				O	End H Segment
23:07.1				A	
23:07.2				A	
23:07.3	Chase			A	
23:07.4				A	
23:07.5				O	Begin H Segment
23:07.6		Chase		O	End C Segment
23:07.7				A	
23:07.8				A	End H Segment
23:07.9				MP	
23:08.0				MP	
23:08.1				MP	
23:08.2				MP	
23:08.3			End Overlapping Turn	MP	