

Avatars in Work Meetings: Correlation Between Photorealism and Appeal

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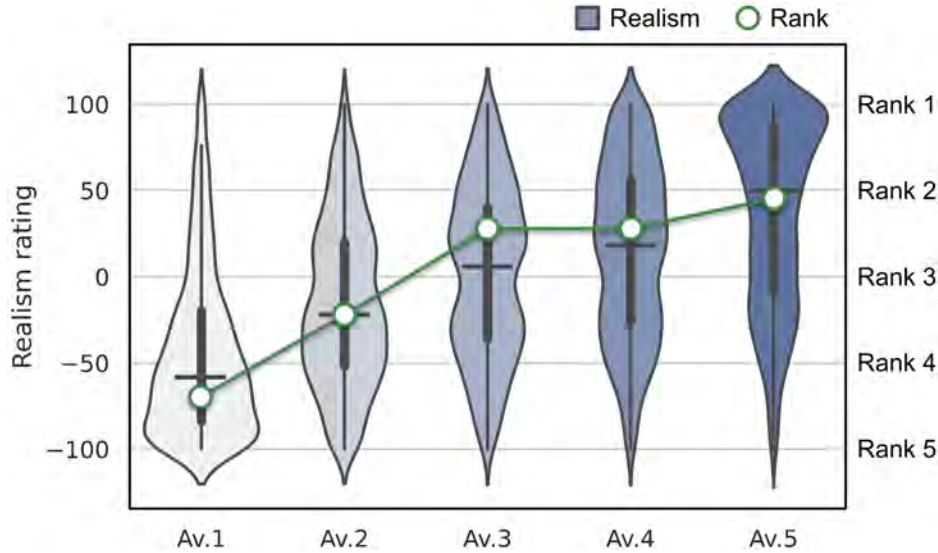


Fig. 1: Realism ratings of avatars overlaid by their corresponding preference ranking for work use.

Abstract—We investigated the effects of realism on acceptability of avatars for work meetings. Our survey of 2509 knowledge workers tested five levels of photorealism using animated GIFs. Avatar styles were rated for usage by: a manager, known colleague and unknown colleague. In all scenarios, we found that higher realism was favored; however fully realistic avatars were sometimes perceived as uncanny by participants. We segmented our results to uncover demographic and firmographic patterns in the survey responses. Lastly, we caveat our findings by evaluating open end responses to provide a qualitative evaluation of factors influencing avatar choices for work meetings.

In conclusion, our findings suggest that photorealism is a key attribute in selecting work avatars. However, regional preferences and relationship with work colleagues using the avatar may also play a role. Exploration of other factors influencing work avatar selection is needed to further understand the implications of avatar use in the workplace.

Index Terms—2D Avatars, Anthropomorphism, Work collaboration, Augmented reality, Remote work.

1 INTRODUCTION

Avatars, once popular amongst gamers and virtual reality enthusiasts, is gaining adoption in other social and professional settings. Avatars can be embodied in immersive formats like virtual reality or on 2D interfaces through augmented reality based applications. The latter use is more common and can be accessed through web-camera based videoconferencing [22], and smartphone-based augmented reality applications [5]. As an example, Zoom’s beauty enhancement filters and Microsoft Teams’ Mesh avatars are gaining adoption in work meeting settings.

Avatars provide escapism from our daily lives by portraying an alternative, more appealing version of ourselves [4]. However, their acceptability is context dependent and the ethics of such portrayal are debatable [25]. Especially as more realistic avatars become available.

The professional and social norms of representing oneself in virtual environments are unclear. Large deployments of avatars have already been done in the metaverse, like the Accenture on-boarding program during the pandemic where employees met in virtual spaces. However, the reality is that most of the research on avatars in professional scenarios has been restricted to lab experiments and case studies with small participant pools [22]. Our contribution is an assessment of avatar perception amongst knowledge workers (Sec. 3.1) using a large scale survey across five countries. Specifically, we study the acceptability of avatars in a new context of work meetings. In doing so, we answer the following research questions.

Primary research questions

- **P1:** Does photorealism affect the acceptance of avatar styles for workplace meetings by knowledge workers?
- **P2:** Is the acceptance of avatar styles dependent on the closeness of the relationship with the impersonating colleague?
- **P3:** Does avatar style acceptance vary by demographics: age, gender, and region?

