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Gaze, Turn-Taking and Proxemics in Multiparty Versus Dyadic Conversation Across Cultures

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Dedication

To God, my loving parents, Gloria Alvarez and Edmundo Herrera, my girlfriend, Gloria Ronquillo, my siblings, José and Cristina Herrera, my best friend, Andrew Frye, and all my friends and my teachers who never gave up on me.

GAZE, TURN-TAKING AND PROXEMICS IN MULTIPARTY VERSUS DYADIC CONVERSATION ACROSS CULTURES

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Abstract

When people converse with others, they participate in joint interaction behaviors, like proxemics or interpersonal distance, mutual gaze, and turn-taking or pause and overlap, which they may not consciously negotiate. How these behaviors manifest depends on many factors, such as gender, age, personality, culture, and number of participating conversants. Understanding these differences is important for situations where intercultural joint interaction behaviors are necessary for mission success, such as for military personnel in foreign countries. They may also be useful for modeling embodied conversational agents where culture and group vary. Joint interaction behaviors have been extensively studied for American dyads, and multiparties have recently received attention for some of these behaviors. In particular, differences in these behaviors as a function of group size have been addressed by comparing studies under differing conditions, settings, and experimental designs. However, less attention has been given to how these behaviors vary across cultures.

This study collects, annotates and analyzes joint interaction behaviors of two-person and four-person standing conversations from three different cultures: American, Arab, and Mexican. It looks at differences in proxemics, speaker and listener gaze behaviors, overlap and pause at turn-transitions, and mutual gaze to coordinate turn to answer this question: How do people use joint interaction behaviors differently in multiparty versus dyadic conversation and how is this relationship affected by differences in culture?

Data analysis shows that proxemics, gaze, mutual gaze to coordinate turns changed with group size and with culture. However, these changes do not always agree with the way the literature would suggest or what one might expect. For example, proxemics was actually larger for dyads than quads (4 persons), American listener gaze increased significantly in quads and not all contact cultures gaze in high amounts. Their interactions also exhibit some interesting correlations. These unanticipated outcomes demonstrate the importance of collecting and analyzing joint interaction behaviors.

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Chapter 1: Introduction

Humans are accustomed to conversing without ever thinking about their turn-taking, gaze, and proxemics. Turn-taking is how speakers coordinate speaking turns in a conversation, including how long to pause before taking a turn or how long an overlap can persist. Gaze is a visual behavior that relates to where conversants look. A conversant can use gaze to show interest, disagreement, desire to speak next, to identify the addressee, or signal who should speak next. Finally, proxemics is the spatial distance and orientation between persons interacting with each other. Conversants rely on these three joint interaction behaviors to coordinate their conversation. Most of the research on these joint interaction behaviors has been limited to dyadic conversations and Anglo-American cultures. In this thesis I address the question: How do people use joint interaction behaviors differently in four-person versus dyadic conversation and how is this relationship affected by differences in culture?

Joint interaction behaviors vary from person to person due to individual differences such as personality, gender, age, social status and culture. For example, in some cultures it is acceptable, even expected to gaze at others during conversation, to stand at a closer distance, to overlap speech, or to promptly take a turn. However, these same behaviors may be misunderstood in other cultures where gaze is interpreted as confrontational, close distances make a person uncomfortable, overlapped speech is considered distracting, and quickly taking a turn is rude.

One benefit of understanding differences between cultures' use of joint interaction behaviors is avoiding potentially life-threatening misunderstandings. Currently, the United States has soldiers in war zones where they find themselves interacting with people of other cultures. Being able to decode or interpret these local behaviors correctly helps keep lives out of harm's way. A number of virtual reality training systems have been developed with this in mind (Johnson, et al., 2004; Deaton, Barba, Santarelli, Rosenzweig, Souders & McCollum, 2005). In these applications, human trainees interact with embodied conversational agents (ECAs), intelligent virtual characters that possess conversational capabilities. ECAs need models of joint interaction behaviors to behave according to culture and group dynamic. Models based on dyadic or Anglo-American studies may not be appropriate for ECAs representing different cultures and interacting with multiple trainees or ECAs. Moreover, the research

literature of interaction behaviors has largely focused on dyadic conversations. The joint interaction behaviors for dyadic conversation may differ from those for multiparty conversation.

Jan, Herrera, Martinovski, Novick and Traum (2007) attempted to simulate culture-specific group conversation of background characters used in virtual reality training systems for the military. The background characters possessed a computational model that accepted parameter input for gaze, proxemics and turn-taking that could be varied to simulate differences in these behaviors across culture. The data available in the literature, however, were not adequate or appropriate to simulate the three different cultures that had been selected. For proxemics, only distances for dyads were available and only data for Americans could be used in the model. Gaze and turn-taking had more data for American multiparty conversations, but none that could serve as input to the model. The simulations were generated using the best available approximations for the remaining cultures, and then evaluated by members of each culture. Instead of rating the realism of these simulations along cultural lines, most subjects agreed that some videos were more realistic than others. Subjects did not even rate videos that representing their own proxemics as more realistic than others. Perhaps the data were not correct for each culture, or perhaps dyadic data can not be used to simulate multiparty conversation.

This dissertation aims to answer or investigate this question through exploratory statistical analysis. First, how do proxemics, gaze and turn-taking in four-person, or quad conversations compare to dyadic conversations? For example, does the role gaze plays in coordinating turn-taking appear as frequently as or more than it does in dyadic conversations? Is the same relationship observed across cultures?

The rest of this dissertation is organized as follows: the background chapter will cover the research data that exist for gaze, turn-taking, and proxemics, as well as the results or conclusions from those studies; the hypotheses chapter will present predictions of how these joint interaction behaviors will change from the dyadic to the multiparty case for the different cultures; the methodology chapter will cover the experimental design and present a description of the corpus; the results chapter will present statistical analyses; and finally the conclusion chapter will discuss results and future work. (Jan & Traum, 2005)

Chapter 2: Background

This chapter will review the literature pertinent to turn-taking, gaze, proxemics, and their interactions. Each section briefly discusses the classic models or theories of these conversational behaviors and discusses empirical results that support or contradict these. Whenever possible, effects of culture, sex, age, personality, task-domain, and group size are included. The chapter concludes with a summary of the results.

2.1 Cultural Dimensions of Joint Interaction Behaviors

The term *joint interaction behavior*, rather than non-verbal behaviors or paralanguage, is used to refer to turn-taking, gaze, and proxemics. The term non-verbal behavior is too broad, as it refers to head nods, gestures, and many more behaviors. Furthermore, overlap in turn-taking is verbal. Finally, one might argue that interpersonal distance in proxemics is not a behavior but rather a relationship. The term paralanguage may refer to non-verbal communication activities that accompany language, but it is also used to refer solely to vocal behaviors such as pitch and prosody. Thus this dissertation refers to turn-taking, gaze and proxemics as joint interaction behaviors, as they are the product of more than one person's behavior.

Hecht, Andersen and Ribeau (1989) presented a structure of cultural dimensions of non-verbal communication for understanding non-verbal behaviors in cultures. This structure consisted of six dimensions borrowed from previous work by Hofstede (1997) and Hall (1966, 1976), as summarized in Table 2.1. The first dimension is attributed to Hall, who contrasted two conversational styles, high- and low-context. In high-context societies, many things are left unsaid, allowing non-verbal behaviors to play a bigger role. This is typical of cultures that share similar experiences and expectations. Arab and Mexican cultures are considered higher-context cultures (Gudykunst & Ting-Toomey, 1988; Hecht, Andersen, & Ribeau, 1989). In low-context cultures, communication needs to be relatively more explicit, and the value of a single word is not as strong. The American culture is considered a lower-context culture (Gudykunst & Ting-Toomey, 1988; Hecht, Andersen, & Ribeau, 1989). The next four dimensions are attributed to Hofstede, who used them to describe cultural variability of people in organizations. Analogous to Hall's high/low-context cultures is Hofstede's individualism-collectivism

dimension. Cultures with a high individualism index prioritize individual goals, prefer autonomy and self-assertion while, at the other end, low index cultures emphasize group goals, harmony and avoiding confrontation. Hofstede also defined power distance, uncertainty avoidance, and masculinity dimensions. Power distance can be seen in terms of hierarchism versus egalitarianism. Factors of hierarchism are gender, age or family background. Power distance tends to be negatively correlated with individualism; that is, a culture with a high power distance index has a low individualism index and vice versa. A culture with a high uncertainty avoidance index describes a culture with a low tolerance for ambiguity or that feels threatened by uncertainty. Finally, a high masculinity index denotes a cultures with strict sex roles; men are assertive and tough, achieve material success and women are modest, nurturing, and concerned with quality of life. A low index denotes overlap in social gender roles. The last dimension, high/low-contact, has qualities from Altman and Gauvian (1981) and describes accessibility-inaccessibility in relationships. This dimension deals with immediacy, such as closeness or distance and behaviors expressing approach or avoidance. Examples of highly immediate behaviors include smiling, eye contact, open postures, closer distances and more vocal animation. Hall (1966) described these cultures as high-contact cultures, because of their preference for close distances and touch. Arabs and Mexican are members of high-contact cultures. On the other end of the spectrum are low-contact cultures, such as Americans, that prefer more distance and less touch (Hecht, Andersen & Ribeau, 1989).

Table 2.1: Cultural variation along dimensions (Hall, 1966, 1976; Hofstede, 1997)

	High/Low-Context	Individualism -Collectivism	Power Distance	Uncertainty Avoidance	Masculinity-Femininity	High/Low-Contact
Arab cultures	High	38	80	68	53	High
Mexico	High	30	81	82	69	High
USA	Low	91	40	46	62	Low

These six dimensions may help explain how turn-taking, gaze and proxemic behaviors are used in different cultures and will be examined in the next sections. The scores relatively rank cultures along those dimensions. They describe cultural tendencies rather than what individuals of those cultures will necessarily do.

2.2 TURN-TAKING

Different cultures have different turn-taking behaviors and attach different meaning to them. In some cultures, it may be appropriate to interrupt or leave short pauses within turns, and the presence of overlap, or two or more speakers performing a turn concurrently, is a sign of interest in a conversation. However, in other cultures this behavior may be considered rude (Tannen, 1984; Clyne, 1994; Fitzgerald, 2003).

According to Sacks, Schegloff and Jefferson (1974), most of the time only one person speaks in a conversation; occurrences of more than one speaker at a time are common but brief, and transitions from one turn to the next usually occurs with no gap and no overlap, or with a slight gap or overlap. The low amount of overlap is possible because participants are able to anticipate a transition-relevance place (TRP), a completion point at which it would be appropriate to change speakers. In English, participants signal TRPs through use of cues, such as intonation-marked phonemic clauses, sociocentric sequences such as "you know", completion of grammatical clauses, paralinguistic drawl, termination of hand gesticulation or decrease of paralinguistic pitch or loudness of sociocentric sequences (Duncan & Fiske, 1977). Minimizing gaps help make it clear how utterances are related to previous utterances and also indicate that prior utterances were correctly understood allowing for rapid correction if needed. Harrigan and Steffen (1983) reported a mean overlap of 400 ms in a five-person group conversation, supporting this theory for American English.

However, in actual conversations this is not always the case. Trompenaars and Hampden-Turner (1993) characterized American turn-taking as having smooth turns with no pause and no interruption, Latin turn-taking as integrating significant overlap to show how interested each is in what the other is saying, and Asian turn-taking as employing significant pause to show respect and properly process the information being conveyed. In a study comparing Spanish and American turn-taking styles, the amount

of overlap in Spanish conversation was more than the slight overlap theorized by Sacks et al. although no timing measures were provided (Berry, 1994). One of the reasons for this behavior was the presence of collaborative sequences, or supportive overlap (Tannen, 1984). These are genuinely collaborative in nature and include completing another speaker's sentence, repeating or rewording what a previous speaker has just said, and contributing to a topic as if one has the turn even though they do not. Also when simultaneous speech did occur, continued speaking during overlap was much more common in Spanish conversation.

Fitzgerald (2003) found similar results when looking at turn-taking involving conversants from different cultures. Fitzgerald reported that dyadic conversations followed the framework of Sacks et al., but group conversations showed significant overlap, sustained simultaneous starts and interrupts with women tending to overlap more than men. Although timing measurements were not provided, conversations were organized into 1) open-house or single-floor style, the most common, where conversants take turns to talk but these turns are not organized in any way, followed by 2) free-for-all where people talk simultaneously, collaboratively developing ideas, 3) round-robin with each person given a turn, and 4) turn-coordinator facilitated where one conversant appointed turns. Long monologues and protracted simultaneous talk were the exception, and situational context was a factor in determining use of overlap. Latin women who normally overlapped would cease when it was not reciprocated, and Asian women who normally would not overlap, would do so in politically charged conversations.

Tannen (1984) proposed a conversational style contrasting involvement and considerateness similar to Hall's high/low-context styles. Involvement entails a speaker using utterances with enough information that require the hearer to fill in the rest (high-context). Cultures with high-involvement exhibit 1) faster rates of speech and turn-taking, 2) fewer turn pauses as those show lack of rapport, 3) cooperative overlap and 4) participatory listenership. In contrast, high considerateness (low-context) cultures attempt to show politeness by not imposing, such as standing too close or interrupting. Gudykunst & Ting-Toomey (1988) described turn-taking dimensions parallel to Hofstede's. The individualism-collectivism dimension predictably contrasts direct and indirect communication styles.

Arabs and Mexicans use an indirect style, while Americans use a direct style. An instrumental-affective style further describes features of the individualism-collectivism dimension. Instrumental describes a sender-oriented style where the speaker advances his or her own goals. Affective, in contrast, is receiver-oriented, and the speaker attempts to gauge how the listener is receiving the message. It is process-oriented and the listener is an active participant. The uncertainty-avoidance dimension is characterized by three divisions, elaborate and succinct turns at the extremes, and exacting turns in between. Arab cultures reflect the elaborate conversational style, using rich, expressive language. Asians use succinct style, with understatements, pauses and silences. Arabs and Asians cultures can therefore use an affective style, but would differ in the elaborate-succinct communication style. Americans use exacting style where a turn contains neither more or less information than is required.

Power distance reflects personal versus contextual styles, or a preference for formal versus informal. In societies where power distance is high, formal styles and roles are observed in contrast to informal addressing in the personal style. Clyne (1994) also looked at turn, considering variation in cultural styles using turn acts: 1) turn-giving – A yields the turn to B, 2) turn-receiving – B accepts the turn from A, 3) turn-maintaining – A keeps the turn, 4) turn-appropriating – B takes the turn, 5) turn-terminating – A's turn comes to a close, 6) turn-direction – A allocates the turn to B by asking a question, and 7) turn-deflection – A appropriates B's turn in order to assign it to C. According to Clyne, turn changes that constitute turn receiving or appropriating are largely determined by power. Of the participants in the study, Central European and South Asian speakers were most succesful in turn maintenance. Members of these groups attempted to appropriate other's turns resulting in simultaneous speech. Turn direction and deflection are more goal-oriented behaviors: turn-direction to keep a conversation going and turn deflection to promote a more "democratic" control of the floor. Short turns were usually associated with adjacency pairs or with South-east Asians. Long turns were exhibited by Europeans, South Asians and Latin Americans.

Pause in English conversation appears to vary by individual and in relation to cognitive load (Goldman-Eisler, 1968). In looking at where pause occurred, how often it occurred, and the range and distribution of pause durations, Goldman-Eisler found that 1) distribution of pause length was different

for each individual, 2) depended on the situation, 3) in discussions, were never longer than 3 seconds, and 99% were less than 2 seconds, and 4) that familiarity with topic reduced time and frequency of pause. Other studies measured this "switching pause" either between turns and backchannels and found it to be in a range of .733 to 1.555 seconds (Jaffe & Feldstein, 1970). Although these studies suggested that pause varies by individual and depends on cognitive load, they did not compare pause values across cultures.

Campione and Véronis (2002) performed a large-scale study on silent pause duration of read speech in five Western European languages and spontaneous speech in French. They found that distribution of pause was trimodal suggesting brief (<200 ms), medium (200-1000 ms) and long (>1000 ms) pauses and normal when projected onto a log scale. Using the geometric mean to adjust for the skewed distribution, they found significant differences between Italian and Spanish reading pauses, which they attributed to speech rate and pause frequency. Weilhammer and Rabold (2003) compared pause and overlap in dyadic conversations across cultures. They found that pause and overlap durations in American English, German and Japanese dialogues fit a Gaussian distribution when projected onto a log scale. Additionally, these distributions were significantly different in American English and Japanese. This study further reported that mean values for overlap were significantly different for all three languages, while the mean values for pause were not. For comparison, the mean values for American English were 380 ms for pause and 257 ms for overlap. The authors proposed that temporal distributions for pause and overlap combined with frequency of occurrence of each turn taking pattern could form the basis for a probabilistic model of natural turn taking. Another study using a Dutch dialogue corpus supported the findings that pause and overlap duration as a log fit a Gaussian curve (Bosch, Oostdijk, & Ruiter, 2004). Furthermore, this study found a high correlation (.88) in average pause duration between both speakers, suggesting that speakers match each other's behavior.

