frontiers | Frontiers in Virtual Reality

TYPE Brief Research Report
PUBLISHED 05 September 2022
DOI 10.3389/frvir.2022.889247

OPEN ACCESS

EDITED BY
Richard So,
Hong Kong University of Science and Technology, Hong Kong SAR, China

REVIEWED BY
Katja Zibrek,
Inria Rennes—Bretagne Atlantique Research Centre, France
Victoria Interrante,
University of Minnesota Twin Cities, United States

*CORRESPONDENCE
Christopher R. Agnew,
agnew@purdue.edu

SPECIALTY SECTION
This article was submitted to Virtual Reality and Human Behaviour, a section of the journal Frontiers in Virtual Reality

RECEIVED 04 March 2022
ACCEPTED 12 August 2022
PUBLISHED 05 September 2022

CITATION
Agnew CR (2022), Feeling close to a Crab-Thing in virtual reality: Does avatar appearance always matter in forming meaningful connections? A case study. *Front. Virtual Real.* 3:889247. doi: 10.3389/frvir.2022.889247

Feeling close to a Crab-Thing in virtual reality: Does avatar appearance always matter in forming meaningful connections? A case study

Christopher R. Agnew*

Department of Psychological Sciences, Purdue University, West Lafayette, IN, United States

Recent experimental research revealed that people can form meaningful relationships interacting with strangers in virtual reality (VR), with resulting affiliative outcomes (e.g., feelings of closeness) at the same levels as those attained via interactions in other sensory-rich communication modalities. The present preregistered experiment examined whether avatar type and avatar matching in VR influence levels of closeness (and affiliated constructs) generated among previously unacquainted strangers using a validated structured discussion procedure. Based on previous theory and research, we hypothesized that affiliative outcomes would not differ 1) regardless of whether the interacting avatars appeared to be human or not, and 2) regardless of whether there was a (mis)match in avatar type between interactants. Two hundred and four previously unacquainted undergraduate students were randomly assigned to interact in VR as pairs in one of three stylized avatar conditions: both human in appearance, both non-human in appearance (Crab-Things, created for this study), or one human and one Crab-Thing. Results were consistent with hypotheses, suggesting that closeness and related outcomes can be generated and experienced in VR regardless of the stylized avatar types used in the current study. Exploratory analyses of individual difference variables (personality and attachment) as possible moderators of stylized avatar type effects yielded non-significant findings, supporting the generalizability of findings across key intra- and interpersonal dispositions.

KEYWORDS

virtual reality, avatar type, avatar matching, close relationships, closeness, affiliative outcomes

1 Introduction

As use of virtual reality (VR) applications by the public rapidly increases (Bidar & Patterson, 2022), more VR users find themselves interacting with previously unknown others in virtual settings. Social psychologists and communication scholars have researched aspects of zero acquaintance relationships for decades (e.g., Albright et al.,

1988; Ambady et al., 1995), including the extent to which interaction modality may serve to moderate shifts from nascent acquaintance to more in-depth personal relationships (see Sprecher, 2020, for a review). Recent experimental research has revealed that people can form meaningful relationships interacting with strangers as human appearing avatars in virtual reality (VR) by following a structured interaction procedure. The resulting levels of affiliative outcomes (e.g., feelings of closeness, enjoyment of the interaction) are indistinguishable statistically from those attained via interactions taking place in other sensory-rich communication modalities (e.g., via video chat; Agnew et al., 2022).

VR applications most often involve an avatar representation of the user and, particularly in massive multiplayer games (e.g., Minecraft VR) but also in an increasing number of business applications (e.g., Horizon Workrooms), users encounter strangers (and are perceived by strangers) in avatar form. Social psychological research has found that appearance can significantly influence interpersonal outcomes, including judgements of relationship partner suitability (Eagly et al., 1991) and perceptions of threat (McElvaney et al., 2021). Previous VR research has examined questions related to avatar appearance, initially as related to avatars featured within computer-based games (e.g., Bente et al., 2008) and more recently associated with avatars interacting within user-immersed VR settings (e.g., Wirth et al., 2021). For example, within VR, researchers have examined whether perceptions of avatar trustworthiness are influenced by the relative realism of the avatar (Aseeri & Interrante, 2021), whether differences in avatar facial characteristics influence perceptions of social presence (Dubosc et al., 2021), whether avatar appearance influences prosocial behavior enacted in a subsequent task (Guegan et al., 2020), whether similarity of avatar appearance to the user's actual appearance has effects on perceptions of body ownership (Jo et al., 2017), whether there are effects when there is a mismatch between an avatar's gender appearance and the user's actual gender (Rivu et al., 2021), and whether there are effects of using human appearing versus abstract (i.e., free-floating cube) avatars on synchrony of avatars' non-verbal behavior (Sun et al., 2019). Such research has markedly increased recognition that avatar-based effects, at times, can and do occur. However, it is not known whether the findings from recent experimental research on the generation of interpersonal closeness in VR featuring human appearing avatars (Agnew et al., 2022) extend to avatars of non-human form. The present case study sought to fill this gap, extending past work by examining how the induction of closeness in VR through a validated social interaction task compares when occurring between stylized avatars of human and non-human form as well as the combination of these types.