Secondary research questions

- **S1:** Why does photorealism matter in choosing an avatar for work meetings?

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Internal validity

- **I1:** Are the five avatar styles used in our experiment significantly different in realism levels?

As seen in Fig. 1, survey respondents favored realism in work avatars. Sec. 4.3 elaborates on this correlation. And Sec. 4.4 shows that expectations of avatar realism held true across all demographic attributes including age, gender, region and firmographic traits like organization size and types. However, we found that non-realistic avatars were rated differently (Sec. 4.2) based on familiarity to the impersonating work colleague.

Our evaluation of open response comments in Sec. 4.5 suggests that knowledge workers value attributes like professionalism, credibility and work-appropriateness when considering avatar styles for work. However, a few comments also suggest that less realistic avatars have a place in some contexts of work. They provide an avenue for fun and are perceived to be more charming.

2 RELATED WORK

2.1 Avatar anthropomorphism

Anthropomorphism or human-like appearance of digital artifacts has been studied in various domains of human-computer interactions (HCI). Researchers have explored various levels of realism to identify the ideal representation of humans in HCI applications [8]. Although more realism is generally preferred, there is no clear consensus [29]. Further, the resulting uncanny valley effects are difficult to overcome [7, 16, 18]. As coined by Mori et al., the uncanny valley effect states that the appeal of a digital representation of inanimate objects drastically drops as its form approaches, but fails to fully obtain human-like appearance [20]. The trade-off between realism and appeal has widely been studied in research settings but large scale field study or surveys are uncommon.

Anthropomorphism has typically been measured using a Rasch-scale based questionnaire [3]. For example, McDonnell et al. used prompts that included Extremely abstract - Extremely realistic and Very unfriendly - Very friendly to assess the photorealism of avatars generated using various rendering methods [19]. We adopt McDonnell et al.'s rating system in our work to determine the realism of our avatar assets.

Avatar realism is perceived from a variety of attributes like appearance, facial expressions, body movement and audio quality [11, 13, 23, 29]. And it is also known that animation of the avatar has an effect on avatar perception [11]. Avatars that fully achieve human-likeness in all aspects are an active area of research but not fully solved [26, 28]. Part of the challenge lies in accurately extracting the input parameters needed to drive avatar rigs [10]. For example, advanced photogrammetry setups involving multiple camera arrays and motion capture systems are prerequisites for creating high fidelity renderings [2]. Further post processing and editing is often needed; making the overall process infeasible for real time use.

Alternatively, 2D avatars like customized emojis and smartphone based augmented reality video filters are gaining popularity [14]. Typically, these use cases are for short duration and context specific. For example, attending an online team bonding event in virtual space. Our work focuses on such short lived, 2D-interface-based avatar use. We use animated GIFs to convey the stylizing of our avatar assets; consistent with prior research on the topic [21].

2.2 Avatars in work meetings

Virtual reality offers a more immersive experience for avatar based interactions that have been of recent interest within HCI [1, 6]. Virtual reality based avatars are generally perceived more realistic because of the enhanced spatial understanding. However, the limited availability of virtual reality devices means such embodiments are typically reserved for niche applications like training and skill building [12, 27]. Alternatively, avatar use in non virtual reality environments has a longer precedence and is conducted using mobile devices and computers as the medium [17, 24].

Given the wider adoption of augmented reality based avatars, the corresponding research efforts have access to larger participant pools.

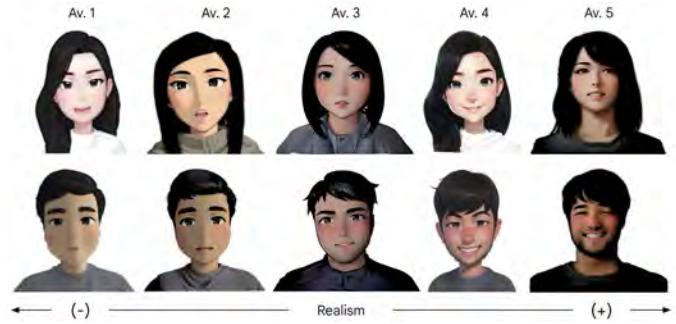


Fig. 2: Representative images illustrating the assets used in the survey.

