Evidence for Alignment in a Computer-Mediated Text-Only Environment

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Abstract

During interaction, people coordinate in both verbal (e.g., syntactically and semantically) and nonverbal (e.g., gestural and prosodic) ways. This alignment has been suggested to be a result of grounding or priming. In both cases, visual cues assist understanding. This study explores how widely and how much participants align in a text-only environment. Forty-two participants debated a topic via Instant Messenger with a confederate. Using length analyses, LIWC, and LSA, results show punctuation and semantic alignment above chance between interlocutors, and an increase in this alignment over time. Affective alignment and alignment in parts of speech are weak, and the nature of the debate nor nonverbal cues affected alignment. These results extend previous theories of verbal alignment to text-only environments in which interlocutors lack visual cues during interaction and propose theoretical implications for alignment. However, lack of nonverbal alignment departs from face-to-face findings, and theoretical implications for such results are suggested.

Keywords: alignment; coordination; synchronization; priming; computer-mediated communication

Introduction

During interaction, people synchronize (Marsh, Richardson, & Schmidt, 2009) or align (Pickering & Garrod, 2004) in a variety of ways. When two people communicate, their levels of linguistic representation align by co-activating similar words, sentence structures, and so on. For example, in classic work by Bock (1986), participants were induced to use the same syntactic structure (among two available) when they were primed by its previous use by a confederate (e.g., active/passive sentences; see also Branigan, Pickering, & Cleland, 2000 and Haywood et al., 2005). This alignment occurs at many verbal levels, including the phonological and syntactic (e.g, Cleland & Pickering, 2003; Giles, Coupland, & Coupland, 1991). In addition to this verbal alignment, several researchers have found nonverbal alignment, including postural alignment (e.g., Shockley, Santana, & Fowler, 2003), alignment in the pitch and rate of speech (Giles, Coupland, & Coupland, 1991) and other bodily movements (e.g., Chartrand & Bargh, 1999).

This evidence for alignment has been gleaned from face-to-face human interlocutors. However, the lack of feedback present in text-based communication environments may impact the level of alignment. Clark and Brennan (1990) show that alignment is reached through grounding, or the establishment of mutual knowledge and beliefs, in which interlocutors provide evidence of their understanding (e.g., attentiveness, eye contact) and seek this type of evidence from their conversation partner. The reduction of this feedback in a text-only environment suggests that the process of alignment may be affected. In consideration of this possibility, Brennan (1991) conducted a study in which humans interacted with a computer program and found significant levels of linguistic alignment. Branigan and Pearson (2006) also found syntactic and lexical alignment in an interaction between a computer and a human. The utterances produced by the computer shaped the humans' subsequent utterances. However, it is possible that such alignment could be explained by the expectations the person had regarding the computer's capabilities; the human may have sought alignment as an accommodation to the computer interface in order to establish effective communication. This same alignment may not occur in a text-based environment if these constraints are not expected.

The alignment of humans with computers suggests that visual feedback is not necessary for alignment. To account for this finding, a recent prominent theory of alignment proposes that priming is a central mechanism underlying alignment (see Ferreira & Bock, 2006, and Pickering & Garrod, 2004 for review and debate). When two people communicate, their levels of linguistic representation align by co-activating similar words, sentence structures, and so on. In this manner, the lack of visual feedback in text-only environments does not affect alignment.

In order to test the persistence of verbal alignment between interlocutors, we designed a task in which two people communicate via text-based Instant Messenger. Not only does this allow us to test for verbal alignment in a text-only environment, but also to look at alignment independent of established methods of feedback (e.g., eye contact, gesture, facial expression). The lack of visual contact between interlocutors in a text-based interaction forces people to establish a way to negotiate understanding and feedback during conversation, the process of grounding that may be responsible for important aspects of alignment (Clark & Brennan, 1990). This process of grounding may be linguistic or nonlinguistic.

Several researchers have argued that text-only environments are rich with nonverbal cues of their own.

Social information processing theory (Walther, 1992) suggests that cues available in face-to-face communication channels have comparable expressions in text-only environments. Indeed, Walther and D'Addario (2001) found that 98% of their sample recognized :) as a symbol of happiness and :(as a symbol of sadness (emoticons for anger, disgust, and fear ranged from 85% to 88% consensus).