More recently, between-turn gaps in ten languages spanning traditional indigenous communities to world languages were studied (Stivers, et al., 2009). When looking at yes/no question-answer pairs, this study supported the theory of Sacks et al. that conversants tend to avoid overlap and minimize silence between conversational turns. Although pause length showed slight differences in cross-

language means of average gap, the range found was within 250 milliseconds. The study only looked at yes/no question-answer pairs because it found no timing differences in response times after questions and non-questions in a Dutch conversational corpus. However, the study also reported that factors that delayed turn response time were non-answering responses, disconfirmations, vocal-only responses and non-gazing questions. In general, responses were faster when they involved gaze and yes/no answer despite no timing differences found in the Dutch corpus.

Turn-taking in multiparty conversation has attracted some research for the purposes of modeling robots and embodied conversational agents (i.e., Matsusaka, et al., 1999; Traum & Rickel, 2002; Jan & Traum, 2005). The robot developed by Matsusaka,et al. (1999) followed four assumptions of turn-taking: 1) a key person controls the conversation, 2) others pay attention to the key person, 3) the key person is the focusee or turn-holder, and 4) changes are dynamic. With this model of turn-taking, the robot would use face-direction as a queue to identify the focusee. It could also detect sound sources and faces and could detect speakers and addressees. It would look at a person to yield a turn or give side-glances to keep a turn. It would also not respond unless it detected gaze upon it. Traum and Rickel's (2002) model for multiparty interaction extended the dyadic model of turn-actions: 1) take-turn, 2) request-turn, 3) release-turn, 4) and hold-turn, with a fifth action, assign-turn, as a result of the next turn taker not being assigned by default. Jan and Traum's (2005) algorithm for background characters centered around making decisions at transition relevance points. At each point, a character could claim a turn, hold a turn, and track or respond to others based on likelihoods to talk and participate. Character could signal intent to other characters through gaze and gesture. Other researchers have looked at simulating or predicting multiparty turn-taking (Yuasa, Tokunaga & Mukawa, 2009; de Kok & Heylen, 2009). Yuasa, Tokunaga & Mukawa (2009) designed a turn-taking model based on three observations of conversational gaze behaviors from a Japanese female triad: 1) the person being looked at by the previous speaker takes the next turn (65%), 2) the person not being looked at by the speaker takes the next turn, even though the previous speaker looks at another listener (26%), and 3) one of the listeners takes the turn even when the previous speaker looks at no one (9%). Three probabilities were then assigned to these three rules to create turn-taking patterns: p1) the "hearer" being looked at by the

previous speaker takes the turn, p2) the "hearer" who is not being looked at starts to speak, and p3) the "speaker" looks at someone at the end of a turn. The most typical pattern was described by p1=100%, p2=0%, p3=100% where turns occurred smoothly with no overlap. Overlap or simultaneous speech was simulated by p1=100%, p2=100%, p3=100% and occasional silence by p1=30%, p2=0%, p3=100%.

De Kok and Heylen (2009) were interested in how to predict end-of-turn in multiparty conversations using visual and prosodic cues without using pause. Human conversants apparently rely on visual, syntactic, and prosodic cues to determine transition-relevance places. In this study, de Kok and Heylen considered four modalities relating to head gestures, prosodic features, focus of attention and dialogue acts available from previous annotations. Results were poor, indicating that the annotated data was not appropriate for prediction. They proposed future work looking at head nods or shakes that accompany end of turns, gaze direction and changes in posture.

Four of these five turn-taking studies used gaze as a key component to describe their models. The next section discusses research that has observed an association between turn-taking and gaze. In summary, actual conversations may not always fit Sacks et al.'s conversational model of one speaker at a time with relatively little overlap. Overlap behaviors seem to be strongly influenced by culture, while between-turn pause in dyadic dialogue may not. Furthermore, conversational partners seem to mirror the pause behavior of their partners in dyadic dialog.

2.3 GAZE

Much like turn-taking, the timing and duration of gaze can be interpreted differently across cultures. In some cultures, gaze can be a signal of interest; in others, too much gaze can seem rude or antagonizing. For example, more gaze was one factor preferred by Arab men when interacting with Englishmen (Collett, 1971).

Gaze plays an important role in coordinating turn-taking. A speaker can yield the floor or signal the next speaker by his or her gaze behaviors. Kendon (1967) attributed at least four functions to gaze behaviors in a conversation: 1) to provide visual feedback, 2) to regulate the flow of conversation, 3) to communicate emotion and relationships, and 4) to improve concentration by restriction of visual input.

He also showed that speakers tend to look away at the beginning of an utterance and look at the listener at the end of an utterance.

2.3.1 Gaze Frequencies

Argyle and Cook (1976) compared gaze behavior between dyads and triads as reported in previous studies (Exline, 1960; Argyle & Ingham, 1972). Table 2.2 shows how the amount of gaze differs between the two situations (although the tasks and physical conditions in the two studies were different so group size may not be the only variable) (Argyle & Cook, 1976). In the dyadic study, people looked nearly twice as much when listening (75%) as while speaking (41%). These results have been repeated by others, such as Levine and Sutton-Smith (1973) who found that listeners looked more (67%) than speakers (45%) in dyadic conversations. Dovidio et al. (1988) reported less extreme differences in mixed dyads, where men looked almost equally while speaking (47%) and while listening (53%), and women followed the normal trend of looking while speaking (41%) and while listening (77%). In contrast, in triadic conversation, people looked almost equally when listening (36%) as while speaking (31%). Lesko and Schneider (1978) looked at gaze in triads and found, in one experiment, gaze while speaking of 15% and gaze while listening of 57%. However, this study required each conversant to speak about himself for 135 seconds without allowing turn-taking.

Table 2.2: Amount of Gaze (%) in triads and dyads (Argyle & Cook, 1976)

	Dyads (Argyle & Ingham, 1972)		Triads (Exline, 1960)	
Sex Combination	MM	FF	MMM	FFF
Average amount of gaze by individuals	56	66	23	37
Gazing while listening	74	78	30	42
Gazing while talking	31	48	26	37
Mutual Gaze	23	38	3.0	7.5

A study looking at gaze behavior in a seven-member seminar found a role reversal where people looked at each other 70% of the time while speaking and 47% while listening (Weisbrod, 1965, as cited in Kendon 1967). Kendon attributed this reversal of the pattern as compared to dyadic situation to the fact that in multiparty situation the speaker must make it clear to whom he or she is speaking (Kendon, 1967). He also added that the decrease in gaze while listening could be attributed to activities such as making notes or referring to books, common in seminars.

A study of gaze behaviors in four-person conversations somewhat confirms the preceding results. Listeners looked at speakers (88%) more than at other listeners, and speakers looked at addressees (77%) more than at other listeners (Vertegaal, Slagter, van der Veer & Nijholt, 2001). More specifically, a listener gazed at the speaker 62% of total gaze time and 8.5% at other listeners. After each session, subjects were asked to watch the recordings of themselves and specify when they were addressing a single person or addressing all three at once. When addressing a single person, a speaker gazed 40% of the time at the addressee and 12% at other listeners for a total of 52% gazing at conversants. However, when addressing all three at once, speakers gazed 59% of the time at the addressees. The authors suggested that a conversant compensates for addressing three individuals at once by increasing the amount of gaze (59% vs. 52%). Table 2.3 summarizes the results of this study.

Table 2.3 Amount of Gaze (%) in 4-person conversations (Vertegaal et al., 2001)

	Listening to individual	Addressing individual	Addressing all three
Gaze at individual	62	40	20
Gaze at others	8.5	12	
Gaze at all equally			59

In sum, gaze behavior, as a percentage, seems to vary with number of conversants. Studies reported gaze while listening from 36% to 75% (Exline, 1960; Weisbrod, 1965; Argyle & Ingham,

1972; Vertegaal et. al., 2001). The same studies reported gaze while speaking between 31% and 70%. Table 2.4 summarizes these results.

Table 2.4 Amount of Gaze (%) while listening and talking from four unrelated studies (Argyle & Ingham, 1972; Exline, 1960; Vertegaal et. al., 2001; Weisbrod, 1965)

Number of conversants	Dyads	Triads	4-person	7-person
Gazing while listening	75	36	71	40
Gazing while talking	41	31	52/59	70

The results summarized in Table 2.4 seem to suggest that gaze percentages differ between dyadic and multiparty conversations. Gazing while listening seems to decrease with more conversants, and gazing while speaking seems to increase with more conversants. At the same time, a gaze trend seems to arise: except for the last column, conversants spend more time gazing while listening than they do while speaking. There seem to be some inconsistencies, perhaps due to differences in experimental procedure for the four different studies such as setting and task-domain. For example, Kendon suggested that gaze while speaking increases in multiparty conversations to explain the seven-person results, yet the triad case does not exhibit this pattern. Furthermore, gaze while listening seems to be high in four-person conversations but not in triads or the seven-person party. Looking at Table 2.3 and 2.4, it appears that the speaker gazes at the addressee as much in the four-person case (40%) as in the dyadic case (41%), with the increase in gaze while speaking in the four-person case (52%) due to the additional requirement of looking at non-addressees. However, a listener does not gaze as much at the speaker in a four-person conversation (62%) as in a two-person one (75%) even when including gaze at others (8.5%) in the multiparty case. Gaze while listening is still higher than gaze while speaking in the four-person case, but not as much as in the dyadic case. More data are needed to confirm these results, and experimental procedures should be reasonably similar to make comparisons and draw conclusions between groups of different sizes.

2.3.2 Gaze With Respect to Turn

Other studies have focused on the role that gaze plays in turn-taking in face-to-face interactions, including Duncan and Fiske (1977), who looked at gaze count, length, gaze rate while speaking and listening. Gaze played a role in coordinating turn-taking, where 42% and 29% of turn exchanges involved a mutual-break and a mutual-hold pattern, respectively (Novick, Hansen, & Ward, 1996). Mutual-break is a term that describes a pattern where both conversants momentarily gaze at each other at a turn exchange followed by the turn-taker breaking gaze. Mutual-hold is a similar pattern except that the turn-taker does not break gaze immediately, but later on in the turn.

A couple of studies reported gaze patterns with respect to turn-taking in multiparties. In a five-member group conversation, speakers gazed toward a listener when beginning a turn in 79% of the turns (Harrigan & Steffen, 1983). This gaze pattern was also reported by turn classification: TRP (79%), overlapped (63%), unsuccessful (83%) and successful interruption (90%). Listeners gaze was not as frequent, as gaze toward a speaker when producing a backchannel occurred in only 65% of all feedback responses. Finally, speakers gazed toward an auditor in 69% of all turn endings. Kalma (1992) reported a prolonged gaze used in 95% of turns by speakers who were ascribed high influence.

Turn-taking explains only some of the gaze patterns observed in conversation. A study modeling gaze using discourse structure along with turn found that using rhemes and themes better predicted gaze behavior than turn alone (Torres, Cassell & Prevost, 1997). A rheme refers to old content in a conversation, while a theme represents new information to the conversation. The speaker tended to look at the listener at the beginning of a rheme, and always if it coincided with the end of a turn. The speaker tended to look away from the listener at the beginning of a theme, and always if it coincided with the beginning of a turn. Using this discourse structure still left 40% of look-aways and 45% of look-towards unaccounted for. It was suggested that the remaining look-towards could be associated with backchannels. With respect to turns, Torres et al. found that 44% of beginning of turns involved 38% of all look-aways. Similarly, 16% of end of turns involved 15% of look-towards. Perhaps not surprisingly, Vertegaal, Van der Veer & Vons (2000) found that, in three-person conversations, conversants produced more turns the more they were gazed at.

More recently, a different approach to gaze and turn-taking was proposed by Rossano, Brown and Levinson (2009). who noted that gaze at turn-taking boundaries only occurred some of the time. Instead, they proposed that gaze coordinated the development and closure of sequences and courses of actions, such as adjacency pairs. Gaze also served to pressure for and pursue responses and to indicate a special state of recipiency. They looked at three unrelated cultures: Italians of northern Italy, speakers of Yélî Dnye from Rossel Island off Papua New Guinea, and speakers of Tenejapan Tzeltal, a Mayan language spoken in southern Mexico. Focusing on dyadic gaze behaviors in question-answer pairs, they found more gaze from all speakers, regardless of culture, than from listeners to a statistical significance. When comparing the speaker gaze across culture, the two indigenous groups were significantly different, as speakers of Yélî Dnye were significantly more likely to gaze at the listerner than speakers of Tenejapan Tzeltal when asking questions. They cautioned against this result though, as a model evaluation did not yield a Wald statistic that was significant, meaning that language was not a good predictor of speaker gaze. However, they did find significant differences in both tests for listener gaze. In Tzeltal, listeners showed active recipiency by looking down and away, showing that their surroundings are not distracting them as they listen. In Yélî, on the other hand, listeners looked at speakers to show they were paying attention. Mutual gaze also differed in these two cultures, as they occurred in 50% of exchanges in one and 33% in the other, with most of it occuring around repair-questions. As predicted, Tzeltal has more verbal feedback to compensate for less gaze including repeating parts of the previous utterance. Although they did not find support for the same gaze coordinating turn patterns found in other studies, Rossano, Brown and Levinson recognized that question-answer pairs imply turn exchanges, thus bypassing the need for gaze to signal turn exchanges. However, this seems to reinforce their hypothesis that gaze is structured around development and closing of sequences and courses of actions rather than turns.

2.3.3 Gaze and Culture

There are some data available on cultural differences in gaze behavior. Matsumoto (2006) reported that people from Arab cultures gaze much longer and more directly than do Americans. In general, contact cultures, those that permit more touch and stand closer, engage in more gazing and have

more direct orientation, facing each other rather than at an angle, when interacting with others (Watson, 1970). Other factors, such as sex, task, personality, age and social status, also influence gaze behavior. Female and mixed dyads tend to gaze more than male dyads. Extroverts and people of higher status gaze more than their counterparts. Gaze is higher in confrontational situations and in children and elderly.

There have been some attempts to model gaze both as a social function for multiparty conversation and to express attention and cognitive load (Gu & Badler, 2006). The models have yet to be empirically evaluated with human subjects to determine the naturalness and effectiveness of the animated nonverbal behavior of the ECAs during real-time interactions. For a review of the research in gaze as social visual interaction, see Fehr and Exline (1987).

2.3.4 Summary of Gaze

In summary, gaze appears to coordinate turn. As discussed in section 2.3.2, studies have shown as much as 71% of turn exchanges involved some sort of mutual gaze (Novick, Hansen, & Ward, 1996), and gaze while speaking occurred at most start and end of speaking turns in multiparties (Harrigan & Steffen, 1983; Kalma, 1992). As the second study did not report mutual gaze occurrences, it is not clear how it coordinates turn exchanges as group size increases. However, turn exchanges only accounts for part of gaze behavior. Discourse along with turn was proposed to model gaze, essentially looking at a finer grain of turn to predict gaze (Torres, Cassell & Prevost, 1997). While it could produce more specific gaze rules in relation to discourse, 40% of look-aways and 45% of look-towards remained unaccounted for. A coarser grain of turn structure, namely courses of actions or sequences such as adjacency-pairs to explain gaze patterns, has also been proposed (Rossano, Brown, & Levinson, 2009). Their results showed consistently that gaze was related to initiation and completion of question sequences, or pairs of turns rather than to each individual turn, suggesting that gaze to coordinate turn under these conditions be re-examined.

2.4 PROXEMICS

Proxemics refers to the spatial distance between persons interacting with each other and their orientation toward each other. One could argue that proxemics is a relationship rather than a non-verbal

behavior, although it may communicate things like a person's intention or emotion. A more elaborate definition of proxemics encompasses eight behaviors, including touch, amount of eye contact, voice loudness, and body-contact distance (Hall, 1963). Like other joint interaction behaviors, the proxemics between interacting persons can be interpreted differently across cultures. In some societies close distances are reserved for personal relationships and may not be comfortable for interacting otherwise; in other cultures, close distances are not so exclusive and not interacting closely is interpreted as aloofness (Hall, 1959, 1966, 1976).

Americans generally divide their personal space into four distinct zones (Hall, 1968). The intimate zone is used for embracing or whispering, the personal zone is used for conversation among good friends, the social zone is used for conversation among acquaintances, and the public zone for public speaking. While proxemics are culturally defined, there are also variations based on sex, social status, environmental constraints and type of interaction. There has been much research into these spaces that by and large support these ranges. For a review of this literature, see Altman and Vinsel (1977). Hall also noted that other parts of the world would have different patterns for these spaces. In Spain, Portugal, and their former colonies, a family/non-family pattern would define these spaces. India would have a caste and outcaste system. Arabs would have a system very different from that in the United States; Hall found that Arabs' personal space did not include the concept of intrusion in public. In terms of Hofstede's cultural dimensions, cultures with high power distance and high uncertainty avoidance scores such as Arabs and Mexicans have few rules and norms regarding proxemic zones while low power distance low uncertainty avoidance scores such as Americans have many rules and norms for status and relational proxemics (Gudykunst & Ting-Toomey, 1988). Deviating from these zones in the latter culture may result in aggressive reactions from the members while only passive reactions will result in the former cultures.

