The Effects of Consultant Avatar Size and Dynamics on Customer Trust in Online Consultations

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ABSTRACT

This study investigates the impact of avatars on interactions between customers and consultants in remote, online consultations supported by Augmented Reality (AR). Based on past research, we were interested whether the appearance of an avatar and its dynamics affect important factors for online consultations such as social presence, trust in the consultant and perceived customer satisfaction. In particular, we chose avatar size and dynamics (movement/gaze) to compare different avatars in a 2x2 experiment, in which customers wear AR head mounted devices to consult a remotely located consultant in a mock furniture consultation session. Our results show no significant differences in trust and satisfaction, but significantly different levels of perceived social presence for life-sized, dynamic avatars as well as significantly higher co-presence for all life-sized avatars. Additional data from interviews with the participants revealed a clear preference for dynamic avatars over static ones. Based on an analysis of these findings, we make design recommendations and suggest directions for future research.

CCS CONCEPTS

• Human-Computer-Interaction~User Experience Design • Human-Computer-Interaction~Virtual Characters and Avatars • Human-Computer-Interaction~Affect • Human-Computer-Interaction~Aesthetics • Human-Computer-Interaction~Emotion

KEYWORDS

Augmented Reality, Avatars, Social Presence, Co-presence, Trust

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1 Introduction

Over the last years, many retail branches have shifted (parts of) their sales platforms to online outlets, as these reduce costs for spacious showrooms and enable the customer to compare many alternatives easily from home. However, some retailers have held back when entering the online market space, because in-store services such as customer consultations and live product experiences are an integral part of their offering. Consultations are especially important if the customer wishes to buy a highly configurable product, and such products entail a high risk for online businesses: If the good is highly configurable, it will most likely have to be custom-built for the customer. Should the customer find something that they do not like about the finished product after delivery, complaints and returns are likely. In addition, while remote, online consultations seem to provide great potential for sales and services, providing them at a high level of quality is difficult because of limited options for facial expressions and body language when communicating online. As "trust needs touch" [14], it is difficult to build a trusted relationship between customers and consultants in such settings.

Like in face-to-face conversations, context is important in remote consultations: They require additional references to documents, pictures or other media to ensure understanding and quality. While such references can be made by sharing media or referring to the same areas in a document, this becomes difficult if larger goods are to be integrated into houses, gardens, facilities or similar. The customer might want to preview the good in its real size, which, depending on the situation, might be impossible. For such cases, augmented reality (AR) has been proposed to virtually refer to the same object from different locations [6, 17, 47]. However, consultations that involve design or purchase recommendations rely heavily on the consultant's empathy and understanding of the customer as well as the customer's trust in the consultant [19], both of which might not get conveyed and built correctly if using a remote solution [20]. Therefore, special procedures and tools are needed to lead online consultations to a satisfactory result for both participants.

As part of a joint research project on digital, remote possibilities for furniture consultations and sales that applies AR for these areas, the study presented here explores ways to create

trust and presence in such consultations. Specifically, it investigates the influence of the visual appearance of a virtual consultant avatar on presence, trust and client satisfaction. Prior research indicates that avatars as "artificial, computer-animated representations of human interlocutors within virtual environments" [2] can be used to visualize the consultant. It is unclear, however, how such an avatar would have to look or act like in order to provide a good consultancy experience. For contexts that involve building a relationship based on trust, such as online consultations, avatars have not been used extensively and research remains sparse.

Existing work from other domains suggests that varying the size of the avatar [32, 44] as well as its degree of realism [18] and how much its behavior fits its appearance [39–41] influences the amount of *social presence* and *trust* perceived by humans interacting with the avatar. Neither of these aspects have been investigated in consultation scenarios, yet. Therefore, we designed and conducted an experiment to investigate the role of these factors on presence, trust and satisfaction in online furniture consultations. In particular, we compared **life-sized** and **miniature** avatars for avatar appearance, as well as **dynamic** (as *realistic*) with **static** (as *unrealistic*) avatars. Our results indicate that life-sized, dynamic avatars might work better for building trust and satisfaction, which is partly different from available results in other areas. By looking deeper into these results, we identified factors that led to this result and enable us to make design recommendations for avatars in online consultations.

2 Related Work

2.1 Trust in online commerce and consultancy

In consultation processes, especially online, the buying behavior of customers is largely dependent on customer **trust** towards the business and its employees [19]. Lewis et al. [23] generally define trust by first dividing it into cognitive and emotional processes: The **cognitive** process is based on *good reasoning* of the individual, while the **emotional** process takes the emotional bond of the individual towards the entity to trust into account. After deciding to trust the other entity, the individual will begin the **behavioral enactment** of the trust process: They execute an action, which they perceive as *risky*, under the assumption that the other entity will execute their own part of the interaction dutifully. When considering **trustworthiness** of an individual [30], humans unconsciously take four dimensions into account [9]: Perceived honesty, expertise, predictability and reputation. More personalized factors influencing trust include individual tendencies to trust, their expertise of online interactions, their perception of the usefulness of a service and the acceptable fulfillment of any ordered services [8]. Mou et al. [26] name a high amount of trust and a low amount of perceived risk as the most important aspects in online commercial environments.

