How Do Bias Strategies and Appearance Shape Avatar Preferences?: Toward the Development of Avatars for Health Support

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Abstract

In recent years, avatar technology with voice interaction capabilities has garnered attention as a tool to enhance patient communication and promote health advice and behavioral change in the medical and healthcare fields. In this study, we conducted two experiments to investigate effective persuasion methods and avatar appearances in healthcare contexts, targeting participants from four nationalities: Japanese, German, Russian, and Egyptian, to clarify the conditions for effective healthcare avatars. In the first experiment, we examined the effectiveness of persuasion by avatars, utilizing cognitive biases and data-driven persuasion that have both been proven effective in real-world settings. Specifically, we used videos promoting the "vegetable-first diet," which encourages consuming vegetables before other foods, and compared four conditions: neutral persuasion, persuasion with synchrony bias, persuasion with data and evidence, and persuasion with authority bias. A total of 102 participants, including Japanese, German, Russian, and Egyptian individuals, took part in this experiment. In the second experiment, we investigated the influence of avatar appearances on the receptivity of health advice, featuring 12 avatar variations based on ethnicity (Asian, Caucasian, and Arab), gender, and clothing style (casual white shirt or lab coat). This experiment involved 67 participants across the same four nationalities. Based on the results of our studies, we propose design guidelines for developing culturally and nationally adaptive healthcare avatars with enhanced persuasive effectiveness. Our findings provide fundamental insights into the practical application of avatars in the healthcare domain across nationalities.

Keywords

Avatar, Healthcare, Cognitive Bias, Appearance Preferences, Nationality, Persuasion

1. Introduction

In recent years, avatar technology used in virtual spaces and games has attracted attention for its potential to enhance patient communication and improve the quality of services in the medical and healthcare fields [1, 2, 3]. In particular, avatars equipped with voice interaction capabilities are expected to facilitate natural communication with patients, providing health-related advice and promoting behavioral changes [4]. However, cognitive biases proven effective in real-world settings, such as synchrony bias and authority bias, as well as persuasion methods like data-driven persuasion, remain insufficiently studied regarding their potential to enhance or harm the persuasive power of avatars. Moreover, the impact of the appearance of avatars on their persuasive effectiveness, particularly considering differences in nationality and cultural background, has not been comprehensively investigated. Therefore, this study conducted two experiments to examine the effectiveness of persuasion by avatars and the impact

of avatar appearance on the receptivity of health advice, targeting participants from four nationalities: Japanese, German, Russian, and Egyptian.

The first experiment aimed to examine the effectiveness of persuasion by avatars in a healthcare context using cognitive bias-based persuasion and data-driven persuasion. The second experiment focused on investigating the preferred appearance of avatars in healthcare settings.

Specifically, in the first experiment, we used videos promoting the "vegetable-first diet," which encourages individuals to eat vegetables before other foods. Four persuasion conditions were compared: neutral persuasion, synchrony bias-based persuasion, data-driven persuasion, and authority bias-based persuasion, with both avatar-based and real-human presentations. In real-world settings, synchrony bias has been shown to be effective in facilitating behavioral changes among Japanese participants under certain conditions [5, 6], authority bias has been reported to influence individuals from various nationalities, including Germans, under specific circumstances [7, 8], and data-driven persuasion has demonstrated effectiveness across diverse cultural contexts under particular conditions [9]. Furthermore, in some countries, including Japan, the impact of cognitive biases has been found to vary depending on the situational and contextual factors [10, 11, 12]. Based on these insights, the fisrt study aims to elucidate how persuasion using healthcare avatars influences users' perceptions and behaviors.

The second experiment examined the receptivity of health advice for 12 different avatar designs, featuring male and female avatars of Asian, Caucasian, and Arab ethnicities wearing either a white T-shirt or a white coat. Additionally, participants were asked to estimate the perceived age of each avatar to investigate how age perception influences the acceptance of medical advice. The second study further analyzed how the perceived age of avatars relates to their persuasiveness and credibility. Through these two experiments and based on the findings, we aim to derive design guidelines for developing highly persuasive healthcare avatars that are adaptable to users from diverse national and cultural backgrounds.

This paper is organized as follows. Chapter 2 reviews case studies of healthcare using avatars, prior research on cognitive biases and data-driven persasion, and avatar appearances in real-world and virtual settings, and the positioning of this study. In Chapter 3, we describe the experiment and results investigating effective persuasion methods with avatars, analyzed by nationality. In Chapter 4, we describe the experiment and results examining the appearance of avatars effective for persuasion, analyzed by nationality, and provide a discussion. Chapter 5 discusses future directions, and Chapter 6 concludes the paper.

2. Related Work

Avatars are utilized as characters or icons to represent users in virtual and online environments such as games, virtual events, and virtual reality (VR). Users often communicate with others in virtual spaces through avatars, which serve as extensions of themselves within these environments. Avatars play an important role in communication and persuasion across various digital platforms, acting as a critical medium for interaction in virtual settings [13].