While studies have not verified Hall's alternate space patterns for other cultures, some studies have found significant differences in proxemics between cultures. One study of Anglo-, Black-, and Mexican-Americans in natural settings found that Mexican-American adults stood significantly closer than their Anglo-American counterparts as listed in Table 2.5 (Baxter, 1970).

Table 2.5 Mean interpersonal distance in feet (Baxter, 1970)

Ethnic Group	Sex Combination	Indoor Adults	Outdoor Adults
Anglo	M-M	2.72	2.72
Anglo	M-F	2.33	2.59
Anglo	F-F	2.45	2.46
Mexican	M-M	2.14	1.97
Mexican	M-F	1.65	1.83
Mexican	F-F	2.00	1.67

Another investigation of proxemic behavior in Latin America provided some useful data about proxemics in Spanish cultures. This study compared proxemics of pairs involved in conversation in a natural setting between different geographic regions (Shuter, 1976). It concluded that the conversants stood farther apart and the frequency of tactile contact diminished as one went from Central to South America. Table 2.6 lists the distances recorded in this study.

Table 2.6 Mean interpersonal distance in feet (Shuter, 1976)

Sex Combination	Costa Rica	Panama	Colombia
M-M	1.32	1.59	1.56
M-F	1.34	1.49	1.53
F-F	1.22	1.29	1.40

Another study involving 32 male Arab and American college students conversing in pairs (six possible combinations) found that Arabs and Americans differed significantly in proxemics, the Arabs interacting with each other closer and more directly than Americans (Graves & Watson, 1966). Differences between subjects from different Arab regions were smaller than for different American regions. While the study confirmed that Arabs interact much closer to each other, its measurements were

made of seated subjects. A follow-up experiment of 110 male foreign students at the University of Colorado found that Latin Americans exhibited less closeness than Arabs but still interacted much closer than Anglo Americans (Watson, 1970). This study found evidence that cultures fall into contact and non-contact groups. Some have suggested that low-contact cultures inhabit cold climates and score high along the individualism dimension while high-contact cultures inhabit warmer climates and are collectivistic (Andersen, 1988). A similar study compared Japanese, Venezuelans and American seated dyads (Sussman & Rosenfeld, 1982). In this study, subjects conversed with a confederate of the same nationality. Venezuelans sat the closest (2.68 ft.), followed by Americans (2.95 ft.) and Japanese (3.35 ft.), with female pairs sitting closer than their male counterparts. Interestingly, when subjects conversed in English, they displayed American proxemics.

For a more detailed review of the cross-cultural research in proxemics, see Baldassare and Feller (1975). For a critique of cultural and other models of proxemics, see Gillespie and Leffler (1983), who suggested that proxemic differences are affected less by cultural differences than by a combination of situational and status differences.

While these studies were limited to dyads, their results suggested that differences exist between cultures in proxemics. Standing measurements for Anglo-Americans were well above two feet while those for Hispanic and Latin Americans were around two feet and below.

Jan and Traum (2007) modeled proxemics of multiparty conversation based on the notion that conversants position themselves at comfortable distances. They also considered functional reasons, such as being able to see all other conversants engaged in the conversation and being able to hear the current speaker. Each character positioned itself relative to the speaker and at a comfortable distance to other characters. If there were distracting noises, the character would move away from that source. Finally, if a new character joined the conversation, they characters would reposition themselves while maintaining the conversational group by tracking the center of mass of the formation. This model not only modeled multiple conversants, but regarded turn-taking and gaze in an multichannel approach.

2.5 MULTI-CHANNEL APPROACH TO JOINT INTERACTION BEHAVIORS

Joint interaction behaviors should not be studied independently. Gaze, proxemics, and pause have been shown to affect each other (Argyle & Dean, 1976; Argyle & Cook, 1976). At greater distances, more feedback is required to keep the channels open, resulting in increased gaze. Speaking turns also becomes affected when gaze is reduced. Speakers take fewer turns to account for the reduced feedback being provided from gaze (Vertegaal, Van der Veer & Vons, 2000). Researchers began to suggest models and systems that explained these interactions.

Argyle and Dean (1965) noted that eye gaze served an affiliative function and could regulate approach-avoidance forces. They postulated that, once equilibrium was established between two people, reducing or increasing gaze served to compensate for any changes in distance. They found that the intimacy of the conversation also produced changes in gaze. Aiello (1977) tested the limits of intimacy equilibrium theory and found that men tended to look more as distances increased and women tended to look less. He suggested that comfort plays a role: when levels of discomfort are reached, gaze is discontinued. However, intimacy equilibrium did not account for cases where increased gaze and decreased proxemics were reciprocated rather than compensated. Patterson (1976) suggested instead that the interaction was regulated by an arousal function. He proposed that increased gaze and decreased distance precipitated arousal in the other, which was interpreted as either positive or negative based on the relationship and other factors. A positive response would yield reciprocation of behaviors rather than compensation, as in the previous theory. Finally, in a discrepancy-arousal model, Cappella and Green (1984) suggested that a person's nature (i.e. introvert or extrovert) and expectancy of others creates a discrepancy, resulting in positive, neutral, or negative arousal, much like Patterson's arousal model. In this case, cognitive processes affect the reactions. Finally, Patterson (1995) introduced a parallel process model that emphasized behavioral (encoding) and person perception (decoding) processes into a single system that considers 1) determinants, such as culture, personality and gender, 2) the social environment, and 3) cognitive-affective mediators, such as goals, interpersonal expectancies and cognitive resources. While including as many different factors may improve the model, it also makes it more difficult to verify empirically. However, difficulty of verification should not be a reason to exclude these factors from the model.

As discussed above, researchers have suggested several models to explain the interactions between joint interaction behaviors. Unfortunately, these simple models only work in certain cases (e.g., compensation) and in other cases are explained by contradicting models (e.g., reciprocation). A unifying model to explain the general case includes too many factors to be easily confirmed empirically.

2.6 SUMMARY

This section presented three joint interaction behaviors separately—turn-taking, gaze and proxemics—and some attempts at constructing multi-channel models for these. For each, a general model was presented along with empirical data for subsequent comparison. For dyadic turn-taking, overlap was shown to vary between cultures, while pause was not. For gaze, researchers have looked at gaze while speaking and while listening in dyads, triads and multiparties. It appears gazing while listening occurs more often than gazing while speaking. It has been suggested that gazing while speaking increases in multiparties. This would suggest people use gaze differently in dyadic and multiparty conversations. However, more data are needed to confirm this conclusively. Finally, for proxemics, the data seem to suggest that high-contact cultures stand at closer distances than low-contact cultures.

In previous work on multiparty conversations across culture (Jan, Herrera, Martinovski, Novick, & Traum, 2007), the gaze, proxemics, and turn-taking behaviors of virtual agents were manipulated by parameters collected from literature of cultural studies involving dyadic conversations. The virtual agents then simulated a conversation for each cultural group: Mexican, American, and Arab. The videos of the simulation were presented to subjects belonging to each cultural group, who were asked to rate the realism of the conversation with respect to their own culture. Instead of subjects rating the simulations along cultural lines, most subjects rated certain videos as more realistic than others. Perhaps the realism of a conversation cannot be mimicked by mean and frequency values for gaze, proxemics, and turn-taking alone, or perhaps data for dyadic conversations is not valid for multiparty conversations. Thus it is important to know the extent to which the rules that apply to dyadic conversations also apply to multiparty conversations. Thus the following chapters will present the hypotheses based on data reported

in the literature and a methodology to present an experimental design to compare the data collected from the multiparty dialogues to dyadic data across culture.

Chapter 3: Hypotheses

Do the same joint interaction behaviors for dyadic conversation appear in four-person or quad conversation across cultures? The previous chapter covered the most relevant results for proxemics, gaze and turn-taking data. But most of the data involved dyadic dialogues, with only a few of these for Arabic and Latin American subjects. Some of the data were collected from three-person or four-person conversations, and some specified the gender distribution. The remainder of this chapter will present a model of how joint interaction behaviors might change from dyadic to quad conversations within a culture, the sub-questions for each behavior that follow from the main research question, and the hypotheses to address these sub-questions.

3.1 Predictions Based on Cultural Dimensions

Results discussed in Chapter 2 for American turn-taking showed that the average overlap for a dyadic pair was around 250 ms and 400 ms for a five-person group (Harrigan & Steffen, 1983; Weilhammer & Rabold, 2003). Pause data from separate studies showed vastly different means. One study reported 380 ms for dyadic between-turn pause (Weilhammer & Rabold, 2003), while another reported over 700 ms (Jaffe & Feldstein, 1970). Pause values for quads were not reported. Americans are a low-context high-considerateness culture, meaning they do not speak more than needed, and try not to interrupt another speaker. In a quad situation, I predict that Americans will be more attentive to who gets the next turn, as it is not always guaranteed to the listener, and thus conversants will pause longer and overlap less than they would in a dyadic conversation.

Pause and overlap measurements were not found for Arabs in the literature, but Arabs have been described as high-context and elaborate in conversational style (Gudykunst & Ting-Toomey, 1988). Their turns are indirect and receiver-oriented, so the listener is expected to participate in the communication and provide feedback about how the message is received. This style is high-involvement and process-oriented. Thus for Arabs, I predict that all members in a quad situation will be actively involved in the conversation, turns will be long, and listeners will be expected to provide feedback, perhaps resulting in a decrease in pause and an increase in overlap.

Like Arabs, Mexicans are also classified as high-context. Although specific measurements were not found in the literature, Spanish or Latin American speakers were said to overlap more than Americans. Pause rates in Spanish read speech were significantly shorter than other European speech. Hofstede indices suggest Mexicans are more collective and more concerned about avoiding uncertainty. Latin Americans are said to take longer turns and adept at maintaining them (Clyne, 1994). Based on this, in a quad conversation, I predict Mexican quads will overlap more and pause less than compared to dyads because there are more members trying to negotiate turns, trying to show agreement, or using collaborative sequences.

Gaze behaviors for American dyadic and quad conversations were reported for speakers and listeners in the literature. Overall, gazing while listening decreased from a dyadic to quad conversation and gazing while talking increased. As a low-contact culture, Americans are not expected to gaze as much. The increase in gaze while talking might be attributed to an attending function or to designate the next turn recipient. The decrease in gaze while listening might be attributed to the reduced role of listener gaze for a low-contact culture.

For Arabs, the literature reported high amounts of gaze when compared to American cultures, supporting the claim that Arabs are high-contact cultures. Thus I predict that Arabs, unlike Americans, will gaze as much while speaking regardless of group size because the already high amounts of gaze enable them to perform attending and designating functions. I further predict that Arab listeners. Also unlike Americans, will gaze as much while listening regardless of group size, as their responsibilities to participate remain the same.

Mexicans are also a high-contact culture and are said to produce high amounts of gaze. At the same time, Latins are also reportedly good at holding a turn (Clyne, 1994), so perhaps speakers may use more gaze aversion as the group size increases. Obtaining a turn may also be more challenging requiring a listener to gaze more if the turn is desired. However, if the speaker is not trying to monopolize the turn or the listeners are not interested in competing for it, I predict the gaze behavior remain the same from the dyadic to the quad case.

From the mutual gaze reported in the literature, American male dyads showed mutual gaze almost a quarter of the time, while female dyads showed it a little over a third (Argyle & Ingham, 1972). In American triads, these values were far below a tenth of the time (Exline, 1960). Other results for dyadic conversation reported almost 70% of turn exchanges involved some form of mutual gaze (Novick, Hansen, & Ward, 1996). In cross-cultural studies, mutual gaze was seen to occur in half of question-related turn exchanges in high-gaze cultures, which amounted to initiation and completion of adjacency pairs. In low-gaze cultures, the mutual gaze occurred a third of the time (Rossano, Brown, & Levinson, 2009).

The mutual gaze patterns for quad conversation should follow from the gaze patterns of listeners and speakers in that case. In the American case, I predicted speakers to increase gaze while listeners to decrease it. Mutual gaze may be higher in the dyadic case because the listener gazes at the speaker more. In the quad case, the listener does not seem to have the same attending requirements while the speaker does. However, at any given turn, one speaker and one addressee in a quad case probably behave as a dyadic pair unless that speaker addresses all listeners at once. Therefore, in the quad case, it is likely the mutual gaze will not increase from the dyadic case.

In the Arab and Mexican case, I predict speakers and listeners to maintain the gaze amounts they exhibit in the dyadic case. However, as they need to negotiate the next turn, mutual gaze might increase to coordinate turn-taking.

Finally, the proxemics literature has supported that American dyadic interpersonal distance is significantly different from Arab and Latin American (Watson & Graves, 1966; Watson, 1970). The quad case, however, is not as clear, as no results were found for interpersonal distance in quad conversation. Low-contact cultures prefer more distance between conversants, so in a quad conversation, more participants may require more space to interact. In contrast, high-contact cultures prefer to maintain closer distances. With more participants, the preference to minimize interpersonal distance between conversant across from each other would reduce interpersonal distances of conversants next to each other. Therefore, interpersonal distance might be expected to increase from the dyadic case to the quad case for low-context cultures while it would decrease for high-context cultures.

In the next section, I will outline the specific hypotheses for each of the three behavioral components based on these predictions. For each culture, I will hypothesize how the behaviors may change when the group dynamic increases from dyads to quads.

3.2 TURN-TAKING

With respect to turn-taking, the literature reported that in the dyadic case, overlap seemed to vary by culture while between-turn pause did not. However, pause did seem to be affected by conversational partners. Results from the literature also suggested that pause varied by cognitive load. More speakers could mean increased demand for a turn in which case between-turn pause lengths may be shorter and overlap may be longer. However, it is also plausible that speakers feel less responsibility to control the floor and wait for others to do so resulting in the opposite result. The demand for the turn may follow high-involvement high-considerateness differences, where Americans are a high-considerateness culture and Arabs and Mexicans are a high-involvement culture. Based on this analysis, I hypothesize that for turn-taking in quad conversation relative to dyadic conversation:

HYPOTHESIS 1A: Americans will **decrease overla**p at turn-transitions.

HYPOTHESIS 1B: Americans will **increase pause** at turn-transitions.

HYPOTHESIS 1C: Arabs will **increase overlap** at turn-transitions.

HYPOTHESIS 1D: Arabs will **decrease pause** at turn-transitions.

HYPOTHESIS 1E: Mexicans will **increase overlap** at turn-transitions.

HYPOTHESIS 1F: Mexicans will **decrease pause** at turn-transitions.

3.3 GAZE

With respect to gaze, the literature reported that listeners gazed more than speakers in dyadic, triadic, and quad conversational groups. Listeners gaze seemed to drop by group size, perhaps because non-addressees are not required to gaze at the speaker as much as an addressee. Speakers' gaze presumably increased with group size, due to the demand for addressee disambiguation and next-speaker selection. I note, though, that gaze percentages of speakers in quads gazing at addressees in Veertegal et al. (2001) showed numbers similar to dyadic speaker gaze. In this view, speaker gaze is composed of a dyadic component and gaze at other listeners. But in general, gaze behaviors in dyads varied by culture

where high-contact cultures gazed more than low-contact cultures. Based on this analysis, I hypothesize that in quad conversation relative to dyadic conversation:

HYPOTHESIS 2A: Americans **speakers** will **increase** gaze at other conversants.

HYPOTHESIS 2B: Americans **non-speakers** will **not increase** gaze at other conversants.

HYPOTHESIS 2C: Arab **speakers** will **not increase** gaze at other conversants.

HYPOTHESIS 2D: Arab **non-speakers** will **not increase** gaze at other conversants.

HYPOTHESIS 2E: Mexican **speakers** will **not increase** gaze at other conversants.

HYPOTHESIS 2F: Mexican **non-speakers** will **not increase** gaze at other conversants.

3.4 MUTUAL GAZE AT TURN-TRANSITIONS

Hypotheses 1A-F and 2A-F treat turn-taking and gaze time independently. I now look at the possible interaction of these joint interaction behaviors. Gaze appears to coordinate turn with as much as 70% of turn exchanges involving mutual gaze in dyadic conversation. In five-person conversation, speakers gazed toward a listener when beginning a turn in 79% of turns and when ending a turn in 69% of turns. Speaker gaze remains an important component in coordinating turn-taking as group size increases. As was speculated in the turn-taking hypotheses, mutual gaze will depend on the competitiveness of floor control. Essentially, listeners will determine how much mutual gaze may occur based on interest in taking a turn. If there is no competition for the floor, mutual gaze in quads will essentially behave as in dyadic interaction. Based on this analysis, I hypothesize that in quad conversation relative to dyadic conversation:

HYPOTHESIS 3A: Americans will **not increase** the amount of mutual gaze at turn-transitions.

HYPOTHESIS 3B: Arabs will **increase** the amount of mutual gaze at turn-transitions.

HYPOTHESIS 3C: Mexicans will **increase** the amount of mutual gaze at turn-transitions.

3.5 PROXEMICS

With respect to proxemics, studies suggest that differences exist between cultures in the dyadic case. Standing measurements for Anglo-Americans were well above two feet, while those for Latin Americans were around two feet and below. But how does proxemics change as group size increases? In low-contact cultures, I predict an increase in distance as participants increase, because more bodies will

require more space to comfortably interact. In high-contact cultures, I predict the distance between conversants diagonally across from each other will be close enough to allow for touch to occur within reach. Thus, I would expect that proxemics would increase for low-contact cultures and decrease for high-contact cultures in the quad case.

