




# Gender Effects on Physical Contact in Social VR

Kanami Tsuda, Junko Ichino<sup>(✉)</sup> , and Kouki Shimizu

Tokyo City University, Yokohama, Japan  
{g1872063, ichino, g1872048}@tcu.ac.jp

**Abstract.** Despite increasing research on user perception, action, and behavior via avatars in virtual spaces, few studies exist on user behavior on social virtual reality (VR) platforms. We focus on physical contact, the most fundamental mode of human communication, and investigate the effects of gender factors on physical contact among social VR users in a virtual space. Using VRChat, a social VR platform, as a field, we collected data for 168 general users by observing their responses when a confederate approached them. We analyzed three factors: the apparent gender of the avatar of the interaction partner (2 levels: male and female), the actual gender of the interaction partner (2 levels: male and female), and whether their natural voice is used (2 levels: with and without voice). The results showed that when the actual gender of a user's interaction partner was female, the user had more frequent and intimate physical contact, such as hugging and patting the head. In contrast, the apparent gender of the avatar of the user's partner did not affect the frequency of physical contact. Furthermore, users had more frequent physical contact when not speaking than when speaking with their natural voice. These results suggest that the actual gender of a partner affects user behavior more than the apparent gender of the partner's avatar.

**Keywords:** Social VR · Avatar Appearance · Physical Contact · Gender · Field Study · VRChat

## 1 Introduction

Physical contact is a basic need and an essential form of human communication [1]. In clinical settings, for example, nurses make contact patients to form relationships with them and ease their pain.

What kind of physical contact occurs in the increasingly popular social-networking service metaverse (social VR) platforms? It is unclear how physical contact between avatars will be affected by their embodiment in the 3D virtual world, even if this is supposed to boost the reality of communication. Avatar appearance affects the perception, actions, and behaviors of users regarding communication, such as their liking [2], acceptable personal space [3], and gender bias toward avatars [4]. However, various avatar factors and their effects on physical contact have not been sufficiently studied. Furthermore, there have been few field studies on this question.

Therefore, we investigate how factors related to avatars affect physical contact through a field study of social VR platforms.

## 2 Preliminary Observation and Research Questions

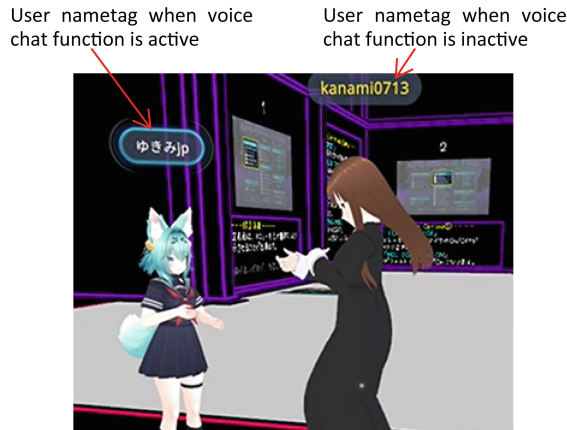
We conducted preliminary observations prior to conducting the field study. We used VRChat [5] (Fig. 1) for a total of 15 h to observe user behaviors. Because avatars of various appearances were present in VRChat, we focused our observations on the relationship between the avatar's appearance and physical contact. We observed that the degree and details of physical contact varied depending on the apparent gender of the avatar and the actual gender of the user.

We also observed that users often did not use the voice chat function (which enables conversations in the natural voice of the user and can be freely set; see Fig. 2) in VRChat, and the physical contact between users differed depending on whether they used this function. If users do not use the voice chat function, i.e., do not speak with their natural voices, their actual gender is hidden from other users. However, if they use the voice chat function, their gender is revealed to other users. Consequently, we anticipated a correlation between the actual gender of users and the use of this voice chat function.

Based on the aforementioned observations and considerations, we set the following research questions: **RQ1:** *Does the apparent gender of the avatar of the interaction partner affect physical contact in virtual spaces?* **RQ2:** *Does the actual gender of the interaction partner affect physical contact in virtual spaces?* **RQ3:** *Does speaking in one's natural voice affect physical contact in virtual spaces?*



**Fig. 1.** Tutorial World of VRChat, the social VR platform selected as the field for the study.



**Fig. 2.** User nametag showing the status of the voice chat function in VRChat. When a user activates the function, their nametag is surrounded by a blue line.

