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Increasing Persona Effects: Does It Matter the Voice and Appearance of Animated Pedagogical Agent*

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The animated pedagogical agent has been implemented to promote learning outcomes and motivation in multimedia learning. It has been claimed that one of the advantages of using pedagogical agent is persona effect – the personalization or social presence of pedagogical agent can enhance learning engagement and motivation. However, prior research is inconclusive as to whether and how the features of the pedagogical agent have effects on the persona effect. This study investigated whether the similarity between a pedagogical agent and the real instructor in terms of the voice and outlook would improve students' perception of the agent's persona. The study also examined the effect by the size of pedagogical agent on the persona perception. Two experiments were conducted with a total of 115 college students. Experiment 1 indicated a significant main effect of voice on the persona perception. Experiment 2 was conducted to examine whether the size of pedagogical agent would affect the voice effect on the persona perception. The results showed that the instructor-like voice yielded higher persona perception regardless of the pedagogical agent's size. Overall, the study findings indicated that the similarity in voice positively fostered the agent's persona.

Keywords : Persona Effect, Animated Pedagogical Agent, Voice Effect, Appearance of Agent

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Introduction

Animated pedagogical agents in multimedia

The animated pedagogical agent (APA) is a computerized character delivering instructional messages with narration and gestures to support learners in multimedia learning (Heidig & Clarebout, 2011; Mayer & DaPra, 2012; Veletsianos, 2012). Various APA have been applied as a means of providing instruction and facilitating motivation to promote learning in computer-mediated learning environment (Heller & Procter, 2011; Ozogul, Johnson, Atkinson, & Reisslein, 2013). One of the promising features of using APAs is persona effect, meaning the personable presence of APA can promote learning and motivation (C. Kim & Baylor, 2008; Miksatko, Kipp, & Kipp, 2010; van Vugt, Konijn, Hoorn, Keur, & Eliëns, 2007). Although multiple studies in APAs were conducted to examine the persona effect of pedagogical agents, comprehensive reviews indicated that there were no conclusive positive results of the persona effect (Heidig & Clarebout, 2011; Heller & Procter, 2011; Ozogul et al., 2013). Given the inconsistent results in the persona effect, a speculation is that APAs did not present the instructor-like presence to the learners. The lack of instructor presence may lower the persona effect.

This study aims to examine whether a real instructor's voice and appearance influence the persona perception when it was applied to a pedagogical agent. Voice and appearance are important design factors of APA because they play a central role in communication (Tien & Osman, 2010). The agent's appearance guides people to characterize who the APA is representing (Moreno & Flowerday, 2006; Ozogul et al., 2013). Higher similarities of an APA's voice and appearance with a real instructor may yield stronger persona perception, thus enhancing learning and motivation. In this study we also investigated the effect of instructor's voice and appearance on the persona perception in an immersive display that scaled up a

pedagogical agent to a lifelike size. Recently the immersive environment has attracted a lot of attention in the virtual learning setting (Mazikowski & Lebiedź, 2014; Ruotolo, 2013). The immersive scale may enhance the persona perception regardless of the voice and appearance of the APA.

Lifelike pedagogical agent and persona effect

A learner interacting with a pedagogical agent accepts it as a real human because of its humanlike features. This persona acceptance helps the learner engage in learning. It has also been argued that the pedagogical agent should present a personality; thus, the learning with APAs can be more convincing (Cassell, 2000). Prior research claimed that the persona presence fosters better understandings and higher motivation by making learners more attentive and eager to interact with the APA (Baylor & Kim, 2009; Osman & Lee, 2013; Tien & Osman, 2010). With the positive persona effect, the pedagogical agent can provide instructional guides as to what is important and how the information should be interconnected. And the humanlike appearance of pedagogical agents will motivate learners to pay more attention towards learning. The verbal and nonverbal communications of an APA help learners engage in cognitive and affective processes of learnings. Mayer and DaPra (2012) reported that the integration of verbal and nonverbal communications creates a high level of embodiment that results in a stronger persona effect. When learners interact with the pedagogical agent that is capable of demonstrating conversation, providing scaffolding, and supporting problem-solving, they would consider the pedagogical agent as a valuable learning partner (Y. Kim, Baylor, & PALS group, 2006).

