Movement Correlation as a Nonverbal Cue in the Judgment of Affiliation during Social Interaction

Nida Latif (n.latif@queensu.ca)[1] **Adriano V. Barbosa (adriano.vilela@gmail.com)[3]**
Eric Vatikiotis-Bateson (evb@mail.ubc.ca)[3]
Monica S. Castelhano (monica.castelhano@queensu.ca)[1]
Kevin G. Munhall (kevin.munhall@queensu.ca)[1,2]

[1]Department of Psychology, Queen's University
Kingston, ON K7L 3N6 Canada
[2]Department of Otolaryngology, Queen's University
Kingston, ON K7L 3N6 Canada
[3]Department of Linguistics, University of British Columbia
Vancouver, BC V6T 1Z4 Canada

Abstract

It has been demonstrated that brief exposure to behavioral information is sufficient for making accurate social judgments. Movement coordination during social interaction, is one potential cue. Although coordination between individuals has been identified, our ability to perceive it when making judgments regarding affiliation (friends vs. strangers) is unknown. In the present studies, we investigated how correlated movement contributes to observers' accuracy when judging affiliation. Using correlation map analysis to quantify coordination, we showed that individuals familiar with each other correlated their movements more frequently. Observers were able to use coordination as a cue, but only when the information presented was restricted to movement related to speech (i.e. while only viewing faces). These results suggest that observed movement coordination is influenced by speech-related movements. We suggest that social perception is multi-faceted and cues may be prioritized differentially based on availability.

Keywords: social perception; social interaction & conversation; movement correlation

Introduction

Humans are constantly immersed in social interaction and conversation. It is not surprising that we have mechanisms to facilitate these interactions, both while engaging in and observing them. One mechanism is our ability to create a rich representation of social cues from very brief exposures as short as a few seconds. These short exposures or "thin slices" of behavioral and linguistic information are sufficient for making remarkably accurate judgments regarding social situations. Research has demonstrated great accuracy in judgments in a variety of domains including personality, social status and mental states (Ambady & Rosenthal, 1993). However, little known about *how* specific cues contribute to our accuracy in social perception.

Understanding how we use available social cues is important to human behavior because monitoring others' intentions and actions is a prerequisite for modulating and guiding our own behavior, interactions, and relationship formation (Foulsham et al., 2010). In addition, using social cues is often impaired in many social and psychological disorders such as autism spectrum disorder and schizophrenia leading to difficulty in successful interaction (Klin et al., 2002).

Previous research has looked at specific motion patterns that occur during interpersonal communication. Studies have demonstrated that individuals unintentionally synchronize and coordinate their movements and converge in linguistic properties during conversation (Richardson, Dale & Shockley, 2008; Richardson & Dale, 2005; Chartrand & van Baaren, 2009; Pardo, 2006). This has been shown with different attributes of conversation such as facial expression, postures and accents (Capella & Planalp, 1981; McHugo, Lanzetta, Sullivan, Masters & Englis, 1985). Individuals even unintentionally coordinate their movements without visual information from their partner (Shockley et al., 2003). Coordination without visual information suggests that convergence in behavior can be directly influenced by vocal information exchanged during conversation. Further, studies examining social-cognitive variables in convergence have shown through subjective observation that individuals with good rapport coordinate their movements (Grahe & Bernieri, 1999). Also, friends converge more in linguistic properties than strangers (Dunne & Ng, 2002). Coordination may occur because of inherent biological and behavioral rhythms as well as a coupling of conversation-engaged individuals' mental representation of their perceptions of each other (Richardson & Dale, 2005; Meltzoff & Prinz, 2002).

Although the presence of convergence in nonverbal and linguistic properties has been examined, our ability to perceive this convergence has not been investigated. In particular, the contribution of correlated movements has not been examined objectively in the perception of affiliation (i.e. whether individuals engaged in conversation are friends or strangers). The current studies use movement and coordination quantification methods to examine convergence between interacting individuals. These methods allowed us to investigate whether the amount of coordination differs as a function of affiliation and whether it contributes to the accuracy of affiliation judgments made by an external observer.

Experiment 1: Movement Analysis

This experiment investigated if there was an observable variation in coordination between individuals as a result of known affiliation differences.

Methods

Participants Sixty-two undergraduates (Mean Age = 21.2, 36 females) from Queen's University were recruited in pairs to engage in video-recorded conversation. Thirty-one dyads were either recruited as friend pairs or were experimentally paired. Conversations from 15 same gender friend pairs (10 female), 12 same gender stranger pairs (6 female) and two mixed friend and stranger pairs were video recorded.