### 3 Related Work

#### 3.1 User Perception, Action, and Behavior Regarding Appearance of Self-avatar

The literature on the extent to which self-avatar appearance affects users' perception, action, and behavior is extensive. The avatar's appearance is crucial, particularly in social situations [6]. Recent studies have shown that self-avatar appearance (for example, face [3, 7, 8], hands [9–12], and full body [12–14]) affects user perception, action, and behavior. For example, even with avatars having diverse appearances, users can feel embodied within that avatar to the extent that they identify with it and have some degree of ownership [15, 16].

Several studies have found that user perceptions, actions, and behavior regarding their self-avatar appearance also vary depending on the apparent gender of the self-avatar [2, 4, 17–19] and the actual gender of the user [2, 19]. For example, Schwind et al. [2] compared users' perceptions of self-avatars with six types of hands, including male, female, and androgynous, using hand-operated tasks such as typing and drawing. The results showed that female users had lower acceptance and perception of presence when their self-avatar had a male hand, whereas male users had a higher acceptance and perception of presence regardless of whether their self-avatar's hand was male or female. Beltran et al. [4] compared male and female self-avatars for the task of working in a virtual office from the first-person perspective. They found that users' implicit gender bias decreased when their self-avatar was female.

#### 3.2 User Perception, Action, and Behavior Regarding Appearances of Other Avatars

Several reports exist on the effects of the appearance of other avatars on user perception, action, and behavior, although they are fewer than those on the appearance of self-avatars, which were described in the previous section. For instance, Bönsch et al. [3]

showed that the facial expression of approaching avatars can influence the level of personal space a user can tolerate. Smith et al. [20] and Abdullah et al. [21] found that communication between avatars in virtual environments involves rich nonverbal behaviors such as eye contact and gestures, which are similar to human communication in face-to-face situations.

A few studies exist on users' perceptions, actions, and behaviors regarding the apparent gender of other avatars. Lopez et al. [18] showed that gender bias is higher when the apparent gender of the other avatar is female than when it is male.

Thus, as shown in Sects. 3.1 and 3.2, studies on the relationship between avatar appearance in virtual space and user perception, action, and behavior have progressed in recent years. However, the question of how the apparent gender of the avatar and the actual gender of the user manipulating the avatar affect physical contact in virtual space has not yet been fully investigated. Furthermore, less research has been conducted in the field than in laboratories.

## 4 Field Study

Using an existing commercial social VR platform, we observed the behavior of public users when confederates approached and spoke to them. To obtain ecologically valid data, we did not divulge to the users that we were conducting a study. The study was conducted for a total of 50 h over two months, from October to December 2021.

### 4.1 Study Design

To answer the research questions described in Sect. 2, three factors were varied: the apparent gender of the avatar of the interaction partner (i.e., the apparent gender of the avatar of the confederate, two levels: male and female), actual gender of the interaction partner (i.e., actual gender of the confederate, two levels: male and female), and whether the users speak with their natural voices (two levels: with and without natural voice).

### 4.2 Study Environment

Existing commercial social VR platforms include VRChat, Facebook Spaces, Rec Room, and High Fidelity. From these, we selected VRChat as our field of study because it is the most common platform. Among the many worlds in VRChat, we conducted the study using the Tutorial World (Fig. 1), which is the first place that Japanese novices visit to learn how to use VRChat. Tutorial World has various types of users, not only novices but also experts who are willing to assist novices. VRChat users can identify if an avatar is using the voice chat function (i.e., whether the avatar speaks with their natural voice) described in Sect. 2 by the difference in the design of the user nametag displayed above the avatar's head (Fig. 2).

### 4.3 Participants

The study was conducted to ensure that the number of VRChat users for each level of each factor was approximately equal. Data were collected for a total of 168 users (Table 1).

Two confederates,  $C_1$  and  $C_2$ , were paired to conduct the study. The same confederates were assigned to a person throughout the study. One confederate ( $C_1$ ) was an interaction partner, while the other confederate ( $C_2$ ) was a passerby and observed the interaction between confederate  $C_1$  and the user. The actual gender of the two confederates was one male and one female, and  $C_1$  and  $C_2$  were switched according to the level of each factor (Sect. 4.1).

