

Sometimes More Is Better: Agent Gestures, Procedural Knowledge, and the Foreign Language Learner

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Research has found that gestures help students learning English as a foreign language to increase comprehension and learning in human-to-human communication. However, in multimedia environments with computer-to-human communication with pedagogical agents, little research has examined how gesture type and rate affect foreign language students learning procedural knowledge in English. This study used four gesture conditions (no gesture, conversational gesture, average gesture, and enhanced gestures) to measure the free recall of information. Results found that participants in the enhanced gesture condition significantly outscored the no gesture condition. Implications and suggestions are further discussed in this paper.

Keywords: Pedagogical agent, Gestures, Free recall, Computer-to-human communication

INTRODUCTION

Without realizing it, people communicate and comprehend spoken language through other means than just the articulation of words. Such strategies of communication include non-verbal cues such as mutual gaze, body language, facial expressions, and gestures. How these non-verbal communication strategies function in human-to-human communication has been well studied for over half a century, but how about non-verbal communication in computer-to human communication in multimedia-learning environments with pedagogical agents (PAs)?

One area of non-verbal communication that needs further research with PAs is how gestures assist comprehension in the multimedia-learning environment. Most of the PA gesturing research has only used deictic (pointing) gestures with native speaking populations. Because foreign language students learning English learn language concepts or vocabulary, not much is known about how other gesture types assist foreign language students with comprehending procedural information in English that is not related to the learning of the language itself. This research examines how gesture type and rate affect foreign language students learning the procedural information of how lightning forms.

LITERATURE REVIEW

Gestures types

Gestures are more often seen as the movement of arms and hands as people speak (McNeill, 1992). These movements are not haphazard, but either convey some form of meaning (representational) or emphasize key language (beats). Depending on the type of information being expressed, representational gestures fall into the categories of iconic, metaphoric, or deictic (Hostetter, 2008). Iconic gestures represent physical items such as a mirror, brick, or the Sun. Metaphoric gestures present abstract information such as a person's high intellect with a cupped hand rising above the head. Finally, deictic gestures are commonly known as "pointing gestures" because they direct spatial awareness. Deictic gestures are commonly found in the classroom with the teacher pointing to the board so students can match the spoken information with the written concept. Another gesture that is commonly used, but is not representational in nature is the beat gesture. Beat gestures emphasize certain words and are performed to match the intensity of the speech (Thuene & Brandhorst, 2009). An example of beat gestures and the performance of speech can be when a scolding parent says, "I told you to stop!" with each word being emphasized with back and forth movements of the arm and hand. Depending on the level of parental disapproval that is expressed in tone and speed of speech, the beat gestures will vary according to the same parameters.

Gesture rate

The rate at which gestures are performed can be culturally specific. Therefore, when measuring

gesture rates, it is important to measure gestures with the amount of words spoken and not in time, since the rate of speaking can be different between individuals. Research examining gesture rates of American native English speakers gesturing when retelling what happened in a cartoon, which represents procedural action, measured representational and beat gesture rates per 100 words spoken at 9.4 and 4.2 respectively (Alibali, Heath, & Meyers, 2001).

Gestures and pedagogical agents

Gesturing PAs have been used in multimedia learning environments, and a recent meta-analysis (Davis, 2018) found that gesturing increased near transfer ($d = 0.39$), retention of learning ($d = 0.28$), and agent persona ($d = 0.44$). However, all the studies except one only used deictic gestures, so it is not fully understood how the full complement of gestures helps or hinders outcome measures. One study that used deictic and iconic gestures found redundant gestures with speech increased recall, explanation ratings, and likability ratings (Buisine & Martin, 2007). Likewise, children’s math transfer of knowledge and generalizability significantly increased with deictic and beat gestures compared to no gesture conditions.

On the other hand, there is not much literature on PA gesturing in foreign language learning in multimedia learning environments. Many of the studies found no significant differences with PAs using deictic gestures with college undergrads learning grammar concepts (Choi & Clark, 2006; Carlotto & Jaques, 2016), and with full gesture use with elementary school students learning English comparatives (Davis & Antonenko, 2017). Therefore, a closer examination of representational and beat gestures should be conducted to understand whether gesturing fulfills the same role in computer-to-human communication as gestures do in human-to-human communication.

METHODS

Participants

The participants were 183 undergraduate students from a university in Seoul, South Korea. Of the participants, 108 identified as female, 74 as male, and one preferred not to answer. The average of the participants was 21.96 years ($SD = 2.67$).

Instructional content and instruments

The topic for this research was on the procedural information of how lightning forms from colliding air currents into the visible flash of lightning. The script was 329 words in length and had a Flesch-Kincaid grade level of 7.59.

Before watching the two minute and forty-seven second video, students provided demographic

information and a prior knowledge assessment. After watching the video, students participated in a free recall test with a single questions that asked, “Please write down how lightning works.” The top score possible for the test was 19 points with each point awarded for describing a major idea unit as outlined by Moreno and Mayer (1999, p.362). Two raters independently scored the tests and the results were entered into SPSS 25 to calculate Cohen’s Kappa interrater reliability. The reliability score was found to be substantial at $k = .67$. A third party reconciled any disagreements between the raters.

Gesture conditions and design

There were four conditions in this experiment: average gesture, enhanced gesture, conversational gesture, and no gesture. Gesture type and rate were set using Alibali and colleagues (2001) findings that people produced 9.5 representational gestures and 4.2 beat gestures per 100 words. The average gesture condition contained 9.4 representational gestures and 5.1 beat gestures per 100 words. The enhanced gesture condition contained 19.1 representational gestures and 10.1 beat gestures. Since conversational gestures are designed to carry no semantic meaning, the PA performed 4.8 nonrepresentational gestures per 100 words. And the no gesture condition eliminated all movements of the hands or arms.

All gestures were designed in iClone 7.1 and edited in the timeline. All conditions were exactly the same except gesture type and rate.

RESULTS

Free Recall

The prior knowledge test was not significant, so an ANOVA was performed on the recall data. The ANOVA indicated a significant difference between conditions ($F(3,179) = 3.493, p = 0.017$). A Tukey post hoc test found that the enhanced gesture condition scored significantly higher ($p = 0.017, d = 0.59$) than the no gesture condition, and was approaching significance against the conversational gesture condition ($p = 0.059, d = 0.46$). See Table 1 for free recall means and standard deviations

Table 1. Prior knowledge and recall tests scores

	Prior Knowledge			Recall Test	
	N	M	SD	M	SD
Average Gestures	45	4.78	2.36	2.13	2.16
Double Gestures	46	4.80	2.70	2.87	3.07
Conversational Gestures	46	4.30	2.50	1.63	2.28
No Gestures	46	4.43	2.25	1.39	1.77

DISCUSSION

This research examined whether gesture type and rate affect foreign language learners' ability to learn procedural information through English. The results indicated that enhancing the gesture rate while using representational and beat gestures does significantly benefit learners compared to no gestures, and approaches significance against conversational gestures.

These results further expand the literature of gesturing PAs in multimedia learning environments. These findings closely connect to research conducted by Baylor and Kim (2009) that found deictic gestures significantly increased procedural understanding with native speaking populations. In addition to this, these findings are evidence that students learning English as a foreign language benefit from enhanced representational and beat gestures to assist with the comprehension of procedural information.

Likewise, the result of this research provides evidence that gestures can perform a similar function in computer-to-human communication as gestures do in human-to-human communication. Therefore, instructional designers should consider using the full complement of representational and beat gestures in multimedia learning environments.

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