Looking the Part: The Effect of Attire and Setting on Perceptions of a Virtual Health Counselor

Dhaval Parmar, Stefan Olafsson, Dina Utami, Timothy Bickmore
Northeastern University
Boston, MA, USA
dhavalparmar,stefanolafs,dinau,bickmore@ccs.neu.edu

ABSTRACT

The visual design of virtual agents and scenes presents developers with a plethora of choices. We conducted two studies in which we manipulated the design of a virtual health counselor agent's attire and its virtual environment. Our studies demonstrate that virtual agents dressed to fit their health care role are perceived to be more professional, trustworthy, reassuring, and more persuasive regarding medical decisions, compared to agents whose appearance is not role-appropriate. Furthermore, the effect of an agent's attire is greater than that of its virtual environment. The results of this research can help create visual guidelines for the development of virtual agents in tasks that rely on user trust.

KEYWORDS

Virtual Agents, ECAs, Agent Appearance, Agent Perception

1 INTRODUCTION

Embodied conversational agents (ECAs) effectively portray varied roles associated with human professionals, such as nurse, exercise coach, therapist, museum guide, or teacher [4, 9]. When designing such virtual agents, the appearance of the agent and the virtual setting it appears in are often taken for granted or left as design choices for artists, occasionally with input from user testing or anecdotal sources. However, the visual appearance of these ECAs and the characteristics of their virtual environments can play an important role not only in how users perceive the agents, but also in task outcomes involving agent trust and credibility.

Several studies have investigated aspects of virtual agent design such as anthropomorphism [2], gender, age, attractiveness [3], rendering styles and proportions [23], and their effects on perceived characteristics of virtual agents. ECAs that provide information, advice, or counseling for users need to be perceived as trustworthy,

credible, and experts in their domain [1, 24]. However, there are no empirical studies demonstrating that ECAs in specialized, role-appropriate attire and environments are more likeable, trustworthy, persuasive, and preferable to their non-specialized counterparts. Creating task-appropriate, specialized virtual characters and environments requires time and effort, and evidence-based guidelines for their design would streamline the process.

In this paper, we investigate the impact of agent attire and environment design on the effectiveness of an ECA providing information about serious medical topics. In order to determine which attire and setting choices should be evaluated, we first present a preliminary study eliciting user feedback on images of various attire and setting options, where the ECA and the environment were evaluated on professionalism, trustworthiness, credibility, likeability, and persuasiveness. In the main study, we vary the agent's attire between professional (role-appropriate) and casual (not role-appropriate), and the virtual environment of the ECA between professional setting (medical examination room) and no setting (empty room), eliciting user feedback on the conversational interaction with the ECA in one of four combinations of the conditions. We hypothesize:

H1: An agent wearing role-appropriate attire will be rated higher on trustworthiness and credibility, and will be more persuasive, compared to the same agent wearing casual attire.

H2: An agent in a role-appropriate virtual setting will be rated higher on trustworthiness and credibility, and will be more persuasive, compared to the same agent in an empty room.

2 RELATED WORK

2.1 Virtual Agent Appearance

The appearance of virtual agents has been shown to affect user perception. Baylor investigated the influence of age, attractiveness, and "coolness" of agents on students' motivation towards engineering as a career [3]. Undergraduate women preferred learning from agents who were male and attractive, even though they were considered "uncool", not "like themselves", and not who they "most wanted to be like". Shiban et al. found that a young and attractive female agent positively impacted students' interest in learning [25]. Ring et al. evaluated agent rendering style and found that toon-shaded characters were perceived to be more likeable and caring in social tasks, and realistic human-proportioned characters were perceived as more appropriate for medical tasks [23].