Based on this analysis, I hypothesize that in quad conversation relative to dyadic:

HYPOTHESIS 4A: Americans will **increase** proxemics.

HYPOTHESIS 4B: Arabs will **decrease** proxemics.

HYPOTHESIS 4C: Mexicans will **decrease** proxemics.

3.6 SUMMARY OF HYPOTHESES

Table 3.1 shows a list of all the hypotheses that were proposed in this section. In summary, these hypotheses can provide some light to how conversants use joint interaction behaviors differently in dyads versus multiparties.

Table 3.1 Predicted change from dyadic to quad conversations for each joint interaction behavior.

Joint Interaction Behavior(s)		Changes observed as group size increases (dyadic to multiparty)		
		American (non-contact)	Mexican (contact)	Arab (contact)
Turn-taking	Overlap	Decrease	Increase	Increase
	Pause	Increase	Decrease	Decrease
Gaze	Speaker	Increase	No change	No change
	Non-Speaker	No change	No change	No change
Turn-taking x Gaze: mutual gaze at turns		No change	Increase	Increase
Proxemics		Increase	Decrease	Decrease

Chapter 4: Methodology

To answer the question how people use joint interaction behaviors differently in quad conversations and how this relationship changes across culture requires comparing data for turn-taking, gaze, and proxemics in quad conversations to dyadic data collected under similar circumstances.

4.1 CORPUS COLLECTION

For the quad case, conversational groups comprising of four members were recorded with video and audio equipment for later annotation. The video equipment consisted of six to eight iMac computers with built-in cameras that were placed on desks along the walls of the room. The audio equipment included four wireless lapel microphones and a four-channel receiver and sound card to record each subject separately. There were four groups for Northern Mexican, American and Arab. In recruiting subjects, I sought to obtain a mix of people, some of whom were strangers and some of whom knew each other. Appendix A provides a description of the composition of the groups. Subjects were mainly recruited by word of mouth. To facilitate analysis of culture as an independent variable, most of the groups were male-only, but we had one group in each language condition with at least two female subjects. The groups were asked to speak in their native language while standing in a space of approximately 18 feet by 10 feet. Tiny markers were placed on the carpet at one-feet intervals in a horizontal and vertical direction to facilitate proxemics annotations. Each group was given the same five topics of conversation to discuss in the same order: movies seen, pet-peeves, cross-cultural experiences, a toy-naming task, and telling a story about the toy. The topics were presented one at a time and discussed for around 8 to 10 minutes. The toy was included in two tasks to study the differences in gaze and proxemics behaviors when an artifact was introduced. After completing all five tasks, subjects were assessed a post-test questionnaire to get their age, the length of time they were acquainted with the other conversants and the length of time spent in their own culture, or extent of acculturation.

For the dyadic case, the same experiment was run using pairs from the same cultural groups. All the tasks and procedures, including the setting, were kept constant. The only difference was that each task was discussed for around 4 to 5 minutes in dyads. Considering that the conversants had to talk

more given the reduced participants, this seemed like a reasonable change. Efforts were made to match the dynamics of the quad groups, so that if all the conversants were female, the dyadic conversants were also female. If the conversants were married or mixed sexes, the pairs would also follow this dynamic. If they knew each other, then pairs who knew each other would be used.

Two coders recorded standing position, gaze direction, and speaking state of each subject from one of six to eight angles available of the conversation. For standing position, coders marked the x and y position that represented the subject's center of gravity each time the subject occupied a new position. For gaze, they marked which conversant the subject was gazing at, if they were gazing at the toy, or if they were gazing elsewhere. For turn, coders marked when a subject began and ended speaking or laughing, ignoring within-turn pauses lasting less than a quarter second (250ms). Any other interval was labeled as pause. I wrote a program to use these annotations to calculate at each tenth of a second the actual interpersonal distance between all pairs, whether all conversants were pausing or any conversants were overlapping, and which pairs were in mutual gaze.

Annotating was a monumental effort and so only excerpts from the first four tasks were made. I chose 30-second excerpts in the first and second halves of each task, usually at the two- and six-minute marks into the task for quads and the one- and three-minute mark for dyads. I only diverged from these times when a subject's gaze could not be determined from any of the camera angles because of occlusion by other conversants or because the camera angle cut off their gaze. Four tasks were selected to have a balance of tasks with and without the toy. For each conversational group, the coders annotated four minutes (two 30-second excerpt per task for 4 tasks) for a total of 96 annotated minutes (4 minutes per group by 4 conversational groups per condition by 2 conditions by 3 cultures).

I assessed inter-rater reliability for annotations using Kappa to compare coder agreement at each tenth of a second. Inter-rater reliability for proxemics (within three inches) yielded a Kappa value above 84%, 86% for gaze and 90% for turn-taking. Afterwards, coders were given a list of annotations that disagreed for longer than one second to reconcile differences due to error. Changes were made only if a coder believed she had made a mistake rather than for the sake of agreeing. For example, a coder may

have miscounted the tick marks going from one video angle to the next or they may have annotated gaze from one angle, but another angle showed gaze direction more clearly.

4.2 ANALYTICAL APPROACH

A 3 x 2 x (4) mixed factorial design was employed in which participants from one of three cultures, American, Arab or Mexican, were assigned to one of two between-subject group-size conditions: quad or dyad. Each condition had four groups of conversants across each culture (24 subjects, 4 quads and 4 dyads) discussing four topics (repeated measure): movies seen, pet-peeves, toy naming, and toy story-telling during two 30-second excerpts (control variable). The quad condition was composed of 48 subjects (4 conversants x 4 groups x 3 cultures) and the dyadic condition had 24 subjects (2 conversants x 4 groups x 3 cultures). For each conversant, annotations for each joint interaction behavior from the two 30-second excerpts across four tasks were averaged. For example, if two subjects had stood 30 inches apart from 0 seconds to 12.3 seconds of task T excerpt E, and then 60 inches apart for the remainder of the excerpt, the average proxemics distance for each subject would be 30 inches times 12.3 seconds plus 60 inches times 17.7 seconds divided by 30 seconds, or 47.7 inches for task X excerpt Y. Thus, for each of the 72 conversants, there were eight mean measures for each joint interaction behavior. Additionally, there were covariate measures for gender, age, familiarity, and acculturation.

For each dependent variable, a 3 x 2 x (4) mixed factorial ANOVA was conducted, controlling for relevant covariates, including gender, age, familiarity and acculturation. Follow-up t-tests were computed to assess differences between conditions that demonstrated significant main effects or interactions. Additionally, within-subject analysis was conducted for the repeated measures, task and its interactions.

For proxemics, to compare measures of interpersonal distance across group size, a minimum spanning forest was determined for the quad case and the average length was assigned to each conversant. For the dyadic case, the interpersonal distance assigned to each conversant was the proxemics distance. These assigned values were then be compared across group size.

For gaze, measures of speaker and non-speaker acts were treated separately using the percentage of the duration of gazing-at-conversant to total duration of gaze for that role. Each subject was then assigned a percentage for speaker and listener and these values were compared across group size.

For turn-taking, measures of mean pause and overlap at turn-transitions were compared in seconds. There seems to be no definitive rules for turns; some count backchannels as turns and others do not. The annotations for this corpus simply specify whether a person is talking or not, rather than categorize turns, such as backchannel turns or turn attempts that were unsuccessful. For the purposes of measuring pause and overlap at turn-transitions, I define a turn-transition as occurring when a conversant that is speaking yields the turn to another conversant that begins to speak. If the second conversant speaks before the first completes the speaking turn, the overlap is expressed as a negative number representing the seconds of simultaneous talk for the second conversant. Otherwise, the pause is represented as a positive number in seconds for the second conversant. As the turn-transition requires the first conversant to complete the speaking turn, this excludes backchannels that occur by the seconds conversant while the first conversant is speaking. In the quad case, a conversant that is speaking can yield a turn to several conversant simultaneously if, while that first conversant was speaking, the other conversants began to speak. In this case, each of the other conversants is assigned an overlap or pause value in seconds with respect to the first conversant. They would also have pause and overlap values with respect to each other depending on who spoke first and if that conversant yielded the turn. The mean for all pause and overlaps for each subject are then compared across group size.

Finally, calculating mutual gaze at turn-transitions requires determining what turn-transitions, as defined in the previous paragraph, co-occurred with mutual gaze. For mutual gaze to coordinate turn-transitions, the mutual gaze must occur before the conversant who is speaking completes the speaking turn. Thus, for each occurrence of mutual gaze between a pair, the turn-transitions between that pair, where mutual gaze begins before the pause or overlap and continues during or after turn-transition, are counted and divided by the number of turn-transitions between that pair. These are then average for each subject's pairs. For example, assume subject A in one of the quads had five turn-transitions with B and C, and ten turn-transitions with D, regardless of whether A took or yielded the turn. Two of those

turn-transitions with B involved mutual gaze before the first turn completed and lasted into the turn-transition or beyond. One of those turn-transitions with C involved mutual gaze as defined and three were counted for D. Subject A would then have 2 of 5 (40%), 1 of 5 (20%) and 3 of 10 (30%) occurrences of mutual gaze to coordinate turn-transition, or 9 of 30 (30%) turn-transitions involving mutual gaze. These percentages are then compared across group size.

To compare the measures of joint interaction behavior between subjects across group size and culture and within subjects across task and excerpts requires an SPSS general linear model with repeated measures. The results will be presented in the next chapter.

4.3 CORPUS SUMMARY STATISTICS

Having collected the corpus, I summarized the annotations taken of proxemics, gaze, and turn. The quad data are presented first, followed by the dyadic data. This summary provides an overall picture of the corpus as background for the specific statistical analyses discussed in Chapter 5.

4.3.1 Quad Joint Interaction Behaviors

This subsection presents proxemics, turn-taking and gaze data, descriptions, and analyses for quad interactions. Each topic presents one of the joint interaction behaviors.

Proxemics

For quad proxemics, area was calculated by making a polygon with each subject as a vertex. This area was calculated at every tenth of a second and arranged into a matrix where each row contained all the measures for each quad across all tasks and excerpts. T-tests were run using the mean area for each row for each conversational group. Table 4.1 shows minimum and maximum area values, and arithmetic mean for each group, suggesting that Mexicans stood closest, followed by Arabs and Americans. Americans differences were marginally significant when compared to Arabs, $t(7) = 2.083$, $p = .082$, $d =$ and Mexicans, $t(7) = 2.273$, $p = .063$, $d =$, suggesting a difference for contact versus non-contact cultures. Figures 4.1 to 4.3 are histograms of the pair-wise distances between conversants for each culture.

Table 4.1 Statistics of interpersonal area for each culture

Culture	N	Min (in^2)	Max (in^2)	Mean
American	4	1863	3400	2542
Arab	4	1740	1987	1865
Mexican	4	1083	2110	1651

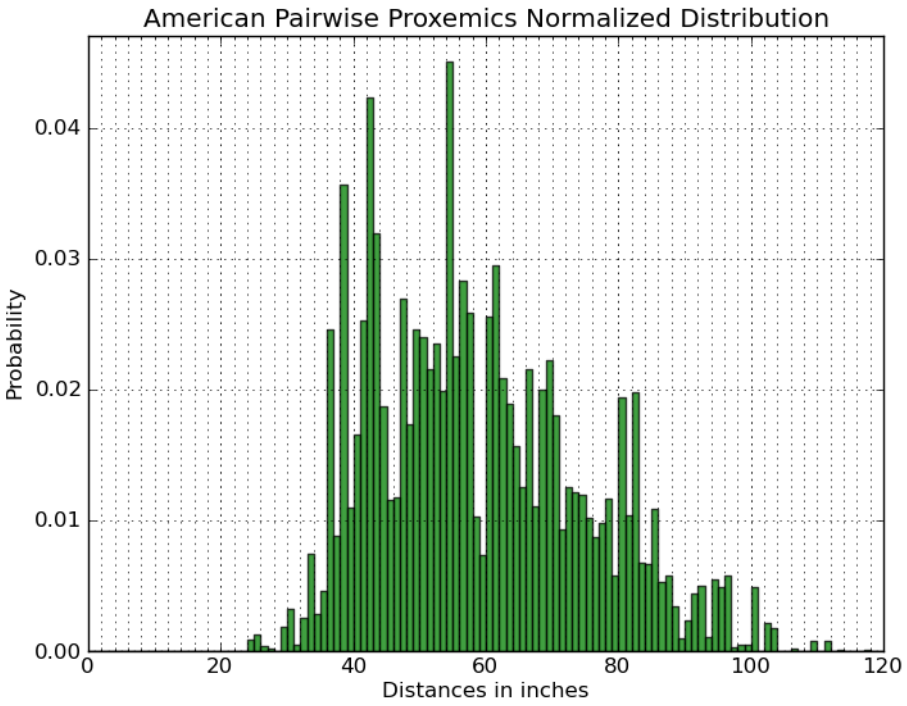

Figure 4.1 Probability density of American quad interpersonal distances in all tasks

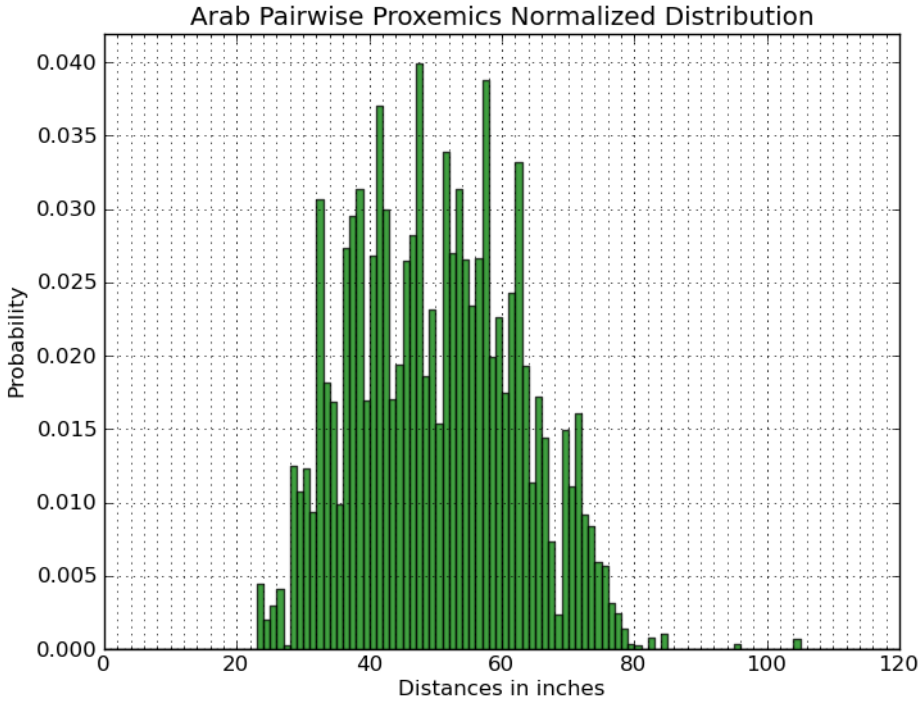

Figure 4.2 Probability density of Arab quad interpersonal distances in all tasks

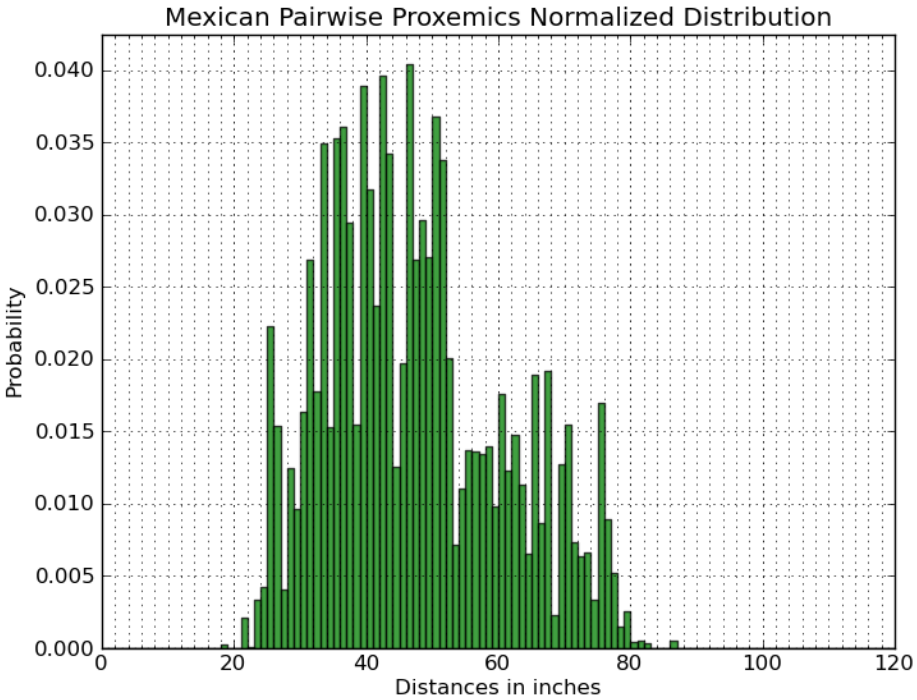

Figure 4.3 Probability density of Mexican quad interpersonal distances in all tasks

Turn-taking

T-tests did not disclose significant differences in pause or talk across cultures for quads. T-tests were also run on laugh and surprisingly showed significant differences between Arab and American, $p < .01$, and marginally significant differences between Mexican and American, $p = .07$. Laughter may be a characteristic of a non-contact culture. Figure 4.4 shows the total occurrences of time spent talking, silent, and laughing by all conversants.