Social interactions, particularly those that involve mutual and reciprocal self-disclosure (Collins & Miller, 1994; Willems et al., 2020), have been shown to increase positive affiliative outcomes (such as closeness and liking) among previously unacquainted individuals (Sprecher et al., 2013). Aron and colleagues (1997) introduced a novel methodological procedure for generating closeness between previously unacquainted people meeting in person for the first time within a laboratory setting. The procedure, sometimes referred to as "fast friends," involves unacquainted participants discussing sets of questions designed to elicit increasingly deep self-disclosure. The current investigation made use of this validated methodology, examining potential limits of the procedure when one interacts with another in VR who is represented as a non-human avatar.

Based on previous theory and research, we posited that dyadic interactions in VR are likely to cue established face-to-face interaction norms associated with both giving and receiving self-disclosures with another person in real time, leading interactants, regardless of avatar appearance, to evidence similarly high levels of affiliative outcomes. Past research using the "fast friends" paradigm has demonstrated the generation of positive affiliative outcomes when conducted in both audio only and audio-video modalities (Sprecher, 2021). Assuming that vocalizations of interactants in VR are unaltered from "live" versions, VR users remain aware that they are interacting with another person irrespective of avatar appearance. Thus, we hypothesized that affiliative outcomes would not differ 1) regardless of whether the interacting stylized avatars appeared to be human or not (Hypothesis 1), and 2) regardless of whether there was a (mis)match in avatar type between interactants (Hypothesis 2). In an exploratory vein, we also examined the possible moderating role of individual differences in affiliative outcomes by avatar condition, focusing on personality (John & Srivastava, 1999) and attachment (Mikulincer & Shaver, 2016). Previous research found essentially no moderating effects of these intra- and interpersonal variables with respect to interaction modality in producing affiliative outcomes in VR with human appearing avatars (Agnew et al., 2022), but we advanced no specific hypotheses with respect to any differential effects of individual differences.

2 Method

2.1 Design

The experiment featured one between-subjects independent variable that focused on the types of avatar pairs interacting in a given VR session, with three conditions: 1) both human avatars, 2) one human in appearance and one non-human (Crab-Thing, created for this study; see Figure 1), and 3) both Crab-Thing avatars. Participants were randomly assigned to one of the three conditions and instructed to take part in a structured interaction with a previously unacquainted other. Random assignment to condition was based on numbers generated from Research Randomizer (Urbaniak & Plous, 2013).

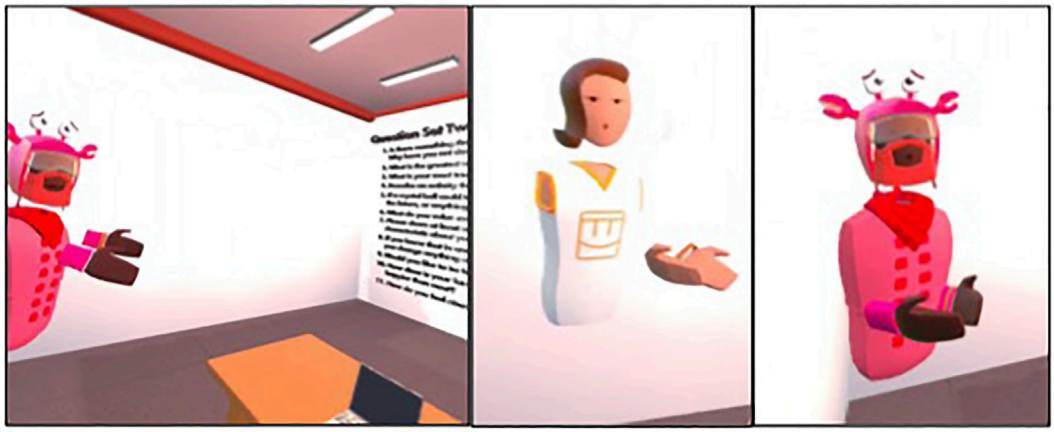

FIGURE 1
Virtual experimental room and participant Avatars.

TABLE 1 Means and Standard Deviations, Overall and by Avatar Condition.

	Overall ($N = 204$)	Avatar Condition		
		1	2	3
		Humanoid-Humanoid ($N = 72$)	Humanoid-Crab-Thing ($N = 70$)	Crab-Thing-Crab-Thing ($N = 60$)
Affiliative Outcomes	*M* (*SD*)	*M* (*SD*)	*M* (*SD*)	*M* (*SD*)
Closeness	4.11 (1.10)	4.18 (1.12)	4.12 (0.99)	4.03 (1.17)
Liking	5.75 (1.00)	5.67 (0.94)	5.98 (0.99)	5.62 (1.04)
Responsiveness	6.06 (0.87)	6.02 (0.87)	6.23 (0.78)	5.96 (0.92)
Enjoyment	5.63 (0.91)	5.58 (0.96)	5.70 (0.79)	5.61 (0.98)
Potential Moderators				
Attachment Anxiety	4.54 (1.28)			
Attachment Avoidance	5.34 (1.04)			
Open-Mindedness	3.75 (0.58)			
Conscientiousness	3.66 (0.59)			
Extraversion	3.41 (0.64)			
Agreeableness	3.88 (0.54)			
Negative Emotionality	2.85 (0.76)			
Control Variables				
Experience with VR	1.30 (0.74)			
Relationship Status	1.61 (0.88			

N, number of individuals; M, mean; SD, standard deviation.

