EXTRACTION, SYNTHESIS AND EVALUATION OF CHARISMATIC TEACHERS' NONVERBAL CUES – INITIAL FINDINGS

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Abstract - The paper reports ongoing research aimed at advancing knowledge on the role of expressive, charismatic gestures in education. More specifically, the objectives of the work described in the paper are to(a) measure expressive nonverbal cues from motion captured data and video images of successful instructors at Purdue University, (b) synthesize the identified nonverbal cues using 3D animation technology, and (c) study their effects on students. Current progress towards these goals and initial findings are discussed.

Keywords - About Four Key Words Or Phrases In Alphabetical Order, Separated By Commas.

I. INTRODUCTION

Imagine two different instructors delivering the same lecture. The two instructors are the same age and gender, have equivalent knowledge of the subject, use the same lecture script, same supplementary materials and take the same amount of time to cover the lecture topics. One instructor receives significantly higher student evaluations than the other. Why? What specific characteristics lead students to perceive one instructor as more effective than the other?

In an article published in the Chronicle of Higher Education, Jenkins (2015) identifies four properties of powerful teachers, one of these properties is what he calls 'presence'. "Presence is the unmistakable capacity some people have to "own" any room. We might call it charisma.. It's the ability to appear completely at ease, even in command, despite being the focal point of dozens (or even hundreds) of people."

Although there is ample evidence that nonverbal expressive style can be a core element of effective teaching, theprecise role of body language in instruction is still not well understood. In general, the gestures that a teacher makes in concurrence with speech include embodied cognition gestures and expressive gestures. Embodied cognition gestures depend on the learning context. For example, research on mathematical learning suggests that certain gestures such as point, sweep and balance promote conceptual understanding supporting learning of new content (Alibali et al., 2014). In addition, some gestures, such as beat gestures, can be used to segment and emphasize the verbal explanations. In this research we are not concerned with embodied cognition gestures, which have been studied extensively by educators and psychologists in a variety of learning domains. The ongoing project discussed in the paper focuses on the less studied role of charismatic expressive gestures in education, e.g., those gestures that make the lecture engaging and memorable, thus influencing how learners perceive their instructors. Both excellent content and a captivating presentation style are important to optimal teaching (McGuire, 1970). Most simply, the more perceivers attend to important information, the more likely they are to learn it (McGuire, 1970); such perceptual salience is related to nonverbal expressiveness (Sullins, 1989). Psychology research indicates that public speakers who gesture with their hands and arms during discourse are perceived as more charismatic and more engaging (Church et al., 2007). We are concerned with these types of gestures and want to discover what they are, their parameters and to what extent they affect student perception of the instructor and student learning.

Because body language is inherently complex and difficult to measure and replicate, additional research is needed in order to identify the specific nonverbal cues (and their parameters) that make a teacher charismatic. Our work aims to fill this gap. More specifically, the goals of our project are to: (1) extract charisma gestures from motion captured data and video images of successful instructors and measure their properties (e.g. speed, amplitude, frequency), (2) synthesize the identified gestures using 3D animation technology; and (3) study their effects on learners.

II. GESTURES AND LEARNING

A century ago, Edward Sapir's pioneering studies of ethnology and linguistics noted that we "respond to gestures with an extreme alertness and, one might almost say, in accordance with an elaborate and secret code that is written nowhere, known to none, and understood by all" (Sapir, 1928/1949).

Teachers frequently use their hands to depict information (Goldin-Meadow et al. 2001; Nunez, 2004; Valenzeno et al., 2003). For example, a study of Piagetian conservation (Church et al. 2004) compared instruction with gesture to instruction without gesture and found that instruction with gesture lead nearly two times as many students to demonstrate deep learning. In addition to promoting conceptual understanding, gestures also make the accompanying speech more memorable, supporting learning of new content. In a

wide variety of studies, speech accompanied by gesture has been shown to be more likely to be subsequently remembered than speech that is not accompanied by gesture (Cutica&Bucciarelli, 2008; Feyereisen, 2006; Galati & Samuel, 2010). For example one study (Cutica&Bucciarelli, 2008) demonstrated that learners were more likely to remember material from instruction that included accompanying gesture, and were more likely to make deep inferences after instruction that included accompanying gesture.

Gestures may also influence how learners perceive their instructors. More than thirty years ago, a "Doctor Fox" began giving lectures to unsuspecting audiences (Williams & Ware, 1977). It was actually an experiment. Doctor Fox, a hired actor who played the role of an expert in Mathematical Game Theory, varied the expressiveness or "seductiveness" of the lectures as well as the content. Even if the lecture was filled with double talk, neologisms, and non-sequiturs, it was highly rated by the audience if the lecturer showed a charismatic nonverbal style. The general finding of these studies was that an enthusiastic, expressive lecturer is more highly valued (Abrami et al., 1982; Marsh & Ware, 1982). Even when the speaker speaks double-talk, an appealing presentation style can elicit plaudits, even from educated audiences. It is now well documented that an enthusiastic, nonverbally-skilled instructor tends to create positive impressions in students, attract their interest, and increase their motivation.