2.2 Physician Attire

Physician attire has an influence on patient perception, known as the "white coat effect". Physicians wearing a white coat and formal attire (tuxedo) are perceived as authoritative, whereas casual attire

Figure 1: Images of agents used in the first study: white coat (A), scrubs (B), formal (C), semi-formal (D), smart casual (E), and casual (F). All images had two versions, with and without stethoscope. (G) shows an example of the agent with a stethoscope.

decreases perceptions of authority, friendliness, trust, and attractiveness [6]. Physicians in white coat are perceived as appropriate to share personal information with [22]. Doctors in white coat are more confidence inspiring [12], and their attire is associated with expertise, knowledge, credibility, and sympathy [8].

2.3 Media Specialization

A related concept is explored in media specialization research, where "specialist" media (e.g. testimonials from experts) is found to be more favorable and trustworthy than "generalist" media (e.g. testimonials from laypersons) [14, 18]. Research by Liew and Tan shows that agents introducing themselves as specialists enhances the perception of expertise, information credibility, website trust, and purchase intention as compared to a generalist agent [16]. A specialist virtual physician dressed in professional attire would similarly be perceived as expert, credible, and trustworthy.

2.4 Anthropomorphism

The degree of anthropomorphism of an ECA can further contribute to how it is perceived. Entities resembling humans in appearance and behavior are deemed to have social potential, also known as the "social bias" effect [18, 20]. When anthropomorphic agents are the source of information, their human-like appearance and behavior bring expectations of credibility, intelligence, and appropriate social responses [2, 19, 20]. People allocate more cognitive resources and create complex mental models of those they deem to have social potential, which subsequently triggers social category assignments and related judgments [5, 15, 20].

2.5 Virtual Environments for ECAs

The virtual environment that an ECA is placed in also has the possibility of affecting the perception of the agent. For example, Papachristos et al. studied the role of environment design in an educational multi-user virtual learning environment and found that learning outcomes were better in a traditional university auditorium setting compared to an open-air setting [21]. The perceived believability and usefulness of a virtual character also depends on the appearance of the virtual environment it inhabits and on the extent to which the character is integrated into a specific environment for a particular set of tasks [10, 17].

3 AGENT EVALUATIONS

3.1 Common study method and measures

Both experiments were conducted on the Amazon Mechanical Turk (AMT) platform. All participants were required to have a 90% or higher approval rating on AMT, located in the United States, and use either Mozilla Firefox or Google Chrome with WebGL 2.0 support as their web browser. Our primary manipulations were the virtual character's attire and the appearance of its virtual environment. To measure the role-appropriateness of different designs, we developed composite self-report measures to rank designs on perceived medical professionalism (Table 1). These measures had high internal consistency, with Cronbach alpha ranging from 0.89 to 0.96 for attire, and 0.97 to 0.98 for setting across our two studies.

**Table 1: Perceived Professionalism Questionnaire
(1=Completely disagree – 5=Completely agree)**

The **character** appears very **competent**.
The **character** appears very **skillful**.
The **character** appears very **knowledgeable** about medical care.
The **character** looks like an **expert**.
The **character** looks very **professional**.
The **scene** looks like a place where a very **competent** professional would work.
The **scene** looks like a place where a very **skillful** professional would work.
The **scene** looks like a place where a professional who is very **knowledgeable** about medical care would work.
The **scene** looks like a place where an **expert** would work.
The **scene** looks like a place where a **professional** would work.

4 EXPERIMENT 1: PRE-RANKING ATTIRE AND SETTING

Experiment 1 explored role-appropriate attire and environment setting for a healthcare counseling agent by measuring the perceived professionalism of various outfits and settings. We designed images of a virtual agent wearing six different outfits based on the research in section 2.2: white coat, scrubs, formal, semi-formal, smart casual, and casual (Figure 1, A-F). Additionally, we created six more images where the agent wore a stethoscope around her neck (Figure 1, G), since research shows that a person wearing a stethoscope is considered to be honest, trustworthy, honorable, moral, ethical, and genuine [13].

Table 2: Object counts (#) within a typical doctor's office and their categorical groupings.