Stimulus Collection Stimuli were collected by video recording, unstructured conversation between two participants, using a single camera aimed to capture both individuals[1]. Individuals sat on fixed chairs and were left to converse without an experimenter present for approximately 10 minutes.

Stimulus Analysis An algorithm computing spatiotemporal coordination was used on the video clips. In these experiments, only the visual information was examined using this algorithm. The algorithm developed by Barbosa et al. (2012) first computes optical flow using a standard image processing technique where velocities of brightness patterns in an image are calculated within a region of pixels and summed to give a global value for a particular cluster of pixels (Horn & Shunck, 1981). Then, a correlation analysis is used to compute instantaneous correlation between movement signals within a specified region of interest.

Using the optical flow analysis, the Barbosa et al. (2012) algorithm computes total motion in an identified region of interest by summing the optical flow in that region. Regions of interest were drawn around each individual engaged in conversation, for a gross estimate of their total body motion. Correlation Map Analysis (CMA) was then used to quantify the coordination between the two speakers' movements. A key characteristic of CMA is that it computes the correlation between a pair of signals as a function of both time and the lag between the signals. This not only allows us to characterize the correlation throughout the duration of the signals, but also to capture correlations between events that are not perfectly aligned in time. Therefore, CMA is able to capture coordination between signals, where events in the signals are related to each other but do not necessarily happen at exactly the same time; rather, they fluctuate around some specific lag between the signals as the signals evolve through time. Capturing coordination at a time lag allows for alternating behavior, such as that seen in social interaction, to be captured. This kind of mechanism is ideal for biological rhythms that are rarely synchronous and allows for convergence in social interaction to be quantified (Winfree, 1980, Barbosa et al, 2012).

Correlation Data Analysis Average distributions of correlation were created for each of the friends and strangers groups. For statistical comparison, a resampling non-parametric technique was used to create null distributions. The correlations for friends and strangers were compared to a null distribution. The distributions were simplified to look only at the positive lags (0 - +0.5s). Because of the rhythmical structure of conversation, the positive and negative lags tend to be redundant and we included only the positive lags in all analyses. This resulted in distributions looking at 16 lags in total, including 0 lag (i.e. completely synchronous correlation; Frame rate = 30fps; 0.5s = 15 frames plus one 0 lag frame).

Motion Magnitude Analysis To control for the magnitude of motion when looking at the correlation, distributions of all motion magnitudes from the friends and strangers pairs were generated. The two distributions were compared to determine differences in total motion.

Results

Correlation Analysis The probability distributions of each of the friend and stranger correlations at each lag were compared with a null distribution representing the correlations computed between the motions of all subjects who were not actually in a conversation together. The means for the correlations at lags closest to synchronous were significantly different ($p<0.05$) from the null distribution for both friends and strangers. These results are displayed in Figure 1 where the first half of both the friend and stranger distributions (first 8 lags/frames) displays higher mean correlations than observed for the random pairings. Correlations significantly different at time-points closest to synchronous indicates that individuals engaged in conversation are highly sensitive to their partner's movements and coordination occurs within moments of the movement first being initiated. Thus, the data indicate that engaging in a face-to-face conversation produces correlations greatly exceeding what would be produced by chance pairings of motion signals.

To determine how correlation differed based on affiliation, the friends and strangers distributions were subtracted from each other to create a difference distribution. This was compared with two null difference distributions: One looked at correlation differences between randomly paired individual's movements and randomly assigned affiliation categories and the second distribution looked at correlation differences between real pairs that actually conversed but who were arbitrarily categorized as a particular affiliation for this analysis. Both the overall difference as well as the mean difference per lag was significantly different when compared to both null distributions where friends had more correlated events than

[1] Although audio was recorded, it was not analyzed in these experiments. Only visual information was examined.

strangers. ($p<0.05$) (See Figure 3). Although comparisons to both these null distributions is interesting in that they suggest that friends' and strangers' conversation contain content unique to their affiliation categorization, the comparison to the null containing real pairs is more informative. The real-pair null contains motion that can be attributed to conversational motion in general as opposed to random motion. These results support our hypothesis that affiliation results in correlational variation, and that friends correlate more frequently than strangers.

