THE IMPACT OF ANIMATED PEDAGOGICAL AGENT GESTURES ON AGENT
SOCIAL ACCEPTANCE AND LEARNING OUTCOMES WITH ELEMENTARY
SCHOOL FOREIGN LANGUAGE STUDENTS

By

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To my wife and my daughter
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Abstract of Dissertation Presented to the Graduate School of the University of Florida in Partial Fulfillment of the Requirements for the Degree of Doctor of Philosophy

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By

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Animated pedagogical agents (APAs) are lifelike characters in computer-based environments that help to facilitate learning through social interactions (Son, 2014). APAs are useful when designing multimedia presentations because of the flexibility with agent design, the ability to perform multiple roles, and the affordance to be manually manipulated for better learning opportunities. However, one area that has been sparsely researched to date with APAs is the act of gesturing. APA studies routinely use deictic gestures, but ignore the potential role of iconic, beat, and metaphoric gestures. If APAs are to simulate human-like interaction, then APAs need to incorporate deictic, iconic, metaphoric, and beat gestures into their speech. This study examined APAs in three conditions: full gestures, deictic only gestures, and no gesture conditions. In the full gesture condition, the APA was designed to use body sway, facial expressions, eye blinks, lip synchronization, and a variety of gestures such as deictic, iconic, metaphoric, and beat gestures. The deictic only gesture condition used body sway, facial expressions, eye blinks, and lip synchronization, but only used deictic gestures – to replicate the common gesture design of APAs. The no gesture control condition
included body sway, facial expressions, eye blinks, and lip synchronization, but all gestures were eliminated.

Social acceptance was measured by the completion of the Korean agent persona instrument (Ryu, 2012) and analyzed with a multivariate analysis of variance (MANOVA). No significant difference was found in learning outcomes across conditions. However, APAs in the full gesture condition supported the person effect as they were found to be significantly more human-like and engaging than APAs in the no gesture condition. Stepwise multiple regression analysis found evidence that social acceptance factors “human-like” and “engaging” had negative associations with learning outcome scores. This research provides evidence that APAs with full gesture capabilities have the ability to increase social perception by learners.
CHAPTER 1
INTRODUCTION

Animated pedagogical agents (APAs) are lifelike characters in computer-based environments that help to facilitate learning through social interactions (Son, 2014). These social interactions can simulate various human roles such as expert, instructor, mentor, tutor, and learning companion (Baylor & Kim, 2004). In multimedia presentations, APAs have the ability to provide a human-like social component that is typically absent in a more traditional electronic environment such as text with images and animations (Phan, 2011). APAs can communicate information both verbally and nonverbally with nonverbal communication conveyed through means of facial expressions, body movements, and gestures (Woo, 2008). APA nonverbal communication and APA gestures specifically are understudied in educational research and thus more empirical research on the effects of gestures on student learning and attitudes is needed. It is important to understand the parameters in which gestures may have a positive impact on learning, especially in a foreign language learning environment that benefits from both verbal and nonverbal communication to enhance comprehension (Kendon, 1994; Lazaraton, 2004; Saitz, 1966).

Context of Problem

This study was conducted in South Korea, where educational policy makers are planning a large-scale, national implementation of digital textbooks into the public school system (Kang & Everhart, 2014). The government has already begun an initiative to promote ubiquitous learning (U-learning) environments for students to learn anytime, anywhere, and through different forms of technology such as computers, tablets, and smart phones without limitations (Kim, Cho, & Lee, 2013). With books
becoming digital, and designers creating digital lessons for the U-learning government initiative, it is important to evaluate the affordances of gestures used by APAs in foreign language learning multimedia. Understanding the benefits or hindrances of APA gestures in a multimedia learning environment can inform researchers and educational designers on best practices in educational multimedia design and implementation.

APAs have the ability to add social presence to a learning environment (Kim & Baylor, 2006). When a teacher is not available, APAs and humans are not perceived as any different socially (Vassileva, 1998); and with South Korea’s emphasis on U-learning for the future, APAs need to possess the nonverbal communication strategies to be perceived as an instructor in the multimedia environment. This perceived social interaction is important in foreign language learning because interpersonal communication gives way to intrapersonal operations that are crucial for foreign language acquisition (Ellis, 1999). In other words, when learners perceive they are being instructed, it causes an inner interaction to assist with acquiring foreign language. Empirical research has shown that learners recognize the role of the APA as an instructor, and it may lead to significant changes in motivation and learning (Baylor & Kim, 2005).

APAs provide the opportunity to enhance foreign language learning using nonverbal communication strategies such as gesturing because non-native speakers are more likely to possess weak verbal skills (Hostetter, 2011). Gestures support the spoken word and provide extra assistance for comprehension. For example, deictic gestures with words like straight, right, or left convey directions even if the listener does not understand the direction words. Similarly, a native speaker holding her hand in front
of her face and styling her head with the other hand can convey the concept of “mirror” without the foreign language learner understanding the word. Therefore, deictic, iconic, metaphoric, and beat gestures are beneficial to foreign language learners when they lack the ability to understand from words alone. Empirical evidence generated by Sueyoshi and Hardison (2005) indicated that when a human instructor on video used deictic, iconic, metaphoric, and beat gestures during instruction, low proficiency students had significantly higher listening comprehension scores when compared with high proficiency students. On the other hand, high proficiency students had higher scores with a face only condition when compared with low proficiency students. These results suggest that low proficiency students rely on gestures to comprehend spoken words, whereas, high proficiency students focused more on words than gestures. It is important to understand how gesturing conditions (full, deictic only, and no gesture) influence the social acceptance of an APA in multimedia presentations, and what effect these conditions may have on the retention and transfer of grammar knowledge. Ultimately, this study will enhance our understanding of the role and use of APA gesturing in digital curriculum for foreign language learning students.

**Purpose of Research**

The purpose of this dissertation study is to investigate how APA gestures influence the social acceptance of APAs and what effects full gestures, deictic only gestures, and no gestures produce on the retention and transfer of grammar knowledge with 5th and 6th grade South Korean elementary school students. Examining social acceptance of APAs with and without gestures will allow teachers, designers, and researchers understand how students socially perceive the gesturing of APAs, which informs stakeholders on the potential benefits APA nonverbal communication in
multimedia. Likewise, the data on retention and transfer amongst the three conditions of full, deictic only, and no gesture conditions will add to the literature on the effects of gesturing APAs on learning.

**Research Questions**

1. To what extent does APA gesturing (full, deictic only, and no gesture) affect the retention of English grammar knowledge?

2. To what extent does APA gesturing affect the transfer of English grammar knowledge?

3. Which of the APA gesturing conditions (full, deictic only, and no gesture) do elementary school students perceive as more social?

4. To what extent does the social perception of APAs influence learning performance?

The intervention was created using iClone 6™ to build the scene and APA characteristics, Audacity™ to record voice tracks, and Camtasia 2™ to combine text and export to .mp4 format. All three experimental conditions (full gestures, deictic only gestures, and no gestures) had the same classroom scene, APA, voice track, and text. However, the gestures in each multimedia presentation were manipulated in the gesture timeline of iClone 6™. The full gesture condition had deictic, iconic, metaphoric, and beat gestures occur before or co-occur with speech (McNeill, 1992; Kendon, 1994). The deictic only condition removed iconic, metaphoric, and beat gestures from the gesture timeline and only use deictic gestures in the intervention as is common practice with current research. The no gesture condition had gestures deleted from the gesture timeline of the APA.

**Hypotheses**

Hypothesis 1: It was predicted that students would perceive full gesture APAs as being more social compared to APAs in the deictic only and no gesture conditions.
because the student’s social treatment and expectations for the APA would be formed according to media equation theory (Reeves & Nass, 1998). Media equation is a communication theory explaining that people tend to treat computers and computer generated media as if they were real people or real objects or places. Empirical evidence generated by Buisine and Martin (2007) suggests that APAs that used deictic, iconic, metaphoric, and beat gestures scored significantly higher on social perception for having more personality and being more likeable compared to the control condition that only used beat gestures.

Hypothesis 2: Students would demonstrate improved retention and transfer of foreign language grammar when they learned with the help of a full gesture APA. Previous research has yielded conflicting results on deictic gestures that direct the learner’s spatial attention to items or information mostly through the act of pointing. Most studies with deictic gestures have found no significant improvement with retention and recall (Craig et al., 2002; Baylor & Kim, 2009; Choi & Clark, 2006; Mayer & Dapra, 2012), but some studies have found significant main effects on transfer (Atkinson, 2002; Lusk & Atkinson, 2007; Mayer & Dapra, 2012). Studies by Choi and Clark (2006) and Ferchette and Moreno (2010) have found no significant differences in any condition with deictic gestures. Conversely, Bergman & Macedonia (2013) examined the use of iconic gestures on free and cued recall of foreign language vocabulary with a human trainer, APA trainer, and a control condition without a trainer or gestures. The results showed no significant difference between the human and APA condition on free and cued recall of information, but the APA condition produced a significant positive main effect with free and cued recall of information when compared with the control condition. The
differences on test scores in the human condition and control condition were not significant. Other types of gestures that seem to hold potential, particularly in a foreign language classroom, such as metaphoric and beat gestures have not been explored. It was predicted that full gesture APAs will improve retention and transfer when compared to deictic only and no gesture conditions due to the APA’s ability to use a combination of gesture types to provide a human-like interaction experience. The deictic only and no gesture conditions would not have significant effects due to the gestures’ inability to reinforce concepts, or the inability to convey such information in the no gesture condition.

Limitations

The generalizability of the proposed research is a limitation. This study was conducted at one public elementary school in a middle class neighborhood. This study did not explore APA gesture effects in high or low socioeconomic status schools. It is not known if the results of this study would be replicated in schools with a different socioeconomic status and demographic makeup. Another generalizability problem is the number of students in each condition. The projected numbers are too low to generalize to all 5th and 6th graders in the town, province, or country. Therefore, these results will apply to the students that were tested with possible transferability to contexts similar to that used in the current study.

Another limitation is the potentially low magnitude of effect. The intervention explained the comparatives of –er and more according to the number of syllables in the comparison word, and only addressed two of the fifteen special rules. The video instruction lasted a total of 9 minutes. Learning this information in a classroom setting, students would have a 50-minute lesson that included instruction of the information, but
also exercises and activities to reinforce the concepts. This means that students spent far less time learning the material than they would in a regular class period. This intervention was designed, however, to be used as part of a digital curriculum supporting ubiquitous learning, which is a major national initiative in South Korea, rather than for face-to-face instruction.

**Delimitations**

The student population in this study was purposefully chosen because it represents the socioeconomic majority of the entire student population in the country. Although high and low socioeconomic class students are a concern in future research, this study controlled for the discrepancies that could occur between the different social classes.

Eight classes from the school were chosen to participate in this study.

The APA gestures were specifically manipulated during the intervention. When humans produce gestures, the production occurs naturally without much thought as to if to use deictic, iconic, metaphoric, or beat gesture. APAs were modified to strategically produce gestures to assist in understanding. In this intervention, gestures were designed to mimic natural human gesture production, but modified in a sequence depending on the flow of previous and future gestures to maintain a naturalness of display.

In addition to gestures, body sway, head movements, and facial expressions were used in all conditions. These elements could have been absent to solely focus on the gestures, but this was chosen to create an APA that was more lifelike and authentic compared to APAs used in K-12 digital materials.
Summary

This chapter examined the context and rationale for this dissertation study, provided the research questions guiding the study, put forth hypotheses for the results, and discussed the limitations and delimitations. The conclusion of this chapter lists the key vocabulary used in this dissertation. The second chapter provides a literature review and theoretical framework for this research. The third chapter discusses the methods of this study. The fourth chapter discusses the results, and the fifth chapter provides a discussion of the findings and potential areas for future research.

Definition of Terms

Listed below are key vocabulary terms that will be used in this dissertation. This section is provided as a reference for the reader.

ANIMATED PEDAGOGICAL AGENTS: Lifelike characters in computer-based environments that help to facilitate learning through social interactions by simulating a human role (Son, 2014).

BEAT GESTURE: The extension and retraction that happens with body parts such as fingers, hands, arms, or legs to the rhythm of speech that carry no semantic information, but mark important words or phrases (Thuene & Brandhorst, 2009).

COHERENCE PRINCIPLE: People learn better when extraneous sounds, words, and graphics are eliminated (Mayer, 2001).

DEICTIC GESTURE: Gestures that involve the use of arms and hands such as pointing to connect speech to some other idea, object, location, or action (Kelly, Manning, Rodak, 2008).

HIGH EMBODIMENT (APA): APAs that mimic human nonverbal communication such as eye gaze, hand gestures, and facial expressions (Mayer & Dapra, 2012).

ICONIC GESTURE: Gestures that illustrate concrete information such
as hands forming a round circle to represent a ball (Straube, Green, Bromberger, & Kircher, 2011).

**LOW EMBODIMENT (APA):** APAs are similar to static images usually with only lip synchronization as the only form of interaction (Mayer & Dapra, 2012).

**FULL GESTURE** Gestures that co-occur and with speech to convey overlapping information (Goldin-Meadow, 2005)

**MEDIA EQUATION THEORY:** Humans have the tendency to humanize media, and through this perception of realness, humans apply the same social relationships to that media (Reeves & Nass, 1996).

**METAPHORIC GESTURE:** Gestures that illustrate abstract information such as pointing to the sky when speaking about grades going up (McNeill, 1992).

**MULTIMEDIA PRINCIPLE:** Combination of words and graphics are better than words alone (Mayer, 2001).

**NONVERBAL COMMUNICATION:** Anything outside of speech that communicates information, which includes facial expressions, hand and arm gestures, postures, positions, and various movements of the body or the legs and feet (Mehrabian, 1977).

**PERSONA EFFECT:** Attributing human form or personality to an agent due to its life-like features of facial expressions, body movements, and gestures that emulate any real-life character (Woo, 2008).

**PERSONALIZATION PRINCIPLE:** People learn better in multimedia presentations when information is presented in a conversational style rather of a formal style (Mayer, 2001)

**PRESENCE PRINCIPLE:** Learning is not enhanced by the presence of an agent (Mayer, Dow, & Mayer, 2003).

**RETENTION:** Information that is being held in either short-term or long-term memory (Cooper, Heron, & Heward, 2007). Retention is an active interaction between the subject matter and the cognitive structure that connect the new ideas (Ausubel & Ausubel,
SEGMENTING PRINCIPLE: Breaking content down into small chunks learners can control and manage (Mayer, 2001).

SOCIAL AGENCY THEORY: The image and voice of the APA results in deeper cognitive processing of learning because of the activation of social interaction schema (Mayer, 2005).

TRANSFER: What is learned in one situation is sufficiently abstracted and decontextualized to apply to other situations (Larsen-Freeman, 2013).

VOICE PRINCIPLE: Using a friendly human voice in a multimedia presentation is better than using a machine generated voice (Mayer, 2001).
CHAPTER 2
LITERATURE REVIEW

Animated Pedagogical Agents

Animated Pedagogical Agents (APAs) are lifelike characters in computer-based environments that help to facilitate learning through social interactions by simulating a human role (Son, 2014). They were developed from the combination of two research areas known as animated interface agents and knowledge-based learning environments (Johnson, Rickel, & Lester, 2000). Animated interface agents assisted users in accomplishing tasks through the computer using embodiment agents that adopt life-like characteristics (Dehn & Mulken, 2000). Peedy the Parrot is an example of an animated interface agent. Peedy acted as a personal desktop assistant by helping users manage their time better with scheduling events, providing reminders, and delivering breaking news (Ball & Breese, 2000). Peedy was able to assist users through the use of scripts activated by speech recognition programs or typed input.

An example of knowledge-based learning environments, or intelligent tutoring systems, is Autotutor, a computer-based tutor that is scripted to emulate discourse patterns and pedagogical strategies that would be used by a human tutor (Graesser et al., 1999). The script anticipated correct answers, called *expectations*, but also anticipated answers that may lack in correctness, which it labeled *misconceptions*. Autotutor is able to provide various styles of feedback, have learners expand on answers by initiating *pumps*, provide prompts, assertions, correct wrong answers, answers questions, and summarizes answers (Graesser et al., 2005).

APAs are the byproduct of combining animated interface agents and knowledge-based learning environments. Through the years, APAs have been implemented in a
variety of ways. APAs have been in the form of inanimate objects (Clippy- Murphy-Hill & Murphy, 2014), animals (Herman the Bug- Atkinson, 2002), and humans (AutoTutor-Graesser et al., 1999; van der Meij, van der Meij, & Harmsen, 2015). Johnson and colleagues (2000) characterize APAs as having the following potentially useful functions: a) demonstrating physical tasks, b) becoming navigational guides, c) providing attention through gaze and gestures, d) promoting teamwork, and e) provide adaptive instruction to the user. In addition, APAs have been shown to decrease anxiety (Clark & Choi, 2005) and increase motivation (Atkinson, 2002; Choi & Clark, 2006; Moreno, Mayer, & Lester, 2000; Moreno, Reislein, & Ozogul, 2010).

APAs have the ability to extend intelligent tutoring systems by adding a social component that encourages deeper levels of cognitive processing within teaching and learning (Baylor & Kim, 2005). APAs have the ability of the fill multiple roles within social interaction such as expert, instructor, mentor, or learning companion (Baylor & Kim, 2004). Depending on the type of interaction being sought, APAs have the flexibility to fill multiple roles within software programs.

Some have argued that the perception of realism is important with APAs in a multimedia environment. APAs can be seen as lifelike (Hays-Roth & Doyle, 1998, Wang et al., 2008) and perceived as a living being (Rizzo, 2000). Therefore, “no virtual difference” is often seen socially between APAs and humans (Vassileva, 1998). Moreno (2005) suggests that visual realness combined with speech makes the learning experience more interesting, believable, or natural for the learner. Baylor and Kim (2004) provided evidence that males who learned with a realistic APA performed significantly better with transfer knowledge than males who learned with a cartoon
character. However, there was no significant difference with knowledge transfer for females and APA realism. A more recent study by Johnson, DiDonato, and Reisslein (2013) found a positive significant difference in preference for realistic APAs over cartoon-looking APAs with K-12 students in elementary, middle, and high school.

**APA Embodiment**

Nonverbal communication is important to the perception of the APA by the learner (Johnson et al., 2000). Based on nonverbal communication representations, APAs can be classified as being either high embodiment or low embodiment. High embodiment APAs are those that mimic human nonverbal communication such as eye gaze, hand gestures, and facial expressions. Low embodiment APAs are not designed using the nonverbal communication strategies high embodiment APAs use. Low embodiment APAs are similar to static images that may contain lip synchronization as the only form of interaction (Mayer & Dapra, 2012).

Mayer and Dapra (2012) provided evidence that high embodiment APAs are more beneficial to transfer of learning and social acceptance than low embodiment APAs. In experiment 1, participants in the high embodiment APA condition significantly outperformed those in the low embodiment APAs and no agent conditions. The effect size between high embodiment and low embodiment was $d = .9$, which is considered a large effect (Cohen, 1988). The low embodiment and no agent conditions did not differ relative to transfer of learning and social acceptance. Social acceptance in this experiment also provided significant main effects with high embodiment outperforming low embodiment in the areas of facilitated learning, credibility, and engagement. The effect sizes for these three dimensions were considered large with ($d = 1.1, 0.9, \text{ and } 0.6$ respectively).
Likewise, a study by Guo, Goh, and Luyt (2014) measured motivation and enjoyment with high embodiment APAs, termed Affective Embodied Agents (Affective EAs), and low embodiment APAs, termed Neutral Embodied Agents (Neutral EAs), with a text-only control condition. Motivation in the study examined attention, relevance, confidence, and satisfaction. Learners were significantly more satisfied with the high embodiment APAs when compared with low embodiment APAs. The other areas of motivation were not statistically significant. In the enjoyment condition, the study examined three aspects of enjoyment: affective, cognitive, and behavioral. The high embodiment APA was significantly more enjoyable than the low embodiment APA across affective, cognitive, and behavioral measures.