**Table 1.** Number of users for each level of each factor.

Apparent gender of partner's avatar	Actual gender of partner	With or without natural voice	Number of users
Male	Male	With	19
Male	Male	Without	23
Male	Female	With	22
Male	Female	Without	20
Female	Male	With	22
Female	Male	Without	23
Female	Female	With	21
Female	Female	Without	18
Total			168

### 4.4 Procedure

A session was defined as the period from the time confederate  $C_1$  approached a user up to 60 s had elapsed. The flowchart of a session is shown in Fig. 3. To ensure that the user recognized the actual gender of confederate  $C_1$  (i.e., the user's interaction partner), the confederate  $C_1$  greeted the user using their natural voice.

Confederate  $C_2$  observed the interaction between the user and confederate  $C_1$  from a short distance, noting details while avoiding being noticed by the user. The notes included the frequency of the user's contact with confederate  $C_1$  and the body parts (head, hands, arms/shoulders, torso, legs, and upper body (hug)) with which the user made contact with the confederate  $C_1$  during the session.

### 4.5 Design of Appearance of the Avatar of the Interaction Partner

Since the apparent gender of the avatar of the interaction partner (confederate) is a factor in this study (Sect. 4.1), we designed the appearance of the confederates' avatar to meet the following criteria: the gender of the avatar is apparent to anyone who sees it, while the degree of skin exposure is minimum (to avoid arousing mere sexual feelings), and the avatar design is conventional (to observe user responses in general, rather than those based on curiosity upon encountering an avatar with an unusual appearance). Avatars were created using Vroid [22] (Fig. 4). The size of the avatar was based on the standard size [23] of each body part of a Japanese person in their 20s.

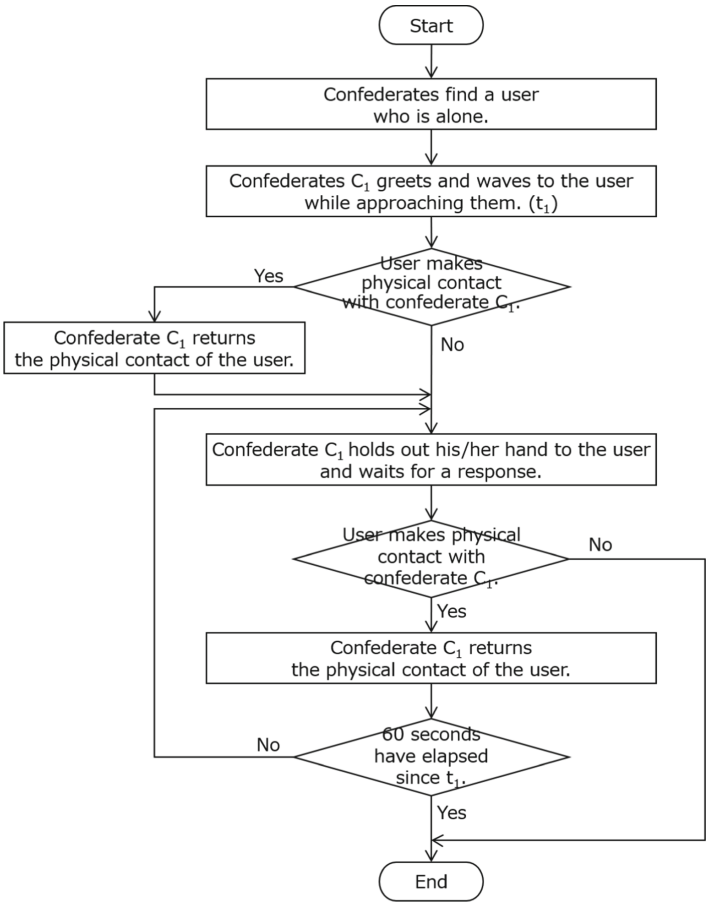


Fig. 3. Flowchart of a session.