2.2 Participants

Inclusion criteria posted for the study included those at least 18 years of age, fluent in conversational English, having no prior VR experience, and no prior acquaintance with their interaction partner as reported in the post-interaction survey. Exclusion criteria included sensitivity to flashing light or motion, a recent injury to the eyes, face, neck, or arms that may prevent the comfortable use of VR hardware, and/or a current diagnosis of epilepsy, dementia, or other neurological diseases that may prevent the safe use of VR technologies. Data that met inclusion criteria and our predetermined data cleaning approach were collected from 204 individuals (forming 102 dyads). A power analysis (conducted prior to data collection using G*Power; Faul et al., 2007) was computed based on effect sizes reported in related past research using the "fast friends" procedure to study modality effects (Sprecher, 2014; Table 1) and indicated power >0.85 for the final sample size.

Participants (112 females and 92 males; age $M = 18.74$, $SD = 1.03$) were undergraduate students at a large U.S. state research university. They were not paid for their participation but received credit toward fulfillment of requirements in a course in which they were enrolled. Participants were mostly White (155 White or 76.0%, 31 Asian, 10 Hispanic, 4 Black, and 4 Mixed Race), reflecting the racial/ethnic composition of the university student population. Each participant took part in one laboratory session in a campus building and sessions took about one hour. Study procedures were approved by the university's IRB.

2.3 Procedure

Participants used an online website (administered by SONA Systems, https://www.sona-systems.com/) to sign up for a laboratory session and were subsequently randomly assigned to interact with a partner in VR in avatar form as described above. Data were collected from two participants (interacting with one another in VR) during each session. In each session, one participant was instructed to arrive at a second-floor waiting room in a campus building and the other participant was instructed to arrive at a third-floor waiting room, to help ensure that the members of each dyad had zero prior acquaintance; this was subsequently confirmed via direct questioning in a post-interaction questionnaire. To prevent transmission of COVID-19, all research assistants and participants were required to wear a face mask throughout each session and maintain at least six feet of distance between one another during the session.

Two research assistants, one on each floor of the building, met and escorted a participant to experimental rooms on their respective floors, where the participants were seated at a desk featuring a laptop. They were presented with a consent form, given time to read and ask questions about it, and instructed to sign if they agreed to participate. Participants were then instructed on how to use Oculus Quest VR headsets to interact in a custom virtual room (designed to mirror in appearance the physical lab room in which participants were seated) created in the Rec Room app. Rec Room was used for this study because it enables the creation and customization of user-generated virtual spaces. Rec Room also allows for the custom creation of stylized avatars. Although the avatar options in Rec Room are human in form, it is possible to create a non-human appearing avatar by using add-on customization features. We chose to create a "Crab-Thing" as this was the most non-human appearing avatar we could produce given the customization options available. Images of the avatars used are shown in Figure 1. Participants were instructed to hold the Quest VR controllers in front of them while interacting, which allowed them to see their own avatar's "hands" in VR, providing an opportunity to compare their own avatar's appearance with their partner's appearance throughout the interaction. Participants could also look down while wearing their headset to see their own avatar body (human or Crab-Thing).

After training, participants engaged in three five-minute discussions, with sets of questions provided for each discussion block. The question sets were designed to elicit increasingly deep self-disclosure (following the "fast friends" procedure; Aron et al., 1997). For example, "How did you celebrate last Halloween?" was included in the first set, while "What is one of your deepest fears?" was included in the third set. For each set of questions, both participants were instructed to take turns answering as many questions as they could during the five-minute discussion, as turn-taking self-disclosure (versus sequential self-disclosure) has been found to yield higher affiliative outcomes (Sprecher & Treger, 2015). The question sets appeared visually on the wall in front of participants in the virtual room. Research assistants moved each question set onto the "wall" of the virtual room and were visible to participants during question set transitions. Although participants were left alone in their respective lab rooms during their interaction, the research assistants reentered the rooms after each five-minute discussion to instruct the participants that it was time to advance the next set of questions or to stop the task when time was up (after the third set). Participants did not meet or interact with their partner after completing the disclosure task.

Following the interaction, participants used the laptop in their lab room to complete an online survey that contained demographic, affiliation, and personality measures. Participants accessed the survey through a secure webpage hosted by Qualtrics.com, and all collected data were stored in a password-secured online database. At the end, all participants were fully debriefed and thanked for their participation. The laptop and headset in both lab rooms were thoroughly disinfected with alcohol wipes both before and after each session.

2.4 Measures

After the interaction, the following measures were collected from each participant (see Table 1 for descriptive statistics, overall and by avatar condition as appropriate):

2.4.1 Affiliative outcomes

Measures of affiliative outcomes largely paralleled those used by Sprecher (2014). *Closeness toward interaction partner* was assessed using two measures. Participants answered the question "How close do you feel toward your interaction partner?" using a Likert scale ranging from 1 (Not at all) to 7 (A great deal). Participants also completed a modified version of the Inclusion of Other in the Self Scale (IOS; Aron et al., 1992). The IOS asks respondents to select a picture from a series of seven increasingly overlapping circles that correspond to different degrees of perceived closeness with their interaction partner. These two measures were significantly correlated (r = 0.65; α= 0.79) and were combined to serve as an index of closeness.