2.1. Examples of Healthcare Services Using Avatars

Yan et al. focused on the role of AI avatars in the healthcare field and proposed a framework to enhance the conversational abilities of chatbots and foster human-like interactions with patients [1]. This framework utilizes a three-category prompt dictionary and a prompt improvement mechanism to fine-tune a general-purpose AI language model, enabling the creation of AI avatars that can discuss medical issues with patients. Additionally, they demonstrated that incorporating personality into chatbots could potentially increase patient engagement. Winkler et al. conducted a scoping review on telecare interventions utilizing avatars and virtual agents, showing that teletherapy and telemonitoring contribute to improved clinical outcomes and increased adherence [3]. Furthermore, these interventions reported high system usability and participant satisfaction, supporting the effectiveness of telecare models in home healthcare settings. Shaked focused on the design and evaluation of assistive applications

for the elderly using avatars and virtual agents, emphasizing the importance of designing interfaces that enable elderly users to build intimate relationships with avatars [2]. Additionally, based on the characteristics of avatars with monitoring and companionship functions for home care, Shaked proposed design requirements tailored to the needs of elderly users.

2.2. Examples of Cognitive Biases Observed for Different Nationalities

In the real world, it has been shown that synchrony bias is effective in influencing Japanese behavioral changes under certain conditions [5, 6], authority bias influences behavior in specific contexts among Germans and many other nationalities [7, 8], and data-driven persuasion demonstrates effectiveness across a wide range of cultures under certain conditions [9]. Additionally, it has been pointed out that the influence of cognitive biases varies depending on the situation and context in certain countries, including Japan [10, 11, 12].

2.3. Examples of Studies Investigating Avatar Appearance

The appearance of avatars can be categorized into three types: realistic, stylized with an emphasis on design freedom, and fully animated. Each type serves specific functions tailored to user preferences and contextual needs. According to prior studies on avatar appearance, users tend to prefer human-like avatars that emphasize trustworthiness and reliability in formal settings, while in relaxed scenarios, such as entertainment or recreational contexts, stylish avatars featuring non-existent colors, shapes, and highly fashionable elements are more often chosen. These findings highlight the impact of situational context on avatar selection [13]. Chandra has demonstrated that realistic avatars are particularly effective in establishing trust and empathy, especially in telemedicine and mental health scenarios [14]. Additionally, research on the impact of avatars on implicit ethnical biases has advanced, with Kyrlitsias et al. revealing that users who experience darker-skinned avatars show a reduction in implicit biases toward individuals with darker skin tones. This effect has been shown to persist for up to one week following the experience [15].

2.4. Positioning of This Work

In the real world, numerous studies have investigated how individuals from different nationalities are influenced by cognitive biases, taking cultural backgrounds into account. However, to the best of our knowledge, no studies have yet explored whether users are similarly influenced by cognitive biases when interacting with avatars, and how this varies across nationalities. Additionally, while extensive research has been conducted on avatar preferences in various contexts, many studies have not sufficiently considered cultural backgrounds. Comparative studies on avatar preferences across nationalities remain scarce. This study aims to examine effective persuasion techniques and preferred avatar appearances in the context of healthcare. For the former, participants will view eight videos, in which both a human and an avatar of the same ethnicy and gender perform neutral persuasion as well as three types of persuasions. The persuasive effectiveness of the avatar will be evaluated by measuring changes before and after viewing the videos, comparing responses across participants from four nationalities: Japanese, German, Russian, and Egyptian. For the latter, we will prepare realistic avatars representing three different ethnicies, each presented in two attire options: a T-shirt and a lab coat. Both male and female avatars will be included, resulting in a total of 12 avatar designs. Using these avatars, we will conduct an experiment to compare preferences for avatar appearances across the same four nationalities: Japanese, German, Russian, and Egyptian.

Through these two investigations, we aim to uncover how effective persuasion techniques and preferences for avatar appearances differ based on nationality and cultural background. Furthermore, this study seeks to provide valuable data for designing appropriate communication methods and avatar appearances for healthcare applications.

3. Experiment Investigating Effective Persuasion with Avatars

This study aims to identify effective persuasion techniques in the healthcare context across different nationalities. Specifically, the study focuses on comparing the persuasiveness of various techniques to promote the "vegetable-first diet," a health method encouraging the consumption of vegetables, fruits, and proteins before carbohydrates. The experiment employed videos where both humans and avatars conveyed persuasive messages. Due to limitations in selecting suitable speakers, the speakers were a Japanese female, a Russian male, an Egyptian female, and a German female. This constraint resulted in variations in the speaker's gender by nationality, which should be noted. However, the primary purpose of this study is to investigate the effects of biases and effective persuasion with avatars across nationalities. While it is difficult to completely eliminate the influence of gender differences, analyses that account for this factor are necessary. To prevent biases stemming from participants recognizing the speakers in the videos, deepfake technology Akool was employed to alter the speakers' faces, and a voice changer CapCut was used to modify their voices. The appearance of the avatars was designed by us to reflect the typical ethnical characteristics of each nationality, based on input from at least two local advisors to ensure a realistic representation using VRoid Studio, a 3D character creation tool. The age range of the avatars was aligned with the human speakers, with avatars representing young adults in their 20s to 30s. Table reftab:designs shows the avatar design. Regarding the specific appearance of the avatars, the 2-B-f design was used for Japanese female participants, the 2-A-f design for German female participants, the 2-C-f design for Egyptian female participants, and the 2-A-m design for Russian male participants (as shown in Table 2).