The persona effect is a result of lifelike features of pedagogical agent with which the learners perceive their learning experience as being accompanied by a real person (Woo, 2009). The persona effect can be explained from the social presence theory. Social presence is a key function underlying learners' interaction with the

APA. It has been claimed that pedagogical agents facilitate social interactions between learners and computer-based contents through their human-like attributes. Social cues presented by the pedagogical agents can reinforce a sense of presence, stimulate learners' interaction with pedagogical agents, and hence enhance learning motivation (Heller & Procter, 2011; Johnson, DiDonato, & Reisslein, 2013; Mayer & DaPra, 2012; Ozogul et al., 2013). The visual appearance and animated functions of the pedagogical agent can retain learners' attention toward the desirable content to learn. The pedagogical agents provide instructional guidance via both verbal narrations and emotional expressions. With the pedagogical agent's assistance, the learners can manage their cognitive capacity to comprehend and transfer knowledge (Dunsworth & Atkinson, 2007; Frechette & Moreno, 2010). Research from the cognitive management perspective shows that the persona presence of APAs foster a better understanding.

Despite the positive potentials of pedagogical agents, Domagk (2010) reported that it is hard to identify significant contributions of using APA in comprehensive reviews. Even with the great number of studies on APA, the effectiveness and design principles for persona effect remain as open questions. Several review studies of pedagogical agent identified no consistent results for persona effect (Heidig & Clarebout, 2011; Heller & Procter, 2011). Heidig and Clarebout (2011) conducted an extensive literature review to examine how effective a pedagogical agent was for learning and motivation. Their review showed inconclusive results of using the pedagogical agent. Because only a small number of studies reported significant results of using APA, it was concluded that the learning effectiveness of APA should be further examined. Furthermore, due to the wide variety of APAs used in the studies, the general effects of APA were too broad to speculate. Consequently, Heidig and Clarebout (2011) suggested that it should be more important to examine the specific design variables rather than the general effect of pedagogical agents. Heller and Procter (2011) came up with a similar conclusion: A more proper research goal is to specify the influence of design variables on APA

and its persona effect.

Design Features of the Animated Pedagogical Agent

APA as a social actor

A potential reason of inconclusive persona effect can be the lack of similarity between APA and a real human instructor. Although it has been assumed that APA can play the critical role of an instructor, it has not been discussed yet how well APA should look and act like a real instructor. The similarity between APA and a real human instructor can create a better relationship between a learner and APA in a virtual learning environment (Mikropoulos & Natsis, 2011). At this point, it is useful to consider how a learner perceives computers like an interactive companion with intentions and emotion. This perspective is known as computers are social actors(CASA) (Nass & Moon, 2000; Lee & Nass, 2010).

The lack of similarity with human instructor of APA may result in the inconclusive result of persona effect. Although a key role of APA is interacting with learners so that it facilitates learning engagement, learners may have disbelief of the instruction by APA due to its lack of human attributes in APA. Furthermore, the CASA perspective emphasizes that computers are perceived as social actors with facilitating social interactions in virtual learning environment (Mikropoulos & Natsis, 2011). More attribution of human properties in APA fosters more social interaction, and hence stronger persona effect of APA. From the pedagogical agent perspective, learners' perception of increased human attribution of APA relies on the similarity between an original instructor and a pedagogical agent in an instructional condition. The higher resemblance of pedagogical agent to original instructor should lead to better learning and motivation. Users may treat computers similar to learning companion to interact with learning process (Susan & Wolff,

2015). Indeed, users are likely to enjoy interacting with APA even if they are fully aware that APA is not a real human instructor. As a result, learners with APA tend to prefer learning with APA as if in the human interaction. Therefore, it is reasonable to design APA having more human like properties to make more preferable learning partners.

Voice and appearance of APA

Making pedagogical agents more lifelike has been the center of prior research (Baylor, 2011; Gulz & Haake, 2006; C. Kim & Baylor, 2008; Woo, 2009). It has been assumed that the more APA demonstrates human like behavior and appearance, the stronger persona effect will occur. Lifelike characters can be perceived more credible and believable than unnatural characters (Ozogul et al., 2013). Gulz and Haake (2006) reviewed design elements of APA in terms of visual rendering. They suggested that there are three crucial factors of APA that delineates the persona characteristics - personality, facial expressions, and appearance. Among these features, appearance along with voice and dialogues are key design considerations (Baylor, 2011).

The design features of the APA were divided into external and internal properties (Johnson et al., 2013). External properties relate to graphical renderings of an APA's age, gender, face, clothing, gestures, and the degree of realism. Internal properties relate to APA's personality and instructional strategies, which cannot be directly observed but will be identified by interacting with an APA. Research on the persona effect suggests that the factors of external properties can affect learners' perception of APAs. (Baylor & Kim, 2009; Heller & Procter, 2011; Johnson et al., 2013; Y. Kim & Baylor, 2006; Mayer & DaPra, 2012; Ozogul et al., 2013). Specifically, the appearance of an APA is critical for its persona presence. APA's face can present the identity of whom APA is representing; thus, learners might have expectations based on the face of APA on the agent's credibility and

familiarity (Johnson et al., 2013; van der Meij, 2013).