Liking of interaction partner was assessed with two measures. Participants were asked "How much did you like your interaction partner?" and provided with a Likert scale ranging from 1 (Not at all) to 7 (A great deal). Participants also completed a question regarding their feelings about future interaction with their interaction partner, answering a 7-point item anchored by 1) I feel that I would never want to interact with this person again in the future and 7) I feel that I would very much want to interact with this person again in the future. These two measures were significantly correlated (r = 0.66; α= 0.80) and were combined to serve as an index of liking.

Perceived responsiveness of interaction partner was assessed with a 4-item measure based on work by Reis et al. (2011) and Sprecher and Treger (2015), using a 7-point Likert scale with responses labeled at 1 (Not at all true in this situation), 4 (Somewhat true in this situation), and 7 (Very true in this situation). The four items (e.g., "My interaction partner seemed to really listen to me") were averaged and the average score was used in analyses (α = 0.85).

*E*njoyment of interaction was assessed with a 4-item measure, using a 7-point Likert scale ranging from 1 (Not at all) to 7 (A great deal). The four items (e.g., "How much did you enjoy the interaction?") were averaged and the average score was used in analyses (α = 0.85).

2.4.2 Individual differences

To assess the possibility that personality moderates the results, we administered the Big Five Inventory-2 (BFI-2; Soto & John, 2017). The BFI-2 assesses all "Big Five" personality traits (60 items total, with 12 items assessing open-mindedness: e.g., "Is curious about many different things"; conscientiousness: e.g., "Keeps things neat and tidy"; extraversion: e.g., "Is outgoing, sociable"; agreeableness: e.g., "Is respectful, treats others with respect"; and negative emotionality: e.g., "Is temperamental, gets emotional easily"). Responses were provided using a Likert scale ranging from 1 (Disagree strongly) to 5 (Agree strongly; α= 0.79, 0.82, 0.83, 0.78, 0.87, respectively).

To assess the possibility that interpersonal attachment orientations moderate the results, we administered the Experiences in Close Relationships-12 Scale (ECR-12; Lafontaine et al., 2016). The ECR-12 consists of 12 items, six of which tap attachment anxiety and six of which tap attachment avoidance. Participants responded to the items regarding "how you generally feel in close relationships (e.g., with romantic partners, close friends, or family members)", using a 7-point rating scale ranging from 1 (Strongly disagree) to 7 (Strongly agree). We averaged across anxiety and avoidance items separately to obtain composite measures for each of these attachment variables (sample item for attachment anxiety: "I worry about being abandoned", α= 0.84; sample item for attachment avoidance: "I don't feel comfortable opening up to close relationship partners", α= 0.83).

2.4.3 Control variables

No prior experience with VR was an inclusion criterion for the study. Nevertheless, to control for the possibility that participants may have had past VR experience, they were asked about any past user experience with VR in the post-interaction survey (response options: 1 = *Never before today*, 2 = *Once in my lifetime*, 3 = *Once a year*, 4 = *A few times a year*, 5 = *Once a month*, 6 = *A few times a month*, 7 = *A few times a week*, and 8 = *Every day*). To control for the possibility that differences in current relationship status (e.g., single versus partnered) would influence interaction dynamics, participants were asked to "Please indicate your current relationship status" [response options (n = frequency observed): 1 = *Single* (n = 134), 2 = *Casually dating* (n = 16), and 3 = *Exclusively dating* (n = 54)]. Responses to both control variables were used as controls in analyses.

2.4.4 Manipulation check

To confirm participants' awareness of the avatar type of their partner, they were asked "What did your interaction partner look like in VR?" (response options: a female human, a male human, a crab-like thing, a unicorn). All participants answered in accordance with the experimental condition to which they were randomly assigned.

3 Results

3.1 Analytic approach

Because individuals were nested within dyadic interactions, multilevel modeling (MLM) was used to account for this non-independence (Scariano & Davenport, 1987). Note that we

TABLE 2 MLM Results for Affiliative Outcomes by Avatar Match.

	Estimate	SE	95% CI		*p*
			LL	UL	
H2[a]: Contrasting Conditions 1 & 3 vs. 2[b]					
Closeness	0.02	0.37	−0.71	0.75	0.95
Liking	0.67	0.36	−0.04	1.38	0.06
Responsiveness	0.49	0.30	−0.11	1.09	0.11
Enjoyment	0.20	0.32	−0.44	0.84	0.54

[a]H2 = Hypothesis 2: Affiliative outcomes will not differ regardless of whether there was a (mis)match in avatar type between interactants.
[b]Condition 1 = Humanoid-Humanoid interaction, Condition 2 = Humanoid-Crab-Thing interaction, Condition 3 = Crab-Thing-Crab-Thing interaction; Hypothesis CI, confidence interval; LL, lower limit; UL, Upper Limit. analyses controlling for VR experience and relationship status.

conducted preliminary analyses to assess for the possibility of experimenter ($n = 6$) and/or room location effects ($n = 2$). None were detected, so these variables were not included in subsequent analyses. Given the number of tests to be conducted and attendant concerns about the generation of spurious associations, alpha level for significance was set at 0.01. Correlations between all study variables can be found here: https://osf.io/f9z8x/

3.2 Differences in affiliative outcomes

To test Hypothesis 1, we began by conducting separate overall mixed model tests (using the REML method and Satterthwaite approximation of degree of freedom, including random intercepts and slopes for fixed effects, via SPSS MIXED version 28) for each of the four outcome variables. Type III tests of fixed effects yielded non-significant main effects for avatar condition (a Level 2 variable) controlling for experience with VR and relationship status at the individual level (Level 1 variables), for all outcomes. Consistent with the pattern of means displayed in Table 1, none of the four outcomes significantly differed by avatar condition: closeness [F (2, 98.93) = 0.20, p = 0.82], liking [F (2, 98.15) = 1.77, p = 0.18], responsiveness [F (2, 97.55) = 1.36, p = 0.36], and enjoyment [F (2,98.39) = 0.22, p = 0.81]. Subsequent analyses excluding the control variables did not alter this pattern.