The videos featuring the avatar were recorded using the motion capture service Calidface3d, which allows the 3D model to move in sync with the speaker's facial expressions and movements. Regarding clothing, the human speakers wore outfits with subdued colors and simple designs to avoid giving viewers overly specific impressions. The avatars, on the other hand, were uniformly dressed in white T-shirts, with compositions showing only the upper body from the shoulders up. All videos were kept under one minute in length. Each video aimed to promote the "vegetable-first diet" using one of four persuasion techniques: neutral persuasion, persuasion with synchrony bias, persuasion with data and evidence, and persuasion with authority bias. A total of eight videos were created, combining these techniques with human and avatar speakers. The general content of each persuasion technique is shown in Table 1. Participants were asked to rate, on a 7-point Likert scale, the extent to which they wanted to practice the "vegetable-first diet" method before and after watching the videos. After viewing the videos, they were also asked to provide reasons for their responses. To prevent biases caused by the presentation order in the questionnaire, the order of the videos was randomized for each participant. Additionally, a questionnaire related to the experiment was conducted, asking participants about their familiarity with AI-equipped voice interaction systems, whether they were previously aware of the "vegetable-first diet" method, and how much attention they typically pay to their health, including specific practices. Through this investigation, the study aims to elucidate how effective avatar-based persuasion techniques vary by nationality in the context of healthcare and to identify appropriate communication methods for healthcare settings.

3.1. Research Question

In this study, we are trying to answer the following research question:

- How does the use of avatars, compared to humans, influence bias-based persuasion across different nationalities?

3.2. Experiment Overview

This experiment investigated the impact of avatar appearance and bias on persuasive effectiveness in a healthcare context, comparing results across different nationalities. The participants included 58 Japanese (38 males and 20 females, mean age 24.25, SD = 2.06), 11 Germans (6 males and 5 females, mean

Table 1

Persuasion Techniques Using Different Biases

Persuasion Technique	Description
Neutral Persuasion	Explains that the "vegetable-first diet" reduces weight gain, lowers blood sugar levels, and reduces fatigue.
Synchrony Bias	Adds to the neutral explanation by stating that 70% of health-conscious young people practice the "vegetable-first diet" and that it is trending on TV and social media.
Data/Evidence	Supplements the neutral explanation with the reasoning behind the reduced blood sugar levels and provides data showing a 30% reduction in blood sugar spikes.
Authority Bias	Enhances the neutral explanation by mentioning a study by a professor from a well-known university reporting 80% of participants experienced positive effects and introducing a book published by another professor from a prestigious university.

age 26.09, SD = 4.64), 15 Egyptians (8 males and 7 females, mean age 27.0, SD = 4.70), and 18 Russians (8 males and 10 females, mean age 28.67, SD = 3.93). Each participant watched videos promoting the health practice of the "vegetable-first diet," a method of consuming vegetables, fruits, and proteins before carbohydrates. The participants rated the persuasiveness of the videos using a 7-point Likert scale to measure their willingness to adopt the "vegetable-first diet" both before and after watching the videos.

3.3. Results and Discussion

All 102 responses were deemed valid. The evaluation and discussion were conducted based on the quantitative data obtained from the Likert scale measuring the extent to which participants intended to practice the "vegetable-first diet" before and after watching the videos, as well as the qualitative data derived from participants' feedback.

The changes in motivation scores for practicing the "vegetable-first diet" are shown in Figure 1. The horizontal axis represents the video types (H-n, H-s, H-d, H-a, A-n, A-s, A-d, A-a), while the vertical axis represents the nationalities (Japan, Germany, Russia, Egypt). The video types are categorized as follows: "H-" represents persuasion by a human, while "A-" represents persuasion by an avatar. Additionally, "n" indicates neutral persuasion, "s" represents persuasion using synchrony bias, "d" refers to data-driven persuasion, and "a" signifies persuasion using authority bias. For instance, "H-n" denotes neutral persuasion by a human, while "A-s" refers to persuasion by an avatar using synchrony bias. These naming conventions were applied to label each video accordingly.The score differences before and after viewing were calculated, and the Wilcoxon signed-rank test was conducted. This method was chosen because the study employs a within-subjects design (each participant provides paired pre- and post-viewing data), and the score distributions may not necessarily follow a normal distribution, making non-parametric testing appropriate. The p-values, which indicate the statistical significance of the score differences, are shown in each cell.

The top part of each cell indicates the mean score difference, while the bottom part presents the p-value from the statistical test. A p-value less than 0.05 is denoted as "p<0.05" to indicate statistical significance, while values equal to or greater than 0.05 are denoted as "p>=0.05." The cell colors are based on the score differences, with red shades representing an increase and blue shades representing a decrease. The intensity of the colors reflects the magnitude of the score differences.