Harris and Paradice (2007) argue that these nonverbal cues in CMC are primarily paralinguistic. Carey (1980) identified five categories of paralinguistic cues in CMC: vocal spelling, lexical surrogates, spatial arrays, manipulation of grammatical markers, and minus features. Vocal spelling and lexical surrogates use nonstandard spelling that imitate vocal intonation or tone. Spatial arrays are generally sequences of keyboard characters that represent nonverbal behaviors, such as emoticons. Manipulating markers may indicate pauses (…), express attitude (!!!), or signal tone of voice (SHOUT). Minus features refer to an absence of certain language standards that are present in normal writing.

In the current experiment, we examine how people communicate and align both verbally and nonverbally in a text-only environment.

Method

Participants

Forty-two participants (11 males; mean age = 22.5 years, *SD* = 7.5) completed the 30-minute session.

Procedure

This study was a joint project with two other researchers to study turn-taking, argumentation, and alignment. To create the necessary conditions to study all three elements, three variables (topic, agreement, and nonverbal cues) were counterbalanced to create eight between-subjects conditions. A confederate was used to ensure counterbalancing of agreement and nonverbal cues. Upon arrival, naive participants met the confederate and then were assigned to adjoining rooms with computers. The participant completed a short questionnaire gathering demographic information. Then participants read a short article about a topic (supporting making Gardasil either a mandatory or voluntary vaccination), and answered two questions to ensure they read and understood the article. Participants were then given instructions on how to use the chat program and screen-recording software was activated. All instructions given to participants were also given to confederates to ensure participants remained naive to the confederate's role.

The confederate was trained to manipulate two of the variables: agreement and nonverbal cues. Depending on the condition, the confederate either disagreed with the participant's arguments or was undecided/neutral. The confederate also either used nonverbal cues (capitalized words, emoticons, and repeating punctuation such as !!! and ???) or did not use any nonverbal cues during the chat. Several practice debates were conducted to ensure proper execution of these manipulations, and, once the confederate and participant entered their assigned rooms, reminders for the condition were placed prominently on the confederate's computer. The confederate remained unaware of any possible analyses to be conducted on the data; she was only told that analyses were to be conducted on the use of nonverbal cues and the impact agreement may have on the use of these cues.

Participants were instructed to debate the article they were given, and to try to persuade the confederate to the point of view of the article. Each chat lasted approximately 27 minutes, with a 2-minute warning given before the debate was to end. Upon finishing the debate, participants were given a short questionnaire asking whether they agreed with the point of view of the topic they were assigned and whether they had pre-existing knowledge about the topic.

Analyses

A transcript was generated for each debate. This transcript was split into two files: one with the confederate's text and one with the participant's text. In this manner, analyses of the text could be carried out to compare the confederate and participant on a variety of dimensions, and test the impact of agreement on alignment.

Several dimensions of alignment were examined. Previous research has found several levels of alignment, ranging from posture to pronunciation; however, the theories of grounding and priming remain largely referential to visual and linguistic phenomena, respectively. The current analyses sought to examine both these areas of alignment, assessing nonverbal, punctuation, semantic, and affective alignment, as well as alignment in the use of parts of speech, in a text-only environment. Two computational analyses were performed to assess such alignment.

LIWC. First, we employed the Linguistic Inquiry and Word Count program (LIWC; Pennebaker et al., 2007), which is a text analysis program that categorizes words from a text file based on an internal dictionary. LIWC then returns a percentage that reflects the number of words in a category divided by the total number of words in the text, thereby calculating the degree to which different categories of words are used in a given text. The program contains a total of 80 categories into which words may fit. These categories include descriptive dimensions (e.g., total number of words in text, average number of words per sentence), linguistic dimensions (e.g., percentage of words in text that are pronouns or verbs), dimensions of psychological constructs (e.g., affect words, cognition words), dimensions of personal concerns (e.g., leisure, work), paralinguistic dimensions (e.g., fillers, assent), and punctuation. The internal dictionary has over 4,500 words and word stems.

LIWC has been shown to have validity as a measure of emotional expression appearing in text (Kahn, Tobin, Massey, & Anderson, 2007) and as a measure of detecting attentional focus, thinking style, emotionality, social relationships, and individual differences (Tausczik & Pennebaker, 2010). LIWC has been used extensively in several disciplines to examine text in online formats (e.g., Dino, Reysen, & Branscombe, 2009; Gill, French, Gergle, & Oberlander, 2008).