In *classical* commerce, a customer's plea for assistance in choosing would be handled by a consultant. Online sales have to rely on different communication channels such as media to provide a similar experience. Komiak et al. [20] have shown that the factors influencing the trust-building process described above also apply to media solutions and "virtual salespeople", but in different ways. They describe the inter-individual connection as more important in face-to-face sales talks, while building trust towards a virtual salesperson appears to be influenced by the customer's perception of its benevolence and competence. They further list the customer having a verifiable control process and fulfilling the customer's expectations as important aspects in this area.

2.2 Trust in VR/AR avatars

Bente et al. [2] showed an influence of the chosen medium on the trust-building process towards virtual salespeople. They compared text-, audio-, audio-and-video-, as well as **avatar**-based media on co-presence and trust (among others). They define avatars as "artificial, computer-animated representations of human interlocutors within virtual environments", a definition that will be used throughout this work as well. Their results show that video or avatar media fares best compared to audio or text-only solutions. Similarly, Riegelsberger et al. [34] found video-based solutions to garner most trust, followed by a combination of pictures and text, audio and avatars. They suggest that using off-the-shelf-avatars might be at fault for the low avatar ratings. Still, both studies found avatar solutions to outperform text.

Papadopoulou et al. [29] showed virtual reality (VR) sales platforms to be preferred over classical online sales platforms by many users. The 3D avatars added into their test platform might have played a large role in this result. Bauer et al. demonstrated [1] that avatars like this can emulate interpersonal interactions with humans, persuade potential customers and improve trust using social influences. They further showed that avatars can mediate trust in online sales and can elicit a positive effect on the customer's trust in the e-service provider the salesperson is representing.

As for the influence of the appearance of an avatar, Wang et al. [44] compared a voice-only solution, an AR featureless cylinder, and AR life-sized human- and miniature avatars in a collaborative setting. They tested for perceived presence, relatability, realism and trust (among others). Humanoid avatars outperformed abstract ones for presence, with the miniatures receiving the best scores. There was no significant difference for trust. Mull et al. [27] examined how the anthromorphism of an avatar influences trustworthiness, homophily, attractiveness and interaction willingness of customers in an online sales setting. More of anthromorphism (e.g., humans or elves) was rated higher than e.g. animal characters, and Mull et al. recommend using avatars close to the actual or the idealistic appearance of customers. Hanus and Fox [15] arrived at a similar conclusion and recommend to enable the customization of sales avatars by the customers if possible. If not, idealistic avatars seem to work best [45]. Lee et al. [22] found a correlation between using avatars as salespeople and a heightened buying intention of customers interacting with them in online commercial settings. They also found avatars that resembled an *expert* more to elicit stronger feelings of cognitive trust, while attractive avatars elicited stronger emotional trust in customers. However, customers planning low investment/risk purchases report a stronger intent to buy if the avatar they

interacted with differed from themselves in gender and race (emotional reaction) [31]. High investment purchases do not lead to the same behavior. To summarize, focusing on humanoid avatars picked by users appears to be advisable for situations requiring a large amount of trust.

2.3 The "Uncanny Valley" effect in avatars

Human features of 3D avatars that differ slightly from how an actual human would look like, e.g., unusually far apart eyes, might cause the "Uncanny Valley" [36] effect in humans interacting with said avatars, leading to feelings of eeriness in humans. This, in turn, might reduce the trust customers feel towards their virtual consultant, and should be avoided. To start, one should avoid mismatching avatar features: In a study by Stein and Ohler [40], avatars were perceived as less uncanny if their voice matched their appearance, even if both could be described as *unnatural*, individually. Participants of Tinwell et al.'s. study [41] reported a greater sense of creepiness from the avatars if its voice and lip movements drifted apart, especially if the voice was played first. Finally, the avatar should appear to be controlled by a human, and not a machine. Failure of doing so resulted in ratings of more uncanniness in a study conducted by Stein et al. [39]. Jo et al. [18] demonstrated that avatars with an abstract appearance can lead to a more pronounced feeling of *co-presence* in customers, while photorealistic avatars improve the trust rating of the avatars in general.

Adapting the avatar's size might reduce the uncanny valley effect as well. Piumsomboon et al. [32] compared differently sized humanoid avatars in two remote expert-helper scenarios. They compared the different avatar sizes based on perceived **social presence**, which in the past has been shown to influence the early stages of the trust-building process between customers and the retailer [3, 24]. They found that if a miniaturized AR avatar represents the expert side of the collaboration, it improves the perceived social presence towards the expert significantly. Another example of this effect can be found in the aforementioned study conducted by Wang et al. [44] in which the miniaturized human avatar was deemed as "almost cute" by some of the participants.

3 Background: Remote, Virtual Sales

As mentioned above, this work is part of a joint project aimed at developing a furniture sales platform, which would allow customers at home to benefit from the expertise and consultation services of a furniture retailer via the internet. To support this, furniture is visualized for customers in their home environment via AR (see Figure 1), using the Microsoft HoloLens as an AR head mounted device (HMD). To counteract disadvantages of online consultations as described above, we use AR to view configured furniture in the space they are supposed to be placed in. In addition, we represent consultants as avatars on the HMD, which is supposed to enhance trust and satisfaction during and after the consultation.