Haake and Gulz (2009) extended the ideas of external and internal properties to look and communication modalities, which focus on properties' functions rather than their observability. Look modality refers to APA's characteristics of appearance, body, graphical style that convey a general overview of whom the APA is. Communication modality focuses on expressivity via facial displays, gestures, postures, and motion generation. The communication modality is important because it delivers behavioral expressivity through narration. Voice is the most representative element of the communication modality. Domagk (2010) argued that agent's appearance and voice are prime factors to support social interactions between APA and learners. Voice can express emotional message as well as instructional content. There are a considerable number of studies examining the differential effect of human voice versus computer synthesized voice of the APA (Atkinson, 2002; Atkinson, Mayer, & Merrill, 2005; Mayer, Sobko, & Mautone, 2003; Tien & Osman, 2010; Veletsianos, 2012). Previous studies indicated that human voice is more preferable for learners and produce better learning outcomes and higher motivation. The lack of human like features in computer synthesized voice lowers learners' attribution of social interactions with APA; thus, human voice fosters better performance and motivation than computer synthesized voice does.

Immersive display

Physically large displays can increase learners' sense of presence in virtual learning environment (Bakdash, Augustyn, & Proffitt, 2006). Because of the enlarged screen size, learners can perceive immersion in the virtual learning environment. Therefore, a larger screen can provide learners to higher emotional status and better memory capacities. During the learning with APA, a larger screen provides a learner with a wider visual field that can improve viewing (Hou, Nam,

Peng, & Lee, 2012). Furthermore, the enlarged screen will give stronger physical presence to enhance the realistic experience (Lee, 2004). Moreno and Mayer (2002) defined the immersion as the inclusive and extensive surrounding and a vivid illusion of reality. A large display can provide learners with a high sense of presence – sense of being there. And the increased sense of presence helps to enhance the persona effect. A larger screen may create more interactions between learners and the learning content (Bakdash et al., 2006). In the same vein, applying APA with a large screen should lead to increased interactions between learners and APA.

Research Problems

Despite the reported advantages of employing human voice to APA, almost no empirical research has examined a specific type of voice for APA. No empirical research has examined the similarities of voice and appearance between APA and the real instructor for the persona effect. Resemblance of voice and appearance to the real instructor may substantiate the advantages of APA for learning. The current study examines whether simulating the voice and appearance of a real human instructor can enhance the persona effect by increasing students' sense of information usefulness and affective interaction with APAs. Furthermore, this study will identify if a larger screen display has a positive impact on the persona effect of using APA.

The present study encompasses two experiments that investigated the realism of voice and appearance in designing pedagogical agents, with the potential effect of the immersive display (i.e., small screen size vs. lifelike size) considered. Specifically, the study addresses two research questions: (1) How do learners perceive pedagogical agents when agents have instructor's voice and/or simulate instructor's appearance (Experiment 1)? And (2) Will the lifelike size of the pedagogical agent via an immersive display have an impact on the persona perception (Experiment 2)?

Experiment 1

Experiment 1 examined the impact of voice (recorded instructor's voice vs. synthesized voice) and appearance (similar graphic vs. animation character) of a pedagogical agent on learners' perceptions of the agents' persona. The API (Ryu & Baylor, 2005) was employed for this study and translated as a Korean version of API. The API has two categories of pedagogical agent persona: 1) informational usefulness and 2) affective interaction with pedagogical agent. Each category has two variables. For the perception of informational usefulness, the variables of facilitating learning and being credible are measured. The variables of being engaging and human-like were evaluated for the perception of affective interaction.

Method

Participants and design

A total of forty-eight college students (16 males and 32 females) were sampled from a large public university located in the southwest of South Korea. They were recruited via the university website as paid participants with a stipend. The average age of participants was 21.3years (SD=1.89) with a range of 19 through 28. The participants included 8 freshmen, 13 sophomores, 15 juniors, and 12 seniors.

The experiment applied two way factorial design, with the appearance and voice design of the pedagogical agent as two independent factors. All of the participants were randomly assigned to one of the four conditions: (a) realistic appearance with instructor's voice, (b) graphic appearance with instructor's voice, (c) realistic appearance with computer synthesized voice, and (d) graphic appearance with computer synthesized voice. An equal number of, participants (n=12) were assigned into each condition.