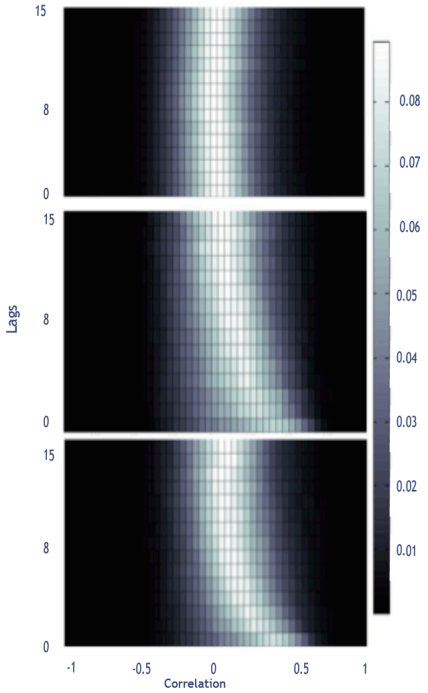

Figure 2. (Top to Bottom) Distributions of average correlation for the null, friend and strangers. Lighter colors indicate larger proportion of events occurring at correlation values plotted along the x-axis. Lag counts (in frames) indicate 16 temporal points between 0 and 0.5s where average correlation was computed. Here, both friends and strangers had correlation value greater than the null but only significant in the first few frames.

Motion Magnitude Analysis A distribution of magnitudes of motion for the friends and strangers was created to determine any differences in motion present within the groups. Results indicated that friend pairs contained more motion (Mean=0.88 pixels/frame, SE=5.79e-04) than stranger pairs (Mean=0.84 pixels/frame, SE=5.38e-04). This analysis was carried in preparation for Experiment 2. We wanted to be able to control the amount of motion presented to observers making perceptual judgments so that judgments about accuracy were not being affected by motion differences.

Results from Experiment 1 demonstrated in a quantified manner that correlation was an inherent part of conversational movement and that friends coordinated more

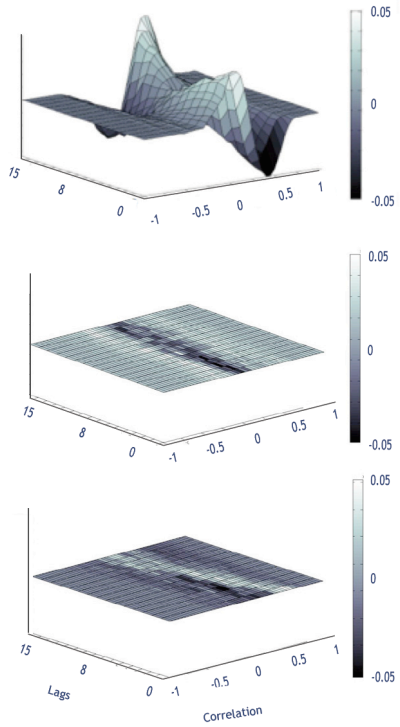

Figure 3. (Top to Bottom) Three-dimensional average correlation difference distributions for friends-strangers, random-pair subtractions and real-pair random subtractions. Lighter colors indicate higher correlation differences along the x-axis with height indicating frequency of events. Lag counts (in frames) indicate 16 temporal points between 0 and 0.5s where average correlation was computed. Greater positive peaks indicate more correlated events for friends in comparison to strangers.

than strangers. This supported our hypothesis and previous studies that indicated that familiarity and good rapport resulted in linguistic and behavioral coordination. The correlation data from this study were used to identify stimuli for a perceptual judgment task in Experiment 2.

Experiment 2: Perceptual Judgment

The previous experiment demonstrated that affiliation led to differences in movement correlation. This experiment investigated whether observers were attuned to the correlational differences and if perception of correlation was influencing accuracy of affiliation judgments. In this study, we varied amount of correlation while controlling for the amount of motion in the perception of thin-slices of conversation

Methods

Stimuli The analysis of motion magnitudes from Experiment 1 was used to control the amount of motion so that differences in perception of clips could be attributed to correlation differences rather than confounded by motion

differences. Clips were selected from a window that was centered at half a standard deviation around the mean of the sum of the motion distributions for friends and strangers. Clips and their corresponding correlation values were extracted if they were contained within a 5s continuous[2] clip that contained average motion from within our defined thresholds. Correlations were re-computed using the same procedure as Experiment 1 for only those clips that were controlled for motion magnitude to ensure that the friend/stranger correlation results were true for our perception stimuli.

All possible clips were sorted from lowest to highest average correlation. Six of the lowest and six of the highest correlated clips were selected for each of the friends and strangers groups (n=24 clips) such that each conversing pair was only presented once. The final clips contained ten same gender friend pairs, ten same gender stranger pairs and two mixed-gender pairs for each group.