An analysis of the open-ended responses regarding each video revealed unique trends for each nationality. First, in terms of familiarity with voice dialogue systems, Japan scored the highest, followed by Russia, Egypt, and Germany. Regarding the degree of attention paid to health, Russia ranked the

highest, followed by Germany, Japan, and Egypt. Furthermore, familiarity with the "vegetable-first diet" was overwhelmingly high in Japan (89.1%), followed by Egypt (33.4%), Russia (27.7%), and Germany (18.2%). The tendency for Japanese participants to exhibit less positive changes after viewing the videos may be attributed to the high familiarity with the "vegetable-first diet". Indeed, some participants stated, "I am already practicing the "vegetable-first diet", so the videos did not influence me."

Each nationality demonstrated distinct trends. Japanese participants showed a tendency to be influenced by conformity bias more than participants from other countries, but there was an equal number of skeptical responses regarding this bias. Many participants expressed mistrust toward information framed as "because everyone else is doing it," resulting in conformity bias having limited positive effects. The negative and statistically large effect for conformity bias in Japan was unexpected. This may be due to the sample largely consisting of university students who are inclined to think independently. Information emphasizing collective behavior may have been perceived as suspicious. These results suggest that employing conformity bias with avatars requires careful consideration of context and target audience.

German participants were more likely to be influenced by data-driven persuasion and authority bias, with many finding expert claims and the presentation of evidence to be persuasive. Conversely, conformity bias had little effect, as many participants indicated that they do not rely on others' behavior as a reference. Among Russian participants, conformity bias elicited predominantly negative reactions, with terms such as "suspicious" and "lacking evidence" frequently used. Citing sources such as television or social media was perceived as lacking authority. In contrast, Egyptian participants exhibited relatively less resistance to persuasion by avatars compared to other nationalities. Many highlighted the importance of the avatar's appearance and movement quality in establishing credibility.

Across all nationalities, human-led persuasion was generally viewed as more trustworthy than avatar-led persuasion. In Japan, in particular, participants displayed a strong sense of caution toward avatars, which suggests a lack of trust in avatars as a new medium. This may stem from Japan's generally conservative attitudes and the perceived unnaturalness of avatar movements and expressions. However, many participants indicated that more natural expressions and eye movements in avatars could improve trustworthiness, highlighting the need for advancements in avatar design and broader adoption to familiarize users.

The reduced effectiveness of avatar-led persuasion across all nationalities may be due to a lack of familiarity and trust in avatars. While participants were generally accustomed to voice dialogue systems, avatars, as a relatively new technology, still evoke a sense of caution. Developing avatars with more human-like, natural movements and expressions could enhance their persuasive power. Additionally, increasing the prevalence of avatars may help users become more comfortable with and trusting of them over time.

4. Experiment Investigating Preferences for the Appearance of Avatars

This study aims to identify avatar appearances that are preferred in healthcare contexts based on nationality. Specifically, 12 avatars with realistic appearances were created, representing three different ethnical groups (Caucasian, Asian, and Arab). Each ethnical group included avatars dressed in either a white T-shirt or a lab coat, with male and female avatars for each outfit type. The design of the avatars was supervised by at least two researchers from each respective country, ensuring that the avatars resembled typical individuals in their late twenties belonging to those ethnical groups. Using these avatars, a comparative survey was conducted among participants from four nationalities: Japanese, German, Russian, and Egyptian. Participants were asked to evaluate which avatars they found most favorable. Additionally, the survey included questions about how old each avatar appeared to the participants and examined whether the perceived age of the avatars influenced the acceptance of medical advice provided by them. The analysis aimed to determine how the perceived age of the avatars related to their persuasiveness and trustworthiness, providing guidelines for designing healthcare avatars tailored to users with different national and cultural backgrounds. The survey presented full-
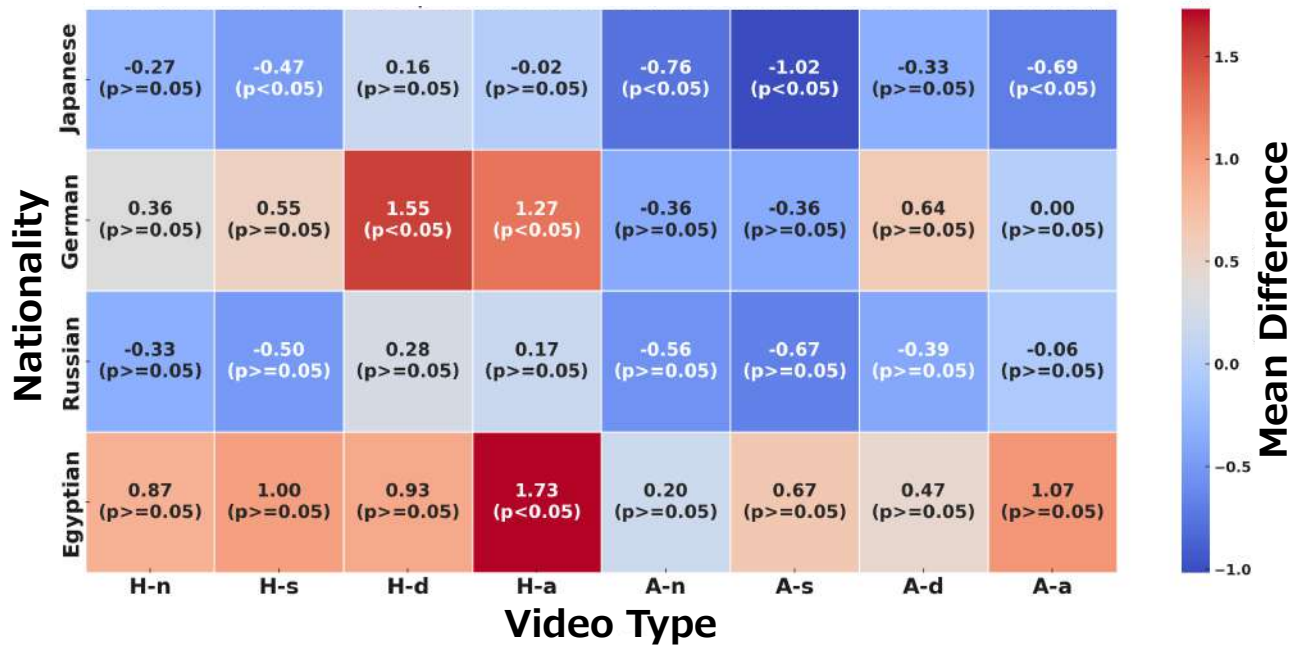
Figure 1: Changes in scores for the intention of practicing the "vegetable-first diet" before and after video viewing comparing the conditions "white-coated avatars" and "T-shirt-wearing avatars" with a Wilcoxon signed-rank test.