Object	#	Group	Object	#	Group
Bench	82	Bench	Computer	36	Equipment
Chair(s)	74	Bench	Desk	29	Equipment
Cabinet	67	Sink	Floor equipment	22	-
Wall equipment	56	Equipment	Charts	21	-
Sink	53	Sink	Table	13	-
Decor	36	-	Couch	8	-

With limited research to inform the design of professional settings for health counselors, we identified the most common items within healthcare professionals' offices by analyzing pictures of such settings. We used the search terms "medical examination room" and "doctor's office" on the Google Images search engine and chose the top 50 images for each query, for a total of 100 images. The objects within the pictures were then counted and grouped into three logical categories of the most frequent objects in a doctor's office: 'bench', 'equipment', and 'sink' (Table 2). Finally, eight images were created from all combinations of the three object groups, ranging from an empty room to a fully equipped office (Figure 2).
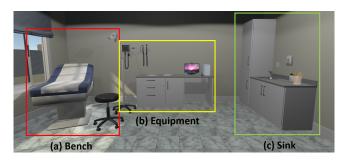

Figure 2: The complete office scene used in both experiments. Colored boxes show the three object groups used to create the eight images of a doctor's office used in Expt 1.

4.1 Method

In a within-subjects design, participants completed socio-demographic and health literacy questionnaire. Then they were presented with twelve images of a virtual healthcare agent wearing different outfits (Figure 1), along with eight images of doctor's offices (Figure 2). Participants were asked to rate their perception of each image using the perceived professionalism scales (Table 1).

4.2 Results

We had 43 participants (23 Male, 20 Female) between the ages of 16-62, of which 28 successfully completed the study. Only their data was included in the analysis.

The average scores for the twelve clothing images are presented in Table 3. We found that the image of an agent wearing a lab coat and stethoscope had the highest professionalism rating compared to all other images, whereas the agent wearing casual clothing without a stethoscope was rated the lowest. Similarly, the office setting that included objects belonging to all the three categories

Table 3: Paired samples Wilcoxon test for professionalism of attire and setting. * indicates p<0.05, comparing this mean with the mean of the highest rated image. (S) indicates attire with stethoscope.

Attire	Mean (SD)	Scene	Mean (SD)
White coat (S)	4.02 (1.05)	Bench, computer, sink	4.64 (0.64)
Semi-formal (S)	4.03 (0.96)*	Bench, computer	4.04 (0.88)*
Scrubs (S)	3.78 (1.11)*	Bench, sink	3.66 (1.09)*
Formal (S)	3.66 (1.20)*	Computer, sink	3.52 (0.84)*
White coat	3.51 (1.27)*	Computer	2.84 (1.07)*
Smart casual (S)	3.55 (0.93)*	Bench	2.63 (1.25)*
Semi-formal	3.41 (1.01)*	Sink	2.38 (1.06)*
Scrubs	3.24 (1.05)*	Empty room	1.59 (1.0)*
Formal	3.24 (1.01)*		
Smart casual	2.69 (1.01)*		
Casual (S)	2.42 (1.07)*		
Casual	1.67 (0.67)*		

(i.e., 'bench', 'equipment', and 'sink') was rated significantly more professional than any scene that had a different combination of object categories. The empty room was rated the least professional.

5 EXPERIMENT 2: EFFECT OF ROLE-APPROPRIATE APPEARANCE ON PERCEPTION

5.1 Method

To evaluate the effect of role-appropriate attire and setting on user perceptions, we conducted a 2x2 factorial (Attire vs. Setting) between-subjects study where participants interacted with the ECA in one of four conditions: CASUAL-EMPTY: casual attire with no setting (Figure 3A), CASUAL-FULL: casual attire with a full professional setting (Figure 3B), PROF-EMPTY: professional attire with no setting (Figure 3C), and PROF-FULL: professional attire with a full professional setting (Figure 3D). These manipulation levels of attire and setting were determined based on the results of Expt 1.