Instructional module

The instructional module used in the experiment was developed based on an existing episode on ethical or moral dilemmas. In this module a human instructor introduced a leading story of the ethical dilemmas. As shown in Figure 1, the instructor was wearing glasses and neckties with a shirt. His appearance was delivered through the instructional module to the participants. The instructor explained that an ethical dilemma will be provided and asked what you would like to decide if the participants were in the same situation. In the following questions, he questioned that the participants need to bring their rationale on the decision.

Figure 1. The instructor shown in the module

After this introduction, different types of APA appeared to tell the dilemma story to the participants. In the episode, a moral dilemma situation depicting survivors in a lifeboat from a shipwreck was narrated to the participants by the APA. In the moral dilemma, the survivors suffered from hunger for more than fifteen days while the youngest one of them was diseased and weakened. After staying in the lifeboat without any food for few more days, the rest of survivors killed the youngest one for the purpose of eating his flesh. Although the survivors were rescued a few days later, they were accused as murders. The episode ended with questions for the participant asking what they would do in the same situation.

The episode was cited from Michael Sandel's book entitled as JUSTICE (2010). The narration started with a brief self-introduction by the APA-embodied professor, which was followed by the introduction on the purpose of instructional module. The oral narration in the episode encompassed a total of four hundred and fifty words.

Pedagogical agent

The pedagogical agent employed in this experiment of this study was named as embodied realistic instructional character (ERIC). ERIC was designed to examine how much the realistic factors of appearance and voice have impacts on students' perceptions of the pedagogical agent. The agent was developed via iClone 5.5, a commercial software package to create animated character. The software enables the animated characters to talk with lip-synched audio, perform gestures, portray facial expressions, and demonstrate divergent movements in three-dimensional perspective. In this experiment, voice and appearance were the independent variables. Except for these two factors, the pedagogical agent across the study groups was acting exactly the same.

The pedagogical agent was designed to use natural movements such as conversational gestures and eye-gaze to direct attention, including blinking, head movement, and posture changes, as well as synchronized lip movement to speech. No particular conversational gesture was employed. ERIC was designed to deliver a lecture-like talk to the participants without any other instructional tool. In order to simulate natural talk movements, ERIC spontaneously changed postures, eye-gaze directions, and head movements during the talk. The pedagogical agent displayed smiles as his default facial expressions and wore a black suit.

ERIC used either instructor's voice or computer synthesized voice in his narration. The instructor's voice was recorded by a male Korean instructor. Neo-speech, a commercial software, was applied to develop a computer synthesized voice based on text-to-speech function. Neo-speech in JUNWOO, a

male Korean voice, was applied to ERIC.

In this study ERIC's face, as the key appearance feature, was manipulated. Two types of face were used for ERIC: (a) instructor's realistic appearance and (b) animated appearance. The realistic appearance was created by embedding the instructor's picture into ERIC via iClone's morphing function. Figure 2 shows an animation character version of ERIC. The animated appearance was selected from the character face library of the development software. Figure 3 shows the realistic appearance version of ERIC. Except for the voice and appearance, two ERICs in Figure 2 and 3 used the same motions and background. To ensure the appearance similarity between the realistic appearance and the instructor Figure 1 and Figure 3 were reviewed by the authors.

Figure 2. Pedagogical agent with animated appearance

Figure 3. Pedagogical agent with realistic appearance

Variables and Instruments

Voice and appearance of the pedagogical agent were the independent variables of experiment 1. Two types of voice, (a) instructor's voice and (b) computer synthesized voice, were applied. The lengths of narration were 4 minute 30 seconds and 4 minutes 25 seconds for instructor's voice and computer synthesized voice respectively. Both narrations were synchronized with lip-movement. Face variable also had two levels: (a) realistic appearance and (b) animated appearance. The realistic appearance was made of the real instructor's picture.

The dependent variables were participant's perceptions as to how much the pedagogical agent was helpful in terms of informational usefulness and affective interaction. Baylor and Ryu (2003) suggested using the agent persona instrument (API) questionnaire to measure agent persona, and the API has been validated in empirical research (Ryu & Baylor, 2005). The API has four factors - Credible, Facilitating Learning, Human-like, and Engaging. These factors were categorized into two latent categories: 1) informational usefulness and 2) affective interaction with APA. The informational usefulness, first latent category, refers to the learner's perception of pedagogical agent's knowledge and expertise. It is to measure how well the APA helped the learners understand the contents.

The Agent Persona Instrument (API) was selected (Baylor & Kim, 2009; Mayer & DaPra, 2012; Ryu & Baylor, 2005) and translated to Korean. The Korean version of API (KAPI) consisted of 20 items with a 7-point Likert rating scale. The KAPI clustered into four subscales as the API has, and they were facilitating learning (FAC), credible (CRE), engaging (ENG), and human-like (HUM). FAC and CRE are subscales of the informational usefulness of APA, and ENG and HUM are subscales of the affective interaction presented by APA (Ryu & Baylor, 2005).