We further hypothesized that affiliative outcomes would not differ regardless of whether there was a (mis)match in avatar type between interactants. Analyses of this planned contrast revealed that, consistent with Hypothesis 2 and as shown in Table 2, participants in conditions featuring matching avatars versus the condition featuring non-matching avatars did not differ significantly in their reported levels of the affiliative outcomes.

3.3 Testing additional contrasts

Although not planned, two additional contrasts were calculated via MLM to test for possible differences in outcomes based on different combinations of experimental condition: 1) conditions featuring a human interactant versus the condition without (Conditions 1 and 2 versus 3), and 2) conditions featuring a Crab-Thing interactant versus the condition without (Conditions 2 and 3 versus 1). As suggested by the means presented in Table 1, neither of these additional contrasts for any of the four outcomes were statistically significant (with p's ranging from 0.28 to 0.93).

3.4 Examining possible moderating effects of individual differences

We tested for the possibility that, despite no significant main effects for avatar condition, there might be effects when condition was considered in light of participant individual differences in personality traits (the Big Five) and/or attachment orientations (avoidance and anxiety). As summarized in the Type III MLM fixed effects tests presented in Table 3, no evidence for moderation was found meeting our alpha standard in any of the 28 moderation tests conducted. We observed marginal evidence for moderation in one instance (for extraversion with respect to enjoyment of the interaction, $p <$ 0.02), but the overall pattern of results supports the conclusion that individual differences do not play an important role.

4 Discussion

As researchers work to isolate and understand critical dimensions underlying VR user experience (e.g., realism and immersion, Cowan & Ketron, 2019), interest in and testing of the possibility of avatar effects on user outcomes has increased. The present preregistered experiment examined whether avatar type and avatar matching in VR influence levels of closeness (and affiliated constructs) generated among previously unacquainted strangers using a validated structured discussion procedure. Consistent with hypotheses, whether dyadic interactions occurred between two stylized human avatars, two non-human avatars, or a combination of the two types, each avatar type and pairing of types resulted in similar levels of affiliative outcomes. In addition, mean levels of closeness (above the mid-point of the measure) found in all conditions were comparable with levels reported in other research using identical or similar paradigms (Agnew et al., 2022, e.g., VR closeness mean = 3.96), and as found in other sensory-rich interaction modalities (such as via video chat; e.g., Agnew et al., 2022, video closeness M = 4.04; Sprecher, 2021, video closeness M = 4.30). Communications between avatars in VR can

TABLE 3 Moderator Analyses of Avatar Condition Effects: Personality and Attachment

Outcome	Moderator	*df* (n, d)	*F*	*p*
Closeness	Open-Mindedness	1, 184.00	0.29	0.60
	Conscientiousness	1, 182.62	0.88	0.35
	Extraversion	1, 183.91	0.61	0.44
	Agreeableness	1, 183.61	5.01	0.03
	Negative Emotionality	1, 184.00	0.70	0.40
	Open-Mindedness x Condition	2, 182.34	0.88	0.42
	Conscientiousness x Condition	2, 181.79	1.49	0.23
	Extraversion x Condition	2, 183.56	1.42	0.25
	Agreeableness x Condition	2, 182.05	0.10	0.90
	Negative Emotionality x Condition	2, 183.83	1.66	0.19
Liking	Open-Mindedness	1, 172.11	0.00	0.98
	Conscientiousness	1, 164.05	0.41	0.52
	Extraversion	1, 175.30	2.59	0.11
	Agreeableness	1, 175.80	3.57	0.06
	Negative Emotionality	1, 170.25	4.78	0.03
	Open-Mindedness x Condition	2, 172.60	1.66	0.19
	Conscientiousness x Condition	2, 162.61	0.89	0.41
	Extraversion x Condition	2, 173.42	2.28	0.11
	Agreeableness x Condition	2, 172.56	0.71	0.50
	Negative Emotionality x Condition	2, 169.48	2.68	0.07
Responsiveness	Open-Mindedness	1, 176.76	2.64	0.11
	Conscientiousness	1, 169.83	1.11	0.29
	Extraversion	1, 179.08	1.03	0.31
	Agreeableness	1, 176.67	6.87	0.01
	Negative Emotionality	1, 175.58	0.24	0.62
	Open-Mindedness x Condition	2, 176.52	0.32	0.73
	Conscientiousness x Condition	2, 168.53	0.07	0.93
	Extraversion x Condition	2, 177.74	0.59	0.55
	Agreeableness x Condition	2, 176.66	0.06	0.94
	Negative Emotionality x Condition	2, 174.85	0.14	0.87
Enjoyment	Open-Mindedness	1, 174.52	0.92	0.34
	Conscientiousness	1, 167.14	0.25	0.62
	Extraversion	1, 177.25	2.45	0.12
	Agreeableness	1, 177.79	5.45	0.02
	Negative Emotionality	1, 173.00	2.68	0.10
	Open-Mindedness x Condition	2, 174.69	0.08	0.93
	Conscientiousness x Condition	2, 165.79	1.61	0.20
	Extraversion x Condition	2, 175.66	4.26	0.02
	Agreeableness x Condition	2, 174.74	0.30	0.74
	Negative Emotionality x Condition	2, 172.28	0.59	0.56
	Attachment	*df* (n, d)	*F*	*p*
Closeness	Anxiety	1, 182.84	3.85	0.05
	Avoidance	1, 185.85	16.27	<0.001
	Anxiety x Condition	2, 183.14	1.51	0.23
	Avoidance x Condition	2, 188.38	0.31	0.74
Liking	Anxiety	1, 158.65	1.59	0.21
	Avoidance	1, 165.56	1.49	0.22
	Anxiety x Condition	2, 159.62	0.18	0.83