One of the main goals of the project is to reduce the bi-directional knowledge gap that exists between the customer and the consultant [4]. Customers are experts of their home, and are often asked for descriptions or pictures of said environment during on-site furniture consultations. Likewise, consultants are experts on furniture and have to provide the customer with an overview and recommendations that fit their wishes: The total amount of available furniture might be too much for the customer, and furniture stores only have a few variations on display.

Figure 1: A virtual couch in a real-life environment

Providing this process digitally (that is, remotely and, in our case, online), can bring the customer and the consultant together in the customer's environment virtually. With our system, furniture previews can be anchored in the 3D space within the customer's home and can be viewed from all angles using AR glasses for a more realistic impression of the furniture. Likewise, consultants supporting the customer could view the customer's surroundings remotely using the built-in cameras of the AR HMD. Doing so could enable them to provide an improved consultation experience when compared to working on descriptions or pictures the customer brought in. Additionally, consultations like this enable the customer to stay home and the consultant to work from the location of the furniture reseller, saving time and money for both parties, which would otherwise be spent on traveling. As mentioned above, to build trust, the consultant is displayed as an avatar present in the home environment of the customer.

4 Study design

4.1 Open Issues and Research Questions

Our literature review has shown that avatars can be helpful for building social presence, trust and satisfaction in AR based interactions. We also found that avatars and their effect have already been studied for several (remote) collaborative settings, including commercial ones. From literature, the appearance (size) [32, 44] and behavior (dynamics) [40, 41] of avatars seem to be variables that warrant more research.

Even though prior work which examines the effect of these avatar features exist, the use of avatars in online consultations has received little to no research attention in the past. As section 2.1 shows, customers build trust in an avatar based on perceived benevolence and competence, which is rarely discussed in research examining the effect of avatars in cooperative AR. Therefore, we can only make assumptions on whether or how the

appearance and behavior of avatars affect social presence and trust ratings as well as customer satisfaction in online consultations. The work presented here therefore aims at providing first insights into avatar influence on remote consultation scenarios that make use of AR.

Even though miniatures as used by Wang et al. [44] and Piumsomboon et al. [32] had a positive effect on social presence and trust ratings, it remains unknown if they create similar effects in an online (furniture) consultation setting as described above. In addition, dynamic consultant avatars may be favorable, as they interact with the users and their environment, which in turn may provide benefits. However, the impact of these measures to improve realism on social presence and trust on the user satisfaction remains to be examined for the consultation context. For our study, we focused solely on the customer side, as it is decisive that customers develop trust in the consultant. The consultant side was taken over by a research assistant who was familiar with furniture consultation processes, while we recruited volunteers as customers for the study.

In our study, we were specifically interested in how avatars representing consultants in AR based remote consultations would influence the perceived quality of these consultations from a customer point of view. Besides measuring social presence and trust, we added overall consultation satisfaction of the customer as a dimension to determine if the customers taking part in our study perceived the consultation as successful. Based on related work as outlined above, we chose avatar size and dynamics as variables in the study. Combining these measures and variables, our work was driven by a central research question:

Figure 2: Avatar picked for evaluation period

RQ 1: *"How do appearance and behavior of consultant avatars affect perceived social presence and trust towards the consultant as well as overall consultation satisfaction for customers in a remote, AR supported consultation?"*

Concerning the appearance of the avatar, as described above, we chose avatar **size** as one of the variables to examine, comparing **life-sized** avatars to **miniaturized** ones. This resulted in a more refined research question:

RQ 1.1: *"How does the size of consultant avatars affect perceived social presence and trust towards the consultant as well as overall consultation satisfaction for customers in a remote, AR supported consultation?"*

Based on prior research as described above, we assumed that a miniaturized avatar would garner higher trust, social presence and satisfaction ratings as a life-sized one.

As literature suggests that avatar behavior may be important but (to the knowledge of the authors) there is no study available that investigates further aspects of behavior for AR interaction, we chose **dynamics** as the second variable to investigate. In our experiments, we varied the amount of movement the avatar would show during the consultation. In particular, we chose to compare what we called **static** and **dynamic** avatars. Static avatars remained in the same place during the consultation and always gaze into the direction of the customers. Dynamic avatars allow the consultant to control the location and gaze direction of the avatar. These modes were chosen due to the new dimension of realism the avatar's room-anchored movement represents. To the knowledge of the authors, there is no work available on the effect of these avatar dynamics on trust, social presence and satisfaction in consultation settings. This resulted in another refined research question:

RQ 1.2: *"How do movement dynamics of consultant avatars affect perceived social presence and trust towards the consultant as well as overall consultation satisfaction for customers in a remote, AR supported consultation?"*

We assumed that a dynamic avatar would be perceived as more realistic, catch more attention of the customer and serve as an improved reference point for social interaction, as it could be moved close to the virtual furniture displayed to the customer. Based on this, we also assumed that avatars like this would improve perceived social presence, trust and satisfaction.