FAC measures how well the agent facilitated learning for participants via the instruction. CRE indicates how knowledgeable the agent appeared during the instruction. FAC and CRE measure the perceptions of pedagogical agent's learning

effectiveness. ENG and HUM measure the social presence of pedagogical agent, and hence the affective role of the pedagogical agent. ENG measures how the agent helps to engage learners in the instruction presented. HUM measures how the agent behaves like a human in terms of his gestures, facial expression, and body movements. The Cronbach's alpha of four factors were evaluated at .92, .89, .89, and .84 for FAC, CRE, ENG, and HUM respectively in Experiment 1.

Procedures

Participants interacted with the instructional module individually in the experiment. Each participant was seated at a desktop computer with a 22-inch-wide monitor (DELL P2210) in a cubical and then randomly assigned to one of the experiment conditions: (a) realistic appearance with instructor's voice, (b) graphic appearance with instructor's voice, (c) realistic appearance with computer synthesized voice, and (d) graphic appearance with computer synthesized voice. First, participants were advised to sign an informed consent form. They then watched two video clips. The professor appeared in the first video clip explaining the experiment procedure and general purpose of using e-learning. This clip presented the professor's appearance to all participants. The second clip acted as the main experimental stage. In this stage one of the four types of ERIC was presented to each study group. Finally, participants were asked to complete a survey. After completion of the survey, participants were given a summary of this experiment and asked if they had any questions. The total time length was approximately 25 minutes.

Results

A two-way multivariate analysis of variance (MANOVA) was conducted to examine if the learners' persona perceptions (FAC, CRE, ENG, and HUM) could

be differed by the factors of voice and/or appearance. Descriptive statistics are presented in Table 1. The assumption of the homogeneity of variance-covariance at multivariate level was tested, and the result of Box's M test revealed no violation, $F(30, 5322)=1.10$, $p>0.05$. MANOVA analysis showed no significant interaction effect and no main effect of the appearance factor, but a significant main effect of the voice factor was found with Wilks' $\lambda=0.78$ ($F(4, 41) = 2.98$, $p<0.05$, partial $\eta 2 = 0.03$).

Table 1. Descriptive data of experiment 1

	Instructor's Voice		Computer Synthesized Voice	
	Realistic face n=12	Animated face n=12	Realistic face n=12	Animated face n=12
FAC	4.90 (1.31)	5.00 (0.92)	4.35 (1.37)	4.95 (1.23)
CRE	4.97 (0.90)	5.32 (0.68)	4.18 (1.43)	4.87 (1.16)
ENG	4.85 (0.84)	5.27 (0.67)	3.90 (1.31)	4.65 (0.82)
HUM	4.50 (1.31)	4.60 (1.05)	3.48 (1.33)	3.82 (1.21)

Given the significance of the overall test, Levene's test was assessed and no violation was found across the dependent variables. The post-hoc univariate analyses by the voice factor showed significant main effect on ENG ($F(1, 44)=8.28$, $p<0.01$, partial $\eta 2 = 0.16$) and HUM ($F(1, 44)=6.44$, $p<0.05$, partial $\eta 2 = 0.13$). As shown in Figure 4, the mean scores indicated that learners who were assigned to the instructor's voice condition ($M=5.06$, $SD=0.78$) showed significantly higher perception of engaging (ENG) than the computer-synthesized condition ($M=4.28$, $SD=1.14$) did.

Similarly, the instructor's voice condition ($M=4.55$, $SD=1.16$) showed a significantly higher mean score in HUM subscale than the computer-synthesized condition ($M=3.65$, $SD=1.26$) did. Although it was not significant, the perception on the credibility of pedagogical agent (CRE) approached a marginal difference at $F(1, 44)=4.56$, $p=0.054$, partial $\eta 2 = 0.08$. Indeed, the instructor's voice condition

showed higher mean score at 5.14 with SD=0.80 than the computerized voice condition at M=4.53 with SD=1.32.

Although there was no significant multivariate effect of the factor of appearance, , the following univariate analysis revealed a significant main effect of the appearance on ENG, $F(1, 44)=4.59$, $p<0.05$, partial $\eta 2 = 0.09$. The mean scores indicated that learners of the animated appearance condition (M=4.96, SD=0.80) showed significantly higher perception of ENG than the instructor's appearance condition (M=4.38, SD=1.18) did.