As a result, survey based data collection is possible and often used to create insights that are more generalizable [15]. On the same lines, we surveyed knowledge workers from five countries to aggregate avatar realism preferences. Respondents evaluated the avatar styles for use by their colleagues but not for self impersonation. Because stylistic expectations for self impersonation are higher [15].

3 METHODS

3.1 Participants

2509 participants were recruited equally from five countries: United States, South Korea, United Kingdom, Germany and France. Parity in gender, age groups, and geographic regions was maintained to create a representative participant pool. Participants under the age of 18, those who were part-time employed or those that did not use video meetings for work were excluded. In addition, we screened participants based on their job profiles and its relevance to knowledge work.

Respondents were reimbursed for participation and there were no performance based incentives.

3.2 Study assets

Fig. 2 shows a representative panel of assets used to portray varying levels of realism in avatars. Av. 1 was the least realistic and Av. 5 approached photorealistic appearance. Assets were created using a single person as the model, emoting the same facial expressions. This helped in minimizing differences from multiple inputs to the avatar systems. Avatars were shown to survey participants in a randomized sequence to limit ordering effects. Fig. 2 shows only a single static frame but survey respondents were presented an animated GIF version of the assets. Note that Fig. 2 does not show the actual assets used in the survey because of confidentiality. Throughout this work, we will refer to each asset by its corresponding naming shown in Fig. 2.

3.3 Survey design

The survey was split into three subsections, as shown in Fig. 3. In the first section, participants answered demographic questions. The second phase collected information pertaining to work behavior. Participants were asked to describe their meeting schedule, type of meeting attendees, amount of time spent working from home and productivity tools used at work. The goal of this phase was to capture any work meeting habits that could influence participants' avatar style choice. Before beginning the third section, participants saw a text blurb describing the meaning of avatars and their use case for work. Please see the supplemental material for the text blurb used. In the third section, participants rated each avatar style on realism and acceptance in work settings [19].

The survey was structured to measure within-subjects differences. It was administered in four languages: English, Korean, French and German. Internal pilots were held with native speakers of each language. Following which, a soft launch was done with 50 users in the United States before releasing to the entire survey pool. We partnered with an external agency for targeted recruitment of knowledge workers. The survey fielded over a period of a month and half.

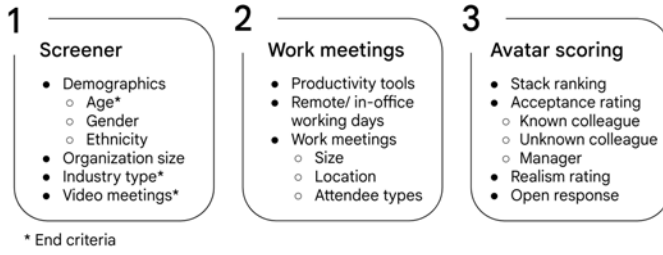


Fig. 3: Survey flow showing subsections and the corresponding topics covered

3.4 Data generation and analysis

Acceptability of avatar style was rated based on use-cases for scenarios with: known colleagues, unknown colleagues and manager. Each scenario was rated on a six point Likert scale response from "Totally unacceptable" to "Totally acceptable". An overall acceptance score was calculated by aggregating scores across all scenarios for all avatars. Realism ratings for each avatar style are based on an Anthropometric scale ranging from -100 to +100, corresponding to an avatar realism rating of "Extremely abstract" to "Extremely realistic" [19]. Lastly, in the open response section, participants responded to a prompt: "Please describe how you feel overall about this avatar style:"

All the quantitative datasets were periodically analyzed during the fielding of the survey using a Python script. This ensured continuous data integrity checks during the survey run. Open response questions were randomly assessed manually to filter out bad responses.

To determine our statistical modeling approach, we tested realism ratings and acceptance scores for normality using the Shapiro Wilk test. Neither dataset passed the test. This deviation of assumptions led to the use of non-parametric tests in our results. We used the Wilcoxon rank sum test to compare two means and the Kruskal Wallis test with Dunn's post-hoc analysis (with Bonferroni adjustment) to compare three or more means. Any statistical differences discussed in Sec. 4 were compared using these tests.