LSA. Latent Semantic Analysis (LSA) is a computational analysis that allows comparisons of the semantic context of texts on many dimensions. Using this method, words and texts that share similar contexts have similar semantic dimensions, and thus have a high semantic similarity. While LSA can locate texts on innumerable dimensions, prior research (Landauer & Dumais, 1997) has shown that more than 300 dimensions does not alter a text's similarity scores.

The semantic space that makes up these dimensions in our analysis consists of the TASA corpus of high school textbooks as well as several Wikipedia Web pages that allow us to include more topic-centric dimensions. To identify these Wikipedia pages, Wikipedia Miner (Milne and Witten, 2009) was used. The Wikipedia Miner "wikify" program uses word frequency information combined with information about word-related concepts to identify which words within a text would be linked to Wikipedia pages. By entering text from all transcripts, 80 topics were identified by Wikipedia Miner as central to our topic: among these were terms such as "sexually transmitted disease," "vaccination," "promiscuity," "birth control," and "clinical trial." The text from the Wikipedia pages of these Wikipedia-Miner-identified terms was added to the semantic space that includes the TASA corpus.

Results

Manipulation Check

The confederate was responsible for manipulating two variables: agreement and nonverbal cues. Each transcript was checked to ensure the correct condition was carried out. The confederate was always accurate as to the agreement conditions. In the nonverbal cues conditions, the confederate was accurate for 39 of the 42 conversations; In the three remaining conversations, all of which were assigned to the no cues condition, the confederate used no more than two cues throughout the conversation.

Length Alignment

Each conversation consisted of, on average, 32 turns with 29 words per turn, for an average of 939 words per transcript and approximately 0.85 turns per minute. A significant correlation exists between the average number of words in a participant's turn and the average number of words in a confederate's turn (r = .48, p < .01). This result is significant because the confederate was unaware that such analyses would be conducted.

A significant correlation exists between the total number of words written by the participant in a transcript and the total number of words written by the confederate in a transcript (r = .59, p < .01). This finding occurs at the turn-by-turn level as well, such that the interlocutors tended to write the same number of words in each turn they took (r = .39, p < .001).

A significant correlation also exists between the number of words in the participants' shortest turns and the number of words in the confederates' shortest turn (r = .72, p < .01); the same was true of their longest turns (r = .31, p < .05).

LIWC Analysis

Several categories were chosen from among those offered by LIWC for the current analysis. First, to detect alignment in parts of speech, categories for word types were chosen (i.e., verbs, prepositions, articles, adverbs, auxiliary verbs, conjunctions, pronouns). Second, to detect affective alignment, affect word categories were chosen (i.e., negative emotion words, anger words, anxiety words, sadness words, positive emotion words). Third, to detect semantic alignment, a category of words for sexual expression was chosen due to the nature of the article being debated. Last, punctuation alignment was measured with the categories of question marks, exclamation points, periods, commas, colons, semicolons, dashes, apostrophes, quotation marks, parentheses, and overall punctuation.

Results show alignment in several categories. Significant correlations between the confederates' turns and the participants' turns were found in the categories of pronouns (r = .57, p < .001) and conjunctions (r = .34, p < .05), suggesting alignment in parts of speech. However, the lack of alignment in any other word category suggests that alignment in these two word types is an effect of the debate-style conversation; for example, "but you," "and I."

A significant correlation was also found for negative emotion words (r = .35, p < .05), suggesting a small but significant alignment of affect. Semantic alignment was also present for sexual expressions (r = .40, p < .01) and punctuation alignment was found in overall punctuation (r = .37, p < .01), though not in any particular form of punctuation. This lack of alignment in any particular form of punctuation suggests that the confederate's use of punctuation as a nonverbal cue did not result in additional punctuation use from the participant; however, overall punctuation alignment still stands.