(Continued on following page)

TABLE 3 (*Continued*) Moderator Analyses of Avatar Condition Effects: Personality and Attachment

Outcome	Moderator	*df* (n, d)	*F*	*p*
	Avoidance x Condition	2, 169.86	0.36	0.70
Responsiveness	Anxiety	1, 166.29	0.44	0.51
	Avoidance	1, 172.38	1.88	0.17
	Anxiety x Condition	2, 167.08	0.15	0.86
	Avoidance x Condition	2, 176.51	0.01	0.99
Enjoyment	Anxiety	1, 165.86	3.22	0.08
	Avoidance	1, 171.08	1.72	0.19
	Anxiety x Condition	2, 165.68	1.77	0.17
	Avoidance x Condition	2, 175.20	0.29	0.75

Type III, tests of fixed effects, controlling for VR experience and relationship status; *df* (n, d) = degrees of freedom (numerator, denominator).

result in the movement of zero acquaintance relationships toward closer relationships relatively quickly and irrespective of at least the two different stylized avatar appearance conditions investigated here.

A strength of the present study is the application of Aron et al.'s (1997) "fast friends" procedure, which enabled us to use a well-established experimental paradigm to examine the generation of interpersonal closeness in VR and to directly test avatar type effects on closeness and allied affiliative outcomes. An additional strength is the inclusion of important individual difference variables (personality dimensions and the attachment orientations of anxiety and avoidance), as past research has rarely examined key personality variables that may influence the generation of closeness among strangers. An exception is recent work focusing on interaction modality effects, which tested for differences in affiliative outcomes between various modalities (texting, audio chat, video chat, and VR), that also found essentially no moderating effects for these individual differences (Agnew et al., 2022). When considered in combination with the results from this related recent work, the current findings imply the robustness of the obtained findings across individual differences.

The current study has clear limitations, including in its ability to more broadly generalize to all avatar types used in all VR settings. This investigation included only two appearance conditions and, despite avatar head and hand differences, both stylzed avatars included humanoid aspects (body trunks, arms, legs) and were, thus, not representative of the multiplicity of appearance types that an avatar form could take. The current findings are a function of the avatar manipulation used; thus, other avatars may not produce the lack of significant differences we found. An important future direction for researchers of interpersonal relationships interested in examining avatar effects would be to investigate other non-human avatars used in interaction as well as other venues of interaction within VR.

A further limitation is rooted in the lack of ultra-realism with respect to avatars afforded by the instantiation of VR provided by Rec Room. Avatars in both conditions were relatively low in resolution and were more cartoonish than realistic in appearance. Research by Torre and colleagues (Torre et al., 2019), involving participants' perceptions of a virtual agent displaying different emotional expressions presented on a computer screen (rather than participants interacting in VR with another participant) found that people reported trusting cartoon-like VR agents more than photorealistic VR agents. This suggests that the use of more cartoonish avatars may influence interpersonal assessments in a more positive direction generally and may have had a role in producing the effects reported here (but see also Volante et al., 2016, which concluded that interactions with more cartoonish humans in VR may suppress the formation of emotional bonds). New methods to improve realism of avatar faces (including the integration of actual facial photos of users; Fysh et al., 2021) are under development and will necessitate confirming the current findings using effectively different human appearing avatars than those available to VR users today. Hyper-realistic human appearing avatars may well generate greater levels of affiliative outcomes than observed here.

It is also possible that more immersive VR applications would provide a different interactive experience and generate different outcomes than those obtained in the current research. In addition, inclusion of a mirror in the virtual environment, along with directions for participants to view their mirrored reflection, would have provided confirmation of awareness of their own appearance. Also, future studies may want to allow for open-ended responses when querying participants about the appearance of their partner rather than providing close-ended response options. Moreover, the laboratory-based nature of the current investigation, including assignment to condition rather than making one's own decision concerning avatar appearance, may also have produced findings that would differ in less constrained conditions. Finally, it is important to note that the current study focused on those with no previous experience using VR. This inclusion criterion was put in place to focus on novice users and their social interaction outcomes given the growing number of new VR users in the

population. Accordingly, it is not known whether the current findings would be obtained among those who have considerable experience using VR. It is hoped that future research will address these limitations.

Data availability statement

The datasets presented in this study can be found in online repositories. The names of the repository/repositories and accession number(s) can be found below: https://osf.io/f9z8x/ (Open Science Framework).