4.2 Avatar Choice and Implementation

Before the study, we had to determine an avatar representation that would suit most participants. Based on the literature research we decided to use a humanoid avatar with expert features the participants could identify with. Literature points out that *ideal* avatar appearance features that leads to social presence and trust may depend on demographics, region and other factors. Therefore, we presented a set of avatars representing people with different ages, demographics, clothing and backgrounds to 20 volunteers., who represented potential customers. We asked the volunteers to choose between the different avatars to pick a consultant. Additionally, we presented avatars that showed (basic) lip movement and avatars that did not move their lips, at all (see section 2.3 for the effect of lip movement). As the researcher to play the consultant was male, all presented avatars were also male, since the consultant appearance needed to match the voice of the researcher to avoid provoking the uncanny valley effect (see section 2.3). Most volunteers picked a Caucasian, middle aged avatar wearing a dark suit and enabled lip movement (see Figure 2). Since our volunteers picked this combination almost unanimously as it met their expectations, an aspect deemed important in prior research, we decided to use it for our study. Please note that this does neither represent a preference of the authors nor any tendency of discrimination among the participants.

As mentioned in section 4.1, for avatar sizes, we implemented a **miniature** avatar versus a **life-sized** one (cf. [32, 44]). Life-size

avatars measured about 170 cm in height and stood on the ground (see Figure 3). Miniatures were shrunk to 25% of the life-size avatar and floated at head-height (Figure 4). The life-sized animation received standard standing and walking animations, while the miniature received floating animations to avoid it standing in midair. Other than these, the appearance of both avatar types was 100% identical.

Figure 3: Life size avatar with dynamic movement (*LiDyn*), facing and walking according to consultant control.

For the avatar dynamics variable, we picked two extremes of values mentioned for movement and gaze. We implemented a **static** avatar, which automatically keeps eye contact with the customer and stands at the same position throughout the whole consultation session, and a **dynamic** avatar controlled by the consultant, which emulated a person walking through the room and turning around. The behavior of dynamic avatars is shown in Figure 3 and Figure 4, the left of each showing the avatar in its starting position (kept by the static avatars all the time) and the right side showing it placed further away and facing a different direction (only possible for the dynamic avatar).

Figure 4: Miniature avatar with dynamic movement (*MiDyn*), facing and floating according to consultant control.

We combined size and dynamics variants, resulting in four different avatars (Table 1): A life-sized, dynamic avatar (LiDyn), a life-sized, static avatar (LiSta), a miniature, dynamic avatar (MiDyn), and a miniature, static avatar (MiSta).

	Life-Sized	Miniature
Dynamic	LiDyn (Figure 3)	MiDyn (Figure 4)
Static	LiSta	MiSta

Table 1: Types and acronyms of avatars used in the study.

Our approach for the implementation of avatars differs slightly from other work (e.g., [32]) in that the miniature avatar does not always stay within the field of view of the customer, but would rather remain anchored in the room where it was initially placed (head height) or (in the case of the dynamic avatar) would move around according to the input of the consultant (see Figure 4). Floating at head height was chosen to keep the face of both the life-sized and the miniaturized avatars at roughly the same height. This ensured that the avatar's face would always be visible in roughly the same place between conditions, and it would leave and reenter the user's field of view of the customer at about the same point of them turning away or turning back towards the avatar. Additionally, customers seeking to gaze at the face of the consultant avatar would look in the same direction for both cases, keeping the results comparable.

4.3 Consultation tool

We developed a consultation tool using the four avatar types described above based on the Microsoft HoloLens, using the *Unity* engine [42] and C#. Basic tasks such as peripheral input were implemented using Microsoft's *MixedRealityToolkit* [48]. The consultant used the prototype on a standard computer, while the customer made use of the HoloLens, which we, despite its limited field of view (around 30° x 17.5° [28]), deemed as the best HMD available for displaying AR content at the time of this study.

The consultant received tools for viewing the surroundings of the customer from a first-person perspective, for managing furniture and for moving their own view port around, which also served as a means to control their avatar on the customer's side if it is set to dynamic. The HoloLens served as a renderer for any virtual content displayed to the customer.

Voice communication was achieved using *Photon Voice for PUN2* [43]. The Models for the consultant avatar were created using *MakeHuman* [46], and all animations were created using *Adobe Mixamo* [25]. The 3D models for any placeable furniture were sourced from free online sources [11–13, 38]. Both the consultant avatars and the furniture models were reduced in model complexity using *Blender* [10] to improve performance.

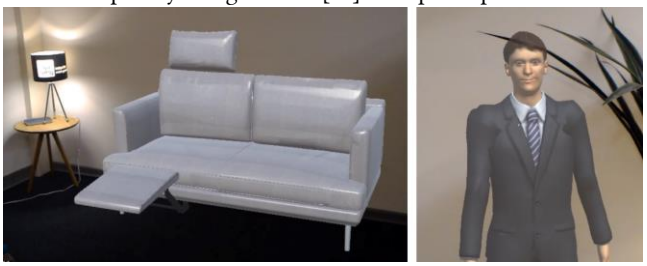

Figure 5: Customer's view of a placed virtual couch (left) and the consultant avatar (right)

4.4 Setting: Living Room Laboratory

To account for external validity and realism, we constructed a laboratory environment that mimicked a living room (Figure 6).