body images of the avatars along with four facial expressions: neutral, smiling, angry, and sad to showcase the various facial expressions of the avatars. Participants were asked to assume that the avatars would provide health-related advice and to rate, on a seven-point Likert scale, how willing they were to accept advice from each avatar. Participants were also asked to provide reasons for their responses through open-ended questions. Additionally, to avoid biases caused by the order of avatar presentations, the presentation order was randomized for each participant.

4.1. Research Questions

In this study, we aim to answer the following research questions:

- Does the clothing of the avatar influence its persuasiveness in avatar-based persuasion?
- Which avatars are most effective for persuasion based on nationality in avatar-based persuasion?
- Is there a relationship between effective avatars and the perceived age impression in avatar-based persuasion?

4.2. Experiment Overview

This experiment investigated the impact of avatar appearance and bias on persuasion effectiveness in the context of healthcare, focusing on differences across nationalities. The participants included 15 Japanese individuals (6 males, 9 females, mean age 26.0, SD = 1.59), 11 Germans (6 males, 5 females, mean age 26.45, SD = 2.97), 12 Egyptians (9 males, 3 females, mean age 23.92, SD = 2.43), and 28 Russians (13 males, 15 females, mean age 23.25, SD = 4.59). Each participant was shown 12 avatars designed to appear in their late 20s, representing White, Asian, and Arab males and females, with two clothing variations: one wearing a white T-shirt and the other a white lab coat. For each avatar, participants were asked to evaluate (1) the perceived age of the avatar, (2) the degree to which they would accept healthcare advice from the avatar (on a 7-point Likert scale), and (3) their reasoning for their evaluations.

4.3. Avatar Design

The 12 avatar designs used in the experiment are presented in Table 2. The names of the avatars are represented as follows: avatars wearing a white coat are labeled as 1, those wearing a white T-shirt as 2, Caucasian as A, Asian as B, Arab as C, male as m, and female as f. In Table 2, from left to right, the avatars' full-body image, neutral expression, smiling expression, sad expression, and angry expression are presented.

Table 2
Complete overview of avatar designs. The avatars are either male (m) or female (f) and either wear a white coat (1) or a white T-shirt (2). The represented ethnicities are Caucasian (A), Asian (B), and Arab (C).

4.4. Results and Discussion

All 66 responses were deemed valid. The analysis and discussion were based on the quantitative data obtained from the questionnaire, which assessed how old each avatar appeared to be and how persuasive each avatar was perceived in a healthcare context using a 7-point Likert scale, as well as qualitative data derived from participants' feedback collected at the end of the questionnaire.

4.5. Does the clothing of the avatar influence its persuasiveness in avatar-based persuasion?

Participants were shown photos of 12 different avatars and asked to evaluate, on a 7-point Likert scale, how much they would want to listen to each avatar and how persuasive they found it in the context of healthcare. The results are presented in a box plot in Figure 2.