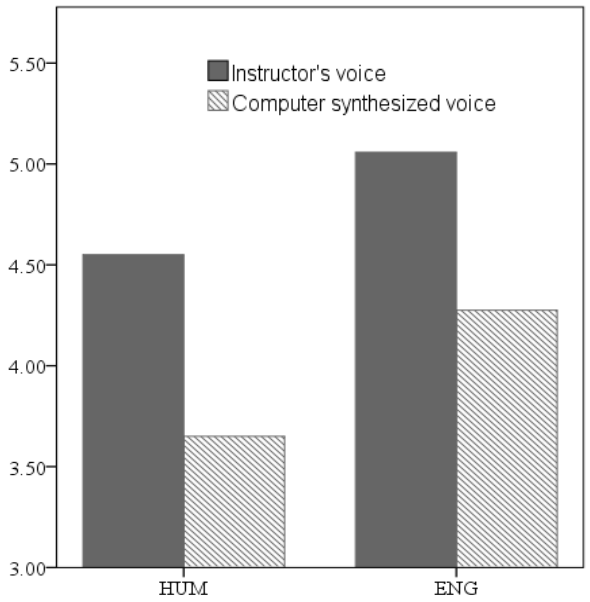

Figure 4. The mean scores of HUM and ENG by the voice

Experiment 1 showed that the voice factor had a significant multivariate effect. The instructor's voice, in comparison with computer synthesized voice, significantly promoted more ENG and HUM (or the affective aspect of the agent's persona). This results indicated that the instructor's voice helped to engage the learners in the learning experience and promoted students' perception of the pedagogical agent as being human-like.

Experiment 2

Experiment 2 was designed to examine whether and how the size (small screen size vs. life-like size) of the pedagogical agent would interact with the voice feature (instructor's voice vs. computer synthesized voice) of the pedagogical agent in influencing students' perception of the agent's persona. The realistic appearance of instructor was applied across all study conditions to control the appearance effect. The primary purpose of Experiment 2 was to examine whether there would be an interaction between the voice and the agent's size on learners' perceptions of agent persona.

Method

Participants and design

Sixty-seven enrolled participants were sampled from the same university of Experiment 1, who were new participants recruited with the same amount of stipend. All of them were screened to exclude the ones who participated in Experiment 1. The average age of participants was 21.5 years (SD=2.37), with an 18-27 age range. They included 15 freshmen, 12 sophomores, 22 juniors, and 18 seniors. Experiment 2 employed a 2×2 factorial design, with the independent variables of size (small size vs. lifelike size) and voice (instructor's voice vs. computer synthesized voice). The dependent variables were the same as the constructs measured in Experiment 1 and by the same instrument - KAPI. Participants were randomly assigned to one of the four conditions: (a) small size with instructor's voice (n=16), (b) lifelike size with instructor's voice (n=15), (c) small size with computer synthesized voice (n=15), and (d) lifelike size with computer synthesized voice (n=15).

Pedagogical agent

The same pedagogical agents used in Experiment 1 were applied to Experiment 2. The verbal message and nonverbal features of the pedagogical agent were identical across the two experiments.

Variables and Procedure

Voice and size of the pedagogical agent were the independent variables of Experiment 2. The same two types of voice, (a) instructor's voice and (b) computer synthesized voice, were applied in Experiment 2. The size of pedagogical agent was the second independent variable, with small screen versus large screen as two levels. A projector was utilized to create the pedagogical agent in a lifelike size.

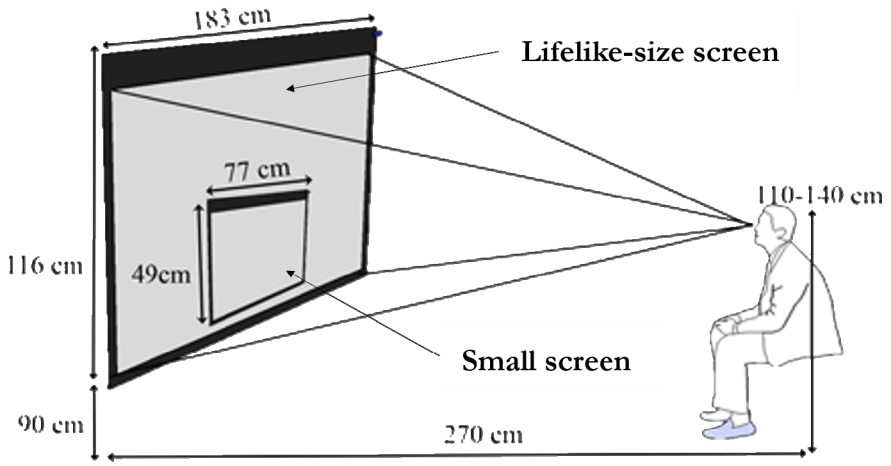

Figure 5. Two screen sizes and experimental setting

As shown in Figure 5, the distance of projector from a screen was maintained to ensure the size of ERIC simulated the lifelike size. The screen size of lifelike screen was measured as 183cm wide and 116cm high. The size of the small screen was measured as 77cm wide and 49 cm high. The total screen of the lifelike condition,

or the large screen, was five times bigger than the small screen. The same dependent measures were used in Experiment 2. The Cronbach's alphas of KAPI were evaluated at .91, .90, .87, and .90 for FAC, CRE, ENG, and HUM respectively.