The living room consists of several tables, shelves, fake plants, a fake TV and decorations. The walls directly opposite of and perpendicular to the TV were left free of furniture to allow for a virtual couch to be placed in front of them.
In this environment, we conducted mock remote furniture consultations. For each consultation, the HoloLens was used to view virtual content by the customer participants of the study. As mentioned above, the consultant was played by a researcher at all times. Both parties made use of the consultation tool described above. The consultant workplace was situated a few rooms away to emulate a remote setting. The participants spent the entire duration of the experiment inside the living room lab.

Figure 6: Living room laboratory built for the study from different perspectives.

5 Study

5.1 Experiment

To compare the four avatar types, we designed a 2x2 experiment combining each value of the variables as mentioned in section 4.2 together for one run of the experiment. Each participant completed four rounds of the experiment, during each of which one of the avatar combinations was tested. Each round consisted of a single remote mock consultation, which was treated by both participants independently of preceding rounds.

At the beginning of each round, the customer started at the same position in the room, facing the consultant avatar. We provided the consultant and the customer with a scenario and corresponding instructions for each round. To create a realistic situation for consultation, customers were instructed to look for a new couch that would complement the provided living room. Each set also contained basic conditions (e.g., "a small couch for me") and several restrictions (e.g., "seats one more person") the customers had to look out for.

The experiment, the scenarios and all instructions were based on and rehearsed with information gathered during an observational study in a real furniture store [4], as well as an observation of salesperson training. The consultant was (unbeknownst to the customer) instructed to always present the customer with two couches fitting their needs perfectly, two couches that would violate minor restrictions and one that would violate the basic condition. This was done to check whether the respective avatar influenced the choice of the customer. The process the consultant went through was kept consistent each round.

5.2 Participants

The experiment was conducted with 12 participants. They were aged from 17 to 62 years, averaging at 28 years, with two of them identifying as female and ten as male. Ten of the participants reported prior experience with AR, and six had taken part in prior experiments of our research group. We did not find a significant influence of this on the results. All participants were recruited on a voluntary basis and provided with informed consent statements for the study. The participants used the four combinations in different orders to counterbalance order effects. Due to our sample size, full counterbalancing was not possible, but since we did not aim to achieve generalizable results, this effect should be negligible and our results should remain valid.

5.3 Methodology

To measure the levels of social presence, trust and customer satisfaction, the participants were handed a questionnaire after each round. Questions about perceived social presence were taken from the "networked minds" questionnaire on social presence by Harms and Biocca [16]. The questions were adapted slightly to correctly address "my consultant" instead of the original "my partner". The questions on the perceived level of trust towards the consultant were taken from the questionnaire by Komiak and Benbasat's work [21], and, again, adjusted to fit our context better ("RA" became "consultant"). For customer satisfaction, we added custom questions: We asked for perceived consultant helpfulness, satisfaction and success, as well as likeliness of interacting with the same consultant for further consultations and recommending the consultant. We used a Likert scale from 1 ("strongly disagree") to 7 ("strongly agree"). At the end, the we asked about preferred consultant avatar combinations in a short interview. In total, each experiment took between 75 and 120 minutes.

The experiments were recorded from the perspective of the customer (through the HoloLens), including virtual content. To analyze the interaction of customers with the avatar, we equipped the HoloLens devices used with a Pupil Labs eye tracker [33], which was used to track gazes of the customer.

6 Results

For the analysis, we used average values for each category in the used questionnaires. Answers from the interviews were examined for similarities as well as for a ranking of avatars. Since Likert-scales are generally regarded as ordinal scales, and, as such, data gathered using these is regarded as non-parametric, our questionnaires were analyzed using Friedman Tests [37] and subsequent post-hoc Wilcoxon Signed-Rank Tests [35], using a significance level of $\alpha = 0.05$ for the Friedman tests and Bonferroni-corrected [5] significance levels for multiple pairwise testing, with the added benefit of high robustness of these measures for small sample sizes. Due to the small sample size, we also used exact significance values.

6.1 Social Presence

The Friedman tests for the social presence score blocks (Table 2) reveal significant differences for perceived co-presence of the consultant as well in the aggregated social presence scores. The other individual blocks of the social presence score did not show any significant differences and have been omitted.

Condition	Mean	SD	Mean Rank	p
Perceived Co-Presence				
Life-Size, Dynamic	6.6389	.38161	3.63	.000*
Life-Size, Static	6.3611	.54510	2.96	
Miniature, Dynamic	5.3194	.99356	1.71	
Miniature, Static	5.2778	.98045	1.71	
Social Presence (Aggregated)				
Life-Size, Dynamic	5.9537	.42826	3.50	.000*
Life-Size, Static	5.8333	.56507	2.92	
Miniature, Dynamic	5.2639	.73058	1.92	
Miniature, Static	5.3009	.66517	1.67	

Table 2: Friedman test results for perceived co-presence and aggregated social presence scores. (* = significant)

Subsequent pairwise Wilcoxon signed-rank tests (Table 3) with a Bonferroni-corrected significance level of $\alpha = 0.0083$ show that all avatar configurations that made use of the miniature setting resulted in significantly lower ratings of perceived co-presence when compared to all configurations using the life-sized setting. The aggregated social presence scores also show significant differences: Using both the miniaturized, dynamic setting (MiDyn) as well as the miniaturized, static settings (MiSta) resulted in significantly lower social presence ratings when compared to the life-sized, dynamic setting (LiDyn). Comparing settings to each other that used the same body size for the avatar did not yield any significant differences for social presence ratings.