In a 5-minute interactive conversation, the agent provided information about a serious healthcare topic. The agent used synthesized speech accompanied by automatically generated nonverbal behavior using BEAT [7]. Participants responded to the agent by selecting utterance options from an on-screen menu. The only difference between the conditions were the manipulations in attire and setting.

5.1.1 Participants and Measures. 308 participants (133 Male, 175 Female) aged 18-76 (M=38, SD=12.32) completed the study. Participants were randomly assigned to the four conditions (CASUAL-EMPTY, N=73; CASUAL-FULL, N=85; PROF-EMPTY, N=80; PROF-FULL, N=70) and answered socio-demographic and health literacy questionnaire prior to the interaction. The agent discussed the importance of having a healthcare proxy, i.e., a person who can make decisions on behalf of another, should they become so incapacitated that they are unable to do so themselves (Table 4), as well as information about receiving life-support via a medical ventilator. During the interaction, the agent asked the user whether they would want to be placed on a ventilator if they needed one (yes, no, unsure) and how confident they were about that decision on a scale from 1 to 7. At the end, the agent asked the user how committed they
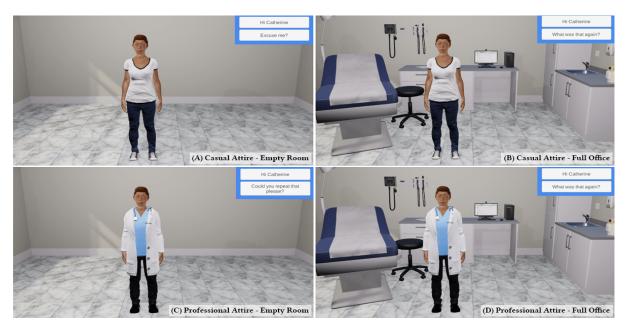
Figure 3: The four conditions within Experiment 2 based on manipulations in agent attire and environment setting.

Table 4: Excerpt from agent-participant dialogue.

Agent:	Alright, the first topic I would like to discuss with you is who would you want to talk on your behalf, if you could not communicate to the doctors for yourself. This person would be your healthcare agent.
User:	Okay.
Agent:	So, on a scale from one to ten, where one is the lowest and ten is the highest, how committed are you to having a healthcare agent?
User:	1
Agent:	Is there anybody you can think of that could be your healthcare agent?
User:	I have someone in mind.
Agent:	That's great! Whom did you choose?
User:	My partner.

are to getting a healthcare proxy on a scale from 1 to 10. After the interaction, participants filled out questionnaire regarding the professionalism of the agent and the environment (Table 1), overall perceptions of the agent and scene (Table 5), and the credibility of the information provided by the agent [11].

The agent was created using Adobe Fuse and Mixamo, and then brought together with the environment within the Unity3D game engine. The simulation was made available to participants on Mechanical Turk on either Mozilla Firefox or Google Chrome web browsers using the WebGL 2.0 API.

5.2 Results

5.2.1 Perceived professionalism. As a manipulation check, we asked participants to answer the Perceived Professionalism Questionnaire (Table 1). Since a Shapiro-Wilk test for normality was

significant ($p < 0.05$), we applied aligned rank transform [26] on our data to run a two-way independent measures ANOVA for the factors of attire and setting. The results are shown in Table 6. Overall, the agent was rated more professional when dressed in a white coat than when dressed casually, and more professional when in the full office setting than the empty room.

5.2.2 Credibility of information. Overall, the information provided by the agent was rated as highly credible across all conditions on a composite measure ranging from 1 to 7 (M=5.92, SD=1.19). Further, a non-parametric two-way independent measures ANOVA showed that the information was rated more credible when presented by the agent dressed in white coat than the agent dressed casually (see Table 6). The ANOVA did not reveal any interaction effects between attire and setting.