3.5 Data validity checks

Various countermeasures were implemented to preserve data integrity. Thresholds on time-to-completion were used to check for speeding, straight-lining and time-outs. Digital fingerprints were recorded and verified using GoIP cookies to discard duplicates and fraudulent responses. Random checks of the open responses comments were done manually during survey fielding. Participants took 10 minutes 30 seconds, on average, to complete the survey.

4 RESULTS

Demographics were equally distributed across gender, age and country of residence but a range of organization types and sizes were represented. Fig. 4 shows this variation. Employees of technology focused companies were dominant in the survey pool and organization sizes of 19 people and below were underrepresented.

4.1 Realism ratings (P1/I1)

In this first step of our analysis, we will evaluate the differences in realism ratings of the five avatar systems. This is an important validity check, as insignificant differences would mean that our study assets could not provide enough resolution to test the primary research questions.

As seen in Fig. 5, there was a noticeable difference in the realism values of the five avatars. The difference in means was found to be statistically significant [$H(4) = 2991.6, p < 0.05$] and all within-group differences were also found to be significant in post-hoc analysis.

4.2 Acceptability for work meeting (P2)

The acceptability score averaged across all the avatar styles and scenarios was 3.9, mapping to a "Acceptable" rating on our Likert scale.

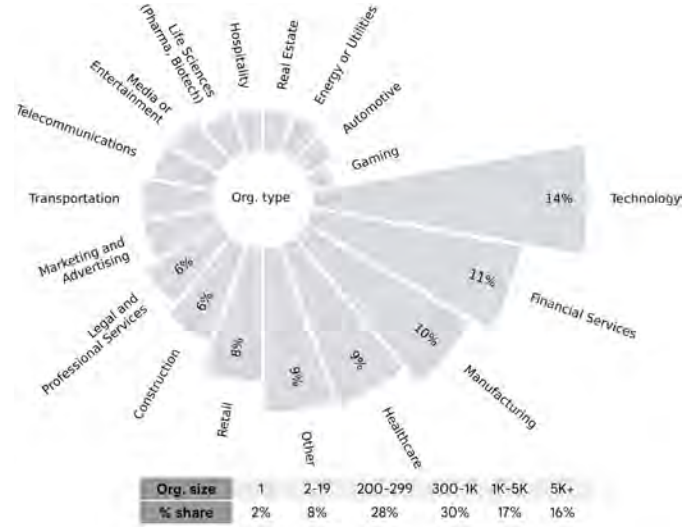


Fig. 4: (Top) Various organization sizes represented in the survey and (bottom) tabular summary of survey participants' company sizes

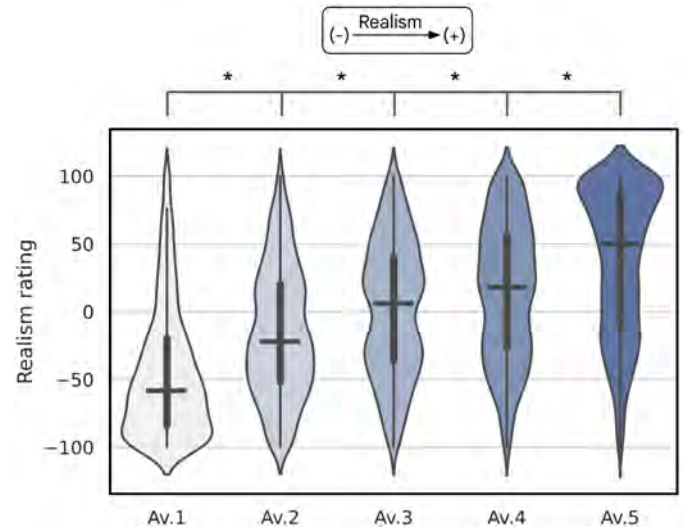


Fig. 5: Aggregate realism score for various avatar styles

Fig. 6 was created by aggregating the acceptance scores for each scenario and plotting the corresponding percentage splits. The acceptance ratings followed the same trend as the realism ratings. All within-group differences were found to be significant [$H(4) = 1337.9, p < 0.05$], except between Av. 3 and Av. 4.