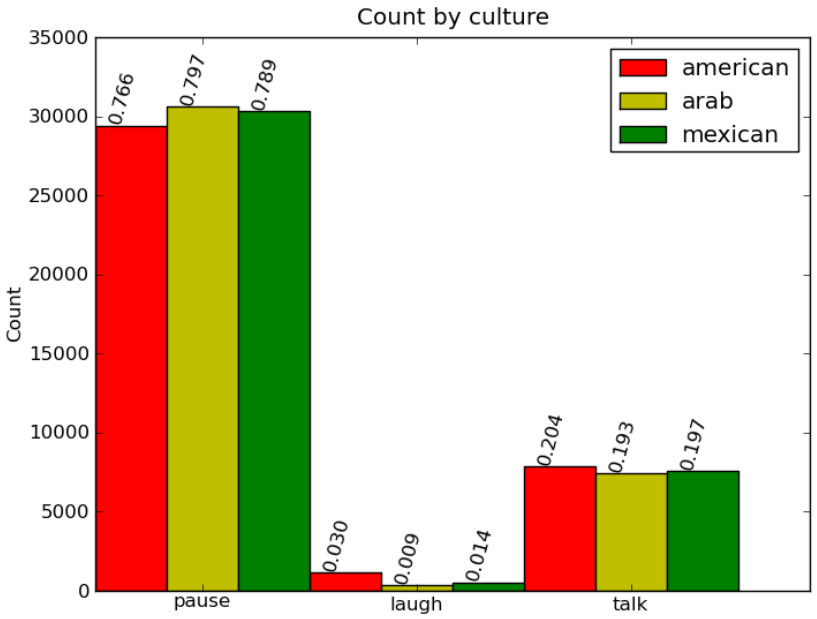

Figure 4.4 Count of talk/pause/laugh occurrences per culture. Maximum count is 38,400 (32 videos x 300 deciseconds x 4 conversants)

Turn-transitions were also counted for each pair-wise combination within the quad and pause and overlap time during that transition were recorded. Figure 4.5 to 4.7 show a histogram of pause and overlap where pause is seconds and overlap is in negative seconds. Pauses lasting longer than five seconds were discarded (a few occurrences).

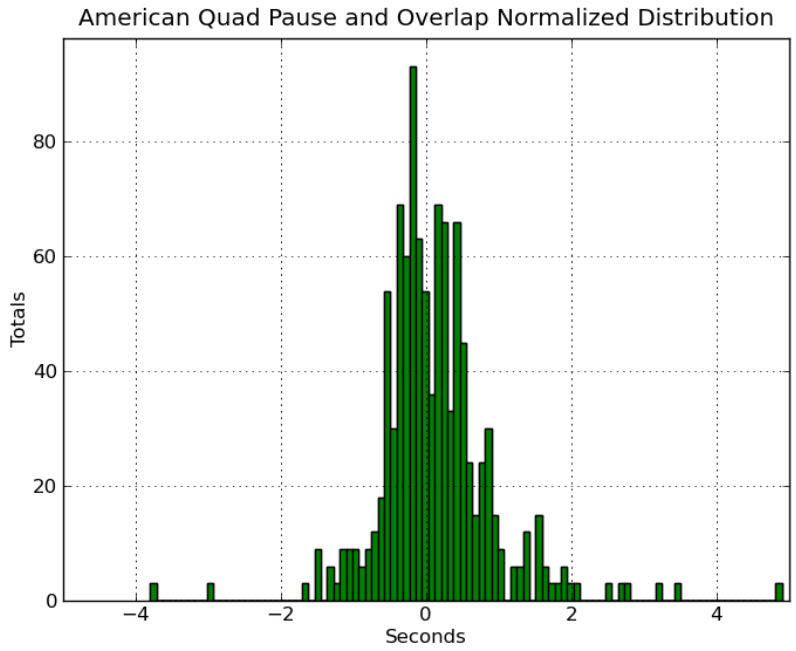

Figure 4.5 Count of pause and overlap in seconds of turn-transition length for all American quad pairs where overlap is in negative seconds. See section 4.2 for a description of turn-transition.

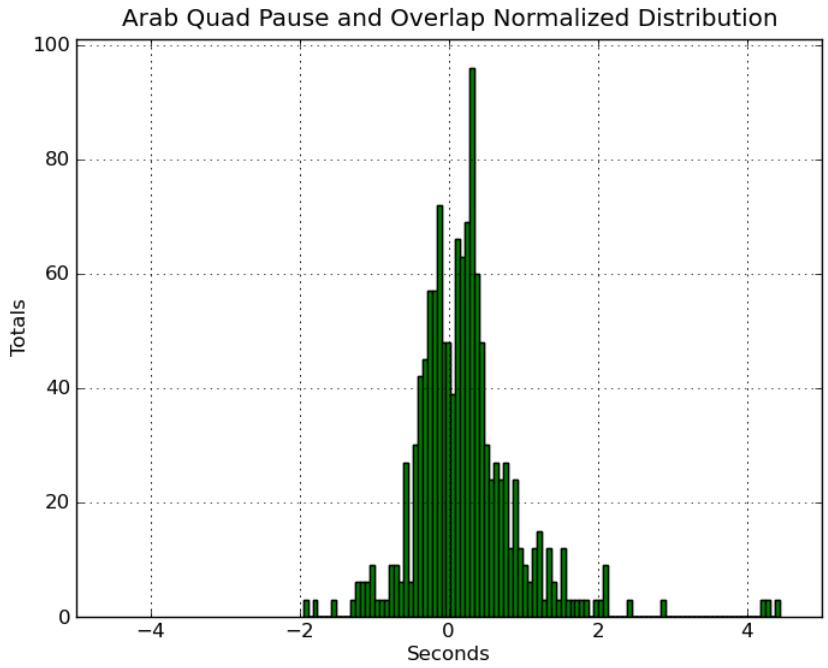

Figure 4.6 Count of pause and overlap in seconds of turn-transition length for all Arab quad pairs where overlap is in negative seconds. See section 4.2 for a description of turn-transition.

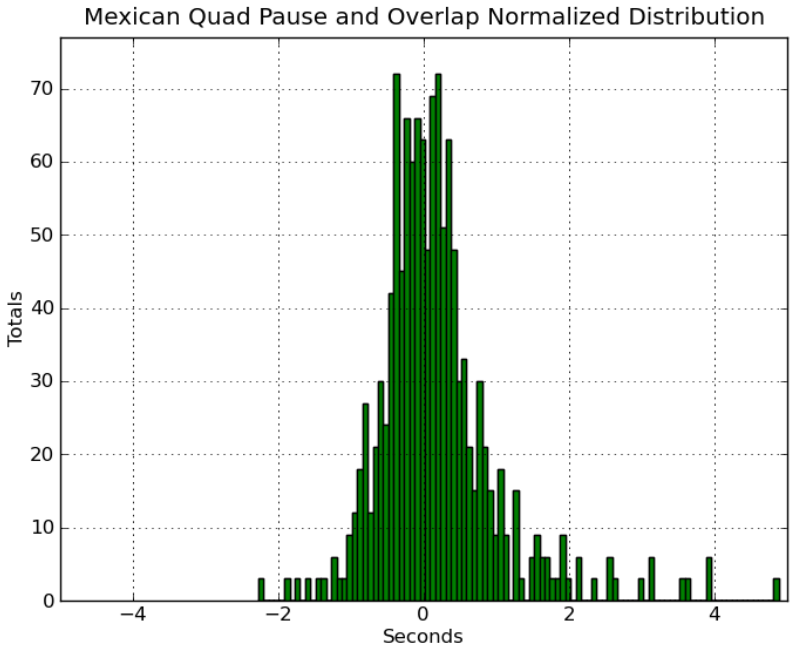

Figure 4.7 Count of pause and overlap in seconds of turn-transition length for all Mexican quad pairs where overlap is in negative seconds. See section 4.2 for a description of turn-transition.

Gaze

Initial observation of gaze data for quads suggests that Arabs gaze more at each other than Mexicans and Americans with the toy present. Mexicans gazed at the toy the most, and tended to gaze elsewhere the most without the toy. However, t-tests showed no significant differences, even when looking at all tasks together.

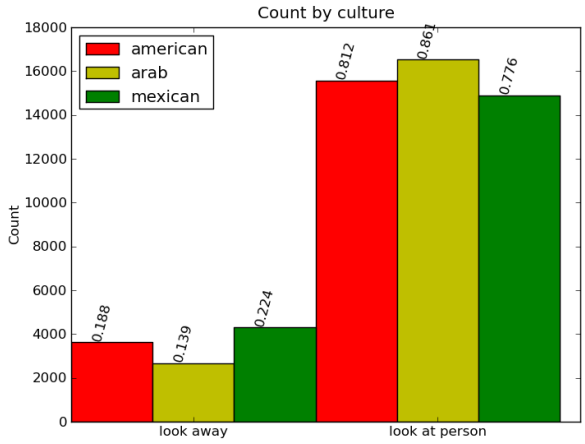

Figure 4.8 Count of gaze occurrences per culture in two tasks (pet-peeves and movies seen). Maximum count is 19,200 (16 videos x 300 deciseconds x 4 conversants)

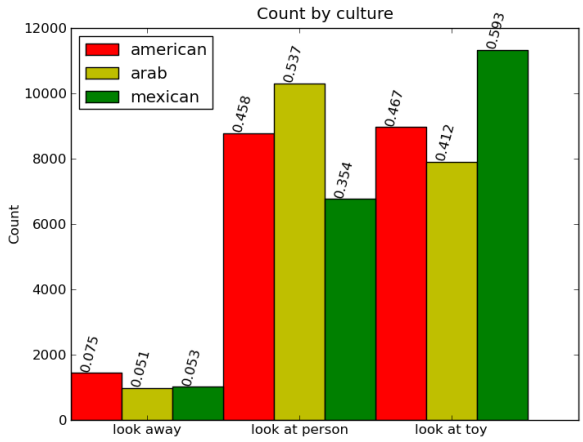

Figure 4.9 Count of gaze occurrences per culture in two tasks (toy naming and toy storytelling). Maximum count is 19,200 (16 videos x 300 timeslices x 4 conversants)

4.3.4 Dyadic Joint Interaction Behaviors

This subsection presents proxemics, turn-taking and gaze data, descriptions, and analyses for dyadic interactions. Each topic presents one of the joint interaction behaviors.

Proxemics

For dyadic proxemics, the interpersonal distance created by the pair was analyzed by t-test using four samples for each culture. As described in section 4.3.1, a mean was taken for each group across all tasks and excerpts. Table 4.2 shows minimum and maximum distances in inches, and arithmetic mean for each group, suggesting that Mexicans stood closest, followed by Arabs and Americans. Americans were significantly different than Arabs, $t(7) = 4.553$, $p < .005$, $d =$ and Mexicans, $t(7) = 4.729$, $p < .005$, $d =$, suggesting a difference for contact versus non-contact cultures. Figures 4.10 to 4.12 are histograms of the pair-wise distances between conversants for each culture.

Table 4.2 Statistics of interpersonal distance in inches for each culture

Culture	N	Min	Max	Mean
American	4	55	71	65
Arab	4	43	52	48
Mexican	4	37	49	44

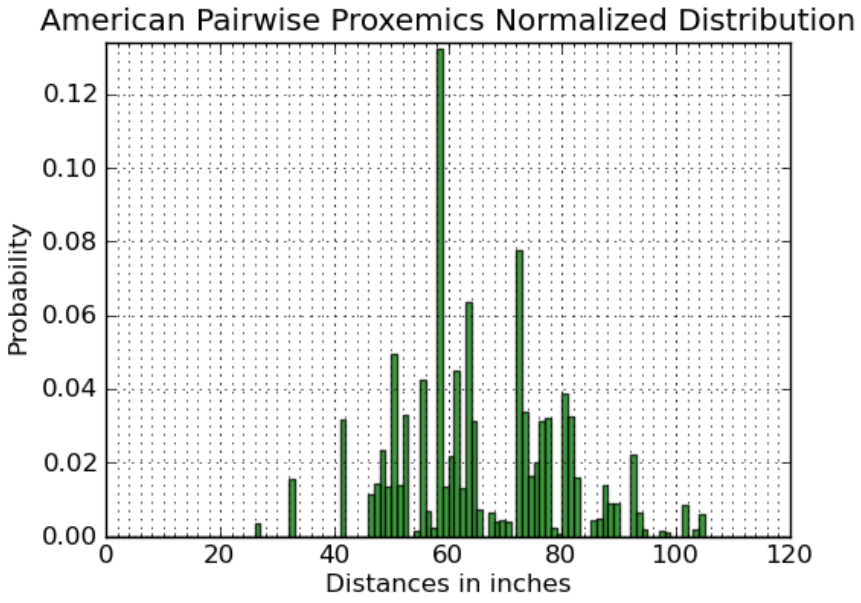

Figure 4.10 Probability density of American dyadic interpersonal distances in all tasks

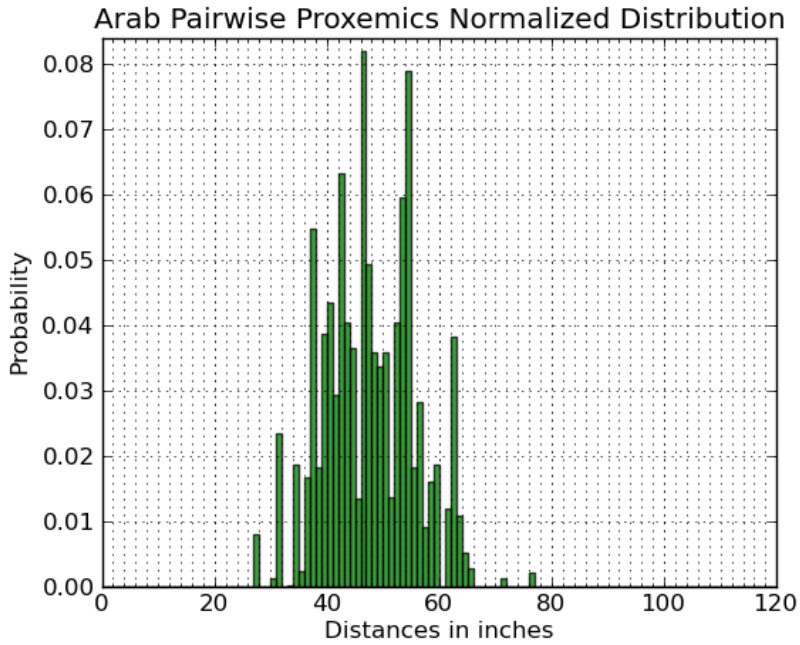

Figure 4.11 Probability density of Arab dyadic interpersonal distances in all tasks

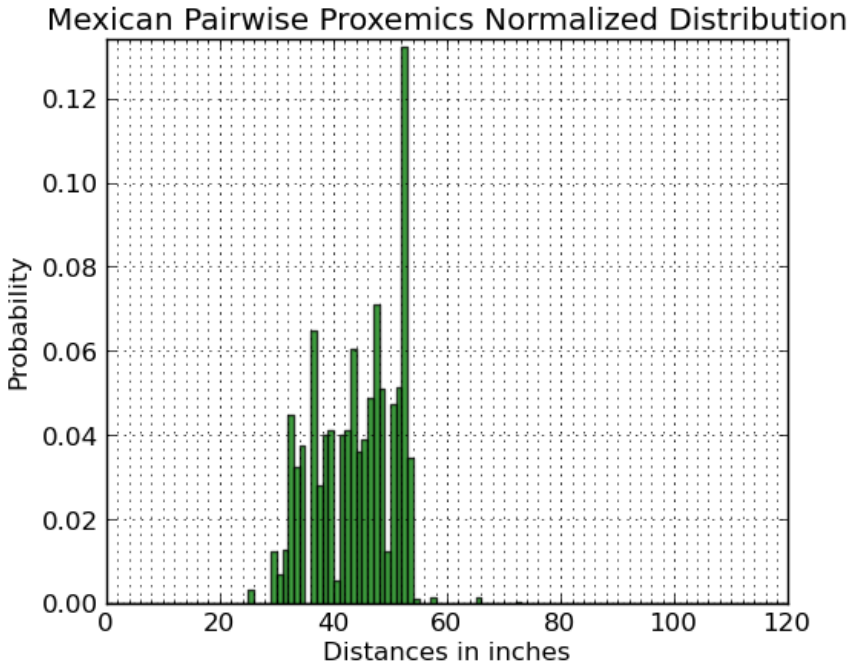

Figure 4.12 Probability density of Mexican dyadic interpersonal distances in all tasks

Turn-taking

T-tests did not disclose any significant differences in pause or talk across cultures for dyads. T-tests run on laugh did not reach significance but showed a similar relationship as in the quad condition, specifically that Americans laughed a lot more than the other two cultures. Figure 4.13 shows the total occurrences of time spent talking, silent, and laughing by all conversants.