Condition	Mean Rank	Z	p
Perceived Co-Presence			
LiSta - LiDyn	4.86	-2.263	.031
MiDyn - LiDyn	6.00	-2.938	.001*
MiSta - LiDyn	5.50	-2.805	.002*
MiDyn - LiSta	7.30	-2.680	.005*
MiSta - LiSta	6.40	-2.759	.003*
MiSta - MiDyn	7.17	-.315	.770
Social Presence (Aggregated)			
LiSta - LiDyn	7.14	-.867	.386
MiDyn - LiDyn	6.91	-2.908	.001*
MiSta - LiDyn	6.50	-3.066	.000*
MiDyn - LiSta	7.78	-2.433	.015
MiSta - LiSta	6.50	-2.499	.010
MiSta - MiDyn	5.21	-.197	.860

Table 3: Wilcoxon signed-rank test results for perceived co-presence and social presence.

6.2 Trust

The Friedman test for cognitive trust in the consultant's competence and integrity showed significant differences (Table 4), warranting further analysis. When compared to the Bonferroni-corrected significance level of $\alpha = 0.0083$, however, the subsequent Wilcoxon Signed-Rank Test showed no significant differences in the results. It should be noted that the MiSta combination garnered a higher mean score than LiSta, directly contradicting our expectations. However, as there were no significant differences between pairs, this is hard to interpret.

Condition	Mean	SD	Mean Rank	p
Cognitive Trust - Integrity				
Life-Sized, Dynamic	6.5278	.68841	3.04	.031*
Life-Sized, Static	6.1667	1.14150	2.21	
Miniature, Dynamic	6.2500	.85428	2.08	
Miniature, Static	6.4722	.64288	2.67	

Table 4: Friedman test result for aggregated cognitive trust - integrity scores.

6.3 Customer Satisfaction

The Friedman test results for the questions on customer satisfaction revealed a significant difference between the results only for the question on consultation satisfaction ("Overall, I was satisfied with the consultation" (see Table 5). Post-hoc Wilcoxon signed-rank test did not reveal any significant differences.

Condition	Mean	SD	Mean Rank	p
Consultation Satisfaction				
Life-Size, Dynamic	6.67	.651	3.29	.019*
Life-Size, Static	5.92	.900	2.13	
Miniature, Dynamic	5.92	.900	2.25	
Miniature, Static	6.00	.739	2.33	

Table 5: Friedman test results for perceived consultation satisfaction.

6.4 Interview Results

For the interview results, we first compared the raw preference data provided by the participants (in what follows, the participants will be referred to as participant #1 to #12). For this, we asked the participants to rank the avatars presented to them from *best* to *worst*. This resulted in nine of the participants (#1-#7, #10 and #12) to choose exactly the same order: LiDyn in first place, then LiSta, MiDyn and, finally, MiSta. #8 and #11 chose dynamic avatars over static ones in general, but otherwise kept the same order in place, resulting in the order LiDyn to MiDyn, LiSta and MiSta. The only participant to choose a miniature in first place (#9 with MiDyn, LiDyn, MiSta and LiSta) stated that they preferred miniatures since they could "ignore the avatars more efficiently", implying that they preferred to not interact with an avatar at all.

When asked why they preferred a dynamic avatar over a static one of similar size, nine (#1-#4, #7-#9, #11, #12) participants stated that they liked the "more lifelike movement of the [dynamic] avatars". Some participants also liked if the avatar "stayed close to the furniture" (#2, #3) or the avatar "faced what the consultant was talking about" (#7-#11). As to why the participants preferred the life-sized over the miniaturized avatars, many of them stated that they "easily lost sight of the miniaturized avatars" (#3-#5, #7, #10, #11), that they preferred being able to "see the mouth movement

[and/or] blinking of the life-sized avatars" (#1, #2, #5, #6) and that the "life-sized avatars felt more personal" to them (#1, #5, #7, #10). Interestingly, some participants, when asked about negative aspects about any avatar, stated that they disliked the "life-sized, static avatar staring at them" (#4, #6, #9, #10), referring to the static avatars automatically looking in the customer's direction, even though most of them (#4, #6, #10) preferred life-sized, static avatars over all miniaturized versions.