Avatars were perceived as more acceptable when meeting with known colleagues than when meetings with managers. And least acceptable to meet with an unknown colleague. This hierarchy was more true for less realistic avatars. As noted by the '*' brackets, known-unknown and known-manager differences were significant for the less realistic avatars: Av. 1 and Av. 2. On the other hand, known-unknown and unknown-manager differences were significant for Av. 3 and Av. 4. None of the Av. 5 scenarios were significantly different [$H(3) = 2.4, p = 0.31$].

4.3 Avatar acceptance vs. realism scores (P1)

The binned histogram in Fig. 7 shows the relationship between realism scores and acceptance scores. All avatars exhibited a positive relationship between realism and acceptance scores. The baseline realism (x-intercept) of all the avatar scores match findings from Fig. 5 and Fig. 6. For example, Av.5 has the highest baseline realism rating and Av. 1 has the lowest. The gradient of the Fig. 7 clusters suggests that

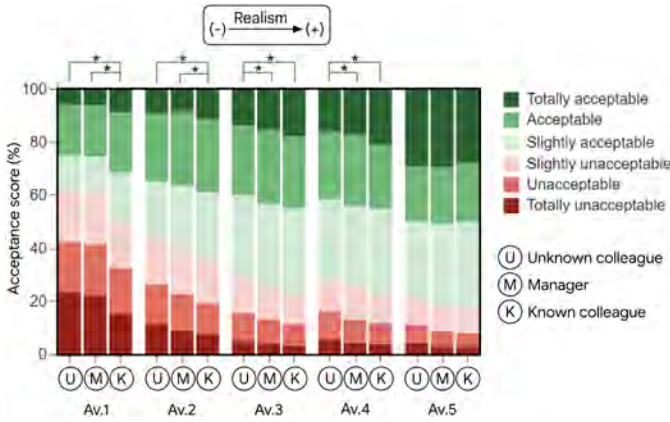


Fig. 6: Aggregate acceptance score for various avatars use for work meetings (*denotes statistically significant difference)

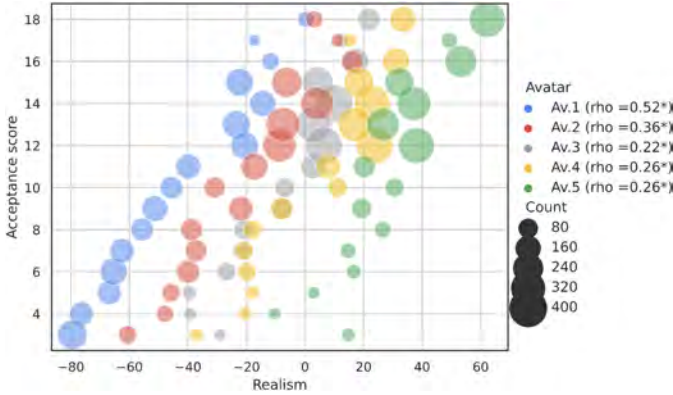


Fig. 7: Binned scatter plot showing relationship between realism and acceptance scores for various avatar styles (*denotes statistically significant correlation). Acceptance score 2 (range: 0-18) is the sum of Acceptance score 1 for a given avatar across all three work colleague scenarios.

incremental gains of acceptance scores per realism values are highest for Av. 1 and lowest for Av. 5.

A Spearman's correlation assessing the fit of realism vs. acceptance scores of all avatars combined was significant [$\rho=0.32$, $p<0.05$], but had a weak-to-strong relationship. Similar results were found for individual correlations for each avatar (see Fig. 7 legend), except for Av. 1 which had a strong relationship. All results showed a monotonically increasing relationship between realism values and acceptance scores.

4.4 Regression analysis: avatar acceptance vs. age, geographic location and gender (P3)

An Elastic Net regression was compiled using acceptance scores as the dependent variable and demographics/knowledge worker traits as the independent variables. The model was built in two phases by iteratively excluding insignificant independent variables to reduce dimensionality. The final version of the model had a mean square error between 0.9-1.0.

Acceptance scores varied minimally across all independent variables. The top three positive and negative coefficients from the model are shown in Tab. 1. Region (country) related independent variables had a higher effect on Acceptance scores in comparison to other variables. Followed by work-from-home schedules and organization types. Acceptance score differences across gender and age were non-significant and the corresponding plots are shown in the Appendix.