Social Agency Theory

The benefit of implementing high embodiment APAs in media is the ability to enhance the social acceptance of the APA by the learner. According to social agency theory (Mayer, 2005), instruction with social cues leads to activation of social responses by the learner, this increases active cognitive processing within the learner, and results in the increase of quality of learning outcome. Therefore, the image and voice of the APA results in deeper cognitive processing for the learner because it activates the social interaction schema that is found in human-to-human interaction (Mayer, 2005). If the APA looks like a human, and sounds human, then the learner will treat the APA as it would a human. This is supported by the media equation theory that postulates that humans have the tendency to humanize media, and through this perception of realness, humans apply the same social relationships to that media (Reeves & Nass, 1996).

The image of an agent can signal to the participant that someone is present in the space (Nam et al., 2008). However, there are many components to APA image
when conducting research. Some of the research on APA image has explored the
effects of such variables as age, gender, ethnicity, dynamism, visual appeal, and other
factors (van der Meij, et al., 2015). For example, visual appeal can have positive and
negative effects on the learner. Domagk (2010) found appealing agents, according to
image and voice, had a more positive effect on the transfer of learning on Gestalt
principles of perception than unappealing agents, which hindered learning. Other
studies have shown that learners stereotype APAs based on appearance (Haake &
Gulz, 2008; Veletsianos, 2007, 2010). In the 2010 empirical study by Veletsianos, he
compared the perception of knowledge by an APA that resembled a scientist and one
that resembled an artist. Veletsianos also measured the recall of nanotechnology and
punk rock information in a 2X2 between subjects design. As far as perceptions of
knowledge by the APA, the artist APA was perceived as being more knowledgeable
about punk rock, even though there was no perceived difference between the scientist
and artist in regards to nanotechnology. Likewise, recall of information in the artist and
punk rock condition scored higher statistical significance than the scientist and punk
rock condition. All other conditions were not statistically significant.

Another social cue that social agency theory is concerned with is how the voice
of the APA is presented to the user. Voice can be presented either by a human who
records a script, or by text-to-speech software that creates machine generated voice.
The voice effect states that human voice is better for learning than machine generated
voice (Mayer, 2009). The voice effect is supported by many studies that have shown
human voice produces better results (Moreno et al., 2000; Moreno & Mayer, 2002;
Mayer, et al., 2003; Atkinson et al., 2005; Louwerse et al., 2005; Domagk, 2010; Mayer
& Dapra, 2012). For example, empirical research conducted by Atkinson, Mayer, and Merrill (2005) provided evidence that APAs using human voice were significantly more favorable compared with APAs using machine generated voice. The effect size for human voice was $d = .83$, which is considered large (Cohen, 1988). Human voice is one variable that produces consistent results when compared against machine generated voice. Table 2-1 provides an overview of the relevant aspects of studies that focused on the social agency of APAs.

<table>
<thead>
<tr>
<th>Author/Year</th>
<th>Theories</th>
<th>Variables</th>
<th>Outcomes</th>
</tr>
</thead>
</table>
| Dunsworth & Atkinson | Embodiment agent effect (social agency) | Modality (Narration vs on-screen text)  
Embodiment agent effect (narration + agent vs on-screen text)  
Image effect (narration + agent vs narration) | Overall: EAE: nar + agent > on-screen text  
IE: nar + agent > narration  
Retention: EAE: nar + agent > on-screen text  
IE: nar + agent > narration  
Near Transfer: No significant differences |
| Mayer & Dapra (2012) | Social agency theory               | High embodiment (HE), low embodiment (LE), no agent (NA), and human voice (HV) | Retention: No significant difference in all conditions  
Transfer: HE+HV > LE+HV  
LE+HV & NA + HV - not significant  
Social Acceptance: HE+HV > LE+HV  
HE+HV = NA+HV |
| Mayer & Dapra (2012) | Social agency theory               | High embodiment (HE), low embodiment (LE), and human voice (HV), machine voice (MV) | Retention: No significance in all conditions  
Transfer: HE+HV > LE+HV  
HE+MV = LE+MV |
Social agency theory suggests social interaction schema is activated by the image and voice of the APA, which creates deeper cognitive processing for learning (Mayer, 2005).

**Concepcional Underpinnings of Retention and Transfer**

Before discussing the effects social agency theory has had on knowledge retention and knowledge transfer, it is important to define retention and transfer and describe how retention and transfer work together to assist learning.

Retention has been defined as information that is being held in either short-term or long-term memory (Cooper, Heron, & Heward, 2007). Retention is an active
interaction between the subject matter and the cognitive structure that connects the new ideas with prior knowledge (Ausubel & Ausubel, 2000).

The notion of transfer dates back to the early 1900’s when Thorndike and Woodworth (1901) were among the first to examine learning using transfer of knowledge tests. In the field of education, the idea of learning knowledge in one context and transferring that knowledge to other contexts has been a focal point for over a hundred years. Unlike retention, transfer can be surmised as “what is learned in one situation is sufficiently abstracted and decontextualized to apply to other situations” (Larsen-Freeman, 2013, p. 114). Transfer is a complicated process that has been difficult to operationalize in research because there is no solid consensus on the nature of transfer, the role of inference in transfer performance, the extent of occurrence, and its underlying mechanisms (Barnett & Ceci, 2002).

Within the study of transfer, there are no shortages for taxonomies to explain transfer. One such taxonomy is near and far transfer. Near transfer occurs in contexts that are similar in nature such as a student using a computer at the library and one at the school that are the same model and have the same software (Larsen-Freeman, 2013). Far transfer occurs over two very distinct contexts such as a skilled chess player using the knowledge of chess to run a business (Perkins & Salomon, 1992). In the field of education and the world of high-stakes testing, teachers normally teach for knowledge retention or near transfer for testing purposes (Barnett & Ceci, 2002). Students would benefit more from far transfer, but it is not guaranteed students will make the connection between the two contexts and it is difficult to measure far transfer using traditional assessments.
Effects of Social Agency Theory on Knowledge Retention

Effects of social agency on knowledge retention have been demonstrated in at least two experimental studies. Dunsworth and Atkinson’s (2007) experiments found significant difference between narration with agent over on-screen text (d = .80) and narration (d = .66) conditions. A study by Veletsianos (2009) found expressive agents significantly increase retention over non-expressive agents (d = .64). In both of these studies, the agents resembled the human form, but were starkly different. The agent in Dunsworth and Atkinson (2007) was a full body agent with a cartoon-like appearance, miniaturized in an environment of colorful graphs, and used deictic gestures and narration to direct student attention. Conversely, the agent in Veletsianos (2009) was the only display on the screen with the upper chest, shoulders, and head visible. The agent did not use any gestures as arms and hands were not present, but did use lip synchronization, eye blinks, eyebrow movement, and a predetermined gaze.

Atkinson (2002) was the only researcher in the studies reviewed not to measure retention. Five experiments measuring the retention of information with APAs found no significant difference. Three of the non-significant studies came from Mayer and Dapra (2012) where they found no differences between any of the conditions of embodiment (high, low, no agent), voice (human, machine), and choice of agent (choice, no choice). Two other studies by Moreno and associates (2001) provided no difference in retention scores with agent present and agent not present.

Moreno and colleagues (2001) suggest two limitations to the experiments. The first was the use of only low-experience students, and the second was the learning materials focused on a science system of designing plant parts. Since students had little to no experience with the subject matter, this could have influenced how much the
students could retain when no prior knowledge is present. The same could be said about the three experiments from Mayer and Dapra (2012), as their topic centered on the technical workings of solar cells.

**Effects of Social Agency Theory on Knowledge Transfer**

When examining the experiments involving social agency and transfer of knowledge, influence of human voice and high embodiment on transfer became a prominent theme. Human voice was a factor in all the significant transfer tests. The only time human voice was not significant was when it was paired with low embodiment agents and compared against high embodiment agents (Mayer & Dapra, 2012). At no time did machine voice conditions show any significance. High embodiment was significant with transfer when compared against low embodiment and no agent conditions.

Mayer & Dapra (2012) performed three experiments identical in nature, but focused on different variables. All experiments were designed as narrated slideshows describing how solar cells convert sunlight into electricity. A full-bodied APA was present in each experiment, although different variables such as presence, absence, high embodiment, low embodiment, human voice, and no human voice were tested across the three experiments. The high embodiment agent performed deictic gestures, conversational gestures (not defined), posture, facial expressions, eye gaze, and lip synchronization. The low embodiment agent only performed lip synchronization with a natural posture and facial expressions that remained unchanged during the experiment. An American male speaker recorded the human voice, whereas the machine voice was generated in text-to-speech software.
Experiment one compared high embodiment, low embodiment, and no agent present with all using human voice. Results found the high embodiment plus human voice significantly outperformed low embodiment with human voice ($d = .9$) and no agent but using human voice ($d = .64$). In experiment two, utilized a 2 X 2 model of high embodiment, low embodiment, human voice, and machine voice. The high embodiment with human voice condition significantly scored better than the low embodiment with human voice condition ($d = .9$). With experiment three, human voice with high embodiment and low embodiment were randomly assigned to choice or no choice conditions. Participants in the high embodiment plus human voice condition scored significantly higher on transfer tests than low embodiment plus human voice conditions ($d = .5$). These experiments provide evidence that there is an embodiment effect with social acceptance with the transfer of knowledge.

However, there were also some conflicting results with transfer in the studies. Moreno and colleagues (2001) showed significant differences in the transfer of knowledge when APAs were present, but Atkinson (2002) in experiment 1 showed no significant differences with near transfer or far transfer when agents were present. Atkinson (2002) reasons that the small sample size of the experiment may have decreased the power to the point that no significant difference could be found. The other study that contradicted the rest of the empirical evidence was Dunsworth and Atkinson (2007). In their assessment of transfer, they failed to find any significant difference between the groups, the authors speculated that the jargon and exposure to new vocabulary on human circulatory system might have overloaded students with lower prior knowledge.
Effects of Social Agency Theory on Social Acceptance

Social acceptance of the agent was significantly higher when the agent was present versus absent (Moreno et al., 2001), displayed verbal expressiveness versus no verbal expressiveness (Veletsianos, 2009), and possessed qualities of high embodiment with human-like gesturing (deictic), facial expressions, eye gaze, and lip synchronization versus low embodiment that was a static image except for lip synchronization (Mayer & Dapra, 2012). However, everything was not uniform in the outcomes of social acceptance. In experiment 1 of Mayer and Dapra (2012), high embodiment plus human voice, and no agent plus human voice provided evidence of positive significant effects on learning over low embodiment plus human voice. This could suggest that having no agent with a human voice is a better social cue than having a low embodiment agent with a human voice.

Persona Effect

Another relevant effect of APAs on learners that has been addressed via prior research, is the persona effect, or the anthropomorphization of an agent due to its life-like features of facial expressions, body movements, and gestures that emulate any real-life character (Woo, 2008). This anthropomorphization is important in creating a real-life presence because APA presence keeps students deeply engaged (Kim & Baylor, 2006; Dunsworth & Atkinson, 2007; Woo, 2008) and APAs lend believability to learning environment activities (Towns et al., 1998). The persona effect is similar to social agency theory as they both focus on the APA being anthropomorphized in human-to-computer interaction. The difference between the two theories is social agency theory focuses on image and voice, whereas the persona effect focuses on facial expressions, body movements, and gestures.
Research has shown that the APAs exhibiting the persona effect can be more helpful and credible (Lester et al., 1997), help with concentration (van Mulken, Andre, & Muller, 1998), provide more engagement through the use of verbal and nonverbal communication (Dunsworth & Atkinson, 2007; Gulz, 2005; Lusk & Atkinson, 2007; Sklar & Richards, 2010; Woo, 2008; van Mulken et al., 1998; Lester et al, 1997), and create a strong positive impression of the learning experience in general (Lester et al., 1997).

However, the results on the persona effect are mixed. Dirkin, Mishra, and Altermatt (2005) conducted a study to test the learning experience and social presence of APAs with 116 participants. The study consisted of four conditions: text-only, voice only, voice and image, and fully social agent. The results supported the persona effect hypothesis as the fully social agent was rated significantly higher in social presence, but at the same time, the text-only condition scored significantly higher than the voice only and voice and image conditions. Other studies regarding the persona effect have shown that the APAs did not significantly influence student interest (Domgak, 2010; Choi & Clark, 2006). The mixed results cause a conundrum for researchers as to the legitimacy of the persona effect. However, the quality of the APAs may have had an effect on the negative results (Veletsianos & Russell, 2014). The design of APAs has been an evolving process, and currently, there is no guide as to best design of APAs in multimedia presentations. Therefore, it is difficult to compare APAs across the two decades of research because the technology has enabled researchers to create APAs that closely resemble the human form, and move in life-like ways. Table 2-2 provides an overview of relevant findings that focus on the effects of APA design on social acceptance.
<table>
<thead>
<tr>
<th>Author</th>
<th>Theories</th>
<th>Variables</th>
<th>Outcomes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Baylor &amp; Kim (2009)</td>
<td>Persona effect (not explicitly stated)</td>
<td>Deictic gestures (DG) vs facial expressions (FE) vs learning outcome</td>
<td>Learning&lt;br&gt;FE &gt; No FE&lt;br&gt;DG &gt; No DG&lt;br&gt;Facial expression present: DG &lt; No DG&lt;br&gt;Facial expression absent: DG &gt; No DG&lt;br&gt;Persona (social acceptance)&lt;br&gt;FE &gt; No FE</td>
</tr>
<tr>
<td>Moundridou &amp; Virvou (2002)</td>
<td>Persona effect</td>
<td>Agent vs no agent</td>
<td>Retention&lt;br&gt;Agent = no agent</td>
</tr>
<tr>
<td>Craig, Gholson, &amp; Driscoll (2002) Experiment 1</td>
<td>Persona effect</td>
<td>Agent properties (agent only, agent with gestures, no agent)&lt;br&gt;Picture features (static picture, sudden onset, animation)</td>
<td>Persona&lt;br&gt;No significance with agent properties&lt;br&gt;Retention&lt;br&gt;No significance with agent properties&lt;br&gt;Sudden onset &amp; animation &gt; static picture&lt;br&gt;Transfer&lt;br&gt;No significance with agent properties&lt;br&gt;Sudden onset &gt; static picture&lt;br&gt;Animation was not significant in any comparison</td>
</tr>
<tr>
<td>Dirkin, Mirsha, &amp; Altermatt (2005)</td>
<td>Persona effect</td>
<td>Conditions&lt;br&gt;1. Text only&lt;br&gt;2. Voice only&lt;br&gt;3. Image of agent plus voice&lt;br&gt;4. Social agent</td>
<td>Perception of Learning Experience&lt;br&gt;Text &gt; Image&lt;br&gt;No other conditions were significant&lt;br&gt;Social Presence&lt;br&gt;Text &gt; Voice &amp; Image&lt;br&gt;Social Agent &gt; Voice &amp; Image&lt;br&gt;Text = Social Agent&lt;br&gt;Recognition of Information (Performance)&lt;br&gt;No significant effects</td>
</tr>
</tbody>
</table>

**Persona Effect and Knowledge Retention**

All of the studies exploring the persona effect labeled the outcome measures as retention or learning (attitudinal and procedural). With only four studies to review, it is difficult to generalize any real outcomes, as they all seem to be different. For example,
Baylor and Kim (2009) found facial expressions increased learning over no facial expressions with both procedural and attitudinal knowledge. Conversely, procedural knowledge scored significantly higher when deictic gestures were present, where as attitudinal knowledge was significantly higher when deictic gestures were absent. Interestingly, when facial expressions and deictic gestures were assessed combining both learning domains, facial expressions produce significant results when deictic gestures were absent, and deictic gesture conditions produced significant results when facial expressions were absent. Baylor and Kim (2009) noted that the type of instruction might have played a role with facial expressions and gestures. Students who were in the attitudinal instruction condition preferred facial expressions with no deictic gestures, while students in the procedural instruction condition preferred no facial expressions with deictic gestures. The authors suggest that more than one nonverbal communication strategy might be a distraction.

Other studies that found no significant differences among conditions were Moundridou and Virvou (2002) with agent and no agent, and Craig and colleagues (2002) with agent properties of agent only (gaze, eye blinks, and mouth movements), agent with gestures (deictic gestures and head turns were added to the agent only condition), and no agent. In the Moundridou and Virvou (2002) study, the APA used was a talking head, so it does not truly fit the definition of a personified agent. Craig and associates (2002) listed some limitations to their study that could have influenced the results. They specifically point out that the conditions were only 180 seconds long, not long enough to learn cause-effect relationships. Also, the students were novices in the domain, so these two factors could have played a role.
In the Dirkin and associates’ (2005) study, retention was significant between text and agent + voice. The other conditions of voice and social agent produced no significant results. Dirkin and colleagues (2005) list as a limitation that the study could have caused split attention effect (Mayer & Mareno, 1998), which could have caused students to divert their attention or use additional mental resources to integrate graphics, text, and voice in the same condition.

**Persona Effect and Social Acceptance**

Only two of the four studies focusing on the persona effect measured social acceptance. Baylor and Kim (2009) found that agents with facial expressions resulted in higher acceptance than APAs with no facial expressions. The Dirkin and colleagues’ (2005) study found that the social agent was more socially accepted than the voice and agent + voice conditions. However, in a surprising twist, text was more socially accepted than the voice and agent + voice conditions. Considering that text and a social agent are on two opposite ends of the information representation spectrum, it is difficult to reconcile these data. The authors suggest that social acceptance is more complicated than researchers think.

**Relevant Cognitive Theories of Learning**

Cognitive load theory and cognitive theory of multimedia learning are relevant because they are concerned with the way information is processed in the memory stores in the brain. Three studies in Table 2-3 used a cognitive theory to frame their explorations of APA effects on cognition and learning. The learning outcomes measured by these studies mainly focused on retention and transfer. None of them measured social acceptance.
Table 2-3. Previous Studies of APA Effects on Retention and Transfer

<table>
<thead>
<tr>
<th>Author</th>
<th>Theories</th>
<th>Variables</th>
<th>Outcomes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Experiment 4</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Choi &amp; Clark (2006)</td>
<td>Cognitive efficiency</td>
<td>Human Agent vs arrow</td>
<td>Retention Human agent = arrow</td>
</tr>
<tr>
<td>Lusk &amp; Atkinson (2007)</td>
<td>Cognitive load theory</td>
<td>High embodiment (HE), Low embodiment (LE), voice only (VO)</td>
<td>Near Transfer HE significant Presence Far Transfer HE &gt; VO</td>
</tr>
</tbody>
</table>

Two of the three studies (Mayer et al., 2003; Choi & Clark, 2006) found no significant differences in retention tests between experimental conditions. Mayer and colleagues (2003) compared agent and no agent conditions, while Choi and Clark (2006) compared a human agent and an arrow. Although these two studies have produced negative results for the use of APAs, a closer look at the studies identifies several problems.

Mayer and associates’ (2003) study used an “animated pedagogical agent” called Dr. Phyz. An argument could be made that the agent displayed in this study should not be considered an APA. Dr. Phyz is a static image of a head with glasses, a cape, and trailing stars that moves across the screen as the student progresses. Therefore, Dr. Phyz could become a distraction as he does not perform as an embodiment agent should. It is from this experiment that the common description of APAs as “seductive details” with little influence on learning outcomes originates.
The Choi and Clark (2006) study has some weaknesses as well. It can be argued that their APA, Genie, is not a proper APA for this situation. Genie is a genie with a turban and torso. There are no legs because from the waist he tapers down like he is coming out of a bottle. Genie violates contextual relevance in this situation (Veletsianos, 2007). The visual appearance does not match the agent’s function. In other words, a genie’s function is to grant wishes, not teach English.