The top left shows the results for Japanese participants, the top right for German participants, the bottom left for Russian participants, and the bottom right for Egyptian participants. The horizontal
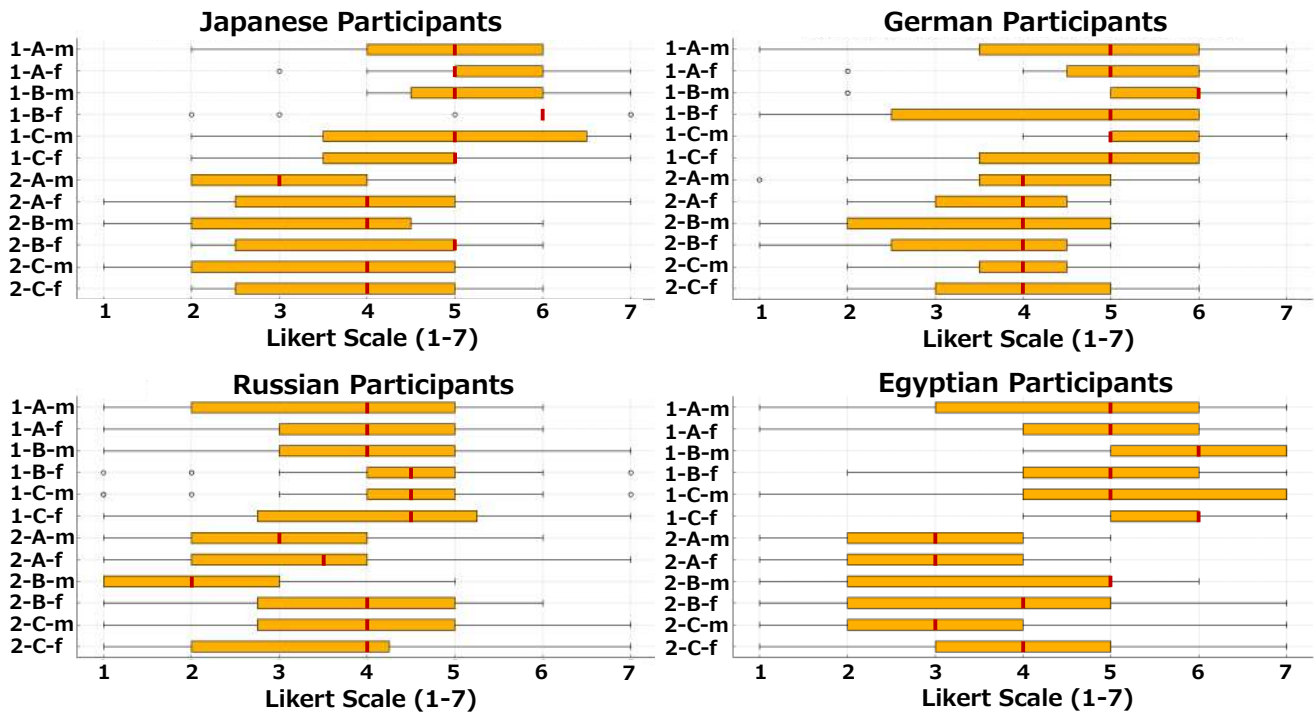
Figure 2: Box plot of participant ratings on preferred avatar appearances in a healthcare context across four nationalities: Japanese, German, Russian, and Egyptian. Participants rated their preferences on a 7-point Likert scale. Outliers are marked with circles, and the median is indicated by a red bar. A box plot visually represents the distribution of data, with the box covering the interquartile range (IQR), whiskers extending to 1.5 times the IQR, and points outside this range considered outliers.

axis represents the persuasiveness of the avatars, rated on a 7-point Likert scale, while the vertical axis represents the 12 different avatars.

The results of this study revealed that avatars wearing white coats ranked among the top six across all nationalities, suggesting that a "doctor-like appearance" is a critical factor in enhancing an avatar's persuasiveness. White-coated avatars visually evoke associations with "expertise" and "trustworthiness," making them effective in contexts involving health advice. On the other hand, avatars wearing T-shirts gave a casual impression, likely reducing their persuasiveness in contexts requiring professional advice. However, some participants mentioned that T-shirt-wearing avatars resembling gym trainers seemed capable of providing "professional health advice," indicating that such avatars could be persuasive in specific contexts.

To confirm whether there was a statistically large difference in the persuasiveness ratings between "white-coated avatars" and "T-shirt-wearing avatars," a Wilcoxon signed-rank test was conducted. This test was chosen because the data consisted of paired measurements, and the sample size was small, necessitating a method robust to non-normal distributions. The results showed that the ratings for "white-coated avatars" were notably higher across all nationalities. Specifically, the test statistic for Japanese participants was 330.5, with a p-value of 2.06×10^{-7}; for Egyptian participants, the test statistic was 97.0, with a p-value of 3.23×10^{-10}; for Russian participants, the test statistic was 1072.0, with a p-value of 1.54×10^{-8}; and for German participants, the test statistic was 50.0, with a p-value of 1.31×10^{-7}. These findings suggest that "white-coated avatars" were consistently rated higher than "T-shirt-wearing avatars" across all nationalities. Many participants expressed the opinion that an avatar wearing a white coat evokes associations with knowledge and sincerity, suggesting that a doctor's attire directly contributes to a sense of trustworthiness. This trend indicates that the authoritative bias introduced by the visual characteristics of the white coat influenced participants' evaluations. It underscores the importance of appearance in enhancing the trustworthiness and evaluation of avatars.