The more interesting questions for education involve the amount of learning that occurs. Certain teachers are well liked, but do they teach better? Both excellent content and a captivating presentation style are important to optimal teaching. Most simply, the more perceivers attend to important information, the more likely they are to learn it (McGuire, 1970) and such perceptual salience is related to nonverbal expressiveness (Sullins, 1989). Further, expressive presentations may be emotionally arousing, and such emotional information may be more easily remembered (McGaugh et al., 1995). In a more complex manner, students with certain nonverbal sensitivities may be highly motivated to study more when instructed by teachers with certain positive, expressive nonverbal styles. Much of this work can be found in the voluminous educational literature on how to evaluate teaching (e.g. Burroughs, 2007; McKeachie, 1994; Harris & Rosenthal, 2006). Clearly, the content of the class and the knowledge of the professor do matter. Yet the maximum impact comes from the optimal presentation style, which often depends significantly on gestures.

III. DESCRIPTION OF THE PROJECT: GOALS AND ONGOING ACTIVITIES

In this section we outline the project goals and report ongoing activities.

The first objective of the project is to identify and measure charisma nonverbal cues of successful instructors in the Polytechnic Institute at Purdue University using video and motion capture technology. We are using the Xsens portable motion capture system (Xsens, 2018), video cameras and video analysis software to record and analyze non verbal cues of charismatic teachers in order to identify and measure those elements of body language that are common to and repeatedly exhibited by such teachers during lectures. We are focusing on Construction Management Technology (CMT) instruction and are recording 50 videos of CMT instructors who are considered charismatic by the students, e.g. instructors who have consistently received high student evaluations (4.5/5 or above on the instructor core questions) and whose Affective Communication Test (ACT) score is >80 —the ACT is a widely accepted measure of personal charisma developed by Friedman and his research group (Friedman et al. 1980). Each video is a 5-minute segment extracted from lectures delivered by these instructors. The curriculum of the School of Construction Management Technology Bachelor of Science is undergoing a radical transformation in order to integrate construction topics both horizontally and vertically throughout the four-year degree. The new curriculum utilizes authentic projects obtained from industry partners, which provide the basis of the project-based learning and instruction. Groups of faculty team-teach the content of these large, 6-9 credit-hour project courses exposing the students to a wide variety of teaching styles within the same course. CMT250 Intermediate Construction Management is a 9 credit hour, sophomore level course with eight faculty instructing at various points throughout the course. The eight faculty involved provide a wide range of teaching styles, hence the course is an ideal test bed for the project.

For the extraction of the nonverbal cues we are using both manual and automated techniques. Nonverbal cues such as facial expressions, head orientation, gaze direction, mouth open-closed, eyes open-shut, eyebrows raised- neutral-lowered are extracted automatically from video images using Face reader software by Noldus (Stockli et al. 2018; Noldus, 2018). Body gestures are being extracted manually from video images by a group of coders (students) who use software tools such ELAN (Wittenburg et al., 2006; The language archive, 2018) and ANVIL (Cassidy & Schmidt, 2017; ANVIL, 2017). The coders also usespeech analysis software to examine the relationship between charisma nonverbal cues and speech. In particular, they are examining presence or absence of speech during the production of the identified nonverbal cues, and the relationship between speech prosody elements such as pitch and loudness, and charisma nonverbal cues.

We have also recorded body gestures and their parameters using the Xsens portable motion capture

system for those instructors who agreed to wear the motion capture body sensors while delivering the lectures. The Xsens motion capture system is a lightweight, unobtrusive full-body human measurement system (finger tracking included) based on inertial sensors. It is easy to set up, can be used anywhere and does not impede people's movements in any way. The recorded motion capture data is an invaluable resource for analyzing and measuring body motions in a very precise way.

The second goal of the project is to represent the identified charisma nonverbal cues using 3D animated avatars. Once key gestures have been identified and measured through video analysis and motion capture, we will reproduce them using 3D animation technology in order to assess to what extent these nonverbal cues and their parameters affect students' perception of the instructor and students' learning. In other words, we will create a set of animated sequences in which a 3D character (virtual teacher) delivers a few lecture segments (selected from the recorded videos) with and without the identified nonverbal charismatic cues. We will also vary the parameters of the animated charismatic cues (speed, acceleration, range, direction, etc.) to see if changes in the values of these parameters affect perception.

The third goal of the project is to assess the effect of the identified charisma nonverbal cues on students' perception of the instructor and on students' learning. A group of Polytechnic students will be asked to view the animated lectures with different gesture conditions and rate the perceived quality of the instructor avatar in each sequence. Research shows that even short segments of teaching can capture at least some of the variance in teacher evaluations. So-called "thin slices" of behavior can be quite revealing (Ambady& Rosenthal, 1992; Babad, 1993). For example, brief (under a minute) segments of nonverbal expressive cues can predict some of the variance in end-of-semester evaluations of professors. For our studies we will use 30 to 60 seconds animated clips.