The third experiment by Lusk and Atkinson (2007) had different learning outcomes than would be expected for high embodiment and low embodiment. For understanding worked examples, students in the low embodiment condition performed significantly better than high embodiment and voice only conditions. In addition to understanding worked examples more, participants in the low embodiment conditions performed significantly lower cognitive load than those in the high embodiment and voice only. It could be assumed that high embodiment would lead to better retention, but this was not apparent in this study.

The Lusk and Atkinson (2007) study was the only to use transfer tests. Although the low embodiment condition performed significantly better than the high embodiment and voice only conditions with work examples on retention, the high embodiment condition performed significantly better than the low embodiment and voice only condition on near transfer tests. In addition, far transfer with presence showed the high embodiment condition as more significant than the low embodiment and voice only conditions.

**Presence Principle**

Not everyone agrees that APAs are beneficial to learning. The presence principle proposes that learning is not enhanced by the presence of an agent (Mayer, Dow, &
Mayer, 2003). Mayer and colleagues suggest the bodied image of the agent is not important, but the voice is important for learning. Some researchers have claimed that the agent is either ignored (Moreno, 2005) or is a distraction (van Mulken, Andre, & Muller, 1998; Veletsianos & Russell, 2014; Mayer et al., 2003). The use of APAs has been challenged in their effectiveness with learning outcomes (Choi & Clark, 2006). Choi and Clark (2006) questioned if the presence of APAs provides any benefit to learning and motivation for the learner. Foreign language learners studying English relative clauses with an APA performed no better than foreign language learners studying the same content with only an arrow to direct attention and voice.

However, Veletsianos (2007) has questioned the contextual relevance of the APA in the Choi and Clark (2006) study for being a Genie. Veletsianos suggests that Genie’s appearance conflicts with the content area and does not provide an authentic context. In other words, if the foreign language student is looking for an instructor to learn English, does an APA who resembles a fairy tale character fit that role? Veletsianos (2007) argues that Choi and Clark (2006) did not provide an APA that would assist learning or motivate the learner to learn. So the presence of Genie was a distraction.

In regards to this dissertation study, the issue of the APA producing no gestures, or only deictic gestures, could cause the presence of the APA to be hindrance to learning. With the participants being foreign language learners, they may rely on the art of gesturing to help them understand the content. Without this assistance, the presence of the APA may not enhance learning, but serve as a distraction.
Nonverbal Communication

While the presence principle challenges the usefulness of APAs in education, research on nonverbal communication that APAs can potentially provide demonstrates promise of APA effectiveness. Nonverbal communication plays an important role in interpersonal interaction (Argyle, 1988; Hall, 1959). Nonverbal communication is considered anything outside of speech, which “includes facial expressions, hand and arm gestures, postures, positions, and various movements of the body or the legs and feet” (Mehrabian, 1977, p. 1). Nonverbal communication is best summed up as “transmission of information and influence by an individual’s physical and behavioral cues” (Patterson, 1995, p. 424).

The study of nonverbal communication began when Hall (1959) began studying proxemetics, interpersonal distance, and the meaning people assign to the distance. One of the many factors that guide interpersonal distance is culture. Hall (1966) noted that Arabs and Americans have a different sense of personal distance. For Americans, there is a certain sense the space outside of their presence that belongs to them, and should not be encumbered. However, Arabs see all public space as a freedom to occupy. When Americans feel their personal space has been occupied, they normally use some nonverbal cue to show displeasure such as shifting away from the individual. Arabs see this nonverbal communication as being “pushy” (Hall, 1966).

Nonverbal communication has been a focus of APAs in recent research. The field of proxemetics has been studied with APAs and have found that users apply the same social norms in virtual environments as they do in real life situations (Friedman et al, 2007; Yee et al, 2007). APAs have been studied to determine what nonverbal communication aspects of the agent are beneficial to the user’s perception of realness,
or believability, when interacting with APAs. The use of nonverbal communication such as mutual gaze, facial expressions, and deictic gestures have become key areas of study with APAs and realness.

**Mutual Gaze**

An important component to nonverbal communication is mutual gaze. Mutual gaze has been shown to maintain conversation sequencing (Argyle, 1988), attention (Reed, Christiansen, & Larson, 1972), power (Argyle, Lefebvre, & Cook, 1974), and at high levels it exhibits intimacy (Scherer & Schiff, 1973). Mutual gaze is a very strong nonverbal communication cue; however, many people may not realize they are being influenced by it (Zajonc, 1980). This has led researchers to examine the mutual gaze of APAs and the effects it has upon users during interaction.

An experiment conducted by Bente, Eschenburg, and Kramer (2007) showed research participants preferred avatars that had longer gazes (4 seconds) to those avatars with shorter gazes (2 seconds). Participants evaluated long gaze more positively, believed it was more active, and felt there was more social presence than shorter gaze. This supports literature that studied human-to-human research on mutual gaze between individuals (Larsen & Schackleford, 1996).

Other research has shown that people see APAs as more lifelike when the virtual representation exhibits realistic gaze (Reeves & Nass, 1996). In addition to this, Blascovich et al. (2002) found evidence that mutual gaze was a bigger factor in participants’ feeling of social presence from APAs than photographic realism. Therefore, mutual gaze is an important nonverbal cue when creating APAs that are to increase the social component of human-to-agent interaction.
Facial Expressions

An important form of nonverbal communication, and this emphasis of this dissertation study, is the act of gesturing. Gestures are the movements of hands and arms as people talk (McNeill, 1992). These movements can be considered as another form of language production (Kendon, 2004), and as such, are called representational gestures because help support or convey content supplied by speech (Hostetter, 2008). Representational gestures can be divided into three categories: a) deictic gestures that bring attention to items normally through the act of pointing, b) iconic gestures that represent concrete information, and c) metaphoric gestures that represent abstract information. Another type of gesture that is commonly used, but is not representational in nature, is the beat gesture. Beat gestures are simple movements to the rhythm of speech that carry no semantic information, but mark important words or phrases (Thuene & Brandhorst, 2009).

Gestures and speech work together to form a cognitive representation (McNeill, 1985). Kelly et al., (2008) explains how the very act of gesturing when speaking about a car accident provides more information than speech alone in the following:

Suppose a friend describes to you how he got into an auto accident by saying, ‘I didn’t see it coming’. In gesture, your friend might represent how the cars collided by making two, perpendicular flat-handed gestures that move toward one another (making a T shape). The addition of this iconic gesture would provide a much clearer and more elaborate representation of what happened: the reason your friend ‘didn’t see it coming’ was that the other car blindsided him from the passenger side. In this way, the simultaneous coupling of gesture and speech conveys information that is much more complete than the information conveyed through speech or gesture alone. (p. 2-3).

If gestures have the ability to provide information similar to speech, then these two areas should be seen as one system because gestures without speech make little
sense (McNeill, 1992), and speech without gestures is more difficult to comprehend (Krauss, Morrel Samuels, & Colasante, 1991). The very act of gesturing activates cognitive structures within the brain that help with speech comprehension (Willems & Hagoort, 2007), therefore, the two combine together to form comprehensible information in a way that is impossible with the isolated modality of either speech or gestures (McNeill, 1992).

However, there is one type of gesture that does not need speech to be understood, and that is the emblem gesture. Emblem gestures require no language and require cultural knowledge to be understood (McNeill, 1992). An example of this can be seen in the “come here” gesture. In the United States, a person will gesture another person to “come here” by holding the palm up and moving the fingers back and forth quickly. If calling an animal like a dog, the person may whistle and turn the palm down and move the fingers back and forth quickly. No words are needed as the gesture carries meaning, but it depends on the culture. In South Korea, the gesture to “come here” is the exact same, except to call people the palm faces down, and to call animals the palm faces up. This emblem gesture is the same, but the cultural understanding of the gesture can cause problems for unwitting users.

**Gestures in Communication**

Gestures have been well studied over the past forty years. Two areas of research interest have included the production of gestures by the speaker, and the comprehension of gestures by the listener. Many of the theories on gesture production only consider gestures from the production of the speaker, such as sketch (de Ruiter, 1998), growth point (McNeill, 1985, 1987), facilitory (Krauss, Chen, & Chawla, 1996), rhythmical pulse (Tuite, 1992), and entrained (Iverson & Thelen, 1999). All these
theories have examined gestures from a production standpoint. However, research has shown that listeners do benefit from gestures being produced, and individuals do produce gestures to aid understanding (Kendon, 1980; Melinger & Levelt, 2004; Holler & Stevens, 2007). Krass, Chen, and Chawla (1996) contest the notion that gestures help increase comprehension for the listener because the information expressed by gestures is considered too small to make a meaningful contribution.

A meta-analysis conducted by Hostetter (2011) of sixty-three studies found evidence that gestures benefit comprehension with an overall moderate effect size \(d = .61\). One of the categories the author examined was age and the effect sizes from those studies. Age was separated according to two age groups, children (12 years of age and under) and adults (over 12 years old), with children comprising twenty-one studies, and adults of forty-two studies. Analysis showed gestures greatly benefited children \(d = .84\) with comprehension more than adults \(d = .51\). Hostetter (2011) suggests the large effect size for children might be due to less proficient verbal skills and/or attention keeping benefits of gestures. Children may need that extra layer of communication because they do not have the verbal skills of a teenager or an adult. On the other hand, gestures may work at engaging children to keep their attention.

In addition, Hostetter (2011) found that gestures were equally effective whether the gesture was performed spontaneously or scripted. For APA research, this is important because an agent’s gestures can be scripted without the concern of losing the positive effects gestures may have on communication and comprehension.

**Cognitive Neuroscience Support for Using Gestures in Communication**

Cognitive neuroscience provides supporting evidence for the use of gestures while speaking. Neurons called *mirror neurons* were first discovered in the premotor
cortex of the F5 region of macaque monkeys (Gallese et al., 1996). Mirror neurons are special neurons that activate within the subject whether the action is either being observed or performed (Rizzolatti, Fadiga, Gallese, & Fogassi, 1996). Rizzolatti and Arbib (1998) suggest this mirroring of neurons helps the receiver to understand the communicative gesture provided by the sender. The firing of mirror neurons not only happened when the monkeys saw or performed an action, but when the monkeys heard actions as well. There is an audio-visual category to mirror neurons where the neurons that activated during observation and performance, also activated when the monkey only heard the sound associated with an action such as cracking a peanut (Kohler, Keysers, Umilta, Fogassi, Gallese, & Rizzolatti, 2002).

Mirror neurons have also been found in the human brain. They are activated in the motor regions of the hand and foot areas of the brain when action verbs such ‘catch’ and ‘kick’ are spoken to subject (Tettamanti et al., 2005). Likewise, different gesture types have been shown in fMRI studies to activate all the same mirror neurons with equal strength regardless if the individual viewed, produced, or imitated the gestures (Montgomery, Isenberg, & Haxby, 2007).

To support gestures and speech as being one modality, research using fMRI to examine the language center of the brain, Broca’s area, has provided evidence that the area processes gestures integrated with speech (Willems, Ozyurek, & Hagoort, 2007). PET scans have found evidence of Broca activation with arm and hand movements (Schlaug, Knorr, & Seitz, 1994), and mental hand grasping and rotation tasks (Decety et al., 1994; Parsons et al., 1995). Additional PET scans have provided evidence that the Broca’s area is not activated by pure movement (Johnson-Frey et al., 2003) or by
meaningless gestures (Greze, Costes, & Decety, 1999), but is activated by gestures that have meaning.

**Gestures in Foreign Language Learning**

Gestures perform an important role in second language instruction and learning (Moskowitz, 1976). Gestures have been shown to assist with retaining foreign language items, and slowing the forgetting process (Quinn-Allen 1995; Tellier 2008; Macedonia & von Kriegstein, 2012).

Research on gestures and listening comprehension with foreign language learners has provided evidence that gestures, or lack thereof, influence comprehension. In a study conducted by Church and colleagues (2004), English speaking and Spanish speaking students received math instruction through an instructional videotape via the English language. Each population was divided and placed into one of two conditions: videotape instruction with speech and gestures, or videotape instruction with only speech (no gestures). Regardless of native language, students who watched the speech and gestures videotape performed significantly better in terms of learning. The Spanish speaking participants had no knowledge of English, so the authors speculate that the use of gestures allowed the Spanish speaking group to access the lexical knowledge of Spanish to assist learning. This lexical access would be missing in the speech only condition.

Vocabulary learning can also benefit from gestures. Allen (1995) conducted research on students learning French as a foreign language. The students in this study were divided into three groups: experimental group that learned gestures and used them in the recall posttest, a comparison group that did not learn gestures, but were exposed to them in the recall posttest, and a no treatment group that were not exposed
to gestures at any time. Results showed that the experimental group had significantly higher recall on posttest scores, and in delayed recall assessments.

It is not the sole act of hand and arm movement that makes a difference; empirical research has provided evidence that gestures should match the speech content (Kelly et al., 2009). In a study with psychology college majors at an American university, Kelly and colleagues (2009) recruited native English speaking students to learn Japanese verbs. The within-subjects research design used four conditions: Speech (S), Speech + Congruent Gesture (S+CG), Speech + Incongruent Gesture (S+IG) and Repeated Speech (RS). The speech condition provided no gestures, the speech and congruent gesture condition full speech and gestures, the speech and incongruent gesture condition did not match gestures with speech, and the repeat speech condition repeated the information twice with no gestures. In the treatment, students were told to watch instructional videos of Japanese verbs and remember as many as possible. Students in the speech plus congruent gesture condition significantly outperformed all the other conditions. The speech plus incongruent gesture condition performed significantly worse than all the other conditions. This remained true in recall testing one and two weeks later. The condition order at which Japanese verbs were recalled across all times: S plus CG, RS, S, S plus IG. The authors suggest this supports their hypotheses that gestures improve learning because of semantic content, and speech with gestures are better than speech with no gestures. This provides support to the notion that speech and gesture are one modality (McNeill, 1992).

**Types of Gestures**

Gestures are representational in nature because they convey or support content supplied by speech (Hostetter, 2008). And because speech can carry simple to
complicated linguistic information, various types of gestures are performed to account for the range of information being expressed. There are five different types of gestures: deictic, beat, iconic, metaphoric, and emblem. Emblem gestures will not be discussed because these gestures can be understood without language by those who view them. For example, two fingers being held up to form a V sign can be seen as “peace” in the United States, or an offensive gesture in England. These are easily understood in the culture they are presented. For this dissertation study, we will only focus on the gestures that are combined with speech to convey meaning, namely deictic, beat, iconic, and metaphoric gestures.

**Deictic Gestures**

For human-to-agent interaction, research has shown deictic gestures (using arms and hands) are important for believability of APAs (Atkinson, 2002; Johnson, Rickel, & Lester, 2000). Johnson, Ozogul, and Reisslein (2015) state “when an APA uses such human-like movements, learners may more easily perceive it as social agent, thus adopting a social stance in which they feel more obligated to expend efforts to learn” (p.100).

One area that has been studied is visual signalling by an APA. Visual signalling is the use of some item (color code, arrow, flashing, etc.) to direct the learner’s attention to important information (Johnson et al., 2015). Studies have shown that visual signalling by an APA is more effective than an arrow to guide attention (Choi & Clark, 2006; De Koning & Tabbers, 2013; Johnson, Ozogul, Moreno, et al., 2013; Moreno et al., 2010). De Koning & Tabbers (2013) showed visual signalling by an APA improved retention and transfer.
An APA that has been tested using deictic gestures is Billie. Macedonia, Kern, and Roithmayr (2014) compared children’s acceptance of Billie versus a real child on video. The results showed the real child performed the gestures more naturally, but there was no difference between speed and variable intelligence between Billie and the real child. In other words, Billie was accepted as a trainer as well as the child in the video.

Table 2-4 provides an overview of relevant findings that focus on the use of deictic gestures by APAs.

Table 2-4. Previous Studies of APA and Deictic Gestures

<table>
<thead>
<tr>
<th>Author/Year</th>
<th>Participants</th>
<th>Variables</th>
<th>Outcomes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Atkinson (2002)</td>
<td>Undergraduate Students</td>
<td>Text vs voice vs agent + voice*</td>
<td>Near Transfer agent + voice &gt; text, voice</td>
</tr>
<tr>
<td>Experiment 2</td>
<td></td>
<td>*agent made use of gaze and deictic gestures</td>
<td>Far Transfer Agent + voice &gt; voice &gt; text</td>
</tr>
<tr>
<td>Craig, Gholson, &amp; Driscoll (2002) Experiment 1</td>
<td>Undergraduate Students</td>
<td>Agent properties (agent only, agent with gestures, no agent) Picture features (static picture, sudden onset, animation)</td>
<td>Persona No significance with agent properties Retention No significance with agent properties Sudden onset &amp; animation &gt; static picture Transfer No significance with agent properties Sudden onset &gt; static picture Animation was not significant in any comparison</td>
</tr>
<tr>
<td>Buisine &amp; Martin (2007)</td>
<td>Undergraduate Students</td>
<td>Agent appearance + speech-gesture cooperation (redundancy/complementary/control) + presentation content</td>
<td>Written Recall/ Quality of Explanation/ Likability/ Expressiveness Speech-gesture redundancy &gt; complementary = control Graphic Recall No significant effects</td>
</tr>
</tbody>
</table>
The use of deictic gestures has shown to increase transfer of knowledge in several studies (Atkinson, 2002; Mayer & Dapra, 2012), learning (Baylor & Kim, 2009), written recall, quality of explanation, likability, expressiveness (Buisine & Martin, 2007), and social acceptance (Mayer & Dapra, 2012).

Table 2-4. Continued

<table>
<thead>
<tr>
<th>Author/Year</th>
<th>Participants</th>
<th>Variables</th>
<th>Outcomes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Frechette &amp; Moreno (2010)</td>
<td>Undergraduate Students</td>
<td>Conditions 1. Static agent 2. Deictic movements 3. Facial expressions 4. Deictic movements and facial expressions 5. Control</td>
<td>Recall: Static &gt; Facial Expressions, No other significant effects found Comprehension: Static &gt; Facial Expressions, No other significant effects found Transfer: No significant effects found between all conditions</td>
</tr>
<tr>
<td>Mayer &amp; Dapra (2012)</td>
<td>Undergraduate Students</td>
<td>High embodiment (HE), low embodiment (LE), no agent (NA), and human voice (HV)</td>
<td>Retention: No significant difference in all conditions Transfer: HE+HV- significant, LE+HV &amp; NA + HV- not significant Social Acceptance: HE+HV&gt;LE+HV, HE+HV=NA+HV</td>
</tr>
<tr>
<td>Mayer &amp; Dapra (2012)</td>
<td>Undergraduate Students</td>
<td>High embodiment (HE), low embodiment (LE), and human voice (HV), machine voice (MV)</td>
<td>Retention: No significance in all conditions Transfer: HE+HV &gt; LE+HV, HE+MV = LE+MV</td>
</tr>
</tbody>
</table>
The research by Buisine and Martin (2007) was unique because gestures were
the central focus of the study. Other studies combined variables such as high
embodiment (Mayer & Dapra, 2012), gesture and gaze (Atkinson, 2002), or facial
expressions (Baylor & Kim, 2009). In the research conducted by Buisine and Martin
(2007), redundant, complementary, and no gestures were tested in several different
scenarios. Redundant gestures are those that reinforce information, complementary
gestures account for information not stated, and the no gesture condition only provided
speech for the learners. The authors provide an example that characterizes the
difference between redundant and complementary gestures. If a teacher were lecturing
the students on the route Hannibal trekked in his invasion of Italy, using redundant
gestures, the teacher would point to places on the map and refer to them by name. With
the exact same lesson using complementary gestures, the teacher would still point to
the places Hannibal trekked, but instead of saying the name of the country, the country
is substituted with the word ‘here.’ Complementary gestures require the learner to
collect information that has not been explicitly mentioned. In the example above, the
teacher saying ‘here’ instead of Italy could cause problems for comprehension. The
student might not fully see where the teacher pointed, or the student might not know the
country from just looking at a map. These become big issues for student understanding
and comprehension.