4.6. Which avatars are most effective for persuasion based on nationality in avatar-based persuasion?

4.6.1. Results and Discussion for Japanese Participants

In Japan, the most highly rated avatar was an Asian female wearing a white coat. Many participants noted that they felt "a sense of familiarity and trust towards avatars with characteristics similar to themselves." Furthermore, Japan's status as a homogeneous nation with a tendency toward cautiousness may have influenced these results, suggesting a preference for avatars resembling their own ethnicity. Additionally, comments such as "advice on health is easier to accept when it comes from a female" highlighted the appeal of female avatars in this context.

4.6.2. Results and Discussion for German and Egyptian Participants

In both Germany and Egypt, the most highly rated avatar was an Asian male wearing a white coat. Participants from both nationalities remarked that the avatar "conveyed a sense of seriousness and sincerity." This suggests that the stereotype of Asians being perceived as diligent and professional played a role in their evaluation. Furthermore, participants frequently mentioned that "the image of male doctors in medical settings enhances the avatar's persuasiveness," indicating a strong preference for male avatars in healthcare contexts. Additionally, observations like "avatars that appear older are perceived as more experienced and credible" suggest that perceived age has a substantial impact on the formation of trust in these regions.

4.6.3. Results and Discussion for Russian Participants

In Russia, the most highly rated avatar was an Arab male wearing a white coat. Participants often noted that "avatars in white coats convey a strong sense of expertise and trustworthiness." There was also a pronounced recognition that "age and experience are crucial in healthcare," leading to a preference for avatars perceived as older. Conversely, some participants pointed out that "younger avatars do not convey a sense of professionalism." The Arab male avatar wearing a white coat was particularly notable, as his beard made him appear older, earning him the highest level of trust among Russian participants.

4.6.4. Summary

The findings of this study suggest that the appearance and attire of avatars can lead to differences in persuasiveness based on nationality. However, these results also highlight the risk of avatars reinforcing existing stereotypes and biases. For example, while avatars wearing white coats were generally trusted, fixed notions based on ethnicy and gender appeared to influence avatar preferences and acceptance. Therefore, when designing avatars, it is critical not only to enhance trust and persuasiveness but also to avoid reinforcing stereotypes. Incorporating designs and communication strategies that challenge biases can lead to more inclusive and equitable avatars. By leveraging the insights from this study and respecting users' diverse backgrounds and perspectives, it is possible to create avatars that are both effective and fair in their design and application.

4.7. Is there a relationship between effective avatars and the perceived age impression in avatar-based persuasion?

The results of how participants from each country perceived the age of each avatar are shown in Table 3. The analysis was conducted using the mean and standard deviation of the data to evaluate how each avatar was perceived in terms of age by the participants. This method was chosen because the objective was to capture overall trends, and the obtained data had relatively few outliers and a uniform distribution, making the use of mean and standard deviation appropriate.

Excluding the responses from Egyptian participants regarding the white female avatar, all responses indicated that avatars wearing white coats were perceived to have a higher average age than those

Table 3
Avatar evaluation by nationality of the participatns: We report the mean and standard deviation of the perceived age of the avatars.

a) Nationality[1]	b) Avatar Type	c) [2]	d) [3]	a) Nationality [1]	b) Avatar Type	c) [2]	d) [3]
Japan	1-A-m	37.29	6.22	Germany	1-A-m	32.64	4.65
	1-A-f	27.75	2.03		1-A-f	29.09	4.06
	1-B-m	33.1	4.68		1-B-m	28.82	6.08
	1-B-f	27.33	2.72		1-B-f	23.64	4.08
	1-C-m	38.7	4.39		1-C-m	31.0	4.82
	1-C-f	30.43	3.75		1-C-f	26.09	4.57
	2-A-m	33.57	6.39		2-A-m	28.55	3.39
	2-A-f	26.45	3.33		2-A-f	26.18	3.22
	2-B-m	29.62	4.86		2-B-m	27.45	5.15
	2-B-f	26.13	2.24		2-B-f	23.0	3.87
	2-C-m	36.07	4.73		2-C-m	29.73	3.61
	2-C-f	29.45	4.32		2-C-f	24.55	4.23
Russia	1-A-m	28.46	5.78	Egypt	1-A-m	32.08	5.22
	1-A-f	23.93	4.91		1-A-f	25.15	8.16
	1-B-m	24.39	4.93		1-B-m	28.15	4.39
	1-B-f	23.86	3.5		1-B-f	26.77	5.39
	1-C-m	29.71	5.45		1-C-m	30.46	4.12
	1-C-f	27.5	7.01		1-C-f	27.38	5.49
	2-A-m	26.29	4.63		2-A-m	27.38	7.76
	2-A-f	22.5	3.93		2-A-f	25.62	4.56
	2-B-m	18.64	4.99		2-B-m	18.62	5.84
	2-B-f	21.29	3.69		2-B-f	22.54	6.41
	2-C-m	27.18	5.74		2-C-m	25.92	7.66
	2-C-f	25.36	5.44		2-C-f	22.92	4.07