To elaborate on the Elastic Net regression results, Fig. 8 shows acceptance ratings of the five avatars divided across different regions, organization types and working schedules. Barplots for respondents from the United States and South Korea are colored differently to

Table 1: Coefficients and z-score values of the regression analysis with acceptability ratings as the dependent variable and demographic variables as the independent variables.

Independent variable	Acceptance (z-score)
United States (country)	1.3 (0.10)
South Korea (country)	1.3 (0.10)
Manufacturing (org. type)	0.5 (0.04)
United Kingdom (country)	-0.5 (-0.04)
Never WFH (WFH)	-0.6 (-0.05)
Germany (country)	-0.9 (-0.07)

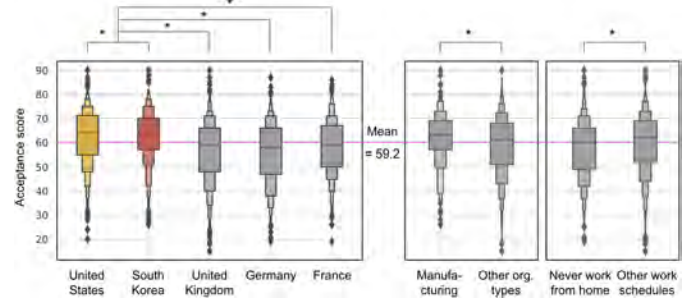


Fig. 8: Avatar acceptance scores for (left) various regions, (middle) Manufacturing vs. non-manufacturing organization types and (right) respondents never working from home vs. other work schedules

emphasize the difference in their acceptance scores. All differences within-group for regions were found to be significant [$H(4)=132.2$, $p<0.05$]. A more detailed split per country is shown in the Appendix.

The difference between manufacturing and non-manufacturing organization types was not visually identifiable but statistically significant [$Z=3.9$, $p<0.05$]. Similarly, the difference in acceptance scores of respondents who never worked from home and others was not visually identifiable but statistically significant [$Z=-3.9$, $p<0.05$].

4.5 Sentiment analysis: Open response analysis (S1)

Open response queries were analyzed using automated sentiment analysis. Scores were calculated from a NLP analysis using NLTK, a python package based on VADER. Fig. 9 shows the percent share of positive and negative sentiment scores for each avatar. Av. 1 was the only avatar that received more negative comments than positive. And Av. 5 showed the biggest difference between positive and negative scores. This result conforms to the acceptance score trends: avatars with higher acceptance scores had more positive sentiment scores and vice versa.

The highest frequency of words uttered remained consistent across avatars but varied in frequency counts. For more context, a few representative quotes from each avatar are described below.

Av. 1:

"The features are far too much in a cartoon version and does not bring credibility to be used in the professional environment."

"I actually find it totally cute, but for the meeting and the world of work + bosses probably not so well, since the two of them are not taken seriously."

Av. 2

"The avatars are about 50/50 when it comes to being abstract or realistic. I still find them acceptable."

"These avatars feel a little too generic - like from a 90s videogame. Ok - but not the best out of the bunch offered."

Av. 3:

"i feel this one would be accepted by most in a meeting, doesn't seem very unprofessional and also not so realistic that it makes others uncomfortable."

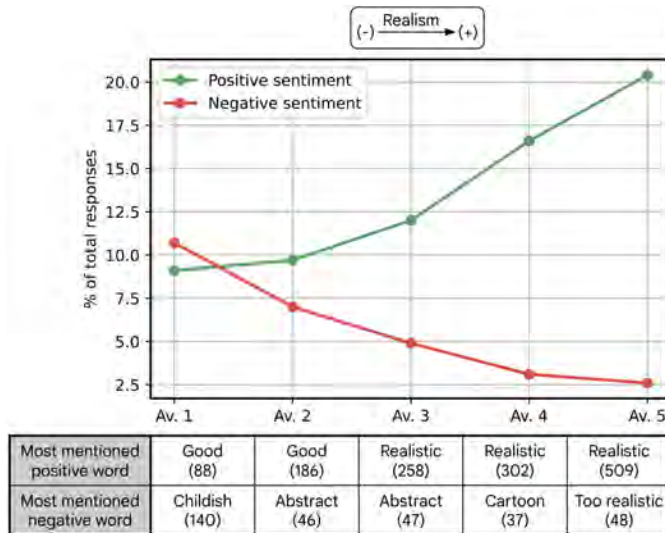


Fig. 9: (Top) Sentiment analysis results and (bottom) table showing the corresponding most frequent words

Av. 4:

"I find it pleasant because it is a mixture of real and comic, and yet it does not seem dubious"

"I find it very lively and cartoon, but at the same time friendly for use on special occasions"

Av. 5:

"I probably would use this! Deffo the best out of all the avatars! The detail is amazing! Perfect for when I don't look put together and still want to be on a meeting!"