5.2.3 Overall perception of the agent and setting. The significant main effects from the ANOVA results for perceptions of the agent and setting are shown in Table 6. Participants found the agent in a white coat more trustworthy, reassuring, caring, friendly, comfortable to talk to, and more appropriate for the job. Conversation with the white coat agent felt like a face-to-face conversation and the participants wanted to continue working with the white coat agent more than the casually dressed agent. The setting of the environment also had an effect, where agent in the full office was rated more reassuring, and the full office looked more realistic than the empty room.

There was an interaction effect between Attire and Setting for the question "How easy was talking to the character?" The white coat agent in an empty room (M=5.1, SD=2.02) was perceived as easier to talk to than the casually dressed agent in an empty room (M=4.21, SD=2.21), F(1,304)=10.86, $p<0.01$, η_p^2=0.034. Effects due to the white coat agent in the full office (M=4.47, SD=2.19) or the

Table 5: 7-point scale items asked following the interaction.

1=Extremely abstract – 7=Extremely realistic
- How **realistic** did the **character** look?
- How **realistic** did the **scene** look?

1=Extremely appealing – 7=Extremely unappealing
- How **appealing** was the **character**?

1=Extremely familiar – 7=Extremely unfamiliar
- How **familiar** did the **character** look?
- How **familiar** did the **scene** look?

1=Extremely eerie – 7=Extremely reassuring
- How **eerie** did the **character** look?
- How **eerie** did the **scene** look?

1=Very friendly – 7=Very unfriendly
- How **friendly** was the **character**?

1=Very trustworthy – 7=Very untrustworthy
- How **trustworthy** was the **character**?

1=Very easy – 7=Very difficult
- How **easy** was talking to the **character**?

1=Not at all – 7=Very much
- Would you like to **continue working** with the **character**?
- How much do you **like** the **character**?
- How much do you feel that the **character cares** about you?

1=Completely disagree – 7=Completely agree
- The **character** looks **appropriate** for her job.
- I felt like I was talking **face-to-face** with a person.
- I could easily **understand** the **character**.
- I felt **comfortable** interacting with the **character**.
- The **character** was **engaging**.

Table 6: Summary of significant main effects from ANOVA.

Factor	Condition	M	SD	F	df	*p*	η_p^2
Perceived professionalism							
Attire	Professional	4.06	0.95	4.81	1, 229	<0.05	0.11
	Casual	3.4	1.02				
Setting	Full office	4.11	1	31.81	1, 229	<0.05	0.12
	Empty room	3.27	1.34				
Credibility of information							
Attire	Professional	6.1	1.08	8.1	1, 304	<0.05	0.02
	Casual	5.75	1.27				
Overall perception of agent and setting							
"How trustworthy was the character?"							
Attire	Professional	5.57	1.44	7.81	1, 304	<0.01	0.025
	Casual	5.07	1.62				
"The character looks appropriate for her job."							
Attire	Professional	5.53	1.57	51.6	1, 304	<0.01	0.14
	Casual	4.09	2				
"How reassuring was the agent?"							
Attire	Professional	4.27	1.79	6.96	1, 304	<0.01	0.02
	Casual	3.78	1.74				
Setting	Full office	4.59	1.72	5.11	1, 304	<0.05	0.02
	Empty room	4.11	1.82				
"Continue working with the character"							
Attire	Professional	5.57	1.44	5.25	1, 304	<0.05	0.017
	Casual	5.07	1.62				
"The character cares about you"							
Attire	Professional	4.61	1.92	9.38	1, 304	<0.05	0.03
	Casual	3.93	2.02				
"Like talking face-to-face with a person"							
Attire	Professional	3.7	2.07	5.65	1, 304	<0.05	0.018
	Casual	3.19	2.07				
"How friendly was the character?"							
Attire	Professional	5.57	1.39	3.9	1, 304	<0.05	0.012
	Casual	5.16	1.59				
"How realistic did the scene look?"							
Setting	Full office	4.51	1.74	5.67	1, 304	<0.05	0.02
	Empty room	3.81	1.83				
"Felt comfortable interacting with the character"							
Attire	Professional	5.48	1.61	7.95	1, 304	<0.01	0.025
	Casual	5.26	1.71				
Persuasion and decision confidence							
Attire	Professional	8.56	1.99	8.45	1, 304	<0.01	0.01
	Casual	7.84	2.41				

casually dressed agent in the full office (M=5.19, SD=1.74) were not significant.