Procedure Twenty undergraduates (Mean age = 20.8, 16 females) from Queen's University participated for monetary compensation. A within-subjects design was used where all participants viewed both high and low correlated friend and stranger clips. The 24 five-second clips were presented and participants were asked to perform a social judgment rating using a Likert scale. On a scale of 1-7, participants indicated whether the two individuals engaged in conversation had just met (1) or were friends (7). Following the experiment, each participant was asked to record the kind of information they used to make their judgments.

Results

Correlation Analysis Average correlations and correlation difference patterns seen in Experiment 1 were also observed in the 24 stimulus clips, confirming that the restricted magnitude of motion was not influencing correlations.

Social Perception Accuracy The accuracy of affiliation perception was determined by computing the average score for all videos presented as a function of their correlation and affiliation. Figure 3 displays the perceptual rating results. A factorial ANOVA was performed and results indicated that although participants could accurately discriminate between friends and strangers ($F(1,20)=4.28$, $p=0.05$), correlation did not seem to affect perceptual judgments. In addition, scores were analyzed using an extreme groups analysis (Preacher, Rucker, MacCallum & Nicewander, 2005) where neutral responses were eliminated and a factorial ANOVA was performed. Results demonstrated the same effect as the simple analysis.

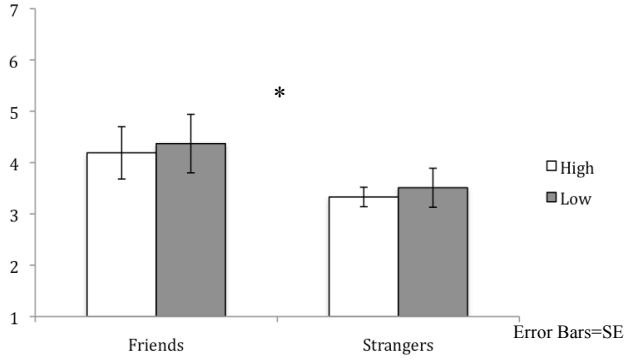

Figure 3. Average score for affiliation rating. A greater score represents a preference towards a judgment of 'friends' and a lower score represents preference towards a 'strangers' rating.

The perceptual judgment results in this experiment demonstrated that observers could clearly make affiliation judgments. However, our results showed no evidence that degree of correlation between pairs influenced perceptual judgments. Subjective responses of reported cues used by participants indicated that subtle movements such as those of the hands and the mouth were given precedence. A high correlation between speech and face/head motion related to speech has been demonstrated in previous studies (Barbosa et al, 2008); perhaps these smaller gestures of speech were not contributing to our correlation measures as much as larger body motions. Experiment 3 was conducted to investigate whether the correlational structure of smaller speech related movements, such as face/head motion, might better account for the perceptual data.

Experiment 3: Selected Perceptual Judgment

In this experiment, we looked at whether an observer's ability to make perceptual judgments of affiliation altered when the social information presented was restricted to more subtle, speech related correlations within the face/head region.

Methods

Stimuli All video recordings from Experiment 1 were cropped at participants' shoulders to include only head and facial movement. Correlation and motion analysis was performed in the same manner as Experiment 1. Motion thresholds and clip selection criteria were created using the same procedure as Experiment 2. Twenty-four clips were selected to include 12 same gender friends and 12 same gender strangers.[3] These included six of the highest and six of the lowest correlated clips in each category.

[2] Continuous was defined as a clip with no sections longer than 0.25s where range of motion magnitude did not fall within motion criteria. This 0.25s buffer was used to accommodate naturally oscillating motion magnitudes.

[3] Mixed pairs were eliminated due to factors related to past relationship studies showing that they are not perceived in the same manner as same-gender dyads.

Procedure Twenty undergraduates from Queen's University (Mean Age=20.1, 16 females) participated in this experiment. The perceptual judgment task used the same procedure as that used in Experiment 2.

Results

Correlation Analysis Overall, average correlations and correlation differences reflected the same pattern as Experiments 1 and 2 confirming that movement correlation was influenced by affiliation, independent of amount of motion.

Social Perception Accuracy Analysis of affiliation perception accuracy was performed as in Experiment 2. Average score for all videos as a function of correlation and affiliation was computed and a factorial ANOVA was performed. Results showed that there was a significant effect of correlation indicating observers provided a higher proportion of 'friends' responses for highly correlated clips ($F(1,20)=7.78$, $p=0.01$). There was no significant effect for affiliation indicating that scores were not dependent on the true affiliation between conversing individuals. Results are presented in Figure 4. Observers were more likely to misperceive high-correlation pairs as friends and low-correlation individuals as strangers. These results demonstrated that movement correlation was a significantly influencing cue when perceiving subtle, speech-related movement.