"It's too realistic, so there's a little bit of a sense of dissimilarity. The impression is a bit awkward and unnatural."

5 DISCUSSION

Our results agree with the overall consensus from prior work on avatars: more realism is favorable. However, these findings are majorly tested in social settings and do not address the nuances of work avatars. Our research contextualizes the effects of avatar realism in work settings. For example, we found that avatar acceptance levels for various work relationships change as realism increases. Less realistic avatars are more acceptable when meeting with known colleagues. As realism increases, it becomes more acceptable to meet with others that you know; but still perceived as less acceptable for unknown colleagues. Until you reach photorealism. At this point avatars are considered acceptable regardless of the relationship to the person. This suggests a strong preference for realistic work avatars and any accommodation for less realism is directly related to the closeness of work relationships.

However, there could be work contexts where an abstract avatar can be advantageous. As noted in the open response comments, the less realistic avatars offer an opportunity for fun and better expressions. Respondents appreciated the lively/cute nature of the less realistic avatars. However, the least realistic avatars were called unprofessional and not suitable for work. On the other extreme, most realistic avatars suffered from uncanny valley effects wherein some participants thought that they looked unnatural or awkward. This leads us to believe that an optimal avatar for knowledge work offers the candidness of cartoon-like avatars without compromising on professionalism needs of knowledge worker meetings.

Avatar acceptability varied the most based on geographic regions. Respondents from the United States and South Korea rated avatars to be more acceptable for work meetings. And avatar acceptability did not significantly vary by age, gender or employment characteristics. This result could possibly be explained by the varying awareness and adop-

tion of avatars around the world. We conjecture that social and local customs play a large role in determining workplace avatar acceptance.

6 LIMITATIONS

Our research relied on the survey takers assessment of hypothetical future work scenarios. Further, respondents did not have control over the avatar animations shown to them. This limits the applicability of our work in real-world context. Although our work discusses the implications of avatars by meeting attendees, we do not consider the content being discussed in the meeting. To fully ascertain the relevance of our results in professional settings, a longitudinal study tracking avatar choices across various work meeting contexts is a possible next step.

A survey-based approach limited us from presenting the avatar systems in an immersive environment like in a virtual reality experience. Our results provide a starting point for such embodiment but need follow-up work to test other nuances to realism like full body avatar movement and voice.

Lastly, we did not test self-impersonation. The implications for avatars embodied by others vs. self are different; potentially with higher uncanny valley effects for self-impersonation [9].

7 CONCLUSION

Realism of avatar renderings had a significant correlation to their acceptability for work meetings. More realistic avatars had higher acceptability.

Avatars were more acceptable for use by a known colleague, than by a manager, and least so by an unknown colleague. However, this preference was more prevalent for less realistic avatars. The most realistic avatar was rated as equally acceptable for all three work scenarios.

Avatar acceptance varied the most by region. United States and South Korea participants rated all avatars more positively. Other demographic/knowledge work factors did not have a significant effect on avatar choices.

Professionalism, credibility, seriousness were the most common adjectives used to describe avatar needs for work settings. However, cuteness, fun and liveliness were also mentioned as desirable qualities for work avatars.

The five avatars styles used in our research were significantly different from each other. This provided the necessary separation in realism levels needed to build other results upon.

FIGURE CREDITS

Figure 2 image credit: www.fotor.com. Note that images are representative and not the actual assets used in the survey.