5.2.4 Persuasion and decision confidence. A Wilcoxon Rank Sum test showed a significant overall increase between pre and post measure of "How committed are you in choosing a healthcare agent?" on a scale from 1 to 10 (M=7.4, SD=2.56 vs. M=8.19, SD=2.24; W=1566, *p*<0.01). Following the interaction with the agent, ANOVA results showed that the participants' commitment to choosing a healthcare proxy for themselves was significantly higher in the professional attire condition than the casual attire condition (see Table 6). The ANOVA did not reveal any interaction effects.

6 DISCUSSION

The first experiment showed that participants perceived the white coat agent and the full doctor's office scene as most professional.

Our first hypothesis (H1) was supported. The agent wearing a white coat was perceived as credible, trustworthy, appropriate for the job, easy and comfortable to talk to, reassuring, caring, friendly, likeable, similar to a face-to-face interaction, and inspired continued interaction. This is congruent with previous work where realistic characters were more appropriate for medical tasks [23], the white coat effect [6], participants favoring physicians wearing professional attire [22], and participants associating expertise, knowledge,

credibility, trustworthiness, sympathy, attractiveness, and friendliness with professional attire [8]. The professional agent was able to persuade more people in choosing a healthcare proxy and led to higher decision confidence. Similar effects were reported by Rehman [22] and Gherardi et al. [12], with patients having higher confidence in professionally dressed physicians.

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Our second hypothesis (H2) was not supported. The full doctor's office setting was perceived as realistic and reassuring, and the empty room made it easy to talk to the agent. However, there were no major effects of setting on the perception of the agent or the credibility of the information given overall. Although research indicates that factors such as learning outcomes are positively impacted in role-appropriate educational simulations [21], we did not find that setting matters for perceptions of the virtual agent, information credibility, or persuasion when discussing a serious topic, like healthcare proxies.

Significant time and effort may be spent crafting realistic virtual environments for virtual agent simulations. However, these results show that the creators of virtual agents for healthcare should focus more on designing role-appropriate attire when providing information on a serious healthcare topic and when motivating people to make healthcare decisions.

7 CONCLUSIONS

In the two experiments presented in this paper, we explored the effect of virtual agent attire and virtual environment setting on the perceptions of an embodied conversational agent (ECA) when providing information about a serious healthcare topic.

In the first experiment we established which agent outfits and environment settings are considered professional by users. In the second experiment we found that a professionally dressed virtual health counselor is perceived more favorably than a casually dressed agent. Specifically, an ECA in a role-appropriate attire is perceived as more credible, trustworthy, likeable, and easy to talk to. Moreover, a professionally dressed agent is able to motivate users in making healthcare decisions and feel more confident about it.

Our studies suggest that the effects we see between physicians and patients, such as the white coat effect, carry over into the virtual world with a virtual physician. When designing ECAs for healthcare, it is important that the attire of the agent is role-appropriate, while the design of role-appropriate setting for the virtual environment may not be as crucial.

Our studies have some limitations. All participants were recruited on Mechanical Turk; thus, the results may not generalize to other user demographics. We have also only explored two of the many factors that can influence trust in an agent. In future studies we aim to explore this space by investigating additional manipulations and their interactions with user traits (e.g., gender) and counseling topics, and also investigate how these effects change over time with longitudinal use.

ACKNOWLEDGMENTS

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