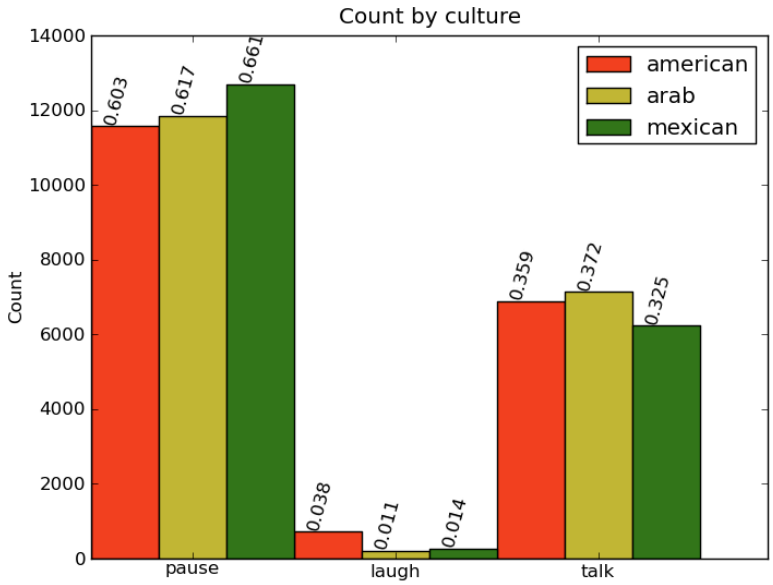

Figure 4.13 Count of talk/pause/laugh occurrences per culture. Maximum count is 19,200 (32 videos x 300 deciseconds x 2 conversants)

Turn-transitions were also counted for each dyad and pause and overlap time during that transition were recorded. Figure 4.14 to 4.16 show a histogram of pause and overlap where pause is seconds and overlap is in negative seconds. Pause lasting longer than five seconds were discarded (a few occurrences).

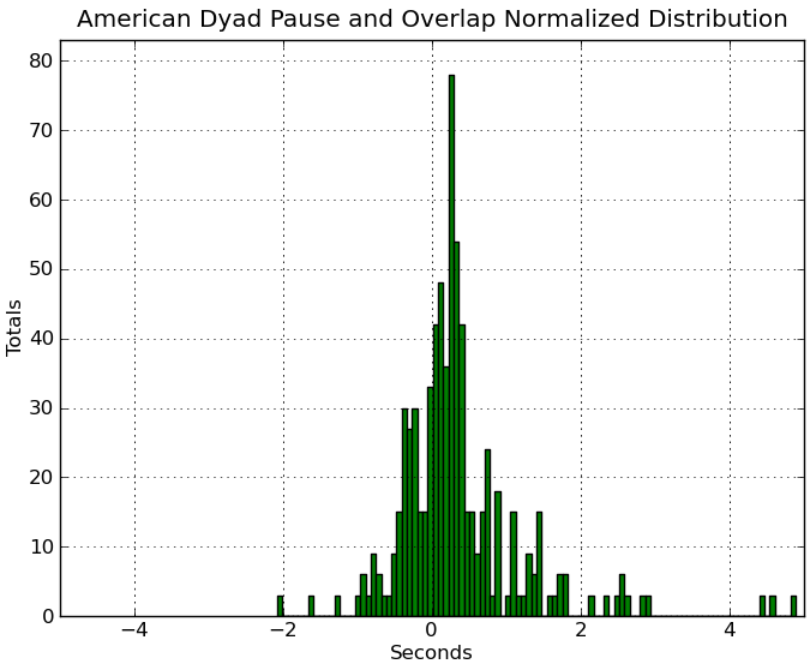

Figure 4.14 Count of pause and overlap in seconds of turn-transition length for all American dyads where overlap is in negative seconds. See section 4.2 for a description of turn-transition.

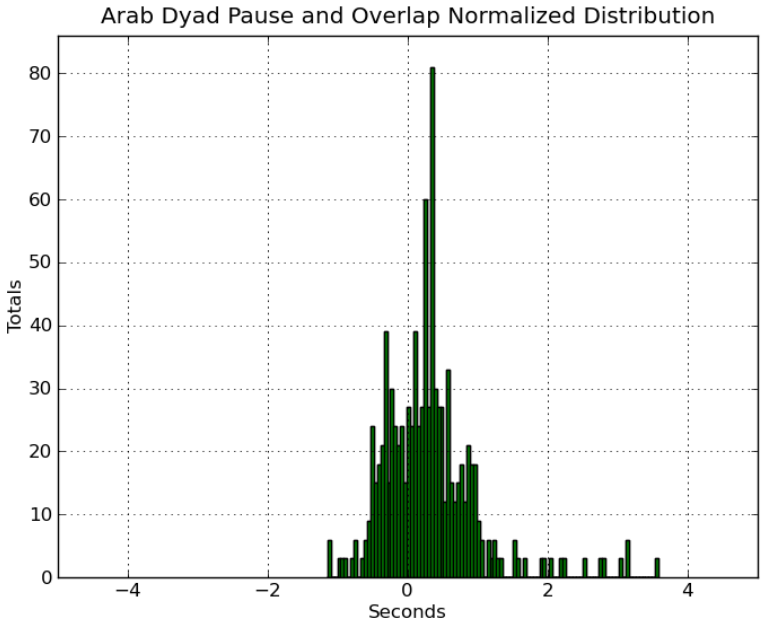

Figure 4.15 Count of pause and overlap in seconds of turn-transition length for all Arab dyads where overlap is in negative seconds. See section 4.2 for a description of turn-transition.

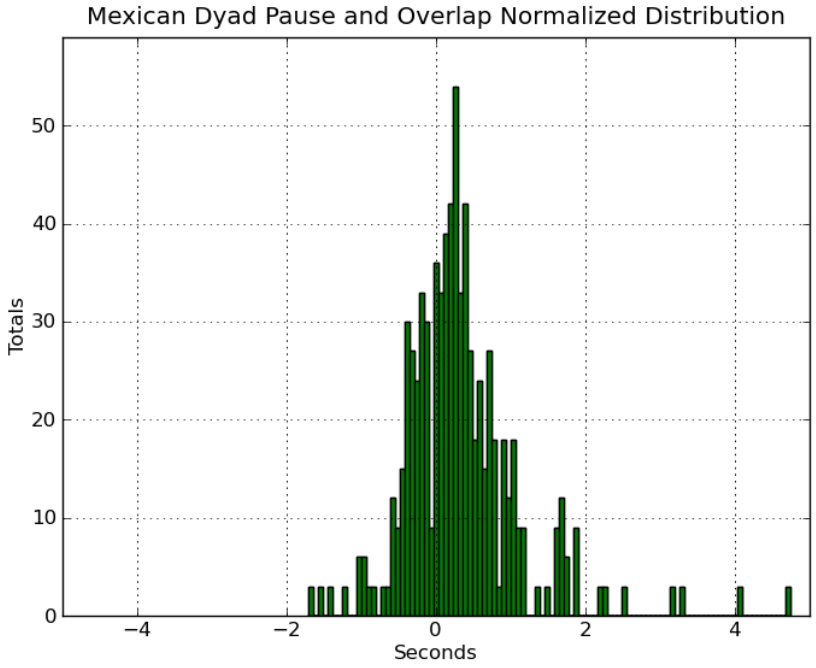

Figure 4.16 Count of pause and overlap in seconds of turn-transition length for all Mexican dyads where overlap is in negative seconds. See section 4.2 for a description of turn-transition.

Gaze

Initial observation of gaze data for dyads suggests that Arabs gaze the most at each other, followed by Mexicans and Americans. T-test showed significant differences between Arab and American ($p=0.03$) and marginal significance between Mexican and American ($p=0.1$) although no significance between Arab and Mexican. These results follow predicted gaze behaviors in the literature for high/low-contact cultures. No significance was found for look-away behavior across the three cultures. Americans looked at the toy significantly more than Arabs ($p=0.03$) and marginally more than Mexicans ($p=0.1$).

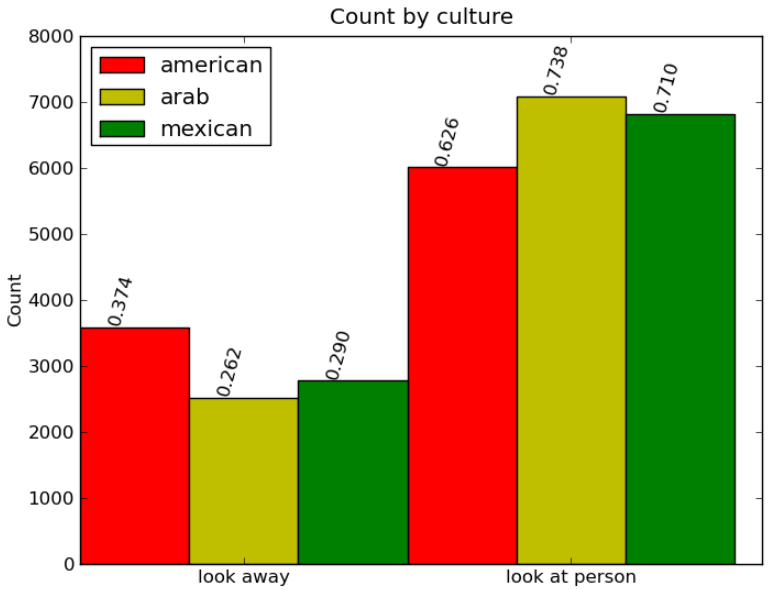

Figure 4.17 Count of gaze occurrences per culture in two tasks (pet-peeves and movies seen). Maximum count is 9,600 (16 videos x 300 timeslices x 2 conversants)

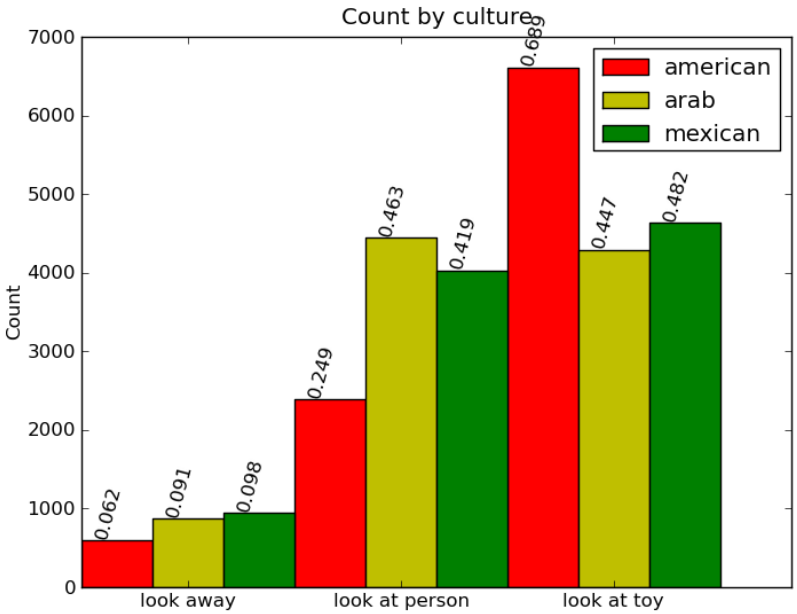

Figure 4.18 Count of gaze occurrences per culture in two tasks (toy naming and toy storytelling). Maximum count is 9,600 (16 videos x 300 timeslices x 2 conversants)

4.3.3 Summary

Not surprisingly, joint interaction behaviors show significant differences across cultures in dyadic and quad conditions. Differences for quads were limited to proxemics and laugh. Differences were not found in other turn and gaze behaviors. However, only total pause and gaze counts were considered; more complex measures like turn-transition pause and overlap, mutual gaze to coordinate turn-transition, and gaze while speaking or listening could yield differences in quads across cultures.

Dyadic differences were more pronounced along the high/low-contact dimension. American interpersonal distances were significantly longer than the other two, and they gazed at conversants significantly less and at the toy more than the other two. This suggests that conversants behave differently in dyads and quads even across cultures, as observed by differences in both conditions, but more so in the dyadic case.

The next chapter will look at more complex behaviors and address the specific question of differences across group size and how they relate across cultures.

Chapter 5: Results

This chapter presents results of statistical analysis on the data to confirm or reject the hypotheses presented in Chapter 3. Results will be presented in the same order they were introduced: turn-taking, gaze, mutual gaze at turns-transitions, proxemics, and the cultures: American, Arab, and Mexican. As described in section 4.2, for each dependent variable, a 3 x 2 x (4) mixed factorial ANOVA was conducted controlling for relevant covariates, including gender, age, familiarity and acculturation. Follow-up t-tests were computed to assess differences between conditions that demonstrated significant main effects or interactions. Additionally, within-subject analysis was conducted for the repeated Task measure, and its interactions. Finally, the interaction between joint interaction behaviors was examined to find any interesting correlations.

For each dependent variable, I list the results for main effects of group size and culture, and their interaction as well as the independent t-tests that assess differences within cultures of the group sizes.

5.1 TURN-TAKING

For turn-taking, the average of pause (in seconds) and overlap (in negative seconds) at turn-transitions as described in section 4.2 for the two group sizes were analyzed using a general linear model with repeated measures. A test of between-subjects effects showed a significant main effect of Group Size, $F(1,62) = 5.8$, $p < .05$, $\eta^2 = .086$, 1-ß = .659. Culture did not show a main effect, $F(2,62) = 1.495$, $p = .232$, $\eta^2 = .046$, 1-ß = .307, nor did Culture x Group Size, $F(2,62) = 1.468$, $p = .238$, $\eta^2 = .045$, 1-ß = .302. Estimated marginal means suggest that dyads spent more time pausing and less time overlapping (M = .42s, SE = .05s) than quads (M = .26s, SE = .04s). A significant interaction of Group Size was found with Familiarity, $F(1,62) = 21.634$, $p < .001$, $\eta^2 = .259$, 1-ß = .996.

A test of within-subjects effects showed a significant main effect of Task, $F(3,186) = 2.671$, $p < .05$, $\eta^2 = .041$, 1-ß = .645. Follow-up pair-wise comparisons indicated that tasks with the toy significantly differed from tasks without the toy, $t(71) = -4.011$, $p < .001$, $d = -0.952$. A look at the mean measure of pause and overlap in seconds suggested that tasks without the toy (M = .21s, SE = .04s) had less pause and more overlap than tasks with the toy (M = .42s, SE = .05s). Significant interactions were

also observed for Task x Familiarity Level, $F(3,186) = 3.354$, $p < .05$, $\eta^2 = .051$, 1-ß = .754, for Task x Excerpts, $F(3,186) = 4.160$, $p < .01$, $\eta^2 = .063$, 1-ß = .847, for Task x Excerpts x Gender, $F(3,186) = 3.404$, $p < .05$, $\eta^2 = .052$, 1-ß = .761, and for Task x Excerpts x Acculturation, $F(3,186) = 3.134$, $p < .05$, $\eta^2 = .048$, 1-ß = .722.

Naturally, one might expect more overlap and reduced pause to occur in quad conversation with more conversants vying for a turn, and in fact this is seen in all three cultures. To address the turn-taking hypotheses, I now compute independent t-test on each culture's group size conditions. As Culture x Group Size was not a significant interaction, these results must be taken with caution. Only Americans showed marginally statistical difference between dyads and quads, $t(22) = 1.867$, $p = .075$, $d = 0.796$.

I now revisit the hypotheses in light of the measurements, treating pause and overlap as a continuous measurement. A decrease in pause means an increase in overlap.

Hypothesis 1A and 1B predicted American quad conversants would decrease overlap and increase pause at turn transitions relative to dyadic conversants. This was not confirmed. American measures decreased for pause and increased for overlap at turn-transitions for dyads (M = .59s, SE = .11s) compared to quads (M = .18s, SE = .07s). This could mean that American quad conversants do not behave as the high-considerateness style suggests.

Hypothesis 1C and 1D predicted that Arab quad conversants would increase overlap and decrease pause at turn transitions relative to dyadic conversants. This was not confirmed. Arab measures increased for quads (M = .31s, SE = .06s) compared to dyads (M = .27s, SE = .08s), although not significantly. This seems to suggest that, at least in this study, Arabs are more likely to yield turns as the group size increases by pausing more and overlapping less.

Hypotheses 1E and 1F predicted a decrease in pause and an increases in overlap at turn-transitions for Mexican conversants. This was not confirmed. Mexican measures did follow the expected behavior, decreasing in quads (M = .28s, SE = .06s) when compared to dyads (M = .42s, SE = .1s), but this was not significant. Table 5.1 shows the mean pause/overlap in seconds at turn-transitions and standard error for the group size condition for all three cultures. The study's results for the turn hypotheses are summarized in Table 5.2.

Table 5.1 Estimated marginal means for mean pause/overlap measure at turn transitions

Culture	Group size	Mean (s)	Std. Error (s)
American	Dyad	.576[a]	.097
	Quad	.268[a]	.069
Arab	Dyad	.294[a]	.093
	Quad	.250[a]	.068
Mexican	Dyad	.387[a]	.095
	Quad	.260[a]	.066

a. Covariates appearing in the model are evaluated at the following values: familiarity = 4.96, gender = 1.33, age = 28.92, acculturation = .86.