6.5 Gaze data

For gaze analysis, we examined the recording of the eye tracker for a number of gazes towards any body part of the consultant avatar, and the duration of these gazes. We counted only those gazes the customers executed unprompted by external influences. Inaccuracies of the eye tracker reduced our usable sample size to n = 7 participants. The amount and duration of recorded gazes per minute did show significant differences in our Friedman test results, however, due to the strongly reduced sample size and inconclusive results, we chose to exclude the results from our analysis. We did use the (eye-tracker independent) recorded camera footage to monitor the on-screen time of the avatars in each condition as well as the participant's reactions and movements, however, and used the results to further bolster our other results.

6.6 Picked Furniture

Only scenarios featuring life-sized, dynamic avatars led to customers picking furniture that fit their needs (8/12 for LiDyn versus 6/12 for all other combinations). This result should be regarded with caution, however, as none of the participants identified the outlier for the LiSta scenario, which might be caused by our experiment design.

7 Discussion & Design Recommendations

Due to our relatively small sample size, our results should not be generalized, but rather be regarded as a case study. They provide valid answers to our research questions and should serve as a stepping stone into further research into the complex context of remote consultations with AR (avatar) support.

7.1 Impact of Avatar Appearance

We found no significant differences in perceived trust and consultation satisfaction when comparing miniature avatars to life-sized ones. In our post-hoc tests. This means that the appearance operationalized by the size variable we used had no influence on these two factors (RQ 1.1). Continuing, we found significant differences in social presence for appearance, with social presence of a life-sized avatar rated higher than with a miniature. This seems to originate from the co-presence part of the social presence score. Here, the miniatures were rated lower compared to *all* life-sized options, suggesting that a life-sized avatar might be better suited to the task at hand. This, as discussed in the literature review [22, 41], may result from a better fit of the life-sized avatar to how our participants expected a consultant to look like. Additionally, the HoloLens recordings mentioned in section 5.3 and the gaze data mentioned in section 6.5 revealed that none of the customers moved closer to the miniature avatars to remedy shortcomings mentioned in their complaints (see section 6.4), which might suggest that outright ignoring the miniature instead is easier or more desirable. This finding is contractionary to existing work, which found miniatures to provide more social presence.

This result may be caused by a difference between our implementation and other approaches of using miniature avatars. While Piumsomboon et al. [32] and Wang [44] kept the miniature avatar automatically within the field of view of their users, we displayed the miniatures at a height that fits the height of the head of their life-sized counterparts. This might have influenced the results: While focusing on virtual furniture, a customer who would shift their view to the left or right of the couch would be able to see the feet of the life-sized consultant avatar in the periphery of the field of view, thus becoming aware of its presence. This might also trigger them to gaze at the avatar, increasing their awareness of the consultant and resulting in higher social presence scores. This effect might have been intensified by the relatively small field of view of the HoloLens (see section 4.3), which caused parts of the life-sized avatars (e.g. their feet) to appear on-screen significantly longer than the counterpart miniature one. However, in our usable sample this did not cause significantly more gazes towards the consultant avatar (see section 6.5), and as such, should not have impacted our results significantly.

Another reason could be the resolution of the avatars. For the analysis of the study, we captured the footage of the HoloLens, including any virtual content. However, this cuts the resolution and refresh rate of the HoloLens displays in half [7] to compensate potential performance losses. This might also have influenced the social presence ratings of the customers, as the lowered resolution might have caused fewer details of the miniature avatars to be visible, which might also explain the preference of some participants liking to see lip movements of the life-sized avatars. However, as mentioned above, none of the participants moved closer to the miniature as a remedy.

7.2 Impact of Avatar Behavior

To the knowledge of the authors, our study is the first study to investigate effects of avatar movements on social presence, trust and customer satisfaction in AR based consultancy and similar settings. We varied the ability of an avatar to move around the room and change its gaze direction, resulting in a comparison of what we called static and dynamic avatars.

From the questionnaire data we collected, there was no significant difference in social presence, trust and customer satisfaction for the different dynamics, regardless of examining the blocks individually or as aggregated scores. Interestingly, asking the participants to order the avatars from *best* to *worst* resulted in the dynamic versions outperforming the similarly sized, static versions: LiDyn was always placed in front of LiSta, and MiDyn was always placed in front of MiSta. This suggests that the customers preferred dynamic avatars over static ones. While

this is only an initial result, it suggests that the dynamics of avatars should be considered in further research.

7.3 Design Recommendations and Future Work

Our results seem to suggest that using life-sized avatars over miniature ones might be preferable in remote consultation settings, as the corresponding results were equal to or significantly better for life-sized avatars than for miniatures. This effect may have been caused by more awareness on the life-sized avatar and, as discussed in the literature analysis, a better fit of the life-sized avatar to the expectations of our customers. However, it should also be mentioned that in terms of trust and satisfaction, there were no significant differences in the ratings and the number of customers picking a couch fitting the provided restrictions of each round did not differ significantly (see 6.6). This suggests that miniature and life-sized avatars might work equally well for remote consultations despite the finding that the miniature avatar produced less social presence than the life-sized one. This suggests that in our study the size of the avatar was not decisive.