[1] Participant Nationality
[2] Mean Perceived Age
[3] Standard Deviation of Age

wearing white T-shirts. Additionally, survey results showed that avatars in white coats were often perceived as "knowledgeable and experienced," with many participants associating them with a higher age. Participants from all four countries indicated that avatars perceived as older were deemed more trustworthy, suggesting that the impression of age plays a substantial role in establishing trust in avatars. Conversely, it was also pointed out that avatars appearing too young risked diminishing their persuasiveness and trustworthiness. In particular, in Russia, the perceived age of the avatar had a substantial influence on its persuasiveness. Many participants expressed a preference for avatars that appeared "older and more experienced in life." While the white coat emphasized "professionalism," avatars perceived as younger were often considered less trustworthy. The Arab male doctor, who was the highest-rated avatar among Russian participants, was perceived as the oldest among the 12 avatars, which likely contributed substantially to its high level of trust. Regarding male avatars, participants noted that facial hair contributed to the perception of higher age, which in turn evoked a sense of "reliability" and "reassurance." On the other hand, some criticisms were directed at the avatars prepared for this study, as participants associated their anime-like style with "youthfulness" or "unnaturalness." Many expressed a desire for more realistic and natural visuals. Japanese participants highlighted that similarity in gender and age to the user enhanced the sense of trust. Female avatars, in particular, were highly evaluated for their "softness" and "approachability." The most persuasive avatar, the Asian female in a white coat, was also rated as the youngest among the avatars wearing white coats. Meanwhile, German and Egyptian participants rated the Asian male avatar as the most persuasive, with feedback noting that he "appears young but seems sincere and trustworthy." This indicates that the relationship between perceived age and trust may vary depending on context and cultural factors.

These findings suggest that the perceived age and appearance of avatars have a large impact on trust and persuasiveness in the context of healthcare support. However, avatars perceived as older are not always deemed trustworthy, as the factors contributing to trustworthiness vary depending on cultural backgrounds and specific contexts. In scenarios requiring expertise, such as medical or health advice, the impression of age as a symbol of experience and knowledge is highly valued. At the same time, youthfulness and approachability may enhance trust in certain circumstances. Moving forward, incorporating these elements in a balanced manner can enable the design of avatars optimized for specific contexts. Furthermore, avatar design must account for the diverse values and cultural backgrounds of users, adopting a flexible and inclusive approach to ensure fairness and accessibility.

5. Future Directions

This work evaluated the persuasive methods of voice-interactive avatars and the impact of their appearance on perceived trustworthiness, yielding valuable insights. However, considering the resistance to avatars expressed by many participants, future research should focus on assessing the long-term effects of avatar use on user trust and behavioral change. In particular, it is essential to examine whether trust in avatars increases over time as users become more familiar with them. Additionally, improving the naturalness and expressiveness of avatar facial expressions is crucial to enhancing the quality of user experience. Addressing the identified issues of unnatural movements and limited facial expressions requires the design of avatars with more human-like behaviors and expressions, as well as designs that are adaptable to diverse cultural contexts and situational demands. Furthermore, the substantial impact of avatar appearance on persuasive effectiveness highlights the need to investigate this phenomenon across participants with diverse national and cultural backgrounds to derive more generalizable findings. Looking ahead, addressing these challenges while advancing comprehensive and equitable avatar design for healthcare support remains a priority. By respecting the diversity of users and pursuing designs that are inclusive and adaptable, this research aims to contribute to the development of systems that meet a wide range of user needs.

6. Conclusion

This work evaluated the persuasive techniques and the impact of appearance on the trustworthiness of voice-interactive avatars, providing valuable insights into avatar design and their application in healthcare support. To this end, we conducted two studies with participants from four different nationalities, namely Japense, German, Russian, and Egyptian. The first study investigated the receptivity of the participants for the "vegetable-first diet", utilizing different cognitive biases for the persuasion. The second study answered questions related to the design of the avatars for providing health advise per nationality.

Therewith, this research represents an initial exploration of the potential of voice-interactive avatars for providing health advise in different cultures and the insights gained are expected to serve as guidelines for avatar design in healthcare support and other fields. Our findings suggest that the appearance, attire, and richness of expressions of avatars has a major influence on their persuasiveness. However, many participants reported resistance or a sense of unnaturalness toward avatars, highlighting opportunities to further enhance their trustworthiness and persuasiveness. By continuing to conduct studies that consider diverse perspectives and user characteristics, we aim to contribute to the development of equitable and inclusive systems.

Future research should focus on evaluating the effects of long-term usage of avatars, examining how trust and sustained behavioral changes evolve over time. Additionally, while this study utilized avatars with limited variations in appearance and movement, there is a pressing need to develop flexible avatar designs that can adapt to diverse cultural backgrounds and individual preferences. Such advancements could enable the creation of universally effective approaches for engaging with various user groups.

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