Table 5.2 Summary of result for turn hypotheses

Mean pause/overlap measure at turn-transtions (s)	Changes observed as group size increases (dyadic to quad)		
	American (non-contact)	Mexican (contact)	Arab (contact)
Hypotheses	Decrease overlap and increase pause	Increase overlap and decrease pause	Increase overlap and decrease pause
Results	Tended opposite	Inconclusive	Inconclusive

5.2 GAZE

For gaze data, measurements were calculated respective to the conversant's role as speaker or listener. That is, for an annotation of look-away, the talk state of the subject would be considered such that, if the conversant was talking, it was taken as speaker look-away, and if listening, then listener look-away. As described in section 4.2, speaker and listener gaze percentages were analyzed with culture and group size as independent variables and task and excerpts as repeated measures.

For speaker gaze, a test of between-subjects effects showed significant main effects of Group Size, $F(1,62) = 6.713$, $p < .05$, $\eta^2 = .098$, 1-ß = .723, and Culture, $F(2,62) = 3.513$, $p < .05$, $\eta^2 = .102$, 1-ß = .635. Culture x Group Size did not show a significant main effect, $F(2,62) = .958$, $p = .389$, $\eta^2 = .030$, 1-ß = .209. Gender also showed a significant main effect, $F(1, 62) = 4.348$, $p < .05$, $\eta^2 = .066$, 1-ß = .537. As one might expect, dyad speakers gazed less ($M = 50\%$, $SE = 3.5\%$) than quads ($M = 61\%$, $SE = 2.4\%$). Follow-up independent t-tests on each pair of cultures revealed significant differences between American ($M = 53\%$, $SE = 3.6\%$) and Arab ($M = 64\%$, $SE = 2.6\%$), $t(46) = -2.496$, $p < .05$, d = -0.736 and marginal differences ($p = .08$) between Arab and Mexican ($M = 55\%$, $SE = 4.4\%$), $t(46) = 1.788$, $p = .08$, d = 0.527 suggesting that Arabs and Mexicans should not be grouped into contact cultures as far as speaker gaze is concerned, but perhaps Arabs belong in their own high-gaze culture. Table 5.3 shows mean percentage of speaker gaze for the three cultures on the two conditions.

Table 5.3 Mean percentages of speaker gaze-at behaviors for each culture.

Culture	Group size	Mean	Std. Error
American	Dyad	.410[a]	.063
	Quad	.604[a]	.045
Arab	Dyad	.600[a]	.060
	Quad	.681[a]	.044
Mexican	Dyad	.484[a]	.062
	Quad	.545[a]	.043

a. Covariates appearing in the model are evaluated at the following values: familiarity = 4.96, gender = 1.33, age = 28.92, acculturation = .86.

A test of within-subjects effects showed a significant main effect of Task, $F(3,186) = 3.884$, $p < .01$, $\eta^2 = .059$, 1-ß = .819. Follow-up pair-wise comparisons indicated that tasks without the toy ($M = 71\%$, $SE = 2.4\%$) significantly differed from tasks with the toy ($M = 43\%$, $SE = 2.4\%$), $t(71) = 13.618$, $p < .001$, $d = 3.23$. A significant interactions was observed for Task x Excerpt x Culture, $F(3,186) = 2.411$, $p < .03$, $\eta^2 = .072$, 1-ß = .812.

Table 5.4 Mean percentages of listener gaze-at behaviors for each culture.

Culture	Group Size	Mean	Std. Error
American	Dyad	.431[a]	.052
	Quad	.644[a]	.037
Arab	Dyad	.632[a]	.049
	Quad	.731[a]	.036
Mexican	Dyad	.546[a]	.051
	Quad	.547[a]	.035

a. Covariates appearing in the model are evaluated at the following values: familiarity = 4.96, gender = 1.33, age = 28.92, acculturation = .86.

For listener gaze, a test of between-subjects effects showed significant main effects of Group Size, $F(1,62) = 8.737$, $p < .01$, $\eta^2 = .124$, 1-ß = .829, and Culture, $F(2,62) = 6.103$, $p < .01$, $\eta^2 = .164$, 1-ß = .872. Culture x Group Size showed a marginally significant main effect, $F(2,62) = 3.020$, $p = .056$, $\eta^2 = .089$, 1-ß = .565. Gender, $F(1,62) = 5.467$, $p = .023$, $\eta^2 = .081$, 1-ß = .634 and Acquaintance, $F(1,62) = 4.128$, $p = .046$, $\eta^2 = .062$, 1-ß = .516 also showed significant main effects. As one might expect, dyad speakers gazed less ($M = 54\%$, $SE = 2.9\%$) than quads ($M = 64\%$, $SE = 6.8\%$). Follow-up independent t-tests on each pair of cultures revealed significant differences between American ($M = 58\%$, $SE = 3.5\%$) and Arab ($M = 67\%$, $SE = 1.9\%$), $t(46) = -2.491$, $p < .05$, d = -0.735, and between Arab and Mexican ($M = 57\%$, $SE = 3.7\%$), $t(46) = 2.518$, $p < .05$, d = 0.743, suggesting that Arabs belong in their own group as far as listener gaze is concerned. Table 5.4 shows mean percentage of listener gaze for the three cultures on the two conditions.

Test of within-subjects effects showed a significant main effect of Task, $F(3,186) = 5.661$, $p < .001$, $\eta^2 = .084$, 1-ß = .943. Follow-up pair-wise comparisons indicated that tasks without the toy ($M = 79\%$, $SE = 2.0\%$) significantly differed from tasks with the toy ($M = 42\%$, $SE = 2.3\%$), $t(71) = 18.231$, $p < .001$, $d = 4.327$. Significant interactions were observed for Excerpt x Group Size, $F(1,62) = 6.340$, $p <$

.05, η^2 = .093, 1- ß = .698, for Task x Excerpt x Culture, $F(6,186) = 7.238$, $p < .001$, η^2 = .189, 1-ß = 1.000, for Task x Excerpt x Group Size, $F(3,186) = 3.547$, $p < .05$, η^2 = .054, 1-ß = .780, and for Task x Excerpt x Culture x Group Size, $F(6,186) = 7.082$, $p < .001$, η^2 = .186, 1-ß = 1.000.

To address the speaker and listener gaze hypotheses, I now compute independent t-test on each culture's group size conditions. As Culture x Group Size was not a significant interaction, these results must be taken with caution. Only Americans showed statistical difference between dyads and quads, $t(22) = -2.286$, $p < .05$, $d = -0.975$.

In non-speakers, statistical significance was reached between dyads and quads for Americans, $t(22) = -3.196$, $p < .01$, $d = -1.363$ and Arabs, $t(22) = -2.736$, $p < .05$, $d = -1.167$.

Based on these results, I now turn to the results for the hypotheses for gaze.

Hypothesis 2A predicted that Americans would increase the percentage of time they gazed at the other conversant in quads relative to dyads. This is supported, as quads gazed more at conversants (M = 60%, SE = 4.5%) than dyads (M = 41%, SE = 6.3%), $t(22) = -2.286$, $p < .05$, $d = -0.975$.

Hypothesis 2B predicted non-speakers would not increase their gaze. However, non-speakers in quads did increase gave compared to non-speakers in dyads. This hypothesis was not confirmed. Quads gazed more at conversants (M = 64%, SE = 3.7%) than dyads (M = 43%, SE = 5.2%), $t(22) = -3.196$, $p < .01$, $d = -1.363$, despite the reduced obligation to gaze with multiple conversants.

Hypothesis 2C's results were inconclusive. Although Arab speakers did increase the percentage of gaze in quads (M = 68%, SE = 4.4%) from dyads (M = 60%, SE = 6.0%), it was not significant.

Hypothesis 2D predicted non-speakers would not increase their gaze. However, non-speakers in quads (M = 63%, SE = 4.9%) did increase gaze compared to non-speakers in dyads (M = 73%, SE = 3.6%), $t(22) = -2.736$, $p < .05$, $d = -1.167$.

Hypothesis 2E and 2F addressed speaker and non-speaker behaviors for Mexicans. Like Arabs, Mexicans were not predicted to increase gaze in either role. Mexican speakers in quads (M = 55%, SE = 4.3%) gazed more at other conversants than dyads (M = 48%, SE = 6.2%). This increase was not significant, and thus the result was inconclusive. Similarly, non-speakers did not increase their gaze as

quads (M = 55%, SE = 3.5%) gazed as much as dyads (M = 55%, SE = 5.1%). The gaze hypotheses are summarized in Table 5.5.

Table 5.5 Summary of result for gaze hypotheses

Joint Interaction Behavior		Changes observed as group size increases (dyadic to multiparty)		
		American (non-contact)	Arab (contact)	Mexican (contact)
Gaze	Speaker	Hypothesis: Increase Result: **Confirmed**	Hypothesis: No Change Result: Inconclusive	Hypothesis: No Change Result: Inconclusive
	Listener	Hypothesis: No Change Result: **Signif. Increase**	Hypothesis: No Change Result: **Signif. Increase**	Hypothesis: No Change Result: Inconclusive

5.3 MUTUAL GAZE TO COORDINATE TURN-TRANSITIONS

To get a better idea of how mutual gaze coordinates turn-transitions in dyads and quads, I looked at mutual gaze that began before a turn-transition and co-occurred during it as described in section 4.2.

A test of between-subjects effects showed significant main effects of Culture, $F(2,62) = 77.916$, $p < .001$, $\eta^2 = .715$, 1-ß = .789, and Group Size, $F(1,62) = 4.421$, $p < .05$, $\eta^2 = .067$, 1-ß = .544 and Culture x Group Size, $F(2,62) = 24.255$, $p < .001$, $\eta^2 = .439$, 1-ß = 1.000. Gender also showed a significant main effect, $F(1,62) = 8.043$, $p < .01$, $\eta^2 = .115$, 1-ß = .797, as did Age, $F(1, 62) = 7.881$, $p < .01$, $\eta^2 = .113$, 1-ß = .537, and Acquaintance, $F(1,62) = 4.083$, $p < .05$, $\eta^2 = .062$, 1-ß = .512. Conversants used mutual gaze to coordinate more turn-transitions in dyads (M = 15.5%, SE = 1.7%) than quads (M = 11.1%, SE = 1.2%). Follow-up independent t-tests on each pair of cultures revealed significant differences between American (M = 2.2%, SE = 0.6%) and Arab (M = 5.5%, SE = 0.7%), $t(46) = -3.692$, $p < .001$, d = -1.089, American and Mexican (M = 30%, SE = 4.0%), $t(46) = -6.880$, $p < .001$, d = -2.029 and between Arab and Mexican $t(46) = -6.032$, $p < .001$, d = -1.779. Table 5.6 shows the percentage of turn-transitions involving mutual gaze for the three cultures on the two conditions.

Table 5.6 Percentages of turn-transitions involving mutual gaze for each culture.

Culture	Group size	Mean	Std. Error
American	Dyad	-.019[a]	.030
	Quad	.044[a]	.021
Arab	Dyad	.032[a]	.029
	Quad	.084[a]	.021
Mexican	Dyad	.451[a]	.030
	Quad	.205[a]	.021

a. Covariates appearing in the model are evaluated at the following values: familiarity = 4.96, gender = 1.33, age = 28.92, acculturation = .86.

A test of within-subjects effects showed no significant main effects, but several significant interactions emerged. A significant interactions was observed for Task x Culture, $F(6,186) = 6.341$, $p < .001$, $\eta^2 = .170$, 1-ß = .999, for Task x Culture x Group Size, $F(6,186) = 2.960$, $p < .01$, $\eta^2 = .087$, 1-ß = .895, for Excerpt x Acquaintance, $F(1,62) = 4.685$, $p = .034$, $\eta^2 = .070$, 1-ß = .568, for Task x Excerpt x Gender, $F(3,186) = 6.341$, $p < .05$, $\eta^2 = .042$, 1-ß = .655, and marginally for Task x Excerpt x Age, $F(3,186) = 2.530$, $p = .059$, $\eta^2 = .039$, 1-ß = .618.

To address the speaker and listener gaze hypotheses, I now compute independent t-test on each culture's group size conditions. As Culture x Group Size was not a significant interaction, these results must be taken with caution. Americans showed statistical difference between dyads and quads, $t(22) = -2.760$, $p < .05$, $d = -1.177$, as did Arabs, $t(22) = -3.357$, $p < .01$, $d = -1.177$, and Mexicans, $t(22) = 3.947$, $p < .01$, $d = 1.683$.

Based on these results, I now review the hypotheses for mutual gaze with respect to turn-transitions.

Hypothesis 3A predicted Americans would not increase the percentage of turn-transitions involving mutual gaze. This hypothesis was not confirmed, as quads ($M = 4.4\%$, $SE = 2.1\%$) used significantly more mutual gaze at turn-transitions than dyads ($M = -1.9\%$, $SE = 3\%$).

Hypothesis 3B predicted Arabs would increase the percentage of turn-transitions involving mutual gaze. This hypothesis was confirmed, as quads (M = 8.4%, SE = 2.1%) used significantly more mutual gaze at turn-transitions than dyads (M = 3.2%, SE = 2.9%).

Hypothesis 3C predicted Mexicans would increase the percentage of turn-transitions involving mutual gaze. This hypothesis was not confirmed, as quads (M = 20.5%, SE = 2.1%) used significantly less mutual gaze at turn-transitions than dyads (M = 45.1%, SE = 3%).

The results for hypotheses for mutual gaze at turn-transitions are summarized in Table 5.7.

Table 5.7 Summary of result for hypotheses for mutual gaze at turn exchanges

Joint Interaction Behavior	Changes observed as group size increases (dyadic to multiparty)		
	American (non-contact)	Arab (contact)	Mexican (contact)
Turn-taking x Gaze: mutual gaze at turns	Hypothesis: No Change Result: **Signif. Increase**	Hypothesis: Increase Result: **Confirmed**	Hypothesis: Increase Result: **Signif. Decrease**

5.4 PROXEMICS

For proxemics data, subjects in dyads were assigned an interpersonal distance to the other conversant. In quads, subjects have proxemic distances to three other conversants. To make a fair comparison of proxemics for quads and dyads that avoids inflated numbers due to distances to conversants across from each other or standing shoulder-to-shoulder and not interacting, the minimum spanning forest of the quad was calculated as described in section 4.2. Conversant proxemics in inches were analyzed with culture and group size as independent variables and task and excerpts as repeated measures.

Test of between-subjects effects showed significant main effects of Group Size, $F(1,62)$ = 63.483, $p < .001$, $\eta^2 = .506$, 1-ß = 1.000, Culture, $F(2,62) = 55.716$, $p < .001$, $\eta^2 = .643$, 1-ß = 1.000, and a significant interaction of Group Size x Culture, $F(2, 62) = 10.218$, $p < .001$, $\eta^2 = .248$, 1-ß = .983. Dyads stood further (M = 52in, SE = .98in) than quads (M = 42in, SE = .68in). Follow-up independent

t-tests on each pair of cultures revealed significant differences between American (M = 54in, SE = 2in) and Arab (M = 42in, SE = 1in), $t(46) = 4.948$, $p < .001$, d = 1.459, between Arab and Mexican (M = 39in, SE = 1in), $t(46) = 2.550$, $p < .05$, d = 0.752, and between Americans and Mexican, $t(46) = 6.040$, $p < .001$, d = 1.78, suggesting that perhaps there is more to consider than grouping into high/low-contact cultures.

A test of within-subjects effects showed a significant main effect of Task, $F(3,186) = 3.424$, $p = .018$, $\eta^2 = .052$, 1-ß = .764. Follow-up pair-wise comparisons indicated that tasks without the toy (M = 49in, SE = 1in) and tasks with the toy (M = 42in, SE = 1in), significantly differed, $t(71) = 8.517$, $p < .001$, $d = 2.022$. A significant interactions was observed for Task x Culture, $F(6,186) = 14.267$, $p < .001$, $\eta^2 = .315$, 1-ß = 1.000, for Task x Group Size, $F(3,186) = 20.802$, $p < .001$, $\eta^2 = .251$, 1-ß = 1.000, for Task x Group Size x Culture, $F(6,186) = 12.970$, $p < .001$, $\eta^2 = .295$, 1-ß = 1.000, for Task x Acquaintance, $F(3,186) = 5.618$, $p = .001$, $\eta^2 = .083$, 1-ß = .941, for Excerpt x Culture, $F(2,62) = 31.561$, $p < .001$, $\eta^2 = .504$, 1-ß = 1.000, for Excerpt x Group Size x Culture, $F(2,62) = 11.317$, $p < .001$, $\eta^2 = .267$, 1-ß = .990, and a marginally significant interaction for Task x Excerpt x Group Size, $F(3,62) = 2.545$, $p = .057$, $\eta^2 = .039$, 1-ß = .621.

Table 5.9 Statistics of proxemic distances in inches for each culture.