The results from the research showed that redundant gestures play an important
role in student recall and perceived attributes of the APA over complementary and no
gesture conditions. This supports the notion that gestures have the ability to support
learning if properly administered.
However, some studies have shown that deictic gestures have had no significant effects on retention (Craig, Gholson, & Driscoll, 2002), transfer (Craig, Gholson, & Driscoll, 2002; Frechette & Moreno, 2010), and social presence (Dirkin, Mirsha, & Altermatt, 2005). These results provide evidence that deictic gestures are not always guaranteed to improve different aspects to learning or create a social presence.

In an empirical study by Craig, Gholson, & Driscoll (2002), APAs were examined with agent properties of agent only (gaze, eye blinks, and mouth movements), agent with gestures (deictic gestures and head turns were added to the agent only condition), and no agent condition. The agent with deictic gestures did not significantly influence retention, transfer, or the social perception of the agent when compared to the other conditions. The same results happened with empirical research conducted by Dirkin, Mirsha, and Altermatt (2005). These researchers provided evidence that deictic gestures did not significantly increase social presence and the recognition of information. However, Dirkin and colleagues did find the social agent who used deictic gestures provided significantly better results on social presence over voice only and image plus voice conditions. On the other hand, the text only condition provided significantly better results on social presence over voice only and image plus voice conditions, so this calls into question the usefulness of a social agent with deictic gestures if the same results can obtained with only text. When compared against each other, the social agent and the text only conditions showed no significant effects in social presence.

Frechette and Moreno (2010) found evidence that deictic gestures may not help recall, comprehension, and transfer. The conditions for this empirical research were
static agent, deictic movements, facial expressions, deictic movements and facial expressions, and a control group. In terms of measuring recall and comprehension, only the static agent was significant over facial expressions. No other significance was found between other groups. In the measurement of transfer, no condition was found to be significant compared to another. It is worth noting this study was designed in a different method when compared to other research using APAs. In other empirical studies, APAs were created with software that made the APA look like it was digitally produced. In the Frechette and Moreno (2010) empirical study, they filmed a human on video and spliced the film into several hundred frames to create the animations. Special software was used to render all the actions and narration together to make a photo-realistic fidelity APA. This could be a problem with this study as the APA is a human, but may not function as human when it comes to movements because of the spliced segments of film. The possible unnaturalness of the APA may have been a reason why the static image was found to be the only significant effect on recall and comprehension, and all other conditions were not significant with recall, comprehension, or transfer.

When researchers use gestures in empirical studies with APAs, they predominantly use deictic gestures. Deictic gestures have shown the ability to help with transfer, recall, likeability, and social acceptance. On the other hand, some empirical studies have shown deictic gestures have no significant influence on retention, transfer, social presence, comprehension, and persona. These mixed results point to the usefulness of deictic gestures, but also to the fact that deictic gestures may need to be supported by other gestures to create a human-like APA capable of fulfilling the needs of the type of instruction being sought.
Beat Gestures

Beat gesturing is defined by the two phases of extension and retraction and can occur with body parts such as fingers, hands, arms, or legs (Leonard & Cummins, 2011). The timing and coordination of speech to beat gestures has been debated within literature. McNeill (1985) suggests that speakers naturally produce gestures simultaneous with meaningful and practical linguistic items. Kendon (1980) proposes that the extension phase occurs at or slightly before the stressed syllable. De Ruiter (2009) proposes that there are problems to link speech and beat gestures simultaneously, but most gestures begin less than a second before the beginning of the speech sound.

Research conducted by Treffner, Peter, and Kleindon (2008) used an avatar to perform beat gestures at various times with the sentence “put the book there now.” Results showed for beat gestures to be perceived as natural, the timing of the gesture should occur simultaneous or slightly proceeding the word being produced. These findings have been reproduced and supported by other studies on timing of beat gestures and speech (Krahmer & Swerts, 2007; Leonard & Cummins, 2011). However, most studies in this area are highly constrained and beat gestures are often overemphasized in studies to be measurable (Leonard & Commins, 2011). Even with various views and results on beat gesturing, research has found beat gestures while speaking showed more neural activation than nonsense hand movements and speaking alone (Hubbard, Wilson, Callan, & Dapretto, 2009). Hubbard et al. (2009) suggest that speaking and gesturing are part of a social interaction that are processed by common neural substrate in the brain.
With the idea of high embodiment being ill-defined when it comes to APA research and the act of gesturing, it may benefit the high embodiment argument to include more gestures than deictic and the sparsely studied iconic gestures, and to better align those gestures to the context or message being conveyed. Beat gestures are a common occurrence in human-to-human communication, but are routinely overlooked when designing gestures for agent-to-human communication (Thuene & Brandhorst, 2009). This is disconcerting because APAs are to be perceived as lifelike characters with human characteristics, but lack a common gesture that is used in human-to-human interaction. In analyzed video of participants narrating a cartoon, McNeill (1992) found that 44.7% of the gestures the participants made were beat gestures. However, the number of gestures varies from individual to individual, and may also be influenced by the type of information given. In a study on participants giving directions, beat gesturing ranged from 15.8% to 43.5% with the average of 32.1% (Thuene & Brandhorst, 2009).

**Iconic Gestures**

Iconic gestures are movements that illustrate concrete information (Straube, Green, Bromberger, & Kircher, 2011). Some examples of iconic gestures are placing hands together in front of the face while talking about a mirror, or hands forming a round circle while talking about a ball. Research studies have shown that this type of gesturing helps new vocabulary recall in children and adult learners of foreign language (Tellier, 2008; Kelly, McDevitt, Esch, 2009). Research by Macedonia, Muller, and Friederici (2011) showed that participants who learned foreign language nouns had significantly better recall after training, and 60 days after the intervention when compared to meaningless gestures. The fMRI results from the Macedonia et al., (2011) study
showed that different brain activation patterns happened between the iconic gestures and meaningless gestures. The iconic gestures were more localized in the premotor cortex, whereas the meaningless gestures were spread to various areas across the brain.

There have been very few studies with iconic gestures and APAs. One study by Bergmann and Macedonia (2013) compared iconic gestures for foreign language vocabulary produced by APAs against those produced by a human instructor and a no agent condition. The within-subjects study tested 29 German students learning the artificial language ‘Vimmi’. The authors hypothesized there would be no difference between the amount of learning between the conditions. In other words, students would be able to learn as effectively with an APA as they would with a human subject. In most tests, the APA outperformed the human condition, but the only significant results were found between the APA and the no agent condition in short and long-term measures of free and cued recall. There were no significant results between the human condition and no agent condition with any measure. When comparing high-level and low-level performers with the artificial language, high-level performers scored higher with the APA condition, while low-level performers scored higher with the human condition.

In another study, an APA named Billie and a human child performed iconic gestures on video to measure children’s social acceptance of Billie as a language trainer when compared with a human (Macedonia, Kern, & Roithmayr, 2014). Significant results showed the human child performed the gestures more naturally, but there was no significant difference between speed and variable intelligence between Billie and the human child. Billie, a high embodied agent who performed the movements of a human
child, was accepted as a trainer as well as the child in the video. The authors suggest that natural gesturing is a technological limitation that will be overcome as technology progresses.

**Metaphoric Gestures**

Metaphoric gestures are movements that illustrate abstract information (Straube, Green, Bromberger, & Kircher, 2011). An example of metaphoric gestures is raising the hand above the head and arching the hand when explaining an individual’s understanding is ‘high level.’ The concept of an individual’s understanding is not a tangible matter, so it is classified as metaphoric. A characteristic of metaphoric gestures, as well as iconic gestures, is that the gesture without the speech is meaningless (Feyereisen, Van de Wiele, & Dubois, 1988). Metaphoric gestures are some of the most common gestures made. A research study by Duncan and Fiske (1977) showed that half of the gestures and all of the referential gestures participants produced were metaphoric.

**Gesture Production**

For researchers to develop theories regarding gesture production, there must be an understanding of what components constitute a gesture. Kendon (1983) breaks a gesture into three phases. The first phase is the preparation phase where the gesture begins from rest. When there is a pause between two gestures, the pause is the preparation phase. The second phase is the stroke phase. This is the distinct motion that is performed by the body part, such as fingers forming pointing, or the wrist and hand moving in a circular motion. The third phase is the return phase where the gesturing limb returns to rest.

Another version of gesture production is similar to that Kendon (1983) proposes,
but adds more variance within the performance. McNeill (1992, 2005) contends there is an initiation phase, gestural stroke phase, and retraction phase when performing gestures. However, McNeill (1992) asserts there can be pre-stroke and post-stroke holds (Kita, 1990) to keep in synchrony with the lexical affiliate. The stroke holds are not necessary for the performance of the gesture, but act as temporal synching mechanism to match gesture with speech.

The pre-stroke and post-stroke holds are important to gesture production because it allows for gestures to be full with prosody. Prosody is the stress, rhythm, intonation, melody, and rate of speech (Kent 1997) that enables the speaker to send different meanings to the listener. Table 2-5 provides an example of stress of words in a sentence can change the meaning of what is being said.

Table 2-5. Use of Prosody and Gesture on Meaning

<table>
<thead>
<tr>
<th>Emphasis</th>
<th>Meaning</th>
<th>Gesture</th>
</tr>
</thead>
<tbody>
<tr>
<td>I love you</td>
<td>Emphasizing that the speaker loves the other as in answering the question, “Who loves me?”</td>
<td>I love you</td>
</tr>
<tr>
<td>I love you</td>
<td>Emphasizing that the speaker loves the listener and not another person.</td>
<td>I love you</td>
</tr>
<tr>
<td>I love you</td>
<td>I love you</td>
<td>I love you</td>
</tr>
</tbody>
</table>

In essence, prosody allows the user to control speech in a way that provides perceptual cues to the listener, and gestures can be manipulated according to prosody of the language to emphasize the message being delivered.
Prosody and gesture production will be a key component to the creation of gestures for this dissertation study. As seen with Table 2-5, and according to McNeill’s (1992) production of gestures to include holds, gestures will be created according to the prosody and semantic meaning of the message being delivered.

**Rhythmical Pulse Theory**

It has been empirically documented that gestures precede or simultaneously begin with the lexical equivalents (Bernardis & Gentilucci, 2006; Butterworth & Beattie, 1978; Feyereisen, 1983; Morrel-Samuels & Kraus, 1992). There are several different gesture theories for the production, but were not considered because they lacked certain constructs that integrate with foreign language teaching. One of the main considerations was prosody of language, and the gesture ability to precede or simultaneously begin with lexical equivalents.

Rhythmical pulse (Tuite, 1993) is a gestural theory that links prosody to gesture and language. The theory suggests that gestures are kinesic, or a rhythmical pulse, and gestures are a “kinetic realization of the underlying pulse” (Tuite, 1993, p.99). Beat gestures match the pulse, or prosodic stress, of the speech. Whereas gestures that are representational in nature are overlaid upon the pulse of speech. Research into prosodic stress and gestures have provided evidence that gesture onset was manipulated according to syllable stress and the apex of the gesture (Rochet-Capellan et al., 2008). More importantly, the theory can be applied to all gesture types, something that is not possible other theories such as the sketch model (de Ruiter, 2000). However, it must be noted that the rhythmical pulse hypothesis is more for the producer than the receiver. So the benefit is not for the listener to understand more, but for the producer to benefit from the use of gestures. However, this does not mean that the listener does not
benefit from the gestures, but gestures are manipulated from the prosody of the language by the producer.

**Conceptual Framework**

The conceptual framework for the proposed dissertation study is based on the literature reviewed above – that is, persona effect (Woo, 2008), social agency theory (Mayer, 2005), and the presence principle (Mayer, Dow, & Mayer, 2003) in reference to nonverbal communication and gesturing with the acceptance and learning with APAs. Humans gesture as they talk, therefore, if APAs are to be perceived as human-like, APAs should perform gestures similar to that of human beings. In previous research with APAs and gesturing, most research has mainly been carried out with deictic gestures, and a couple studies on iconic gestures. Overlooked have been the use of beat gestures, which accounted for 32.1% of gestures in research by Thuene and Brandhorst (2009), and metaphoric gestures which have not been studied with APAs. Humans are not isolated to one gesture, but use a multitude of gestures with speech.

The persona effect suggests lifelike characters have a strong positive effect on the learning experience inside an interactive learning environment (Lester et al., 1997). The benefit of the persona effect is that it provides the learner with a sense of being with a real person while learning (Woo, 2008). The real-life presence of APAs can be an important asset to education because their presence keeps students deeply engaged (Kim & Baylor, 2006; Dunsworth & Atkinson, 2007; Woo, 2008) and APAs lend believability and authenticity to learning environment activities (Towns et al., 1998).

The persona of the APA supports social agency theory, which suggests social cues lead learners to feel as if they are interacting with another person (Mayer, Sobko, & Mautone, 2003), and therefore, media can be viewed as interacting with a real person.
where social rules apply (Reeves and Nass, 1996). In essence, the perceived persona of the APA will lead to the agent being socially accepted by the participant or not.

However, the use of APAs has been challenged in several studies as to their effectiveness with learning outcomes (Choi & Clark, 2006; Clark & Choi, 2007; Heidig & Clarebout, 2011). Some researchers have claimed that the agent is either ignored (Moreno, 2005) or a distraction (van Mulken, Andre, & Muller, 1998; Mayer et al., 2003). For these reasons, the presence principle suggests that learning is not improved by the presence of the agent.

It is hypothesized that the more human-like the APA behaves, the more socially accepted the agent will be in eyes of the participant. Therefore, the full gesture condition of the APA should be more socially accepted than the deictic only and no gesture conditions because the APA performs like that of a human. The deictic only and no gesture conditions will not be as socially accepted because those conditions do not match human-like expectations.

The retention and transfer of information learned are hypothesized to be significantly higher in full gesture condition opposed to the deictic only and no gesture conditions. Gestures play a significant role in comprehending and the development of foreign language (Kelly, McDevitt, & Esch, 2009). The combination of deictic gestures to direct attention, beat gestures to connect syllable training, iconic gestures for concrete information, and metaphoric gestures for abstract information provide much needed support for foreign language learning. The deictic only condition should hinder learning because gestures do not support the comprehension of language learning content.
Likewise, the no gesture condition provides limited assistance for comprehending language for speech, which should not be beneficial to learning.

In sum, the full gesture condition should outperform the deictic only and no gesture conditions in social acceptance because gestures is expected to match human expectations according to persona theory and social agency theory. Likewise, because the full gesture condition is more socially accepted, it should lead to higher retention and transfer scores because participants have the support of gestures to speech to increase comprehension over the deictic only and no gesture conditions. See Figure 2-1 for the conceptual framework.

Figure 2-1. Conceptual Framework for APA Gestures for social acceptance, retention, and transfer
Pilot Test

A pilot test was scheduled and conducted at a different school in the same southwestern Korean city than where the main experiment was conducted. The participants in the pilot study were thirty-four 5th and 6th grade students in the public elementary school system. The experiment context mirrored that of the main experiment in that it was held in the school computer room with twenty-four computers, two computers per table, 17-inch monitors, and computer station and projector in the front for the teacher.

Before the students arrived, computers were turned on and colored envelopes were placed in order of full condition, deictic condition, and no condition with repeating cycles in front of the computers. Due to the unknown amount of time the total intervention would take, it was decided to type in the experiment condition URL into the computer. The shortened URL for the full condition did not work, so the full condition envelopes were opened to use the longer URL produced by Qualtrics. The Quatrics URL worked so all computers had the experiment condition ready for the students when they randomly chose their seats.

The purpose of the pilot test was three-fold: 1) to test the procedure, 2) to test the intervention, and 3) to test how students performed with the interventions. The pilot test exposed study design issues in all three areas. First, the experiment was designed for students to first be read the informed consent form and then go through all phases of the experiment without stopping. This proved problematic because many students started the experiment before listening or reading the informed consent. Because students were paired at a table, many students became distracted by what the student next to him/her was doing, and only a few students were listening. Also, the students did
not know how to use the orange arrow at the end of section to move to the next segment of the experiment, so students would arrive at the end and then ask questions about what to do next. This created a lot of noise and disruption.

Another issue that was widespread across all groups was asking questions about the prior knowledge assessment. Students had no knowledge of the content, so they raised their hands asking what to do when they read a question they did not know. The students were instructed to guess if they were not sure. This instruction caused many students to not read the questions and just go through the assessment clicking responses.

In addition to the random guessing when they were not sure, it was witnessed that students did not understand the logic of the questions. For example, students had to read the sentence, choose an “er/more” answer, and then provide the rule why they chose “er/more.” This caused the students problems because they could not connect the separate questions as being one. Also, the English sentences became a distraction to the students because they were trying to understand the sentences. Because students were being overwhelmed by the knowledge content, logic, and English sentences, many students would arrive at the top of the page, scroll down to see how many questions there were, scroll back up and start randomly choosing answers.

Furthermore, the seating of the students became an issue. Since the students were sat two to a table, that meant that each student had a separate condition than their desk mate. This was an issue with the no condition students. They quickly noticed their APA was not moving and began watching the other student’s computer, and/or raising their hand to question why their APA was not moving.
For all these reasons, it is not surprising that an ANOVA provided no significant results across any condition or between any of the assessments provided.

**Pilot Test Changes**

The pilot test revealed many issues that needed to be remedied before and accurate assessment could be collected from the experiment. Changes made to the experiment are such:

1) Instead of each computer given a condition, each table was provided with the same condition to keep students from becoming distracted because the different performances by the APAs.

2) The whole experiment was made more systematic so that everyone progressed at the same time. Once students logged onto their condition, a huge red stop sign in Korean instructed students to wait and listen to the teacher. The same stop sign was placed at the end of each section so that everyone proceeded at the same pace.

3) All complete sentences in the er/more question section were eliminated and only the English word was provided so the students could only focus on adding er/more. This was designed to keep students focused on the word and not become distracted by peripheral information.

4) The two tiered logic questions were separated into two sections. One section asked the student to add er/more to the word. The second section provided the student with a word and provided the change to er/more. The student was then asked to provide the rule as to why this change was made.

5) “I don’t know” option was added to possible answers so students would not be overwhelmed if they did not know the answer. This caused frustration during the pilot test, so this was added to alleviate some of this frustration and keep random guessing under control in situations where there were only two answers.

6) Directions and some questions and answers were translated into Korean to help with better understanding.

7) The number of questions on each assessment was reduced to ten questions to keep students from feeling overwhelmed with answering many questions.

These changes were made in an effort to remove any extraneous variables that could conflict the results and provide an accurate assessment of how each gesture condition contributes to the retention and transfer of English grammar rules.
CHAPTER 3
METHOD

This between-subjects quasi-experimental study was conducted at one elementary school located in Jeollanam-do Province in South Korea. Data were collected using APAs with different gesturing conditions to test (a) retention and transfer of grammar rules taught by an APA, (b) if social acceptance of the APA differs between gesturing conditions, (c) if APA acceptance influences learning outcomes, and (d) if social perception influences learning performance. The experimental manipulation focused on varying the level of APA embodiment using gestures and so the three conditions consisted of full gestures, deictic only gestures, and a no gesture condition. The grammar rules covered in the study involved counting syllables to use “–er” and “more than” for adjectives in the comparative form. This chapter explains the research design, data collection process, and data analysis of this study.

Participants

The participants for this research included 5th and 6th grade South Korean elementary school students in the Jeollanam-do public school system. A priori sample size calculation, with a medium effect size and an alpha level set at $\alpha = .05$, indicated a sample size of 52 participants was needed for each condition (Cohen, 1992). This study collected data from 160 participants, exceeding the minimum of 156 needed to have sufficient power. There were 54 participants in the full gesture condition, 53 in the deictic gesture condition, and 53 in the no gesture condition.