Procedure

The study procedure employed in Experiment 2 was the same as Experiment 1.

Results

A two-way MANOVA was conducted, with screen size and narration as the two independent factors. Box's M test was examined for the homogeneity of variance-covariance, and no violation was found, $F(30, 8878)=1.20$, $p>0.05$. The MANOVA analysis showed no significant interaction effect, but a significant main treatment effect of the voice with Wilks' $\lambda=0.78$, $F(4, 54) = 3.76$, $p<0.05$, partial $\eta 2 = 0.22$. In the post-hoc analysis of Levene's test, one violation was found on ENG ($F(3, 57)=4.87$, $p<0.05$). Because of the violation of the homogeneity of error variance in the univariate analysis, a more conservative critical alpha level was set at .025 rather than the conventional .05 level. Thus, alpha level .025 for the ENG variable was used to determine the significance in the univariate analysis.

The univariate F-test revealed no significant interaction effect but a main effect of voice in Experiment 2. The results of experiment 2 were similar to those of experiment 1. As shown in Figure 6, the voice factor yielded significant differences on ENG ($F(1, 57)=5.94$, $p<0.25$, partial $\eta 2 = 0.09$) and HUM ($F(1, 57)=14.81$, $p<0.01$, partial $\eta 2 = 0.21$). The mean score of instructor's voice condition ($M=4.61$, $SD=1.10$) was significantly higher than computer-synthesized condition ($M=4.03$, $SD=0.78$) in ENG. Furthermore, the mean score of instructor's voice condition

Table 2. Descriptive data of experiment 2

	Instructor's Voice		Computer Synthesized Voice	
	Lifelike size n=15	Small screen size n=16	Lifelike size n=15	Small screen size n=15
FAC	5.25 (1.12)	5.09 (1.03)	4.63 (0.88)	4.85 (0.78)
CRE	5.23 (0.92)	5.19 (0.96)	4.71 (0.79)	4.88 (0.77)
ENG	4.57 (1.36)	4.65 (0.84)	4.03 (0.81)	4.03 (0.57)
HUM	4.61 (1.20)	4.39 (1.23)	3.44 (1.02)	3.43 (0.81)

(M=4.50, SD=1.20) was significantly higher than that of computer synthesized condition (M=3.43, SD=0.81) in HUM. The result of CRE was approaching a significant difference, F(1. 57)=3.51, p=0.67; the mean score of instructor's voice was 5.21 (SD=0.92), higher than that of the computer synthesized voice at 4.79 (SD=0.77).