Culture	Group size	Mean	Std. Error
American	Dyad	65.340[a]	1.772
	Quad	48.037[a]	1.259
Arab	Dyad	47.191[a]	1.697
	Quad	40.984[a]	1.249
Mexican	Dyad	42.991[a]	1.749
	Quad	37.451[a]	1.213

a. Covariates appearing in the model are evaluated at the following values: familiarity = 4.96, gender = 1.33, age = 28.92, acculturation = .86.

To address the proxemics hypotheses, I now compute independent t-test on each culture's group size conditions. All three cultures showed significant differences between dyads and quads: Americans, $t(22) = 6.868$, $p < .001$, $d = 2.929$, Arabs, $t(22) = 9.202$, $p < .001$, $d = 3.924$, and Mexicans, $t(22) = 2.386$, $p < .05$, $d = 1.017$.

Based on these results, I now turn to the results for the hypotheses for gaze.

Hypothesis 4A Americans increased proxemics going from quads (M = 48in, SE = 1in) to dyads (M = 65in, SE = 2in), rather than the other way around as I had predicted. This seems to suggest that Americans prefer to get closer when more conversants are present.

Hypothesis 4B Arabs also increased proxemics going from quads (M = 41in, SE = 1in) to dyads (M = 47in, SE = 2in), just as I had predicted. This seems to suggest that Arabs prefer to get closer when more conversants are present.

Hypothesis 4C Mexicans also increased proxemics going from quads (M = 37in, SE = 1in) to dyads (M = 43in, SE = 2in), just as I had predicted. This seems to suggest that, like Arabs, Mexicans prefer to get closer when more conversants are present.

The hypotheses for proxemics are summarized in Table 5.10.

Table 5.10 Summary of result for hypotheses for proxemics

Joint Interaction Behavior	Changes observed as group size increases (dyadic to multiparty)		
	American (non-contact)	Mexican (contact)	Arab (contact)
Proxemics	Hypothesis: Increase Result: **Signif. Decrease**	Hypothesis: Decrease Result: **Confirmed**	Hypothesis: Decrease Result: **Confirmed**

5.5 SUMMARY

The previous sections presented the results from statistical analysis for both conditions for each behavior. This section restates those findings comprehensively, presenting the hypotheses as confirmed or not based on p-values less than 0.05. If a t-test achieved significance, but disconfirmed the

hypothesis (decreasing rather than increasing), then that finding is listed. Table 5.11 summarizes the results for the hypotheses presented in Table 3.1.

Table 5.11 Summary of hypotheses results (1 confirmed, 4 disconfirmed)

Joint Interaction Behavior(s)		American (non-contact)	Mexican (contact)	Arab (contact)
		Changes observed as group size increases (dyadic to multiparty)		
Mean overlap/pause at turn-transitions		Not confirmed	Not confirmed	Not confirmed
Gaze	Speaker	Confirmed: Significantly more	Not confirmed	Not confirmed
	Non-Speaker	Disconfirmed: Significantly more	Disconfirmed: Significantly more	Not confirmed
Turn-taking x Gaze: mutual gaze at turns		Disconfirmed: Significantly more	Confirmed: Significantly more	Disconfirmed: Significantly less
Proxemics		Disconfirmed: Significantly less	Confirmed: Significantly less	Confirmed: Significantly less

Several hypotheses were confirmed or disconfirmed, suggesting that group size plays a significant role in joint interaction behaviors. To get an idea of how the effect of group size compares to that of culture, Table 5.12 lists the eta-squared values for group size and culture and their interaction. While culture was significant in four of the five dependent variables, group size was significant in all five.

Table 5.12 Eta-squared values for main effects and interactions

	Group Size	Culture	Group Size x Culture
Listener Gaze	.124**	.164**	.089
Speaker Gaze	.098*	.102*	.030
Proxemics	.506***	.643***	.248***
Turn-transition	.086*	.046	.045
Mutual Gaze at Turn-transition	.715***	.067*	.439***

* Significant at $p < 0.5$, ** $p < 0.1$, *** $p < 0.001$

In terms of the overall question, it seems that having more conversants has a slightly bigger impact on joint interaction behaviors than do cultural differences for gaze, turn-taking and proxemics. However, even when making generalizations, culture helps make more accurate predictions. For example, for proxemics, although all quads stood closer, some cultures did not do so as saliently as others. Furthermore, when group differences relative to dyads are not consistent, culture elucidates some of these differences. The next chapter discusses what the statistics mean and what insights they provide given the small sample size.

5.6 INTERACTION OF JOINT INTERACTION BEHAVIORS

To assess the possible interactions between joint interaction behaviors, a correlations test was run on speaker and listener gaze, proxemics, turn-transition overlap and pause, and mutual gaze to coordinate turn-transition. Results show that speaker gaze and listener gaze are significantly correlated ($r = .815$, $p < 0.01$) suggesting that conversants reciprocate gaze behaviors. Proxemics is negatively correlated to speaker ($r = -.268$, $p < 0.05$) and listener gaze ($r = -.309$, $p < 0.01$), an unexpected result contradicting Equilibrium Model (Argyle & Dean, 1965). This result may be due to the increased gaze in quads and the reduced distances attributed to them. Mean turn-transition pause and overlap is also negatively correlated to speaker ($r = -.274$, $p < 0.05$) and listener gaze ($r = -.314$, $p < .01$). This is consistent with previous research that found gaze reduced turn-transition pause (Stivers, et al., 2009; Rossano, Brown, & Levinson, 2009). Finally, proxemics is negatively correlated with mutual gaze to

coordinate turn-transtion (r = -.370, p < 0.01) suggesting that mutual gaze plays a bigger role at closer distances. Table 5.13 lists the correlations of the joint interaction behaviors.

Comparing the significant correlations within each culture, speaker and listener gaze behaviors showed significant different correlations. Arab speaker to listener gaze (r = .663, p < 0.001) was significantly different from American (r = .847, p < 0.001) as indicated by z-scores (z = 3, p < 0.01), and from Mexican (r = .817, p < 0.001, z = 2.345, p < 0.05). This suggests that Arab gaze behaviors are not only difference from American, but from Mexican as well. Perhaps high-contact cultures do not necessarily include high percentage of gaze behaviors as well, and should be treated separately from proxemics.

Table 5.13 Correlation of joint interaction behaviors

		Speaker gaze	Listener gaze	Proxemics	Mutual Gaze to Turn-transition
Listener gaze	Pearson Correlation	.815**			
	Sig. (2-tailed)	.000			
	N	72			
Proxemics	Pearson Correlation	-.268*	-.309**		
	Sig. (2-tailed)	.023	.008		
	N	72	72		
Mutual Gaze to coordinate turn-transition	Pearson Correlation	.211	.175	-.370**	
	Sig. (2-tailed)	.075	.141	.001	
	N	72	72	72	
Turn-transition pause and overlap	Pearson Correlation	-.274*	-.314**	.196	-.115
	Sig. (2-tailed)	.020	.007	.099	.336
	N	72	72	72	72

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

Chapter 6: Conclusions

Although culture was a significant main effect in many joint interaction behaviors, cultural dimensions such as contact and involvement did not accurately predict them. Despite the small sample size, some joint interaction behaviors within cultures yielded significant differences when going from dyadic to quad conversation. Some of these differences were expected, such as more conversants resulting in shorter pause and longer overlap or more gazing by speakers. Others were more surprising, such as American dyads standing farther apart than quads. This chapter summarizes what these significant differences mean in terms of how conversants behave in the two conditions, specifically how conversants use joint interaction behaviors differently in quad conversations and how this relationship persists across culture.

6.1 Discussion

Unfortunately, not all of the statistical tests were conclusive, which may be attributable to the small sample size. Under such conditions, it is hard to generalize about group behavior as group size changes. However, it is possible to get some insight about these behaviors.

For turn, none of the hypotheses was confirmed. Although group size was a significant main effect, group sizes within cultures did not show any significant differences. Americans were thought to use high-considerateness style, keeping overlap to a minimum and allowing sufficient pause. On the contrary, differences between quads and dyads showed marginally significant differences, suggesting American quad conversants had a high-involvement style. Instead, Arabs mean measures for pause/overlap increased marginally in quads, suggesting they use high-considerateness style with more conversants. Mexican mean pause/overlap behaved as Americans, decreasing with more conversants, although the difference was not as large.

The hypotheses for gaze were also based on the literature. Specifically for Americans, the hypotheses were based on results from empirical data. Not surprisingly, the American speaker-gaze hypothesis was confirmed. However, the American listener-gaze hypothesis was not. Previous findings suggested listener gaze might not increase or be as high as group size increased (See Table 2.2 though

2.4). However, the listener gaze percentage significantly increased as the group size increased. The Arab group seemed to follow the same trend with both roles' gaze increasing. I hypothesized that the speaker gaze would already be high in dyad speakers and thus gaze would not increase significantly in quads. I also hypothesized that non-speakers would not increase gaze either because it was already high. Although the results only approached significance, it seems that Arabs' gaze percentage increase for speakers and non-speakers just as it did for Americans. It seems that the overwhelming factor to consider for quad gaze is the number of conversants, as an increase in the number of conversants provides more persons to look at, thus increasing gaze. Mexicans did not seem to follow this trend, however. Mexican gaze seemed to remain steady across group size. However, a larger sample size is needed before any definitive conclusions can be made about gaze behaviors. If the number of conversants is the overwhelming factor, then Mexican gaze percentage should also increase with the group size. For now, it remains inconclusive.

Looking at mutual gaze to coordinate turn exchange, no change was predicted for Americans and increases were predicted for Arabs and Mexicans. However, American mutual gaze tended to coordinate a larger percentage of the turn-transitions as the group size increased significantly. This was also true for Arabs, as the hypothesis was confirmed. In Mexicans, on the contrary, mutual gaze significantly coordinated a smaller percentage of turn-transitions. The results for Mexicans may be explained in terms of their previous gaze results. Their gaze did not increase in quads. This might suggest that Mexicans, rather than relying on mutual gaze to coordinate turn, simply used the timing of pause/overlap. Perhaps turn-taking was not competitive, and their high tolerance for overlap permitted such an arrangement. There are many more turn-transitions in a quad conversation, and mutual gaze appears to be an important factor in Americans and Arabs, but not in Mexicans.

Finally, to summarize the finding for proxemics, I hypothesized that Americans would increase distance, and that Arabs and Mexicans would decrease it. Proxemics differences did occur for Americans, but not in the direction predicted by Hypothesis 4A. In fact, dyads maintained more distance than quads. It seems that the interpersonal distance for a quad group is already high to begin with that it does not increase. Instead, in the dyadic case, the conversants seem to prefer a distance

comparable to the distances of conversants diagonally across from each other in quad conversation. Americans use more space, and this seems to coincide with their use of longer pause. These behaviors are more pronounced in dyadic interactions than they are in quad. For Arabs and Mexicans, the results were confirmed, although they differences were not as pronounced as American differences. Quads stood slightly closer than in dyads, but this may be the product of the minimum spanning forest measurement.

6.2 SUMMARY

This dissertation was motivated in large part by the need for more realistic models of joint interaction behaviors for digital simulations conversations in, for example, immersive cross-cultural training environments (see, e.g., Jan, Herrera, Martinovski, Novick & Traum, 2007). A key problem faced by the builders of such systems was how to set the parameters for joint interaction behaviors so that these behaviors would provide realistic training for people who would be expected to interact with people in cultures other than their own. While this dissertation's results can not completely determine these parameters, the results do move forward with respect to the way in which the parameters should be set.

The principal result is that joint conversation control behaviors in digital simulations of conversation should reflect the number of conversants. The results suggest that as conversations go from dyads to quads,

- Turn-taking: For Americans and Mexicans, the amount of pause/overlap should decrease; for Arabs, the amount of pause/overlap should increase.
- Amount of gaze: For Americans, the amount of time that speakers and listeners gaze at each other should increase; for Arabs, the amount of time that listeners gaze at the speaker should increase.
- Mutual gaze at turn transitions: For Americans and Arabs, the amount of mutual gaze at turn transitions should increase; for Mexicans, the amount of mutual gaze at turn transitions should decrease.

- Proxemics: For all groups, the mean distance among conversants should decrease. A reasonable guide would be that the diagonal distances among conversants in quads should be similar to the direct distance between conversants in dyads.

A second result is that it is probable that joint conversation behaviors do reflect differences between high-contact and low-contact cultures.

- Amount of time gazing at other participants in dyads should be lower for Americans than for Arabs and Mexicans.
- Interpersonal distances in dyads (significant) and quads (suggestive) should be greater for Americans than for Arabs and Mexicans.

6.3 FUTURE WORK

This dissertation has merely scratched the surface of the complexity of joint interaction behaviors.

The main issue that must be addressed in this study is the small sample size. Although it is a huge undertaking to annotate video excerpts, unfortunately several of the hypotheses produced inconclusive results.

Another issue is how best to select the excerpts to analyze. To the extent possible, 30-second excerpts were selected at the same time into task for all groups, but perhaps it would have been better to select excerpts based on conversational situation, such as many turn exchanges, or specific interactions such as adjacency-pairs, grounding and repair, or using speech acts as a factor. Joint interaction behaviors differed significantly across tasks, and sometimes differed across excerpts. This is not surprising, as some tasks encouraged more turn-taking, and some required closer proxemics, such as the toy-naming task. Similarly, in some tasks, mutual gaze coordinated turns more than in others. To better understand the process that may govern these joint interaction behaviors, it would be useful to consider the context. This provide more insight into these mechanisms and mitigate the efforts to annotate the videos. Likewise, perhaps it would have been better to have several 10-second excerpts rather than a 30-second excerpt; perhaps anything worth observing could be seen in a shorter time span.

It appears that in some tasks mutual gaze played a role in a larger percentage of the turn exchanges. How did conversants negotiate the next turn in other tasks? Did they mainly rely on detecting transition-relevant places? What behaviors can be used to model ECA behaviors to improve turn-taking in group situations?

One finding to address in computational models is the correlation measures. While speaker and listener gaze are correlated, these correlations are significantly different across cultures. Arabs seem to fall into one category, with high amounts of gaze, while Americans and Mexicans seem to fall into another. Closer amounts of proxemics do not seem to decrease gaze levels, and increase mutual gaze at turn-transitions as well as reduce turn-transition times. While 0.5 seconds is a good pause/overlap measure for American dyads, quads in all cultures dropped pause/overlap to half that amount. Models that run on half-second intervals may not be adequate for multiparty interaction. The model in Jan and Traum (2007) uses center of structure to calculate proxemics, while this dissertation analyzed proxemics of the quad using a minimum spanning forest measure. Measures using center of structure may be a more fair measure and should be considered. Nevertheless, significance results were achieved across culture and group size, suggesting that looking at the proxemics differences of quads across culture in more detail could be fruitful. Finally, mutual gaze to coordinate turn-transition was different for each culture. For Americans and Arabs, this significantly increased, as did the gaze for speaker and listener, but for Mexicans, it did not. This could be used to modify the turn-taking model in Jan and Traum (2005), where gaze plays a bigger role in American multiparty conversation than in dyadic, a big role in Arabs, though not much more than in dyads, and a smaller role in Mexican multiparty conversation. These improved correlations hold the promise of improving the model of joint interaction behaviors across cultures and, correspondingly, improving both our understanding of the way people coordinate their conversations and our ability to reflect this understanding in digital environments.

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Appendix A

The following is a description of the gender, age, and familiarity of the subjects within each group beginning with the multiparty groups.

In Arab group 1, there were two brothers, one friend (for three years), and one stranger between the ages of 21 and 23. Arab group 2 comprised two brothers and two cousins between the ages of 18 and 23. Subjects from Arab group 3 belonged to the same English-as-a-second-language program (two friends for 15 years both 34 years of age, the rest for few months both 44), and Arab group 4 had two sisters (17 & 19) and two strangers (32 & 34). In American group 1, there were two sisters (27 & 30) and two strangers (34 & 41). Group 2 comprised a female (25) and her male friend (26) of seven years. She was acquainted with a second male (67) for two years, who in turn was acquainted with the third male (33) for two years. Group 3 comprised three soldiers (26, 27, & 34) taking the same leadership course and a stranger (56). Group 4 consisted of two males and two females. One male (37) knew one of the females (40) for 20 years and the other male (39) for 16 years. The females (23) knew each other for five years. In Mexican group 1, all four males, between the ages of 28 and 53, were acquainted (three months). In Mexican group 2, a married couple (32 & 35), brought a friend (33) of ten years and his mother (63). Mexican group 3 had all females between the ages of 18 and 23 (two were friends for two years) and group 4 had three females and one male, all 19 years old (two of the females friends for 18 years, the rest a few months).

The first and second Arab pair were composed of males, between 19 and 25, who had known each other about 2 years. Arab pair 3 was a mixed-sex pair with a female (36) and a male (26) who had known each other about a year. The final Arab pair were brothers ages 20 and 23. The first and second American pairs were mixed-sex pairs between the ages of 21 and 24. The first pair had just met while the second were acquainted for a semester. The third and fourth American pairs comprised males only between the ages of 20 and 35. The third pair had just met, while the fourth were acquainted for four years. The first Mexican pair was a married couple in their early 30s. The second Mexican pair were females (26 & 37) who had just met. The third Mexican pair was male (21 & 24) who had also just met.

Vita

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