Thirty-nine percent of the participants were girls, and 61% were boys. The average age of the participants was 12.5 years old according to Korean age, or 11.5 years old in Western age.
Materials

Lesson Content

The English language curriculum for the South Korean public school is regulated. Select book publishers are government approved to supply learning materials to the public schools, but each publisher must abide by the same guidelines. This means lesson themes follow a similar pattern with the publishers having choices on layout design and how the information is delivered. Although Korean students learn about comparatives in 6th grade, there is no focus on the grammatical rules of how to use comparatives. It is highly unlikely they have been exposed to the concepts of syllables and special rules of using “–er” or “more than”. The lessons learned in elementary school focus more on memorization and interaction with others using the language without any grammatical underpinning to support the use.

English is considered a stress-timed language where each syllable appears to have an equal time value (Collins & Mees, 2013). This allows English vocabulary to be segmented according to syllables, and beat gesturing applied to learning activities such as grammar rules of comparatives and superlatives. Beat gesturing is defined by the two phases of extension and retraction and can occur with body parts such as fingers, hands, and arms (Leonard & Cummins, 2011).

The lesson focused on the grammar rules of using “–er/more” for comparatives in English. An important part of the lesson included learning the special case rules for comparatives, but using beat gesturing to understand the syllables of English vocabulary. The syllables for English vocabulary were broken down into words that contained one syllable, two syllables, and three or more syllables. The special rules presented in the lesson included adjectives ending with “–ful” and “–ent.” Although there
are around 15 special case endings that deviate from the syllable rule, these two were chosen because they offered more two-syllable words than many of the other special cases. See Appendix A for the intervention script.

This topic for instruction was chosen because students are around the time in the curriculum where they will learn about comparatives using “–er” and “more” in elementary school. However, textbooks do not include any mention of syllables, and the only special rules covered are irregular comparatives like good being transformed to better in the comparative form. This topic is familiar to the students, but provides a variation that is most likely unknown to the students. The concept of syllable beats paired with general and special rules can be covered in a short amount of time.

**Computer Based Materials**

The presentation of the content was constructed in Reallusion’s iClone 6™ and exported to a video format. The head of the APA was created in Crazy Talk 8 Pipeline™ by using the headshot of a person. The digital head was exported to Character Creator™ for embodiment, and the embodied APA was exported to a school classroom environment in iClone 6™. The school classroom background was purchased through the Reallusion Content Store™. The background never changed throughout any of the conditions. The only factor that was manipulated experimentally was the APA’s gesture condition (full, deictic only, and no gesture).

A southern American male recorded the narration of the lesson in the open source audio editor and recorder Audacity. For the full gesture condition, the APA’s arms and hands were altered to support the language content of the character. The full gesture condition used deictic, iconic, metaphoric, and beat gestures. In the deictic only
gesture condition, the APA only performed the deictic gestures used in the full gesture condition. Iconic, metaphoric, and beat gestures were eliminated to keep in line with gesture production in typical APA research studies. For the no gesture condition, all gestures were eliminated inside the program so they were absent during the presentation. See Figure 3-1 for a screenshot of full gesture and no gesture conditions.

Gestures were designed in the iClone 6™ software using the timeline and Edit Motion Layer. The Edit Motion Layer allowed the creator to isolate body parts and alter the movements to mimic those found in human gesturing. The software provides a small sample of motions the APA could perform, but the available motions are not enough to produce the gestures needed for this intervention. Therefore, all gestures were designed and manipulated in the Edit Motion Layer.

Figure 3-1. Full gesture (right) and no gesture conditions (left).

**Gesture Design**

Gestures were designed using rhythmical pulse theory (Tuite, 1993). This theory accounts for the various types of gestures being used in this dissertation study, the prosody of language being used, and McNeill's (1992, 2005) gesture production
sequence that includes the ability to hold and pause gestures. Table 3-1 provides examples of how gestures were employed in the intervention. For complete documentation of agent gestures with the intervention script, please view Appendix B.

Table 3-1. Gesture Design According to Rhythmical Pulse Hypothesis

<table>
<thead>
<tr>
<th>Gesture</th>
<th>Movement</th>
<th>Example</th>
</tr>
</thead>
</table>
| Beat    | Beat     | compare two things in English  
|         |          | *Hand/fist move up and down quickly* |
| Deictic | Beginning | Let's take a look  
|         | End      | *Pointing to an area* |
| Iconic  | Beginning | For these two balls  
|         | End      | *Forming a ball with two hands* |
| Metaphoric | Beginning | How about the word beautiful?  
|         | End      | *Hands form V-shape under chin* |

Measures

Several measures were employed to assess dependent variables in this dissertation study. Demographic information was collected to provide additional data to compare to the outcomes to determine if demographic differences play a significant role in the outcomes. The Korean Agent Persona Instrument (KAPI, Ryu, 2012) was used to collect data on the social acceptance of the APAs. The prior knowledge, knowledge retention, and knowledge transfer tests provided data on what the learners knew before the intervention, and the information learned after the intervention.
Demographic Questionnaire

A demographic questionnaire was presented before learners could participate in the study. The questionnaire collected data on age, gender, hours per week studying English at afterschool academies, and if the participants had ever lived in an English-speaking country for more than four months (Appendix C).

Prior Knowledge Test

A pretest was designed to test the learners’ prior knowledge of syllables, use of “-er/more”, and the special rules that differ from syllable procedure. The information in the pretest was not covered in the intervention lesson to eliminate pre-training from being a confounding variable. There were 10 questions and learners were given one point for each question answered correctly (Appendix D).

Korean Agent Persona Instrument

The KAPI (Ryu, 2012) was used to measure the social acceptance of the APA conditions (Appendix F). The KAPI is an adaptation of the Agent Persona Instrument (API; Ryu & Baylor, 2005) written in Korean for students in South Korea. The questions for the KAPI and the API are identical, but the KAPI has five fewer questions in the facilitating subscale for a total of twenty questions overall. This was done to create a more balanced survey with five questions in each measure of credibility, human-likeness, engagement, and facilitation (Ryu, 2012).

The KAPI scale measures the perceptions of the agent from the affective domain. The instrument contains 5 questions addressing agent credibility ($\alpha = .82$), 5 questions addressing the human-likeness of the agent ($\alpha = .87$), 5 questions addressing the engagement of the agent ($\alpha = .87$), and 5 questions addressing the facilitation of learning by the agent ($\alpha = .81$) (Ryu, 2012). The scale was built for learners to respond
to questions on a five-point Likert scale where responses range from (1) “strongly disagree” to (5) “strongly agree”. It was administered immediately after the intervention. Please refer to Appendix E for the API instrument, and Appendix F for the KAPI instrument.

**Knowledge Retention Test**

The retention post-test was developed from the definitions, words, and rules of the intervention to test the learners. There were a total of 10 questions with each question counting one point each. The retention post-test consisted of four words for students to define the number of syllables, three words to that needed to have either “–er/more” added as a suffix, and three words with the proper suffix added for students to state the rules of application (Appendix G).

**Knowledge Transfer Test**

The transfer test was developed from the rules presented in the intervention, but the words were uncommon adjectives for Korean English language learners. By using uncommon adjectives, learners had to apply the rules that were taught in the lesson. There were a total of 10 questions with each question counting one point. The transfer test consisted of four words for students to define the number of syllables, and six words to that needed to have either “–er/more” added as a suffix (Appendix H).

**Procedure**

Prior arrangements were made with school administration and teachers to gain access to the participants on scheduled days. The experiments were conducted in the morning in the school computer lab.

Each computer lab accommodated 24 students. Each class contained anywhere from 18-22 students each in one section, with four sections in each grade. Once
participants arrived at the computer lab, they were instructed to sit at a computer of their choosing. Each computer included headsets and colored envelope with a URL that directed students to the intervention they were to take. The homeroom teacher informed them of the option to participate in the research, outlined the process of the intervention, and to not discuss the intervention with those who have not taken the intervention. The participants were instructed to login to the system, and test the volume of their headphones and adjust the audio to a level of their preference. Students waited for the teacher to instruct them to proceed, and they clicked the next button to fill out basic demographic information such as gender, age, and how long they have studied at English academies per week. Once completing this section, students waited for the teacher to instruct them to the next section. The next section was the prior knowledge test to assess how much knowledge the students had on the subject.

Once participants finished the pretest, they were directed to the intervention condition (APA full gestures, APA deictic only gestures, or APA no gestures) to watch a 9-minute presentation on comparatives using “–er” and “more” with syllable training and special rules. All scripts and presentations in the intervention were the same except for the gesture manipulation. All videos can be viewed at the following links: full gesture condition (https://youtu.be/0AKRCr3Xgm8), deictic gesture condition (https://youtu.be/-3telymJOIE), and no gesture condition (https://youtu.be/E5oH_n1JcvY).

Following the completion of the intervention, participants filled out the 20-question KAPI Instrument, then completed the 10-question knowledge retention test and the 10-question knowledge transfer test on items not presented in the intervention. In all, the intervention lasted about 30 minutes for participants in each condition.
Data Analysis

The learning data were quantitative. Basic descriptive statistics were used to find means and standard deviations from the prior knowledge test, social acceptance instrument, knowledge retention test, and knowledge transfer test. Results from all pre-test and post-test knowledge tests were compared across groups using a series of ANOVA procedures and Tukey follow-up procedures if significant differences were found. A MANOVA was used to explore any significant differences with Tukey follow-up procedures in social acceptance instrument (KAPI) scores. Any significant differences were then analyzed with independent t-tests. In addition MANOVA tests were carried out using prior knowledge as a covariate to understand if any significant subscales of KAPI emerged. Finally, a series of regression analyses were conducted to explore if KAPI subscales were positively or negatively associated with the learning outcomes, and if any demographic information had similar associations.
CHAPTER 4
RESULTS

This chapter reports the analysis of data collected as part of this study. There were a total of 160 participants assigned to three different conditions according to embodiment level of APA gestures. First, descriptive statistics will be provided, and then results arranged by research questions will be discussed. The significance level of all statistical analysis was set at $\alpha = .05$. All results were analyzed with SPSS™ 24.

Overall Descriptive Statistics

A total of 160 participants from 5th and 6th grade at an elementary school in Southwest of South Korea participated in this study. Students were randomly assigned to one of three APA gesture conditions. Table 4-1 displays participant distribution across the three APA gesture conditions.

Table 4-1. APA Gesture Condition Distribution

<table>
<thead>
<tr>
<th>Condition</th>
<th>5th Grade</th>
<th>6th Grade</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Full Gesture</td>
<td>28</td>
<td>26</td>
<td>54</td>
</tr>
<tr>
<td>Deictic Gesture</td>
<td>28</td>
<td>25</td>
<td>53</td>
</tr>
<tr>
<td>No Gesture</td>
<td>25</td>
<td>28</td>
<td>53</td>
</tr>
<tr>
<td>Total</td>
<td>81</td>
<td>79</td>
<td>160</td>
</tr>
</tbody>
</table>

Prior knowledge test data were explored for normality. Skewness and kurtosis values were in the acceptable range, and visual inspection of Q-Q plot provided evidence the data was normal. Before the Analysis of Variance (ANOVA) was performed, a Levene’s Test was conducted to test the homogeneity of the variance. The Levene’s Test was calculated at $F(2, 157) = 1.533$, $p = .219$, which indicates that the variance did not significantly differ across the conditions. An ANOVA was performed to test if statistical differences in prior knowledge across conditions were found. Table 4-2 shows descriptive statistics for prior knowledge data.
ANOVA analysis showed no significant differences in prior knowledge of lesson information for participants between conditions ($p = .264$). With data determined to be normally distributed across each condition, and no significant findings from the ANOVA, parametric tests without covariates were used to examine the rest of the data.

**Effects of Gesture-Based APA Embodiment on Knowledge Retention**

The purpose of research question one was to examine if APA gesture condition influenced participants’ retention of content presented in the experiment. Participants were provided with a ten-question test on the retention of information presented in the intervention. Before the Analysis of Variance (ANOVA) was performed, a Levene’s Test was conducted to test the homogeneity of the variance. The Levene’s Test was calculated at $F(2, 157) = .982$, $p = .377$, which indicates that the variance was not significantly different across all conditions. An ANOVA was performed to test if statistical differences in retention across conditions were found. Table 4-3 shows the descriptive statistics for the results of retention test.

**Table 4-3. Retention Means and Standard Deviations**

<table>
<thead>
<tr>
<th>Condition</th>
<th>Mean</th>
<th>Standard Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Full Gesture</td>
<td>5.22</td>
<td>2.28</td>
</tr>
<tr>
<td>Deictic Gestures</td>
<td>5.09</td>
<td>1.99</td>
</tr>
<tr>
<td>No Gesture</td>
<td>5.45</td>
<td>2.10</td>
</tr>
</tbody>
</table>

ANOVA analysis showed no significant effects of gesture manipulations on the retention of information between groups ($p > .05$). Therefore, the performance of
gestures had no significant impact on the retention of information presented in the intervention.

However, a multiple linear regression model with gender, grade, age, and outside study in relation to retention of information found that outside study significantly influenced the retention of information \( (t = 2.67, p = .008) \) with a beta of .211 and an adjusted \( R^2 \) for the model as .106. With a part correlation of .224, the unique contribution of outside study to retention test scores was \( (.224)^2 = 5\% \). Table 4-4 provides the condition distribution for outside study. There were no other significant differences found with the multiple linear regression model between retention and gender, age, or grade.

<table>
<thead>
<tr>
<th>Outside Study</th>
<th>Full Gesture Condition</th>
<th>Deictic Gesture Condition</th>
<th>No Gesture Condition</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 (0 hrs)</td>
<td>3</td>
<td>4</td>
<td>7</td>
<td>14</td>
</tr>
<tr>
<td>2 (1 - 2 hours)</td>
<td>18</td>
<td>18</td>
<td>19</td>
<td>55</td>
</tr>
<tr>
<td>3 (3 - 4 hours)</td>
<td>6</td>
<td>7</td>
<td>13</td>
<td>26</td>
</tr>
<tr>
<td>4 (5 - 7 hours)</td>
<td>21</td>
<td>15</td>
<td>11</td>
<td>47</td>
</tr>
<tr>
<td>5 (8+ hours)</td>
<td>6</td>
<td>9</td>
<td>3</td>
<td>18</td>
</tr>
<tr>
<td>Total</td>
<td>54</td>
<td>53</td>
<td>53</td>
<td>160</td>
</tr>
</tbody>
</table>

**Effects of Gesture-Based APA Embodiment on Knowledge Transfer**

The purpose of research question two was to examine if the APA gesture condition influenced participants’ transfer of knowledge. Participants were provided with a ten-question test to assess the application of learned knowledge to information the participants had not been previously exposed to. Before the ANOVA was performed, a Levene’s Test was conducted to test the homogeneity of the variance. The Levene’s Test was calculated at \( F(2, 157) = .262, p = .770 \), which indicates that the variance is not statistically different across all conditions. An ANOVA was performed to test if
statistical differences in retention across conditions were found. Table 4-5 shows the results of transfer test.

Table 4-5. Transfer Means and Standard Deviations

<table>
<thead>
<tr>
<th>Condition</th>
<th>Mean</th>
<th>Standard Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Full Gesture</td>
<td>5.17</td>
<td>2.14</td>
</tr>
<tr>
<td>Deictic Gestures</td>
<td>5.87</td>
<td>2.37</td>
</tr>
<tr>
<td>No Gesture</td>
<td>5.40</td>
<td>2.02</td>
</tr>
</tbody>
</table>

ANOVA analysis showed no significant transfer of information differences between conditions ($p > .05$). Therefore, the manipulation of gesture embodiment in this study had no significant impact on the transfer of information presented in the experiment. Even though participants in each condition exhibited significant increases in knowledge between the prior knowledge test and the transfer test ($F(1, 157) = 116.560$, $p = .000$), there is no evidence that the gesture manipulations contributed to this increase.

A multiple linear regression model with predictors gender, age, outside study, or grade and transfer of knowledge as the outcome variable found these predictors had no significant association with transfer of knowledge.

**Effects of Gesture-Based APA Embodiment on APA Social Acceptance**

The purpose of research question three was to examine if the types of gestures used by the APA influenced the participants’ social acceptance of the agent. A MANOVA was conducted with gesture conditions as the fixed factor and the Korean Agent Persona Instrument (KAPI) subscales of credibility, human-likeness, engaging, and facilitating as dependent variables. Homogeneity was tested and satisfied with Box’s Test of Equality of Covariance Matrices (Box’s $M= 20.096$, $p = .499$). Next, a Levene’s test was
performed to test the homogeneity within error variances. The Levene’s test provided evidence of homogeneity as $p$ values were greater than .05 across all error variances.

The MANOVA showed there were significant differences between conditions with Wilks’ $\lambda = .900$, $F = 2.083$, $p = .037$. Type III Sums-of-Squares provided evidence that the significant difference could be found relative to the subscales Human-like ($F(2, 157) = 4.038$, $p = .019$) and Engaging ($F(2, 157) = 3.394$, $p = .036$). There were no significant differences in the subscales Credible ($F(2, 157) = 1.046$, $p = .354$) and Facilitating ($F(2, 157) = 1.651$, $p = .195$). Table 4-6 below provides the KAPI subscale means and standard deviations for each experimental condition.

<table>
<thead>
<tr>
<th>Table 4-6. KAPI Means and Standard Deviations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Full Gesture</td>
</tr>
<tr>
<td>KAPI Subscale</td>
</tr>
<tr>
<td>Credible</td>
</tr>
<tr>
<td>Human-like</td>
</tr>
<tr>
<td>Engaging</td>
</tr>
<tr>
<td>Facilitating</td>
</tr>
</tbody>
</table>

T-tests were conducted to compare the mean scores of the three gesture conditions in human-likeness. Results from the t-test revealed no significant differences between deictic gesture condition and the other conditions. However, t-tests revealed the full gesture condition was perceived by participants as significantly more human-like when compared to the no gesture condition ($t = 2.77$, $p = .006$, $d = .54$). Cohen’s $d$ provides evidence that this difference is of a medium to large effect size.

T-tests were then conducted to compare the mean scores of the three gesture conditions relative to the subscale Engaging. Results from the t-test revealed no significant differences between deictic gesture condition and the other conditions. However, t-tests revealed the full gesture condition was perceived by participants as...
significantly more engaging when compared to the no gesture condition \( (t = 2.61, p = .01, d = .51) \). Cohen’s \( d \) provides evidence that there is a medium effect size between the full gesture condition and the no gesture condition.

Further analyses with MANOVA revealed prior knowledge as a significant covariate for KAPI subscale ratings \( (\text{Wilks'} \lambda = .881, F = 5.176, p = .0001) \). Specifically, prior knowledge was significantly associated with credibility and facilitation ratings. On average, students who had 1-point higher prior knowledge score provided 0.405 point higher rating for credibility \( (p = 0.030) \), and 0.646 point higher rating for facilitation \( (p = 0.004) \). Likewise, when using prior knowledge as a covariate, facilitation was significantly higher in the full gesture condition when compared with the no gesture condition \( (t = 2.06, p = .041) \), and was approaching significance between the full gesture condition and the deictic gesture condition \( (t = 1.77, p = .079) \).

**Effects of Gesture-Based APA Embodiment on Relationships Between APA Social Acceptance and Learning**

To explore relationships between KAPI scores and learning across APA gesture embodiment conditions, a stepwise multiple regression model was first performed on the outcome variable of retention test score with the four KAPI subscales of credible, human-like, engaging, and facilitating. In terms of significant subscales in relation to retention test score, facilitating and human-like provided significant results. Perception of facilitation was the most significant predictor of retention at \( (t = 3.99, p < .0001) \) with a beta of .457 and an adjusted \( R^2 \) for the model as .081. With a part correlation of .304, the unique contribution of facilitation to retention test scores was \( (.304)^2 = 9.2\% \).