Restrictions and differences to work that found miniature avatars to provide positive effects uncovered in our study may lead to a different conclusion. While this was not mentioned explicitly as a design requirement in previous work, our results suggest that always keeping miniatures within the field of view of the participants might enhance social presence. In addition, as suggested in Piumsomboon' et al.'s [32] work, one could use a life-sized avatar as long as the customer is standing far away from it and then shift to a miniature one once they move closer. To deal with the visibility and interpretability of facial expressions, the avatar could always remain close to the field of view and would never be too small or large to make out details such as facial features. This would also solve the peculiar issue of the customers never moving closer to miniature avatars despite complaining about missing detail and facial expression visibility in the subsequent interviews. Additional experiments will need to show whether life-sized avatars should also be preferred if miniature avatars that stay in the field of view of the user are present. Such experiments – as planned for our work in the future – could use miniatures that automatically adjust their floating height to the gaze direction or height of the user.

Concerning avatar dynamics, even though we did not find significant differences in perceived trust and social presence in our questionnaires that affected static and dynamic avatars, the unanimous preference for the dynamic mode when compared to a static avatar of similar size is remarkable. It suggests that the dynamic avatar could be used as the default mode of a consultation application like the one presented in this work. Consultants could then still change to static modes if necessary (e.g., to avoid feelings of uncanniness when they quickly look into different directions). In any case, we also need to consider that moving an avatar around the room may add additional mental load on the consultant. Our study could not reveal this because the consultant was played by a researcher, and so future work needs to investigate this. If moving the avatar causes too much mental load, one could have the consultant avatar move to always be at least at the edge of the customer's field of view, automatically, similar to the way Piumsomboon et al. [32] moved the miniature avatar automatically into the field of view. As an option to better use the dynamic mode of an avatar, the consultant could use virtual reality (VR) goggles to view a 3D representation of the customer's surroundings. Turning their head in the 3D world would then result in the avatar turning its head in the AR view of the customer. In the sense of Stein at al. [39], this would increase the impression that the avatar is controlled by a human and not by a machine. This, in turn, could be perceived as less uncanny by the customer and result in a higher amount of trust towards the consultant. Furthermore, our future research will include a combination of avatar movements and gaze with pointing or visual referencing to tap from the potential of a dynamic avatar in a consultation (see [32] for a combination of miniature movement and pointing).

As for other directions future research could take, conducting a similar study with real furniture consultants but having the customer use an avatar as well might prove to be interesting. Using an avatar for the customer might influence the perception of the consultant of how much the customer trusts them, how willing the customer is to continue the consultation and how satisfied the customer is, among others. The goal of studies like these would be to design systems that improve the awareness of customer feelings for the consultant, which is an aspect that otherwise falls short due to the nature of remote consultations. Other options may include adding tools such as a pointing tool or furniture configuration tools for customers or consultants in order to see whether and how this influences their impression of the consultation.

7.4 Limitations

Our study was conducted with twelve participants, which is in the scope of most similar studies and sufficient for the purpose of initially investigating the effect of avatar size and behavior that we were interested in. However, this sample size also means that our results cannot be generalized. In addition, acquiring *real* customers that are actually looking to buy new furniture and conducting the experiment within their actual living space might have a large impact and enhance external validity, as having a real buying risk might change or amplify the role of trust ratings towards the consultant (avatar) [31].

Furthermore, our study was conducted along a script with a mock consultant played by a researcher who was familiar with furniture consulting. While this is a valid approach and also enhances the comparability of all cases, it leaves out the effect of different consultants on representing them with avatars. Further work will therefore also include real consultants.

In addition, future experiments that use different hardware and some of the fixes mentioned above (e.g., placing the miniature in the field of view automatically) might create different results. As an example, using hardware such as the recently released

HoloLens 2 might remedy some of the issues discussed, as it comes with an extended field of view.

8 Conclusion

In this work, we presented initial insights into the effects of avatars on social presence, perceived customer trust and customer satisfaction in online consultations. We staged furniture consultation settings with volunteers to determine whether the size of the consultant avatar and its dynamics influence these variables. In a 2x2 experiment, we compared life-sized avatars to miniature avatars, as well as dynamically moving avatars controlled by the consultant to static avatars that stayed in place and always looked at the customer.

Our results show higher ratings of co-presence for consultations that featured life-sized consultant avatars when compared to miniature ones, and higher ratings for the aggregated social presence score when comparing life-sized, dynamic avatars to any miniature one. In addition, many participants stated that they quickly lost track of the miniature or that they disliked not being able to see out any mimics on such avatars. These findings may have been influenced by different visual presences of the avatars in the field of view of the AR HMD. Whether this had any impact is subject to further research. It is remarkable that neither trust ratings nor customer satisfaction ratings revealed any significant differences for all combinations tested, which may indicate that in terms of these important variables the miniature avatar worked equally well despite its lack of co-presence. All participants, when asked to order the presented avatars from *best* to *worst* preferred dynamic avatars to static ones of similar size, which suggests that dynamic avatars should be preferred notwithstanding the size of the avatar.

Based on this, we provided design recommendations such as adapting avatar size when needed or having the static setting as a fallback mode, and provided an outlook for future research, which could examine alternative input modalities and experiments with real customers and consultants, among others. We believe our research provides valuable insights into online consultations supported by augmented reality and will continue research in this area in the future.

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