**Fig. 4.** Appearance of confederate avatars (left: male, right: female).

## 5 Results

### 5.1 Effects of Three Study Factors

To examine whether the three study factors mentioned in Sect. 4.1 affected the contact frequency,  $2$  (apparent gender of avatar of the interaction partner)  $\times 2$  (actual gender of the interaction partner)  $\times 2$  (with or without natural voice) ANOVA was first performed on the frequency of the user's contact with the confederate  $C_1$  during a session. If the main effect was significant, multiple comparison tests were performed using the Tukey–Kramer method as a post-hoc analysis. Table 2 shows the results of the analyses for the total contact frequency of all body parts in contact ([total] in Table 2) and for the contact frequency by body part in contact ([head] to [upper body] in Table 2). Figures 5, 6, and 7 show the total contact frequency of all body parts in contact for each factor. The error bars in the graphs in each figure represent the standard errors of the mean. The asterisks in each figure and table represent the significance levels (\*:  $p < 0.05$ , \*\*:  $p < 0.01$ , \*\*\*:  $p < 0.001$ ).

For the total contact frequency, the ANOVA showed that the two main effects of the actual gender of the interaction partner and with or without a natural voice were significant. Post-hoc tests showed that the frequency was significantly higher when the actual gender of the interaction partner was female than when it was male (Fig. 6) and without the use of a natural voice than with it (Fig. 7).

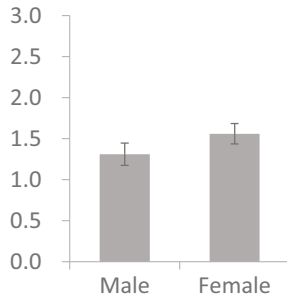
### 5.2 Effect of the Body Part in Contact

To examine whether there is a difference in contact frequency for various body parts, the  $\chi^2$  test was performed to compare the total contact frequency of all users among the six groups: head, hands, arms/shoulders, torso, legs, and upper body (hug). If a significant difference was found, multiple comparison test was performed using the Ryan method as a post-hoc analysis.

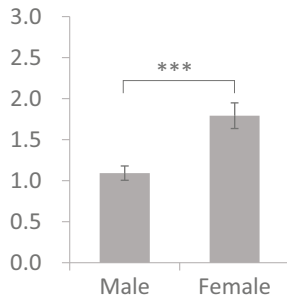
The result of the  $\chi^2$  test was significant ( $\chi^2(5) = 293.37, p < 0.001$ ). The post-hoc test showed that hands had a significantly higher contact frequency than all other body parts. The arms/shoulders had a significantly higher contact frequency than the torso, legs, and upper body (hug) (Fig. 8).

**Table 2.** Analysis results of contact frequency by each factor.

	Apparent gender of the avatar of the interaction partner		Actual gender of the interaction partner		With or without the use of natural voice		Interaction effects		
	F (df1, df2)	p	F (df1, df2)	p	F (df1, df2)	p			
Total	2.46 (1,160)	0.119	18.17 (1,160)	< 0.001***	M < F	10.98 (1,160)	< 0.01**	W < W/O	none
Head	0.38 (1,160)	0.536	9.33 (1,160)	< 0.01**	M < F	4.82 (1,160)	< 0.05*	W < W/O	none
Hands	4.31 (1,160)	< 0.05*	2.82 (1,160)	0.095	M < F	3.30 (1,160)	0.071		none
Arms/shoulders	0.12 (1,160)	0.731	7.07 (1,160)	< 0.01**	M < F	3.32 (1,160)	0.070		none
Torso	0.41 (1,160)	0.522	4.83 (1,160)	< 0.05*	M < F	0.01 (1,160)	0.932		none
Legs	0.04 (1,160)	0.840	0.74 (1,160)	0.391		4.04 (1,160)	< 0.05*	W < W/O	none
Upper body (hug)	0.07 (1,160)	0.793	6.77 (1,160)	< 0.05*	M < F	4.06 (1,160)	< 0.05*	W < W/O	none