Perception of human-likeness was also found to be a significant predictor of retention test scores at \( (t = -2.85, p = .005) \) with a beta of -.326. The negative beta
coefficient indicates a significant negative relationship between human-likeness and retention test scores. This means the higher perception of human-likeness of the APA by the participant, the lower the retention test score. With a part correlation of -.222, the unique contribution of human-likeness negatively affected retention test scores by \((-.222)^2 = 4.9\%\).

Similar to the tests used to examine relationships between social acceptance factors and retention, a stepwise multiple regression model was performed on the outcome variable of transfer test score with the four KAPI subscales of credible, human-like, engaging, and facilitating. In terms of significant subscales in relation to transfer test score, facilitating and engaging provided significant results. Similar to the regression on retention, facilitation was the most significant predictor of transfer at \((t = 4.23, p < .0001)\) with a beta of .597 and an adjusted R2 for the model as .10. With a part correlation of .318, the unique contribution of facilitation to retention test scores was \((.318)^2 = 10.1\%\).

Engaging was also found to be a significant predictor of transfer test scores at \((t = -2.77, p = .006)\) with a beta of -.391. The negative beta coefficient indicates a significant negative relationship between engagement and transfer test scores. This means the higher perception of engagement of the APA by the participant, the lower the transfer test score. With a part correlation of -.208, the unique contribution of engagement negatively affected retention test scores by \((- .208)^2 = 4.3\%\).

**Summary**

This chapter provided results from a research experiment conducted with 160 elementary school students in South Korea. This study examined APA embodiment on learning and social acceptance using three independent variables: full gesture
condition, deictic gesture condition, and no gesture condition. The dependent variables for this study were a retention test, transfer test, and APA social acceptance inferred using the Korean Agent Persona Instrument (KAPI) that consisted of the four subscales of credible, human-like, engaging, and facilitating. Statistical analyses performed in this research were ANOVAs for the retention and transfer tests, MANOVA for the KAPI subscales, and stepwise multiple regression to examine how the KAPI subscales influenced learning outcomes.

In summary, results from this experiment found no statistically significant differences between the three experimental conditions relative to the two dependent variables of retention and transfer tests. However, significant increases in scores were found in two KAPI subscales of human-like and engaging between the full gesture condition and no gesture condition with full gesture APA being rated higher on these subscales. Also, when adding prior knowledge as a covariate, the full gesture condition was rated as more facilitating than the no gesture condition; and overall, for every increased point in prior knowledge learners rated the agents as more facilitating and credible by .646 and .405 respectively. Likewise, facilitation was found to be a significant predictor of retention and transfer scores in a stepwise multiple regression. Interestingly, significant negative relationships were found between with human-likeness and retention scores, and between engagement and transfer scores.

The following chapter will discuss the results, theoretical implications, limitations, and provide future research recommendations.
CHAPTER 5
DISCUSSION

This chapter will summarize the results regarding each research question, discuss the theoretical implications of the experiment, and address the limitations and future areas of research for educational researchers.

Summary of Research Questions and Results

1. To what extent does APA gesturing (full, deictic only, and no gesture) affect the retention of English grammar knowledge?

   An ANOVA analysis of retention test scores showed no significant influence on knowledge retention between the experimental conditions. As one would expect, a multiple linear regression showed that outside English study was a significant predictor retention test scores.

2. To what extent does APA gesturing affect the transfer of English grammar knowledge?

   Results of an ANOVA analysis of the transfer test scores revealed no significant influence of APA gesture manipulations between experimental conditions. However, students’ scores on the transfer test in all conditions were significantly higher than the pre-test prior knowledge test.

3. Which of the APA gesturing conditions (full, deictic only, and no gesture) do elementary school students perceive as more social?

   The results of the Korean Agent Persona Inventor (KAPI) provided evidence that the full gesture condition was perceived by 5th and 6th grade South Korean students as more human-like and engaging than the no gesture condition. When prior knowledge was used as a covariate, the full gesture condition was rated significantly more facilitating than the no gesture condition. Outside of this, there were no other significant differences in the KAPI subscales between the conditions.
4. To what extent does the social perception of APAs influence learning performance?

A stepwise multiple regression found that learners' perception of facilitation was a significant positive predictor of retention scores, while perception of human-likeness was negatively associated with retention scores.

Similarly, a stepwise multiple regression found that perception of facilitation was a significant positive predictor of transfer scores, while perceived engagement was negatively associated with transfer scores.

When prior knowledge was added as a covariate to the MANOVA on social perception subscales across the experimental conditions, higher prior knowledge resulted in higher ratings of credibility and facilitating of the APA.

**Discussion of Results**

The purpose of this research was to determine if APAs performing a full range of gestures produced better learning outcomes and perceptions of social acceptance of the APA when compared with APAs using no gestures and the traditional use of deictic gestures by APAs.

**Effects of Gesture-APA Embodiment on Knowledge Retention**

1. To what extent does APA gesturing (full, deictic only, and no gesture) affect the retention of English grammar knowledge?

Results of the ANOVA showed no significant increase in retention knowledge between the full gesture condition, deictic gesture condition, and the no gesture condition. This finding was unexpected as it was predicted that the full gesture condition would increase the retention of knowledge compared to other conditions because gestures and language were theorized to form a cohesive cognitive representation and work together as a system (McNeill, 1985). In other words, it was hypothesized the full
use of gestures would provide extra support for language learning in the intervention as gestures have been shown to assist with retention and slowing the forgetting process (Quinn-Allen, 1995; Tellier, 2008; Macedonia & von Kriegstein, 2012).

Studies using retention as a variable have routinely found no significant difference when APAs were added (Craig et al., 2002; Mayer et al., 2003; Baylor & Kim, 2009; Choi & Clark, 2006; Mayer & Dapra, 2012), and this study adds to this body of literature. The seductive details hypothesis (Harp & Mayer, 1998) can be used to explain the findings of no significant difference between the three conditions of full gestures, deictic gestures, and no gestures relative to the retention of information. Seductive details are information added to make the topic more interesting and entertaining, but are irrelevant to the theme (Mayer et al., 2003). Most studies examining the seductive detail hypothesis have been conducted in the context of reading texts, with very few studies involving seductive details and multimedia presentations.

Since students in all conditions performed at about the same level, it is possible that gestures served as a form of seductive details, even though they were meant to assist student retention of content. It has been suggested that seductive details can benefit learning performance if students have enough cognitive resources available to attend to the irrelevant information (Park, Moreno, Seufert, & Brunken, 2011). In this research with young foreign language learners, it is possible participants might not have had enough cognitive resources available to attend to the many multi-modal information elements including the English language, intrinsic difficulty of the content, agent appearance, gestures, the appearance of text, and background. Clark and Choi (2007) have argued the APAs could increase extraneous cognitive load within working memory
as the new visual and auditory input could make it difficult to easily process. Likewise, the intrinsic difficulty of grammar may have placed an extraneous cognitive load on the students. Grammar acquisition is not as simple as experiencing explicit instruction and cementing the rules for application. Interlanguage theory (Selinker, 1972) suggests that students learning a second are caught between the grammar rules of their native language and that of the foreign language, and the learning of a foreign language grammar system is a gradual cognitive process that requires mapping forms, meaning, and use (Larsen-Freeman, 1991). During this time of foreign grammar acquisition, beginning students make sense of the foreign language through the grammatical lens of their native language, and adapt more to the foreign language grammar system as they progress in proficiency. Therefore, the amount of cognitive resources needed to attend to the instruction in English, intrinsic difficult of the content, agent appearance, gestures, text, and background may have may produced extraneous cognitive load that relegated gestures to a seductive detail. However, Sweller (2005) suggests familiar information does not load working memory as much as unfamiliar information does, so if students were provided with increased exposure over time, it is possible the APA and its features would decrease the amount of extraneous cognitive load due to the familiar look, sound, and actions (Schroeder, Adesope, & Gilbert, 2013; Moreno, 2005). In other words, once the novelty associated with perceiving a full gesture APA subsides, it is reasonable to assume that the full spectrum of APA gestures would be processed by learners more efficiently and assist in language perception and learning similar to how that occurs with human tutors and instructors (McNeill, 1985).
In regards to the present study, the issue that the participants were learning English grammar that is higher in intrinsic cognitive load could have relegated gestures to become seductive details, even though gestures should have assisted in language comprehension. With the instruction in English, which is not students’ native language, along with experiencing the sights and sounds of an unfamiliar APA, reading key words in English, and the focus on grammar rules they have never studied before, there was a lot for students to process and comprehend. It is likely the students in this study could have devoted more attention to other aspects of the multimedia presentation and less recognition to accompanying gestures. This is supported by a multiple linear regression model that found evidence that students who spent more time studying English outside school scored higher on the retention test (beta = .211). With more increased exposure to English, it is possible those students had more cognitive resources available than those who spent fewer hours studying English outside school.

In addition, part of the extraneous load could be due to the novelty effect. Students in this experiment have never studied English using an APA with or without gesture capabilities, so the novelty of the experience may have contributed to no difference in learning outcomes. During the pilot test, students expressed interest in the APA to the point the researcher had to ask the students not to talk to others. Also, gesturing APAs caught the attention of students in the no gesture condition, and on several occasions students had to be reminded to watch their screen and not the screen of the APA with gesture capabilities. The novelty effect could explain why students in the full gesture condition rated the APA as significantly more human-like than the no gesture condition, and why human-likeness was a negative predictor of retention.
scores. Students may have noticed the novelty of the APA and gestures, but may not have recognized the importance of the information gestures were providing as a learning opportunity. In other words, the novelty of learning English from a human looking APA may have contributed to a novelty effect, and the production of gestures meant to assist language learning by providing an additional supply of information may have been relegated to a seductive detail to the students.

It is hopeful that future studies that explore the effects of the treatment over longer periods of time can minimize the potential negative effects of extraneous cognitive load for foreign language learners to understand how gestures can influence the retention of information.

Effects of Gesture-APA Embodiment on Knowledge Transfer

2. To what extent does APA gesturing affect the transfer of English grammar knowledge?

Results of the ANOVA showed participants in the full gesture condition, deictic gesture condition, and the no gesture condition scored significantly higher between the prior knowledge test and the transfer test, but no significant difference was found in transfer knowledge between conditions. The significant increase in transfer scores from prior knowledge scores was expected as previous studies have provided evidence that transfer knowledge significantly increases after an instructional intervention (Atkinson, 2002; Lusk & Atkinson, 2007; Mayer & Dapra, 2012). It was unexpected that gesture conditions would provide no significant differences in regards to transfer scores. It was predicted that the full gesture condition would significantly increase transfer knowledge since gestures and speech work together as one system (McNeill, 1985) to increase comprehension.
The finding of no statistical difference between gesture conditions in this study is in line with studies that found deictic gestures do not increase transfer knowledge when compared to an APA without gesture production (Frechette & Moreno, 2010).

It is noteworthy that this is the first study to examine the APA use of iconic, metaphoric, deictic, and beat gestures against an APA producing deictic only gestures and no gestures. Similar to the Fechette and Moreno (2010) study, the deictic gestures may have been unnecessary since the gestures referred to information present on the screen. In this study, deictic gestures referenced to text information that appeared on the board, or made pointing reference to the APA or participant. In studies that have shown deictic gestures improving transfer knowledge, the APA directed spatial attention to appropriate content related to math word problems (Atkinson, 2002; Lusk & Atkinson, 2007), and referenced a diagram that illustrated the main point (Mayer & Dapra, 2012). In this study, the referencing to words already on the whiteboard may have added no benefit to the gesture conditions since students already had the visual information present. Adesope and Nesbit (2012) conducted a meta-analysis examining verbal redundancy in learning with multimedia. Verbal redundancy was classified into low verbal redundancy (key words) and high verbal redundancy (verbatim) text with speech. The meta-analysis found learners in low verbal redundancy conditions using key words with spoken narration in multimedia performed better in learning outcomes with an effect size of $g = .99$ (Adesope & Nesbit, 2012). The same meta-analysis found that second language readers benefited from the use of low redundancy text and narration in multimedia contexts by an effect size of $g = .58$. The additional assistance of
displaying key words from the narration in this study could have been a factor in understanding the lesson that decreased the need for gestures when available.

Notwithstanding, the issue of gestures influencing transfer should be examined in terms of near transfer and far transfer. Near transfer is applying knowledge learned in similar contexts, whereas far transfer is the application of information learned between two distinct contexts. This study measured near transfer of grammar knowledge with different APA gesture conditions. Previous empirical research with APAs and near and far transfer has provided mixed results. Lusk and Atkinson (2007) found significant increase in near transfer and far transfer as a function of embodiment. However, Atkinson (2002) found no significant difference between near and far transfer when agents were present, and similar to the results of this study, Dunsworth and Atkinson (2007) did not detect a significant difference between conditions with near transfer with embodied agents.

A possible explanation for the lack of near transfer knowledge differences between gesture conditions may be an issue of the type of knowledge being learned. Clark and Voogel (1985) suggest that near transfer may be better represented with procedural knowledge such as troubleshooting equipment, and far transfer is more involved with declarative knowledge that concentrates on systems of “learning how to learn” (p. 115). Grammar knowledge in this study would be considered declarative knowledge measured in a near transfer context.

Also applicable to transfer of learning is the way grammar knowledge was presented in this study. Students were presented with rules and expected to apply those rules in a near transfer context. Larsen-Freeman (2000) has suggested that the
instruction of grammar should not be rule based, but taught according to reasons. The reason based approach allows for students to understand the reasons of how the grammar operates, and with practice, go beyond the boundaries of the context. The idea of “grammaring” (Larsen-Freeman, 1995, 2003) suggests that grammar needs to be experienced instead of learned through a decontextualized body of knowledge. The learning process for acquiring grammar can be intrinsically difficult because grammar is not accumulated in a sequence (Rutherford, 1987), nor is it uncommon for students to backslide on grammar structures previously thought mastered when a new grammar rule is introduced (Larsen-Freeman, 1991). This can be contributed to interlanguage theory (Selinker, 1972) that suggests students are caught between the grammatical rules of their native language and the rules of the language being learned. In other words, as students begin the second or foreign language learning process they will hypothesize the grammar in the language being learned operates according to the rules of their native language (Larsen-Freeman, 1991). As students advance in proficiency in the second language, they adopt more of the second language grammatical system; however, interference and backsliding are common traits. Selinker (1972) argues that backsliding is a normal process of learning a second language and occurs regardless of error correction or explicit grammar instruction. This suggests that acquiring grammar is a more complicated process to master as opposed to learning vocabulary that can be assisted by familiar features such as phonology, semantic meaning, word class, frequency, and other diverse strategies for acquisition (Ellis & Beaton, 1993). Larsen-Freeman (1997) concludes the rule-based nature of grammar does not provide a noticeable means to measure transfer.
Finally, similar to the retention of knowledge, the novelty effect may have influenced the results of transfer scores. In regards to social perception, APAs in the full gesture condition were rated significantly more engaging than APAs in the no gesture condition. In regards to transfer knowledge scores, engagement was a negative predictor of transfer scores. It is possible the novelty of a human looking APA, with varying degrees of gestures, over engaged students to the point gestures provided no extra benefit for the learner.

Future research needs to explore the use of gesture production with no key words in text to better understand how gestures and key word text are influencing learning outcomes in multimedia presentations. In addition to the absence of key words, future research needs to consider the domain of knowledge and the type of transfer being measured. The failure to observe significant effects on transfer may depend on the type of knowledge being measured. Likewise, further studies measuring grammar knowledge transfer may need to be presented according to experiences with reasons and not solely from a rule based system of learning.

Effects of Gesture-Based APA Embodiment on APA Social Acceptance

3. Which of the APA gesturing conditions (full, deictic only, and no gesture) do elementary school students perceive as more social?

Results of the MANOVA showed significant increase in APA social perception of human-likeness and engaging with the full gesture condition when compared to the no gesture condition. There were no other significant differences between the other conditions or social perception subscales of credible and facilitation.

Although the social perception of the APA in the subscales “human-like” and “engaging” did not increase learning outcomes, it may lend understanding to how APAs
impact the motivation of students in the learning process. Researchers have suggested since the early beginnings that APAs can be motivational (Reeves & Nass, 1996; Lester et al., 1997; Gulz, 2005; Kim & Baylor, 2006; Lusk & Atkinson, 2007; Kramer & Bente, 2010). This is important as Wlodokowski (1978) proposes the time-continuum model that provides three distinct phases for motivation. In the first stage, motivation is based on many factors such as the environment, teacher, self, and/or basic personal needs. In the second stage, motivation is enhanced by the stimulation of the learning process, and the third stage is the reinforcement value of the learning experience. The human-likeness and engaging aspects fit within the time-continuum model proposed by Wlodokowski (1978). If students respond to the social presence of the APA (Reeves & Nass, 1996), then human-likeness may be beneficial for motivation. Likewise, if the APA is found to be engaging during the learning process, this aligns with the second stage of the model. Finally, if the information is reinforced as valuable, then the human-likeness and engaging aspects can support the learning experience.

A recent meta-analysis by Schroeder & Adesope (2014) on the motivation, persona, and cognitive load of APAs in multimedia contexts found sixteen studies with identifiable measures of motivation. A vast majority of the studies, twelve out of sixteen, found positive effects of motivation with an effect size greater than $g > .25$. However, Wang and colleagues (2008) suggest that the motivation may play a bigger role with lower level students as higher level students normally have higher motivation, self-efficacy, and self-regulation skills than lower level students.

This research is in line with results found in studies examining the social perception of APAs in multimedia presentations (Mayer & Dapra, 2012), but in stark
contrast with the results found by Schroeder and Adesope (2013). Comparing this study with Mayer and Dapra (2012) and Schroeder and Adesope (2013), some similarity and differences are noted. In all studies, the APA was human form and performed gestures. It must be noted this study was the only one to use a full range of gestures, where the APAs in the other studies only produced deictic gestures. However, the APAs in this study, and the study by Mayer and Dapra (2012), used gestures to highlight key information in meaningful ways to communicate information. The APA in the study by Schroeder and Adesope (2013) gestured using meaningless deictic gestures five times total during the whole intervention that lasted 240 seconds if participants did not use the rewind feature. In comparison, this study was 540 seconds long, and the study by Mayer and Dapra (2012) lasted 229 seconds and there was no opportunity to rewind the intervention, so the amount of time with the APA was not a factor. Likewise, there as a difference with the voice of the APA. In this study and the Mayer and Dapra (2012) study, the APA used a human recorded voice, whereas the Schroeder and Adesope (2013) study used a text to speech voice generator to present the information.

The highlighted differences should be considered significant and provide information on APA design to increase social acceptance. Schroeder and Adesope (2013) admit the APA gestures reference nothing in the intervention. This study and that of Mayer and Dapra (2012) should highlight that gestures are more than a means to make the APA appear normal, but provides deictic believability to help the APA to appear human-like (Lester, Voerman, Towns, & Callaway, 1999). There is another issue that supports the need for gestures to have meaning when designing environments with APAs. It has been shown that meaningful gestures activate the language area of the
brain called the Broca’s area (Willems, Ozyurek, & Hagoort, 2007), but the Broca’s area is not activated by pure movement (Johnson-Frey et al., 2003) or meaningless gestures (Greze, Costes, & Decety, 1999). Therefore, the meaningless gestures in the Schroeder and Adesope (2013) study could have influenced the social acceptance of the APA because it did not use gestures similar to that of a human. Whereas this current study and the Mayer and Dapra (2012) study used gestures that were meaningful, and participants ultimately found the APAs human-like and engaging.