LSA Analysis

Transcripts for each participant's and partnered confederate's text were entered into LSA to conduct four different analyses: first, to determine the level of semantic alignment between the two interlocutors within each turn (alignment between each turn given by the confederate/participant and each adjacent turn given by the participant/confederate); second, to determine the level of alignment of the first speaker with herself (alignment between each turn the first speaker takes and each subsequent turn the first speaker takes); third, to determine the level of alignment of the second speaker with himself (alignment between each turn the second speaker takes and each subsequent turn the second speaker takes); and fourth, to determine the level of alignment between the interlocutors with one's turn and the other's nonadjacent future turn (alignment between each turn the confederate/participant takes and each second-subsequent turn the participant/confederate takes).

In order to compare these findings with a baseline for alignment that might happen by chance, turns within each transcript were randomly shuffled and analyzed in comparison to the non-shuffled results above. A comparison of the coefficients of a linear mixed-effects model (participant number = random, analysis type = fixed) shows a significant decrease in alignment between the confederate and the participant when turns are shuffled than when they are not (.30 vs. .32; $p < .01$). This significant effect persists for comparisons of the additional analyses (see Figure 1).

Though alignment of adjacent turns between the confederate and the participant was significantly higher than a baseline, the participant and the confederate tended to align more with him/herself than with each other. The second analysis (alignment of the first-speaker's adjacent turns) yields a marginal increase over the first analysis (partner alignment) in alignment score (.34 vs. .32; $p < .06$). The third analysis shows a significant increase (.35 vs. .32; $p < .05$) in alignment score compared to the first analysis (partner alignment). The fourth analysis indicates non-adjacent turn alignment between the confederate and the participant, and shows a significant decrease in alignment (.27 vs. .32; $p < .001$); this result shows that alignment between the participant's and the confederate's adjacent turns is higher than alignment between the participant's and the confederate's alignment on present and non-adjacent future turns. As one interlocutor changes the topic, the other follows. This flow also creates increasing alignment over time as interlocutors continue communicating; a 1.3% increase in semantic alignment occurs with each new turn contributed to a chat (assessed by an addition turn number as a predictor in the linear mixed-effects model; $p < .001$).

Agreement

To determine if the debate style of the conversation was a factor in the results, transcripts were coded for whether the confederate disagreed with or was undecided/neutral towards the participant's stance on the topic. This factor was added to the linear mixed-effects model and results show an additional .03 (16.7%) added to the semantic alignment score for those who disagreed with each other than those who were neutral, though this result proved nonsignificant.

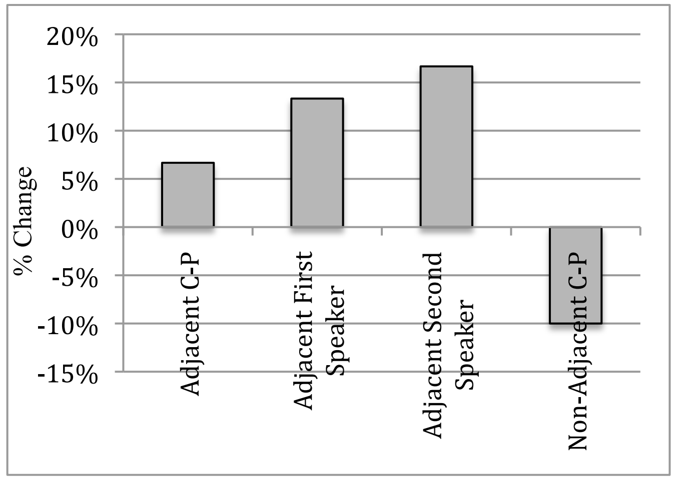

Figure 1: Percentage of alignment increase or decrease compared to baseline scores using LSA.

Nonverbal Alignment

The confederate used nonverbal cues such as repeating punctuation types, emoticons, and capitalized words when interacting with half of the participants. On average, the confederate used 14 cues (*SD* = 9) in each of these conversations. However, whether or not the confederate used nonverbal cues was not related to whether the participant used nonverbal cues ($t(40) = .27$, $p = .79$). To determine if the number of times the confederate used nonverbal cues influenced the number of times the participant used nonverbal cues in a conversation, a correlation was carried out; results show a nonsignificant relationship ($r = .23$, $p = .15$).