Ethics statement

This study involving human participants was reviewed and approved by the Purdue University Institutional Review Board. The participants provided their written informed consent to participate in this study.

Author contributions

CA conceived and designed the study, organized the database, performed the statistical analysis, wrote all drafts of the manuscript, handled all manuscript revisions, read, and approved the submitted version.

Funding

This research was supported by a grant from Facebook (now Meta), for which the author is grateful. Facebook (Meta) had no role in this research other than providing financial support.

Conflict of interest

The author declares that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Publisher's note

All claims expressed in this article are solely those of the authors and do not necessarily represent those of their affiliated organizations, or those of the publisher, the editors and the reviewers. Any product that may be evaluated in this article, or claim that may be made by its manufacturer, is not guaranteed or endorsed by the publisher.

References

Agnew, C. R., Carter, J. J., and Imami, L. (2022). Forming meaningful connections between strangers in virtual reality: Comparing affiliative outcomes by interaction modality. *Technology, Mind, and Behavior* 3 (3). doi:10.1037/tmb0000091

Albright, L., Kenny, D. A., and Malloy, T. E. (1988). Consensus in personality judgments at zero acquaintance. *J. Pers. Soc. Psychol.* (3), 387–395. Journal of Personality and Social Psychology, 55. doi:10.1037/0022-3514.55.3.387

Ambady, N., Hallahan, M., and Rosenthal, R. (1995). On judging and being judged accurately in zero-acquaintance situations. *J. Pers. Soc. Psychol.* (3), 518–529. Journal of Personality and Social Psychology, 69. doi:10.1037/0022-3514.69.3.518

Aron, A., Aron, E. N., and Smollan, D. (1992). Inclusion of other in the self scale and the structure of interpersonal closeness. *J. Pers. Soc. Psychol.* (4), 596–612. Journal of Personality and Social Psychology, 63. doi:10.1037/0022-3514.63.4.596

Aron, A., Melinat, E., Aron, E. N., Vallone, R. D., and Bator, R. J. (1997). The experimental generation of interpersonal closeness: A procedure and some preliminary findings. *Pers. Soc. Psychol. Bull.* 23 (4), 363–377. doi:10.1177/0146167297234003

Aseeri, S., and Interrante, V. (2021). The influence of avatar representation on interpersonal Communication in Virtual Social Environments. *IEEE Trans. Vis. Comput. Graph.* 27 (5), 2608–2617. doi:10.1109/TVCG.2021.3067783

Bente, G., Rüggenberg, S., Krämer, N. C., and Eschenburg, F. (2008). Avatar-mediated networking: Increasing social presence and interpersonal trust in net-based collaborations. *Hum. Commun. Res.* 34 (2), 287–318. doi:10.1111/j.1468-2958.2008.00322.x

Bidar, M., and Patterson, D. (2022). *January 7).* Why 2022 is the year virtual and augmented reality will come to life. New York, NY: CBS News. Available at: https://www.cbsnews.com/news/2022-ces-virtual-reality-augmented/.

Collins, N. L., and Miller, L. C. (1994). Self-disclosure and liking: A meta-analytic review. *Psychol. Bull.* 116, 457–475. doi:10.1037/0033-2909.116.3.457

Cowan, K., and Ketron, S. (2019). Prioritizing marketing research in virtual reality: Development of an immersion/fantasy typology. *Eur. J. Mark.* 53 (8), 1585–1611. doi:10.1108/EJM-10-2017-0733

Dubosc, C., Gorisse, G., Christmann, O., Fleury, S., Poinsot, K., and Richir, S. (2021). Impact of avatar anthropomorphism and task type on social presence in immersive collaborative virtual environments. Paper presented at the 2021 IEEE Conference on Virtual Reality and 3D User Interfaces Abstracts and Workshops (VRW), 27 March 2021 - 01 April 2021, Portugal. doi:10.1109/VRW52623.2021.00101

Eagly, A. H., Ashmore, R. D., Makhijani, M. G., and Longo, L. C. (1991). What is beautiful is good, but . . .: A meta-analytic review of research on the physical attractiveness stereotype.: A meta-analytic review of research on the physical attractiveness stereotype. *Psychol. Bull.* 110 (1), 109–128. Psychological Bulletin. doi:10.1037/0033-2909.110.1.109

Faul, F., Erdfelder, E., Lang, A.-G., and Buchner, A. (2007). G*Power 3: A flexible statistical power analysis program for the social, behavioral, and biomedical sciences. *Behav. Res. Methods* 39 (2), 175–191. doi:10.3758/BF03193146

Fysh, M. C., Trifonova, I. V., Allen, J., McCall, C., Burton, A. M., and Bindemann, M. (2021). Avatars with faces of real people: A construction method for scientific experiments in virtual reality. *Behav. Res. Methods* 54, 1461–1475. doi:10.3758/s13428-021-01676-5

Guegan, J., Nelson, J., Lamy, L., and Buisine, S. (2020). Actions speak louder than looks: The effects of avatar appearance and in-game actions on subsequent prosocial behavior. *Cyberpsychology.* 14 (4). Article 1. doi:10.5817/CP2020-4-1

Jo, D., Kim, K., Welch, G., Jeon, F., Kim, W., Kim, Y., and Kim, G. J. (2017). *The impact of avatar-owner visual similarity on body ownership in immersive virtual reality*. In S. N. Spencer (Ed.), *Proceedings of the 23rd ACM symposium on virtual reality software and Technology*, New York, NY: VRST; Vol. Part F131944. Association for Computing Machinery. doi:10.1145/3139131.3141214

John, O. P., and Srivastava, S. (1999). "The Big-Five trait taxonomy: History, measurement, and theoretical perspectives," in *Handbook of personality: Theory and research*. Editors L. A. Pervin and O. P. John (New York, NY: Guilford Press), 2, 102–138.