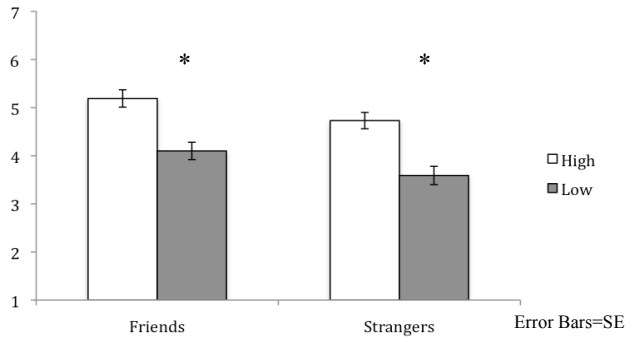

Figure 5. Average score for affiliation rating when viewing only faces. A greater score represents a preference towards a judgment of 'friends' and a lower score represents preference towards a 'strangers' rating.

General Discussion

In these studies, we were interested in examining how affiliation between two individuals resulted in variation in movement and coordination. Additionally, we were interested in determining whether this variation influenced the accuracy of observers making rapid judgments regarding that affiliation. Based on previous studies on convergence in linguistic and behavioral properties, we predicted that familiarity would result in greater coordination which would influence judgments of affiliation by external observers.

The results of these studies demonstrated that there was indeed variation in motion and coordination resulting from affiliation. In general, movement correlation was present during social interaction, regardless of affiliation, although higher correlations were present for friend pairs. This was supported by studies that suggest that we interactively align our representations of conversation content (Garrod & Pickering, 2004). But, is this correlation used as information when making social judgments?

The observation that participants were not sensitive to the correlation differences presented in Experiment 2 suggests that other cues in the full body stimuli such as static postural cues as well as motion cues might have influenced the way participants attributed affiliation. The correlational structure of the larger body movements used to select stimuli clearly was not the major determinant of participant responses. Observers reported that they prioritized more subtle movements related to speech when producing their judgments. Experiment 3 tested this by restricting visible motion to the head and face area to minimize the contribution of other possible cues and showed that coordination was a determinant of affiliation judgments. Observing a clear decrease in accuracy by eliciting use of coordination cues indicates that integration of many cues, including movement correlation, contributes to our remarkable ability to make accurate social judgments.

These studies provided us with two important conclusions regarding movement coordination in social perception: 1) Perception of unintentional coordination observed during social interaction in previous studies is directly influenced by speech-related movement and 2) Multiple factors contribute to social perception however, observers *can* use coordination as their basis of their affiliation judgments.

Previous studies have shown individuals engaged in conversation become mutually entrained in their movements and this coordination persists even when individuals are interacting verbally without visual input from the other individual. Even when facing an individual with whom participants were not conversing, coordinated movements persisted with the direct conversation partner (Shockley et al., 2003). These findings can be explained by the fact that speech-related movement of the head and face is directly correlated with the auditory signal of speech (Barbosa et al., 2008). Our studies have demonstrated that coordination occurred between individuals actively involved in the conversation but also that third-party observers were sensitive to the speech-related correlation between talkers. The complete explanation for participants' performance in Experiment 2 and 3 warrants further research. We know that full body information provides additional information contributing to greater accuracy but the exact nature of this information has yet to be identified.

Human communication provides a rich information set for making judgments and many cues can contribute to perceptual decisions. The perceptual strength of cues will vary with the context and the observer's history with a

judgment and the manner in which multiple social cues are integrated is still unknown. As in the study of the general visual world (Gibson, 1968), we need to identify potential sources of information in the social world.

Future work examining where observers visually fixate when making affiliation judgments is necessary since the distribution of attention will be a window into the perceptual cues observers use. Information about the allocation of attention may explain individual differences in performance as well as accuracy differences in different social contexts.

These studies aimed to investigate social perception in a less arbitrary and more objective manner. We used motoric correlation to address how judgments of affiliation could be affected by nonverbal factors. We demonstrated that affiliation influenced coordination of movement during social interaction. Further, we showed that observers used this correlation information as a cue, at the expense of accuracy, when making judgments but only when the rich social information set present in human communication was restricted. This broad area of research will continue informing us about our sensitivity to information used for the successful social interactions we encounter everyday.

Acknowledgments

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