Discussion

The current study attempts to detect whether verbal and nonverbal alignment between human interlocutors occurs in a text-only environment. Analyses show that people align in sentence punctuation and semantically at high levels, but evidence for alignment at the affective level or in parts of speech is weak. This alignment occurs more highly within-subjects than between-subjects, and is subject to increases over time spent communicating with the interlocutor. The nature of agreement in the conversation does not appear to factor into alignment. Further, the presence of nonverbal cues by the confederate did not affect the level of alignment.

As reviewed in the introduction, previous research has found alignment, synchrony, and entrainment between interlocutors. Our goal was to look for diffuse alignment ongoing during text-based interaction. We indeed found considerable alignment, as predicted, but there were some limitations. Nonverbal alignment did not occur, though we anticipated that it might.

Two possible hypotheses may explain this disparity when compared to the high rates of face-to-face nonverbal alignment found in research. First, the textual nonverbal cues in the current study may be inadequate representations of nonverbal cues present in face-to-face research. Indeed, several researchers (e.g., Derks, Bos, & Grumbkow, 2008; Thompson & Foulger, 1996; Walther & D'Addario, 2001) suggest that cues such as those used in the current study are more deliberate and planned than spontaneous nonverbal cues in face-to-face conversation such as prosody and facial expression, and as a result are less representative of a present state of emotion than they are of the intention or motivation of a writer. For example, an emoticon used after a negative comment does not indicate one smiling while saying something mean, but that the comment was not intended in a malicious manner. In the same line, Kreuz (1996) asserts that certain typographic devices, such as capitalization, underlining, and bold face, play a role in denoting irony in written communication, rather than in contributing in a manner comparable to face-to-face nonverbal cues.

Second, it is possible that nonverbal alignment is, in fact, verbal in CMC. Several researchers (e.g., Tidwell & Walther, 2002; Walther & Tidwell, 1995) suggest that interlocutors in a text-only environment tend to ask more questions and disclose more information when communicating. The use of common terms and development of shared shorthand may signal intimacy.

The high rate of alignment between interlocutors may suggest that the confederate herself is aligning with the participant rather than jointly aligning with each other, much as was seen in the computer-human tasks reviewed in the introduction. However, this is unlikely to be the case; both the confederate and the participant aligned more with their own text than they did with each other's text, and these rates of self-alignment were comparable. Furthermore, the confederate was unaware of plans to conduct analyses on any variables other than nonverbal cues and agreement, which were strictly controlled between conditions and thus unavailable as methods for her to align with the participant.

As mentioned at the outset, researchers have identified different processes that may underlie this alignment, such as grounding and priming. The current results show widespread alignment, but we cannot assess exactly whether one or the other is responsible. Based on the current results, however, we can guess how both processes might work in these cases.

The process of grounding may, in text-based communication, be verbal in nature. The establishment of mutual knowledge and beliefs would require the explicit encoding of familiarity or liking. This encoding, rather than being visual as in face-to-face conversations (e.g., eye contact, facial expression) may instead be verbal (e.g., "I like that," or "Do you like this?"; as Tidwell & Walther, 2002, and Walther & Tidwell, 1995, found). Further analyses on the amount of disclosure and questions that elicit opinions and knowledge would be informative.

Second, the process of priming appears to be a valid theory of alignment at both high and low levels–in the current study, punctuation and semantic content. However, there are limitations to priming. Interlocutors did not align the low level of use of parts of speech or at the high level of affect. Priming appears to be inadequate as a theory for alignment.

While further research would be necessary to establish the interplay of such factors, the suggestion that both grounding and priming occur in tandem is a possible explanation for our results. Priming is inadequate as an explanation because of the necessity to form a common ground of beliefs and knowledge, which is established primarily through question asking and explicit statements of liking. This question-answer format results in the use of different parts of speech and words of affect, and thus alignment is not found in these areas. However, alignment at the semantic level and in the punctuation of sentences would be found as the process of grounding is established. It may be the case that as people communicate more over time, and grounding is further established, priming plays a larger role.

Further studies should examine the role of question-asking and answering in the process of grounding as well as the process of alignment over time between interlocutors in text-based environments. The possible interplay of these two processes may account for many findings of alignment at several levels of analysis, including online social tags (Fu, Kannampallil, Kang, & He, 2010), online video game chat (e.g., Herring, Kutz, Paolillo, & Zelenkauskaite, 2009) and online Twitter conversation (e.g., Honeycutt & Herring, 2009).

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