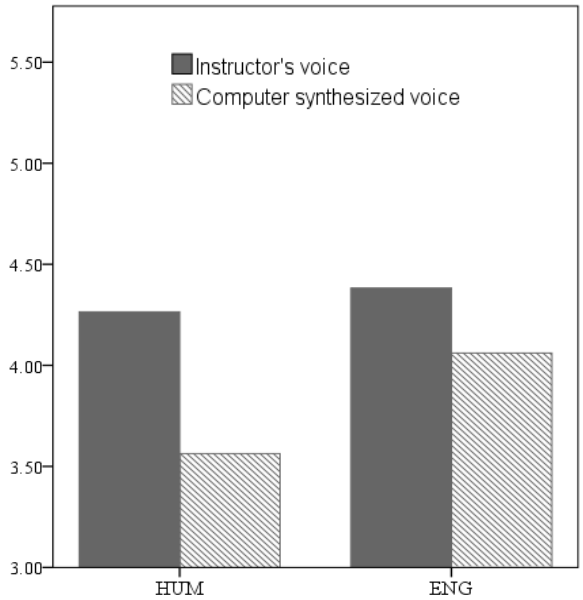

Figure 6. The mean scores of HUM and ENG by the voice

Conclusions and Discussion

This study examined the effects of the resemblance in voice and appearance between the APA and the real instructor on students' perception of agent's persona. Furthermore, this study investigated whether the screen or presentation size of APA will have effects the persona perception. The study results indicated that using a real instructor's voice promoted persona effect. Voice is superior to the appearance of APA in stimulating positive persona perception. Moreover, the voice effect is significant across different screen/presentation sizes of the APA; that is, whether the APA is presented via a big, immersive screen or a small monitor, using real instructor's voice consistently showed significantly positive impacts on the persona perception. Interestingly, the positive impacts of the voice on the persona perception were mainly found on two variables, engaging and human-like. This finding indicated that the voice influences mainly the affective or social presence of APA. This finding supports the report of prior research that human voice was better than computer synthesized voice and the voice feature of APAs is strongly associated with social responses (Atkinson et al., 2005; van der Meij, 2013; Veletsianos, 2012).

There are three potential reasons for the positive impacts of the APA's voice on the persona effect. First, from the perspective of the social agency theory, a learner tends to apply a number of social norms during their interactions with an APA. According to Lin et al. (2013), it is natural for a person to concentrate on dialogue listening during a human-to-human communication. Likewise, a learner will prioritize the verbal information presented by APA. Among the social cues for communication, voice is the primary medium for message delivery. Hence the APA's voice will prime a learner's social response and strengthen learners' social bond with the APA.

The second explanation is the distraction caused by the uncanny speech of the computer synthesized voice, which led to a reduced persona effect. Prior research

suggested that learners found the computer synthesized voice of the APA monotonous, dull intonation, and not appealing (Veletsianos, 2012). Learners also prefer APAs who deliver clear speech that is easy to follow (Johnson et al., 2013; Ozogul et al., 2013). Human voice has various elements that form emotional modes in a speech -- pitch, volume, rhythm, pace, and intonation (Qu, Brinkman, Ling, Wiggers, & Heynderickx, 2014). In comparison, a computer synthesized voice will generate a less appealing narration and diminish learners' attention level due to the lack of emotional communication elements.

The last explanation is based on the lack of expressive features in the computer synthesized voice. It is not surprising that people response negatively when they are told with the computer synthesized voice. This may be due to the limitations of emotional tone, naturalness and pitch (Stern, 2008). In this study the ethical dilemma may bring some kind of sadness because the story is based on a tragic incident. Because of the emotional aspect of the story the computer-synthesized speech was perceived negatively not proper way to describe such a sad story with emotionless tone and pitch (Stern, Chobany, Patel, & Tressler, 2014).

The study did not provide enough evidence suggesting that the uncanny voice had a significant impact on the learner's perception of informational usefulness. Yet in both experiments, the results on the impact of voice on the perceived agent's informational usefulness approached a statistical significance and there is a trend favoring the instructor-like voice for the APA. A potential reason of such an inconclusive result may be the mediation of the message or content that is being presented and the way it is integrated with voice.

In this study, there is some evidence suggesting that the appearance resemblance of an APA to an instructor has a significant impact on the ENG variable of the agent's persona. Interestingly, the animated appearance, in comparison with the realistic appearance, promoted a positive "engaging" perception of the APA. But in general, the study did not find a significant impact of either visual appearance or screen/presentation size on the persona effect. The non-significant effect of the

visual appearance can be explained by the superiority of voice effect. In this study, APA delivered only a one-way, non-interactive lecturing. A significant effect of visual appearance may require more dynamic interactions between APA and learners. The non-significant effect of screen size can be explained in a similar way. Prior research of screen size generally focused on game environments that require an immersive interaction between game players and the game (Hou et al., 2012). It is possible that in this study the lack of requirement for active two-way interactions between the learners and the APA led to the non-significant effect of the screen size on learners' persona perception.

The study findings are consistent with the argument that an optimal integration between the external and internal properties of APA should promote the persona effect (Danforth, Procter, Chen, Johnson, & Heller, 2009; Haake & Gulz, 2009; Johnson et al., 2013; Ozogul et al., 2013). A design challenge of using APAs is to infuse a variety of realistic features to APA, in both external voice/appearance and internal dialogues/messages. It should be noted that in this study the APA was used mainly as a lecturer and storytelling was part of the instruction. No complicated instructional tasks were given to the learners; thus, they may consider the agent more as a storyteller than an instructor. Furthermore, no learning task was given and examined how human properties in APA can have an impact on learning outcomes in this study. Future research should examine whether the nature of agent based interaction (e.g., the degree of content complexity) will mediate the persona effect in using APAs. A future study should also investigate the cognitive or teaching presence of APA by managing and examining both look and communication modalities/features.

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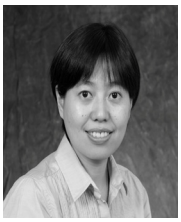

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