Lafontaine, M.-F., Brassard, A., Lussier, Y., Valois, P., Shaver, P. R., and Johnson, S. M. (2016). Selecting the best items for a short-form of the Experiences in Close

Relationships questionnaire. *Eur. J. Psychol. Assess.* 32 (2), 140–154. doi:10.1027/1015-5759/a000243

McElvaney, T. J., Osman, M., and Mareschal, I. (2021). Perceiving threat in others: The role of body morphology. *PLoS ONE* 16 (4), e0249782. doi:10.1371/journal.pone.0249782

Mikulincer, M., and Shaver, P. R. (2016). *Attachment in adulthood: Structure, dynamics, and change*. 2nd edition. New York: Guilford Press.

Reis, H. T., Maniaci, M. R., Caprariello, P. A., Eastwick, P. W., and Finkel, E. J. (2011). Familiarity does indeed promote attraction in live interaction. *J. Pers. Soc. Psychol.* 101 (3), 557–570. Journal of Personality and Social Psychology. doi:10.1037/a0022885

Rivu, R., Zhou, Y., Welsch, R., Mäkelä, V., and Alt, F. (2021). "When friends become strangers: Understanding the influence of avatar gender on interpersonal distance in virtual reality," in *IFIP conference on human-computer interaction* (Cham: Springer), 234–250.

Scariano, S. M., and Davenport, J. M. (1987). The effects of violations of independence assumptions in the one-way ANOVA. *Am. Statistician* 41, 123–129. doi:10.1080/00031305.1987.10475459

Soto, C. J., and John, O. P. (2017). The next Big Five Inventory (BFI-2): Developing and assessing a hierarchical model with 15 facets to enhance bandwidth, fidelity, and predictive power. *J. Personality Soc. Psychol.* 113 (1), 117–143. doi:10.1037/pspp0000096

Sprecher, S. (2021). Closeness and other affiliative outcomes generated from the fast friends procedure: A comparison with a small-talk task and unstructured self-disclosure and the moderating role of mode of communication. *J. Soc. Personal Relat.* 38 (5), 1452–1471. doi:10.1177/0265407521996055

Sprecher, S. (2020). "Creating closeness and interdependence: Results of laboratory-based studies involving getting-acquainted dyads," in *Interdependence, interaction, and relationships*. Editors L. V. Machia, C. R. Agnew, and X. B. Arriaga (Cambridge University Press), 343–367. doi:10.1017/9781108645836.017

Sprecher, S. (2014). Initial interactions online-text, online-audio, online-video, or face-to-face: Effects of modality on liking, closeness, and other interpersonal outcomes. *Comput. Hum. Behav.* 31, 190–197. doi:10.1016/j.chb.2013.10.029

Sprecher, S., and Treger, S. (2015). The benefits of turn-taking reciprocal self-disclosure in get-acquainted interactions. *Pers. Relatsh.* 22, 460–475. doi:10.1111/pere.12090

Sprecher, S., Treger, S., and Wondra, J. D. (2013). Effects of self-disclosure role on liking, closeness, and other impressions in get-acquainted interactions. *J. Soc. Personal Relat.* 30 (4), 497–514. doi:10.1177/0265407512459033

Sun, Y., Shaikh, O., and Won, A. S. (2019). Nonverbal synchrony in virtual reality. *PLoS ONE* 14 (9), e0221803. doi:10.1371/journal.pone.0221803

Torre, I., Carrigan, E., McDonnell, R., Domijan, K., McCabe, K., and Harte, N. (2019). "The effect of multimodal emotional expression and agent appearance on trust in human-agent interaction," in *Motion, interaction and games* (Newcastle upon Tyne, UKNew York, NY, USA: MIG '19ACM), 16–6. October 28–30, 2019. doi:10.1145/3359566.3360065

Urbaniak, G. C., and Plous, S. (2013). Research randomizer. Available at: https://www.randomizer.org/.

Volante, M., Babu, S. V., Chaturvedi, H., Newsome, N., Ebrahimi, E., Roy, T., et al. (2016). Effects of virtual human appearance fidelity on emotion contagion in affective inter-personal simulations. *IEEE Trans. Vis. Comput. Graph.* 22 (4), 1326–1335. doi:10.1109/TVCG.2016.2518158

Willems, Y. E., Finkenauer, C., and Kerkhof, P. (2020). The role of disclosure in relationships. *Curr. Opin. Psychol.* 31, 33–37. doi:10.1016/j.copsyc.2019.07.032

Wirth, M., Gradl, S., Prosinger, G., Kluge, F., Roth, D., and Eskofier, B. (2021). The impact of avatar appearance, perspective and context on gait variability and user experience in virtual reality. *IEEE Virtual Real. 3D User Interfaces (VR)* 2021, 326–335. doi:10.1109/VR50410.2021.00055