We will use a pretest- training-posttest-retention design to explore the effects of charisma gesture on Polytechnic students' learning of Construction Layout and Surveying. The deterministic control of the animated avatar enables running experiments manipulating features of gesture while keeping all other factors identical across conditions. This avoids for instance, differences in intonation, posture, timing, etc., which are confounding factors hard to eliminate when the gestures are performed by real, live instructors.

Students will first complete a pretest designed to measure their knowledge of Construction Layout and Surveying. Only students who score less than 70% on the pretest will continue in the study. After the pretest, students will participate in instruction with the avatar, which will vary across studies according to design. After instruction, students will complete a posttest comparable to the pretest. Approximately three weeks after the study, students will complete a retention test. In regard to data analysis, the primary dependent measure will be the score on the posttest and retention test. The data will be entered into a logistic regression model, with the number of construction layout problems solved correctly on the posttest and retention tests as the outcome variables, and gesture condition as the between subjects factor of interest. We plan to start the experiments in Summer 2020.

IV. INITIAL FINDINGS

Gesture Extraction.To date we have identified 6 beat gestures that are repeatedly produced by charismatic instructors while lecturing. The gestures have been extracted from theexamination of 22 5-minutes video recordings of lectures and from analysis of motion captured data of 13 5-minutes lecture segments. The identified gestures are reported in table 1.

OUTWARD GESTURE	[1] single (one-arm) outward gesture	[2] both hands make outward gestures, but not in synchrony with each other	[3] both hands make outward gestures at the same time
FORWARD GESTURE	[4] single (one-arm) forward focused gesture	[5] bothhands make forward focused gesture, but not in synchrony with each other	[6] both hands make forward focused gesture at the same time

Table 1. Six charisma gestures extracted from video recordings and motion captured data

Observations of video recordings and analysis of mocap data have also revealed that:

- Charismatic instructors gazeand directtheir bodies toward the audience almost the entire time. This makes the interaction seem more intimate, engaging and personal.
- They tend to use open and forward body gestures
- Their facial expressions and body movements match with the emotional content of what they say.
- Even when they appear relatively still, they are still making slight outward focused gestures with either left or right hand while gazing at the audience

Gesture Synthesis.Figure 1 shows the 6 charisma gestures performed by our animated pedagogical agent. In order to produce the animations, each gesture

was performed by one of the instructors, motion captured and then applied to the 3D agent.In future work we will produce different animations showing different gesture conditions in order to examine the effects of the gestures and their parameters on students' perception of the virtual instructor, and on students' learning.

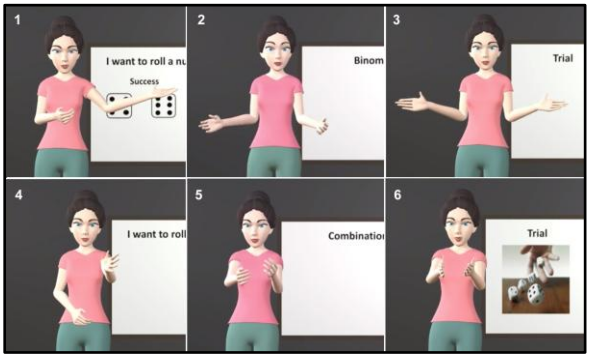


Figure 1.One-arm outward gesture (frame 1); two-arms asynchronous outward gesture (frame2); two-arms synchronous outward gesture (frame 3); One-arm forward gesture (frame 4); two-arms asynchronous forward gesture (frame 5); two-arms synchronous forward gesture (frame 6).

V. DISCUSSION

We believe that the ongoing project outlined in the paper has high intellectual merit and could bring innovation in three areas. First, the findings from the studies will advance education research on the role of gestures in instruction. Although researchers have begun elucidating how gestures enhance learning and how they define and convey emotions, much is yet to be discovered, especially in the area of charisma. A deliverable of the project will be an empirically grounded research base on the role of charisma gestures in education

Second, the project will generate evidence-based guidelines for how to become more nonverbally skilled instructors. Jenkins (2015) argues that although to some extent charisma is something you are either born with or not, it is also an ability that people can develop over time with training and practice. In the article "Can Charisma Be Taught?Tests of Two Interventions", Antonakis et al. (2011) report two studies that suggest charisma can be taught and learned. However, the charisma training used in both studies involved primarily verbal charismatic leadership tactics, and did not focus on nonverbal tactics (e.g. specific expressive nonverbal cues), as these cues are not known yet. Our project will shed light in this area. Third, based on the results of the studies, it will be possible to distill a new set of rules for algorithmic generation of charismatic gestures for expressive teaching avatars. One long-term goal is to integrate the findings from the project with animation algorithms that produce expressive and charismatic teaching avatars for online education.

Although the project uses a course in Construction Management Technology as the test bed for assessing the effects of charisma nonverbal cues on students learning, we anticipate that findings will transfer to other disciplines. Advances in gesture understanding and synthesis resulting from the proposed project can potentially benefit other communication domains such as training for public speaking and leadership, and also special education—attention deficit hyperactivity disorder and autism spectrum disorders, as students with certain nonverbal sensitivities may be motivated to study more when instructed by teachers with certain positive, expressive nonverbal styles.

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