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A APPENDIX

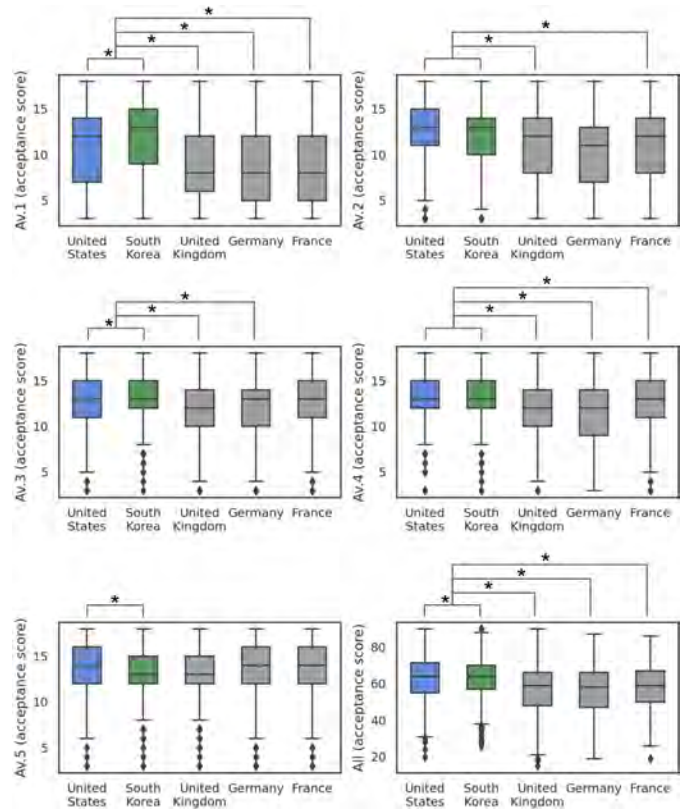


Fig. 10: Avatar acceptance by country (*denotes statistically significant difference). Acceptance score (range: 0-18) is the sum of scores for a given avatar across all three work colleague scenarios. And Acceptance score (range: 0-90) is the sum of avatar scores across all five avatar styles.

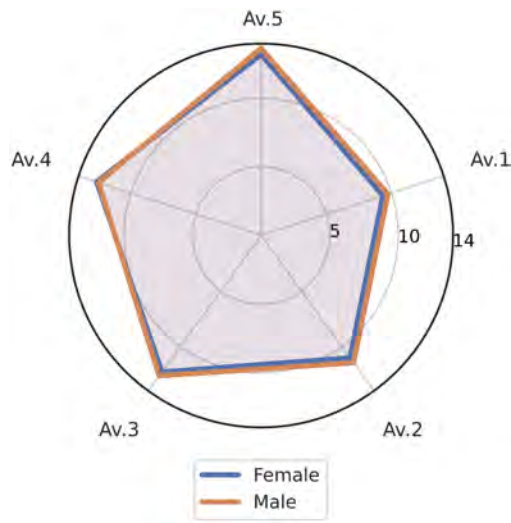


Fig. 11: Avatar acceptance scores for female vs. male participants. There was no clear difference in acceptance ratings split by gender of the survey participants. Note that other gender splits are not shown in this figure as they had a small representation in the sample pool.

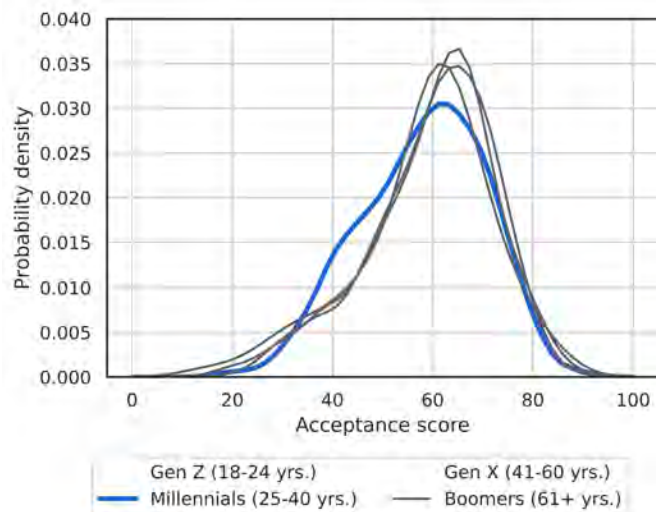


Fig. 12: Avatar acceptance by gender, highlighting that all age brackets had the same score but GenZ scores are more distributed.