On the other hand, gestures may not be the sole reason for the social acceptance of the APA. It is possible the choice of voice production played a major role. This study and Mayer and Dapra (2012) both recorded human voices for the APA, but Schroeder and Adesope (2013) used machine voice for their APA. Countless studies have provided evidence that human voice helps facilitate learning outcomes better than machine voice (Moreno et al., 2000; Moreno & Mayer, 2002; Mayer, et al., 2003; Atkinson et al., 2005; Louwerse et al., 2005; Domagk, 2010; Mayer & Dapra, 2012). Nass and Steuer (1993) suggest human voice in a computer environment assist learners in applying social rules to the computer. This increases interest and interaction because the social presence is motivational to the learner (Reeves & Nass, 1996). Mayer and Dapra (2012) found evidence with this in experiment one of their publication that compared the use of human voice and machine voice. Human voice scored significantly higher ratings in the social subscales of facilitation, credible, and engaging when compared with machine voice.

In the current study, all conditions used the same human voice with gestures being the only difference between the conditions. Therefore, the social perception of
human-likeness and engagement may provide evidence that gestures are an integral part of social acceptance when human voice is concerned.

Social perception of an APA is showing some complexity similar to that of learning. There needs to be further research isolating various factors to fully understand how students socially accept APAs and what long-term effects social acceptance may have on learners' self-efficacy, interest, motivation, and, ultimately, retention and transfer of knowledge. This study corroborates previous research that gestures and voice play some role in the perception of human-like and engaging social perception.

**Effects of APA Social Acceptance on Learning Outcomes**

4. To what extent does the social perception of APAs influence learning performance?

There were no significant differences between any of the conditions with learning outcomes, even though each group significantly improved scores from the prior knowledge test. However, there is evidence that as prior knowledge scores increased, so did social perception of the APA in certain subscales. The addition of prior knowledge as a covariate in the MANOVA analysis found that as prior knowledge scores increased, so did credibility ratings by .405 and facilitating ratings by .646.

The influence on social perception is understandable when examining it from a prior knowledge perspective. Students with higher prior knowledge may have additional cognitive resources available, and not suffer from extraneous cognitive load from the visual and auditory input provided by the APA (Clark & Choi, 2007). Bergmann and Macedonia (2013) found higher perception of APAs when comparing foreign language learning with iconic gestures between an APA and a human instructor with higher-level and lower-level performers. Higher-level performers in that study rated the APA higher
than the human instructor, while the lower-level performers rated the human instructor higher, even though there was no difference in learning outcomes. This is similar to this study as students who scored higher on the prior knowledge test rated the APA higher in facilitation and credibility.

However, when prior knowledge was used as a covariate in a MANOVA analysis, facilitation was significantly higher in the full gesture condition ($p = .041$) when compared with the no gesture condition, and approaching significance between the full gesture condition ($p = .079$) and deictic gesture condition. Likewise, a stepwise multiple regression model found that perception of APA facilitation significantly predicted retention and transfer scores.

In terms of facilitation, the act of gesturing has been shown to facilitate student learning in the presence of human instructors (Valenzeno, Alibali, & Klatzky, 2003; Kelly, Ozyrek, Maris, 2009). However, research on gestures and the facilitation of learning with APAs is scarce. Only Mayer and Dapra (2012) have focused on gestures as a variable within an APA multimedia study. They incorporated deictic gestures and no gestures within the intervention to test if, in their terms, embodiment influenced learning. The gesture condition in the Mayer and Dapra (2012) study was significantly more facilitating than the no gesture condition. Although the gesture condition was different from this current study, these two studies provide evidence that APA gestures have the ability to facilitate learning in multimedia learning environments.

Although perception of APA facilitation was a positive predictor of learning outcome scores in this study, two other social acceptance factors did have negative impacts with retention knowledge and transfer knowledge scores. A stepwise multiple
regression model found that perception of human-likeness was a negative predictor of retention scores, and perception of engagement was a negative predictor of transfer scores.

The negative influence of human-likeness ($p = .005$, beta $= -.326$) is a concern that may relate to the novelty effect. The human-likeness of the APA’s appearance and movement might have caused students to dedicate more attention to these aspects because it is very novel. Students are not used to studying with APAs in multimedia, so this new experience may have had negative consequences.

Likewise, perception of engagement was a negative predictor of knowledge transfer scores ($p = .006$, beta $= -.391$). First, it must be noted engagement in APA literature is normally discussed using persona theory. This is problematic as engagement is not an isolated variable as it depends on the anthropomorphization of an agent due to its life-like features of facial expressions, body movements, and gestures that emulate any real-life character (Woo, 2008). It is the anthropomorphization that keeps students engaged (Kim & Baylor, 2006; Dunsworth & Atkinson, 2007; Woo, 2008). Despite the lack of a clear, well-established definition of engagement, it has been suggested that engagement may increase learning (Dehn & van Mulken, 2000), but can be problematic if the learner becomes over aroused (Gulz & Haake, 2006). However, understanding APA engagement is extremely complex because the number of variables interacting at one time make comparisons difficult (Louwerse, Graesser, Lu, & Mitchell, 2005). Baylor and Kim (2009) provide evidence on the complexity of only two variables (deictic gestures and facial expressions) interacting at one time. When both variables were isolated in a present and absent comparison, the present condition performed
better. When both variables were studied together in present and absent conditions, significance was only found when one variable was present and the other variable was absent. In terms of learning outcomes, Baylor and Kim (2009) suggested that more than one nonverbal cue is inappropriate. This provides an example of the complexity researchers are facing when they try to understand the integration of different variables with APAs, and learners’ engagement levels with APAs in different conditions.

In this study, engagement was significantly higher in the full gesture condition when compared to the no gesture condition. However, the deictic gesture condition, which is considered an in-between condition, was not significant when compared to the other two conditions. This is the type of complexity faced when understanding engagement with APAs. Further researcher needs to include more mixed methods evaluations to better understand what students are noticing, and what is influencing the perception of engagement with APAs.

**Theoretical Implications**

**Presence Principle**

The presence principle suggests that learning is not enhanced by the appearance of an agent, but is merely a seductive detail (Mayer, Dow, & Mayer, 2003). In addition, it has been suggested that the inclusion of an APA could cause split-attention (Moreno, 2005), as learners might become distracted where to direct their attention when an agent and other relevant information are present (Frechette, 2008).

In this experiment, there was a significant increase in learning from the prior knowledge test to the transfer test, but without a no agent condition to compare, it cannot be confirmed that the agent helped learning, nor can it be confirmed that it was a distraction for the learner. This could have been better understood if there was an APA
absent condition as suggested by Clark and Feldon (2014). They have advised researchers studying APAs to include a no agent condition to better understand how APAs affect learning in multimedia.

The results from the learning outcomes data suggest that the image of an APA using gestures was not a distraction, nor did it increase learning outcomes. It is possible the increase in scores were due to text in the form of key words present on the screen, and the presence of the APA was not significant when it came to learning outcomes.

**Social Agency Theory**

Social agency theory proposes that the image and the voice of an APA results in deeper cognitive process by the learner because it activates the social responses of the learner (Mayer, 2005; Mayer, Sobko, & Mautone, 2003). There is evidence that learners do respond socially to an APA. For example, there is strong evidence that human voice facilitate learning better than machine voice (Mayer, Dow, Mayer, 2003; Mayer & Dapra, 2012). In terms of social expectations, research has shown that learners expected the APA to have a personality (Kim, Baylor, & Shen, 2007).

When it comes to learning with the APA in this research, the case can be made that since all three conditions increased across all areas of learning that human voice was important. However, this cannot be fully supported since there was no machine voice condition in this research. At best, it was one of many variables that helped increase learners' test scores across the conditions.

**Persona Effect Theory**

Persona effect is the anthropomorphization of an agent due to its life-like features of facial expressions, body movements, and gestures that emulate any real-life character (Woo, 2008). Research has shown the use of verbal and nonverbal
communication provides more engagement (Gulz, 2005; Dunsworth & Atkinson, 2007; Sklar & Richards, 2010). However, some studies have found the APA did not increase student interest (Choi & Clark, 2007; Dogmak, 2010). Veletsianos and Russell (2014) suggest the negative results are due more to the quality of agents, as there is no best design practice available to researchers.

This research does provide support to the persona effect as gesturing was found to provide persona to one APA condition. The full gesture condition was rated significantly higher than the no gesture condition in both human-likeness and engagement. Even though there were no significant differences between the full condition and deictic condition, and the deictic and no gesture condition, there is evidence that full gesture used by the APA can be seen as more life-like by the learner.

**Practical Implications**

The data generated by this experiment provided no statistical differences in regards to learning outcomes across APA gesture-based embodiment conditions, but did support the persona effect in that an APA using full gestures was perceived as more human-like and engaging than the no gesture condition. However, the practical implications from this study are very limited because this is the first documented instance, to the author's knowledge, that iconic, metaphoric, deictic, and beat gestures have been compared to the commonly used deictic gestures by APAs. More research needs to be conducted to understand the true implications of using full gestures with learning outcomes and social acceptance. For example, eye tracking studies may provide evidence to how closely students are attending to gestures in multimedia presentations. Such evidence may provide insight into how students focus on APA gesture production, and who might benefit most from gesture production (high
proficiency/ low proficiency) if gestures are being attended to during the learning process. Likewise, future research should examine if APAs should hold prominent positions on-screen during interventions. Gesturing APAs might be more beneficial in adaptive displays where gestures and agents are present during supplemental explanations, but absent during core learning information where images, graphs, text, and other means of information display can concentrate cognitive resources on learning content.

Designers need to strongly consider the time and effort to create gestures by the APA in the multimedia learning environment. The creation of deictic gestures is simplified as its purpose is to bring attention to the spatial environment, which is easier to create. The creation of iconic, metaphoric, and beat gestures are much more time consuming because they are designed to provide just-in-time support for dynamic instructional explanations of the content. However, software like iClone™ are making it easier for researchers and designers to create APAs with human-like movement a much easier task.

**Limitations**

There are a few limitations to this research. First, it is not possible to understand if students were focusing on gestures during the experiment. The addition of text in the presentation of information could have allowed the learner to ignore the APA or APA gestures. Two experiments by Louwerse, Graesser, McNamara, and Lu (2008) have provided eye tracking evidence that participants look at APAs during presentations; however the first experiment was an APA talking head, and the second experiment used miniature characters with deictic gestures. Eye-tracking data found that
participants focused on face the majority of the time, but with only gestures created for spatial awareness, the rate of gesturing was probably minimal. Therefore, it cannot be confirmed the participants were focusing their visual attention on the gestures produced by the APAs.

Second, the participants cannot be considered homogenous group, although they were all Korean elementary school students. The knowledge of a second language such as English can vary between students of the same age because of outside study and the opportunities to speak English. There is empirical evidence that low proficiency English speaking students had higher scores on listening comprehension scores than high proficiency students when a human instructor used iconic, metaphoric, deictic, and beat gestures on video (Sueyoshi & Hardison, 2005). Conversely, in the same study, high proficiency students performed significantly better on listening comprehension tests when compared with low proficiency students in a face only condition. The benefit of gestures may rely more on student level and not on homogenous features such as grade or age. One issue in regards to determining high and low proficiency was the pre-test and demographic information were not designed to accurately assess proficiency. An ANOVA analysis found no significant differences between the outside study conditions in regards to the prior knowledge assessment. The only other means to assess proficiency would have been a teacher coded assessment, but the blind design of the intervention did not allow for this to be an option.

Third, the Cronbach’s alpha scores on the retention test (.559) and transfer test (.555) in this study are considered acceptable but poor. These alpha scores fall into range for exploratory, or early stage research, which Nunnally, Bernstein, and Berge
(1967) recommended being between .50 and .60. One factor for the lower reliability score is the number of test questions in each instrument. Each instrument contained ten questions, and this was deemed appropriate because the elementary students showed signs of being overwhelmed with original layout and number of questions in the retention test (20 questions) and transfer test (15 questions) during the pilot test. In the future, more reliable instruments need to be administered in APA gesture production research.

**Future Research**

Since the use of full use of gestures have yet to be studied outside this experiment, it is important to understand the potential benefits or shortcomings of APA gesture production.

First, it is important that researchers start to understand what participants are focusing on in multimedia presentations with APAs using a full array of gestures. Eye tracking data should be performed to fully understand if the participants are attending to gestures and the patterns if transitions between APA face, gestures, and the rest of learning content on the screen. Also, eye-tracking data should be taken with low proficiency learners and high proficiency learners to better understand if gestures benefit some learners, and not others.

Second, in line with eye-tracking studies, APA gesture production needs to be examined in teaching different types of knowledge. For example, do students benefit more from conversational instruction and interaction using full gestures as opposed to procedural knowledge and full gesture usage? This could provide important information for the design of immersive virtual environments in education that require students to interact with an instructor or peer APA. Understanding how students attend to gesture
production with instruction on different types of knowledge could begin a best practice guideline for APA gesture production.

Third, there needs to be more research with different age groups and proficiency levels across the foreign language community, and different age groups and cognitive abilities within the native speaking community. It is possible gestures can be an asset or a hindrance to certain groups and abilities.

Fourth, within subject assessments of the APA need to be performed to gain an accurate measure of perceived differences between the different gesture conditions. It is very likely participants are basing their assessments on the look of the APA, and not the gesture performance. Understanding the social acceptance of APAs with gestures may have important benefits in the future when immersive technology is implemented in the classroom.

**Final Summary**

This research was conducted in an elementary school in South Korea with 160 5th and 6th graders. This study was exploratory in nature as iconic, metaphoric, deictic, and beat gestures have not been used in one condition to test APA social acceptance and effects on learning outcomes. Even though the full gesture condition did not significantly impact learning outcomes, there is evidence that an APA using the full array of gestures can have some benefits on social acceptance. Likewise, there is evidence that prior knowledge may play a role in the social acceptance of an APA. However, there was also evidence that human-likeness and engagement can cause a negative influence on learning outcomes, which might be attributed to the novelty of studying with an APA. This research has provided researchers with some evidence that
full gesture conditions need to be explored further for learning outcomes and social acceptance.
Hello, my name is Otto and want to teach you to compare two things in English. Let’s take a look at these two balls we have on the desk. Do you know what kind of balls they are? (Pause) That’s right, it’s a baseball and a golf ball. Now, if I wanted to compare the size of these balls using the word big, how would I say this? Would I say the baseball is big than the golf ball? No. When we want to compare two things, we need to add either –er or more to the word that is describing the items. For these two balls, we will have to say, the baseball is bigger than the golf ball. But, we cannot say the baseball is more big than the golf ball. So, how do we know when to use er and more to compare two things?

One way is by counting syllables. Syllables are the beats of the word, and we count the syllables as we clap along to saying the word like this: Pre-tty.
How many syllables was that?
You are right, two! Let’s try it again. Pre-tty.
How about if I say the word big? Big. Big only has one syllable.
How about the word beautiful?
Beau-ti-ful.
That’s three syllables. Try it again. Beau-ti-ful.

Okay, let’s try a few more. I’ll say the word, and you tell me the number of syllables.
Small- (pause)- how many syllables? One, that’s right. Small (with clap)
Important- (pause)- how many syllables? Three. Im-por-tant (with clap)
Hungry- (pause)- how many syllables is this one? That’s right, two. Hung-ry (with clap)

(Segment)
Now that we have talked about syllables, let’s talk about using –er with words that compare two things.

When we have one syllable words, you will normally place –er at the end. Let’s look at this sentence. I am ____________ than you (with strong). How many syllables are in strong? One. So what should we say? I am stronger than you.
How about this sentence? I am _____ than you (with tall). Tall has how many syllables?
One. What will be the answer? I am taller than you.
This works for most one syllable comparative words. One word it does not work with is fun. We do not say, Mr. Otto’s class is funner than Mr. Matt’s class. Fun is one syllable, but it uses more. So we say Mr. Otto’s class is more fun than Mr. Matt’s class. When a word is one syllable, the safest choice is –er, but be aware fun uses more and not -er.

When we have two syllable words, many of them take –er also. Remember our word pretty? How many syllables did that word have? That’s right, two. What if I wanted to say, my mom is __________ than my sister (pretty). Pre-tty is two syllables, and we are going to use prettier- my mom is prettier than my sister.
What about this sentence? Using the word heavy, complete this sentence. I am __________ than you (heavy). How many syllables? That’s right, two. Hea-Vy. So we will say, I am heavier than you.
Now, you do this sentence. My dog is __________ than my cat (ugly). (pause)
Did you say, my dog is uglier than my cat.
If you did, good job! Ug-ly is two syllables and takes the –er form. So remember, words that are one or two syllables usually take –er. However, as you are about to see, two syllable words can sometimes take more.

(segment)

There is an easy rule for when we are to use more instead of –er. If a word has three or more syllables than we use more in front. For example, the word beautiful has how many syllables? Beau-ti-ful. There are three syllables in this word. Would we say beautifuler, or more beautiful? Correct, you would say more beautiful, as in my mother is more beautiful than my aunt. How many syllables are in the word interesting? Let’s see, in-ter-est-ing. There are four syllables in our word, so we say more interesting. Remember, three or more syllables and the word uses more and not -er. This rule works 100% of the time. Words like important, im-por-tant, become more important when comparing two things. How about complicated? That’s right, it becomes more complicated because complicated is four syllables. Com-pli-cat-ed.

We just talked about how three or more syllables in an adjective uses the comparative more. Earlier, we talked about how two syllables use –er to compare two things. Well, there some special rules where two syllable adjectives receive more instead of –er. We will discuss two of the special rules right now.

If a word is two syllables, and ends with either –ful or –ent, then it uses more. Let’s look at some words. Mindful. Mindful is two syllables. Mind-ful. Other two syllable words that end with –ful are: boastful. Boast-ful. Artful. Art-ful. Although these words are two syllables, they use more because of the –ful ending. More mindful, more boastful, and more artful.

Using the same rule, two syllable words that end with –ent will use more also. Absent. Absent is two syllables, ab-sent. My mind is more absent than yesterday. Other two syllable words that end with –ent are: content. Con-tent. How about decent? De-cent. All these words will use more. More absent, more content, and more decent.

To sum up, when you are comparing two things, and you are not sure if you use –er or more, think of syllables. If it has one or two syllables, it normally takes –er. If it has three or more syllables, it always takes more. However, there are special rules where two syllable adjectives use more too. Two of the special rules we covered were when the adjective ends with –ful and –ent. If you see –ful or –ent at the end of an adjective, you always, 100% of the time, use more. That rule never changes.

I had a fun time teaching you! I hope you have a great day.
APPENDIX B
GESTURE DOCUMENTATION

Hello, my name is Otto and today I want to teach you how to compare two things in English.

Let’s take a look at these two balls we have on the desk. Do you know what kind of balls they are? (Pause) That’s right, it’s a baseball and a golf ball. Now, if I wanted to compare the size of these balls using the word big, how would I say this?

Would I say the baseball is big than the golf ball?

No. When we want to compare two things, we need to add either –er or more to the word that is describing the items. For these two balls, we will have to say, the baseball is bigger than the golf ball. But, we cannot say the baseball is more big than the golf ball. So, how do we know when to use er and more to compare two things?

One way is by counting syllables. Syllables are the beats of the word, and we count the syllables as we clap our hands along to the word like this: Pre-tty.

How many syllables was that?

You are right, two! Let’s try it again. Pre-tty.

How about if I way the word big? Big. How many syllables was that? One.

Big only has one syllable.
How about if I say the word beautiful?

Metaphoric

Beau-ti-ful.

Beat

That’s three syllables. Try it again. Beau-ti-ful.

Iconic

Okay, let’s try a few more. I’ll say the word, and you tell me the number of syllables.

Beat

Deictic

Deictic

Deictic

Small- how many syllables? Did you say one? That’s right. Small

Metaphoric

Deictic

Iconic

Metaphoric

Beat

How about the word important- how many syllables? Three? That’s right. Im-por-tant

Metaphoric

Metaphoric

Iconic

Beat

Okay, for our last one. Hungry- how many syllables is this one? Did you say two, if you did,

that’s right, two. Hung-ry

Beat

Beat

Now that you know what a syllable is, we’re going to talk about when to use –er and more. See

you in the next segment.

Deictic

Now that we have talked about syllables, let’s talk about using –er with words that compare two things.

Beat

Iconic

Deictic

Metaphoric

Beat

When you have one syllable words like big and small, you normally place –er at the end.

Iconic

Metaphoric

Metaphoric

Deictic

Beat

Let’s look at this sentence. I am ______________ than you- with the word strong. How many

syrllables are in strong? Let’s check the number of beats- strong (beat) One. So what should we

say? I am stronger than you.
How about this sentence? I am _____ than you- with the word tall. Tall has how many syllables?

One. What will be the answer? I am taller than you.

This works for most words with one syllable. One word it does not work with is fun. Fun is one syllable, but it uses more. So we say Mr. Otto’s class is more fun than Mr. Matt’s class. When a word is one syllable, the safest choice is –er, but be aware of words like fun that do not use -er.

When we have two syllable words, many of them take –er also. Remember our word pretty?

How many syllables did that word have? That’s right, two, and we said prettier. What if I wanted to say, my mom is ________ than my sister- with the word lovely. Lovely is two syllables, and we need to use –er to say my mom is lovelier than my sister.

Complete this sentence using the word heavy. I am __________ than you. How many syllables is heavy? Two. Hea-ivy. So we will say, I am heavier than you.

Now for the last one, you do this sentence. My dog is __________ than my cat (ugly).

Did you say, my dog is uglier than my cat.

If you did, good job! Ugly is two syllables, ug-ly, and it takes the –er form. So remember, words that are one or two syllables take –er. However, as you are about to see, two syllable words can sometimes take more.
Okay, I have told you about –er, now let’s look at more. There is an easy rule for when we are to use more instead of –er. If a word has three or more syllables, then we use more in front. For example, do you remember how many syllables the word beautiful had? Three. Because of the three or more syllable rule, we have to say more beautiful instead of beautifuler?

What about the word interesting in this sentence? Math is ___________ than history. How many syllables are in the word interesting? Let’s see, in-ter-est-ing. There are four syllables, so we have to say “Math is more interesting than history”. The word radiant- ra-di-ant- becomes more radiant. Complicated? More complicated or complicateder? (Pause) More complicated, because if it has four syllables. Com-pli-ca-ted.

Remember, three or more syllables and the word uses more and not -er. This rule works 100% of the time

However, there are some special rules where two syllable adjectives receive more instead of –er. We will discuss two of the special rules right now.

If a word is two syllables, and ends with –f-u-l or –e-n-t, it uses more. Let’s look at some words.

Mindful. It has two syllables, but we need to say more mindful because of the –ful ending. The same for words like boastful. Boast-ful. Because of the –ful ending, you say more boastful.
Artful becomes more artful. Although these words are two syllables, they use more because of the –ful ending. More mindful, more boastful, and more artful.

Let’s look at some –e-n-t words. Absent. Absent is two syllables, ab-sent. So we would say, today, my mind is more absent than yesterday. The same with other –ent words like: content becomes more content. Decent becomes more decent. All these words will use more because of the –ent ending. More absent, more content, and more decent.

To sum up, if you are comparing two things, and you are not sure if you use –er or more, think of syllables. If it has one, it most likely takes –er. If it has three or more syllables, it always takes more. However, two syllable adjectives take –er, but there are special rules where two syllable adjectives use more. Two of the special rules are adjectives that end with –ful and –ent. If you see –ful or –ent at the end of an adjective, you always, 100% of the time, use more. That rule never changes.

I had a fun time teaching you! I hope you have a great day.
Appendix C
Demographic Information

School Name:____
School Grade:____
Gender:____
Age:____
Have you ever lived longer than 6 months in an English speaking country?:____
How many hours a week do you have English classes outside of school?:____
APPENDIX D
PRIOR KNOWLEDGE TEST

1. 음절(Syllable)의 의미는 무엇입니까? (What does syllable mean?)
   a. 단어의 철자 (the spelling of the word)
   b. 단어의 독립적인 소리 (the individual sounds (beats) of a word)
   c. 단어를 이루는 각각의 알파벳 소리 (the sounds of each letter in the word)
   d. 단어의 첫 글자의 소리 (the sound of the first letter of the word)
   e. 모두 아님 (I don’t know)

2. 아래에 있는 단어들은 모두 몇개의 음절로 이루어져 있습니까? (How many syllables in the words below?)

   (예)Example: Big: 1
   2-1. hard: ___
       1 개 2 개 3 개 4 개
   2-2. easy: ___
       1 개 2 개 3 개 4 개
   2-3. expensive: ___
       1 개 2 개 3 개 4 개

3. 다음 단어에 대한 올바른 형식을 고르시오. (Choose the correct ending of –er or more.)

   Examples: (a) Fat
   fatter ←
   more fat

   3-1. enjoyable
       b) enjoyabler
       c) more enjoyable
       d) 잘 모르겠음 (I don’t know)

   3-2. smart
       a) smarter
       b) more smart
       c) 잘 모르겠음 (I don’t know)

   3-3. Violent
       a) violenter
       b) more violent
       c) 잘 모르겠음 (I don’t know)

4. 다음과 같이 단어가 변할 때, 어떤 법칙을 사용합니까? ()

   예 (Example):
   fat -> fatter
(i) 1 음절 단어 <---(1 syllable)
(ii) 1 음절단어를 위한 특별한 법칙 (1 syllable with special rule)
(iii) 2 음절단어(2 syllable)
(iv) 2 음절단어를 위한 특별한 법칙(2 syllable with special rule)
(v) 3 음절 또는 3 음절 이상의 단어(3 or more syllables)
(vi) 모두 아님 (I don’t know)

4-1. careful -> more careful
(i) 1 음절단어 (1 syllable)
(ii) 1 음절단어를 위한 특별한 법칙 (1 syllable with special rule)
(iii) 2 음절단어(2 syllable)
(iv) 2 음절단어를 위한 특별한 법칙(2 syllable with special rule)
(v) 3 음절 또는 3 음절 이상의 단어(3 or more syllables)
(vi) 모두 아님 (I don’t know)

4-2. deep -> deeper
(i) 1 음절단어 (1 syllable)
(ii) 1 음절단어를 위한 특별한 법칙 (1 syllable with special rule)
(iii) 2 음절단어(2 syllable)
(iv) 2 음절단어를 위한 특별한 법칙(2 syllable with special rule)
(v) 3 음절 또는 3 음절 이상의 단어(3 or more syllables)
(vi) 모두 아님 (I don’t know)

4-3. quiet -> quieter
(i) 1 음절단어 (1 syllable)
(ii) 1 음절단어를 위한 특별한 법칙 (1 syllable with special rule)
(iii) 2 음절단어(2 syllable)
(iv) 2 음절단어를 위한 특별한 법칙(2 syllable with special rule)
(v) 3 음절 또는 3 음절 이상의 단어(3 or more syllables)
(vi) 모두 아님 (I don’t know)
Agent Persona Instrument (API) : Final Instrument
All items should be presented with a 5-point Likert scale, ranging from 1=Strongly disagree to 5=Strongly agree.

**Facilitating Learning (10 items)**
1. The agent led me to think more deeply about the presentation.
   (Strongly Disagree) 1  2  3  4  5 (Strongly Agree)
2. The agent made the instruction interesting.
   (Strongly Disagree) 1  2  3  4  5 (Strongly Agree)
3. The agent encouraged me to reflect what I was learning.
   (Strongly Disagree) 1  2  3  4  5 (Strongly Agree)
4. The agent kept my attention.
   (Strongly Disagree) 1  2  3  4  5 (Strongly Agree)
5. The agent presented the material effectively.
   (Strongly Disagree) 1  2  3  4  5 (Strongly Agree)
6. The agent helped me to concentrate on the presentation.
   (Strongly Disagree) 1  2  3  4  5 (Strongly Agree)
7. The agent focused me on the relevant information.
   (Strongly Disagree) 1  2  3  4  5 (Strongly Agree)
8. The agent improved my knowledge of the content.
   (Strongly Disagree) 1  2  3  4  5 (Strongly Agree)
9. The agent was interesting.
   (Strongly Disagree) 1  2  3  4  5 (Strongly Agree)
10. The agent was enjoyable.
    (Strongly Disagree) 1  2  3  4  5 (Strongly Agree)

**Credible (5 items)**
11. The agent was knowledgeable.
    (Strongly Disagree) 1  2  3  4  5 (Strongly Agree)
12. The agent was intelligent.
    (Strongly Disagree) 1  2  3  4  5 (Strongly Agree)
13. The agent was useful.
    (Strongly Disagree) 1  2  3  4  5 (Strongly Agree)
14. The agent was helpful.  
(Strongly Disagree) 1 2 3 4 5 (Strongly Agree)

15. The agent was instructor-like.  
(Strongly Disagree) 1 2 3 4 5 (Strongly Agree)

**Human-like (5 items)**

16. The agent has a personality.  
(Strongly Disagree) 1 2 3 4 5 (Strongly Agree)

17. The agent’s emotion was natural.  
(Strongly Disagree) 1 2 3 4 5 (Strongly Agree)

18. The agent was human-like.  
(Strongly Disagree) 1 2 3 4 5 (Strongly Agree)

19. The agent’s movement was natural.  
(Strongly Disagree) 1 2 3 4 5 (Strongly Agree)

20. The agent showed emotion.  
(Strongly Disagree) 1 2 3 4 5 (Strongly Agree)

**Engaging (5 Items)**

21. The agent was expressive.  
(Strongly Disagree) 1 2 3 4 5 (Strongly Agree)

22. The agent was enthusiastic.  
(Strongly Disagree) 1 2 3 4 5 (Strongly Agree)

23. The agent was entertaining.  
(Strongly Disagree) 1 2 3 4 5 (Strongly Agree)

24. The agent was motivating.  
(Strongly Disagree) 1 2 3 4 5 (Strongly Agree)

25. The agent was friendly.  
(Strongly Disagree) 1 2 3 4 5 (Strongly Agree)
APPENDIX F
KOREAN AGENT PERSONA INSTRUMENT

다음은 캐릭터에 대한 질문입니다. 질문을 읽고 여러분이 생각하는 정도에 따라 답해주세요.
만약 질문에 대하여 매우 그렇다고 생각하면 5 점,
약간 그렇다고 생각하면 4 점,
보통이라고 생각하면 3 점,
조금 그렇지 않다고 생각하면 2 점,
전혀 그렇지 않다고 생각하면 1 점을 선택하세요.

Facilitating Learning (10 items)
1. The agent led me to think more deeply about the presentation.
전혀 그렇지 않다(Strongly Disagree) 1 2 3 4 5 매우 그렇다(Strongly Agree)
(04) 캐릭터는 학습내용에 대해 더 깊게 생각하도록 이끌었다.

2. The agent made the instruction interesting.
전혀 그렇지 않다(Strongly Disagree) 1 2 3 4 5 매우 그렇다(Strongly Agree)
(08) 캐릭터가 있어서 학습내용을 흥미롭게 느낄 수 있었다.

3. The agent kept my attention.
전혀 그렇지 않다(Strongly Disagree) 1 2 3 4 5 매우 그렇다(Strongly Agree)
(16) 캐릭터는 내가 학습내용에 집중할 수 있도록 도와주었다.

4. The agent presented the material effectively.
전혀 그렇지 않다(Strongly Disagree) 1 2 3 4 5 매우 그렇다(Strongly Agree)
(12) 캐릭터는 학습내용을 효과적으로 전달하였다.

5. The agent focused me on the relevant information.
전혀 그렇지 않다(Strongly Disagree) 1 2 3 4 5 매우 그렇다(Strongly Agree)
(20) 캐릭터는 학습에 필요한 정보에 집중하도록 도움을 주었다.

Credible (5 items)
6. The agent was knowledgeable.
전혀 그렇지 않다(Strongly Disagree) 1 2 3 4 5 매우 그렇다(Strongly Agree)
(01) 캐릭터는 아는 것이 많은 것 같다.

7. The agent was intelligent.
전혀 그렇지 않다(Strongly Disagree) 1 2 3 4 5 매우 그렇다(Strongly Agree)
(05) 캐릭터가 똑똑하다는 생각이 들었다.  

8. The agent was useful.  
전혀 그렇지 않다(Strongly Disagree) 1  2  3  4  5 매우 그렇다(Strongly Agree)  

(09) 캐릭터는 학습내용을 이해하는데 도움이 되었다.  

9. The agent was helpful.  
전혀 그렇지 않다(Strongly Disagree) 1  2  3  4  5 매우 그렇다(Strongly Agree)  

(13) 캐릭터는 학습에 도움이 되었다.  

10. The agent was instructor-like.  
전혀 그렇지 않다(Strongly Disagree) 1  2  3  4  5 매우 그렇다(Strongly Agree)  

(17) 캐릭터에게 배우는 느낌을 받았다.  

Human-like (5 items)  
11. The agent has a personality.  
전혀 그렇지 않다(Strongly Disagree) 1  2  3  4  5 매우 그렇다(Strongly Agree)  

(02) 캐릭터가 인격을 갖고 있는 것 같았다.  

12. The agent’s emotion was natural.  
전혀 그렇지 않다(Strongly Disagree) 1  2  3  4  5 매우 그렇다(Strongly Agree)  

(06) 캐릭터의 감정표현이 자연스러웠다.  

13. The agent was human-like.  
전혀 그렇지 않다(Strongly Disagree) 1  2  3  4  5 매우 그렇다(Strongly Agree)  

(10) 캐릭터가 사람과 비슷하다고 생각했다.  

14. The agent’s movement was natural.  
전혀 그렇지 않다(Strongly Disagree) 1  2  3  4  5 매우 그렇다(Strongly Agree)  

(14) 캐릭터의 움직임은 자연스러웠다.  

15. The agent showed emotion.  
전혀 그렇지 않다(Strongly Disagree) 1  2  3  4  5 매우 그렇다(Strongly Agree)  

(18) 캐릭터가 감정을 갖고 있다고 생각했다.  

Engaging (5 Items)  
16. The agent was expressive.  
전혀 그렇지 않다(Strongly Disagree) 1  2  3  4  5 매우 그렇다(Strongly Agree)  

(03) 캐릭터는 활달한 성격인 것 같다.  

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17. The agent was enthusiastic.
전혀 그렇지 않다(Strongly Disagree) 1 2 3 4 5 매우 그렇다(Strongly Agree)
(07) 캐릭터는 열정적이었다.

18. The agent was entertaining.
전혀 그렇지 않다(Strongly Disagree) 1 2 3 4 5 매우 그렇다(Strongly Agree)
(11) 캐릭터는 유쾌한 느낌을 주었다.

19. The agent was motivating.
전혀 그렇지 않다(Strongly Disagree) 1 2 3 4 5 매우 그렇다(Strongly Agree)
(15) 캐릭터는 공부를 하고 싶게 만들었다.

20. The agent was friendly.
전혀 그렇지 않다(Strongly Disagree) 1 2 3 4 5 매우 그렇다(Strongly Agree)
(19) 캐릭터가 친근하게 느껴졌다.
APPENDIX G
KNOWLEDGE RETENTION TEST

1. 아래에 있는 단어들은 모두 몇개의 음절로 이루어져 있습니까? (How many syllables in the words below?)

(예) Example: Big: 1
1-1. tall: ___
   1 개  2 개  3 개  4 개
1-2. important: ___
   1 개  2 개  3 개  4 개
1-3. pretty: ___
   1 개  2 개  3 개  4 개
1-4. complicated
   1 개  2 개  3 개  4 개

2. 다음 단어에 대한 올바른 형식을 고르시오. (Choose the correct ending of –er or more.)

Examples: (a) Fat
          fatter ←
          more fat

2-1. fun
     d) funner
e) more fun
f) 잘 모르겠음 (I don’t know)

2-2. boastful
     g) boastfuler
     h) more boastful
     i) 잘 모르겠음 (I don’t know)

2-3. strong
     d) stronger
e) more strong
     f) 잘 모르겠음 (I don’t know)

3. 다음과 같이 단어가 변할 때, 어떤 법칙을 사용합니까? ()

예 (Example):
fat -> fatter

(i) 1 음절 단어 <---(1 syllable)
(ii) 1 음절단어를 위한 특별한 법칙 (1 syllable with special rule)
(iii) 2 음절단어(2 syllable)
(iv) 2 음절단어를 위한 특별한 법칙 (2 syllable with special rule)
(v) 3 음절 또는 3 음절 이상의 단어 (3 or more syllables)
(vi) 모두 아님 (I don’t know)

3-1. ugly -> uglier
(i) 1 음절단어 (1 syllable)
(ii) 1 음절단어를 위한 특별한 법칙 (1 syllable with special rule)
(iii) 2 음절단어 (2 syllable)
(iv) 2 음절단어를 위한 특별한 법칙 (2 syllable with special rule)
(v) 3 음절 또는 3 음절 이상의 단어 (3 or more syllables)
(vi) 모두 아님 (I don’t know)

3-2. content -> more content
(i) 1 음절단어 (1 syllable)
(ii) 1 음절단어를 위한 특별한 법칙 (1 syllable with special rule)
(iii) 2 음절단어 (2 syllable)
(iv) 2 음절단어를 위한 특별한 법칙 (2 syllable with special rule)
(v) 3 음절 또는 3 음절 이상의 단어 (3 or more syllables)
(vi) 모두 아님 (I don’t know)

3-3. interesting -> more interesting
(i) 1 음절단어 (1 syllable)
(ii) 1 음절단어를 위한 특별한 법칙 (1 syllable with special rule)
(iii) 2 음절단어 (2 syllable)
(iv) 2 음절단어를 위한 특별한 법칙 (2 syllable with special rule)
(v) 3 음절 또는 3 음절 이상의 단어 (3 or more syllables)
(vi) 모두 아님 (I don’t know)
APPENDIX H
KNOWLEDGE TRANSFER TEST

1. 아래에 있는 단어들은 모두 몇개의 음절로 이루어져 있습니까? (How many syllables in the words below?)

(예)Example: Big: 1

1-1. potent: ___
   1 개  2 개  3 개  4 개
1-2. sweet: ___
   1 개  2 개  3 개  4 개
1-3. useful: ___
   1 개  2 개  3 개  4 개
1-4. abundant
   1 개  2 개  3 개  4 개

2. 다음 단어에 대한 올바른 형식을 고르시오. (Choose the correct ending of –er or more.)

Examples: (a) Fat
            fatter ←
            more fat

2-1. ardent
    a) ardenter
    b) more ardent
    c) 잘 모르겠음 (I don't know)

2-2. sly
    a) slier
    b) more sly
    c) 잘 모르겠음 (I don't know)

2-3. masculine
    c) masculiner
    d) more masculine
    e) 잘 모르겠음 (I don’t know)

2-4. rueful
    a) ruefuler
    b) more rueful
    c) 잘 모르겠음 (I don’t know)

2-5. scruffy
    a) scruffier
    b) more scruffy
2-6. cheeky
   a) cheekier
   b) more cheeky
   c) 잘 모르겠음 (I don't know)
LIST OF REFERENCES


BIOGRAPHICAL SKETCH

After helping immigrants learn English while working at a hotel resort as an undergraduate, Robert Otto Davis, PhD, found his career as an educator in the field of foreign language learning. During the course of his career, he has developed several different interests within the field, such as learning theory, curriculum design, and technology integration.

He has spent more than a decade living and teaching overseas, mainly in South Korea. Robert has taught Second Language Acquisition in a TESOL Certification program at a university, instructed pre-service teachers in English Education, consulted education businesses, worked with city governments, co-authored textbooks, self-published textbooks, and created online courses involving foreign language learning.

Robert’s current direction seeks to understand the dynamics of animated pedagogical agents with foreign language instruction in multimedia environments. He hopes to build upon this research to examine how virtual reality with animated pedagogical agents can be implemented into the classroom for the next frontier of learning. Robert sees the future of education using virtual environments to provide students the ability to engage with information in a way that students have never had before. Not only for foreign language learning, but for learning in general.