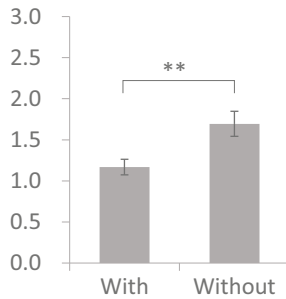


**Fig. 5.** Contact frequency by apparent gender of the avatar of the interaction partner. (left)

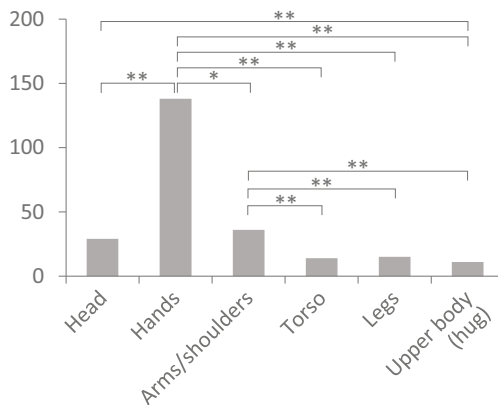


**Fig. 6.** Contact frequency by actual gender of the interaction partner. (center)





**Fig. 7.** Contact frequency with or without the use of natural voice. (right)



**Fig. 8.** Total contact frequency of all users by body part in contact.

## 6 Discussion

### 6.1 Effect of Apparent Gender of the Avatar of the Interaction Partner (RQ1)

The apparent gender of the avatar of the interaction partner did not affect physical contact in virtual spaces (Fig. 5). Given the previous study showing that the appearance of other avatars affect user perception, action, and behavior (Sect. 3.2), our result that the apparent gender of the interacting avatar (i.e., the other avatar) did not affect physical contact was unexpected.

### 6.2 Effect of Actual Gender of the Interaction Partner (RQ2)

The actual gender of the interaction partner affected physical contact in virtual spaces, and users made contact with their partner (confederate) significantly more when the actual gender of their interaction partner was female than when it was male (Fig. 6). It is interesting that the actual gender of the person manipulating the avatar of the interaction partner in the real world, rather than the apparent gender of the avatar of the interaction

partner (i.e., other avatar for the user) in the virtual world (Sect. 6.1), affected the users' physical contact.

We will now discuss the reason why the contact frequency was higher when the actual gender of the interaction partner was female. In this field study, we did not ask the users their actual gender; however, their natural voices suggested that most users were male. Therefore, the contact frequency was higher when the actual gender of the interaction partner was female.

When the actual gender of the interaction partner was male, users often left before 60 s had elapsed from the start of the session and entered into a conversation from a distance after the initial handshake (Fig. 9). This was particularly noticeable when the actual gender of the user's interaction partner (confederate) was male and the user spoke with their natural voice (judging from the voice, the user was mostly male).

In contrast, when the actual gender of the interaction partner was female, longer periods of physical contact were observed, regardless of whether the user spoke in their natural voice or not.



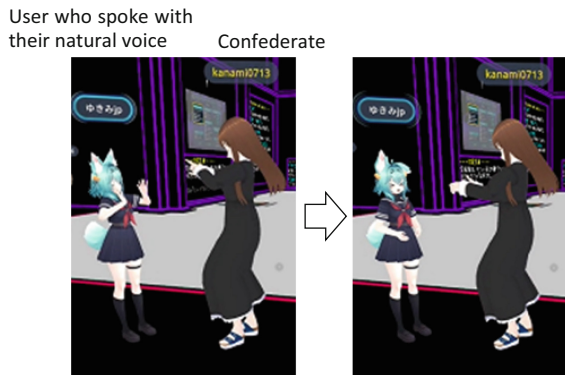
**Fig. 9.** Typical interaction when the partner's (confederate's) actual gender is male. After an initial light handshake, the user continued the conversation without physical contact from a distance.

### 6.3 Effects of Natural Voice (RQ3)

Speaking in one's natural voice affected physical contact in virtual spaces, and the users made contact with their partner (confederate) significantly more when the natural voice was not used (Fig. 10).

When the user did not use their natural voice, a higher contact frequency was observed, along with tendencies for longer contact durations and more intimate contact. These observations can be interpreted as users' attempts to express their interest in others using physical contact as an interaction method in situations where they cannot use their voices. The confederates, unable to hear the user's voice, could only guess what they aimed to say, for instance, "Your avatar looks funny," "Your avatar's clothes are cute," or "Your avatar's ears are cute," when they made contact the area of interest.

When the user used their natural voice, the conversation took precedence, and physical contact did not occur in most cases. This may be because hearing the partner's natural voice diminishes the sense of being in a virtual world and increases that of being in reality, which may have prevented physical contact in accordance with social norms in the real world.

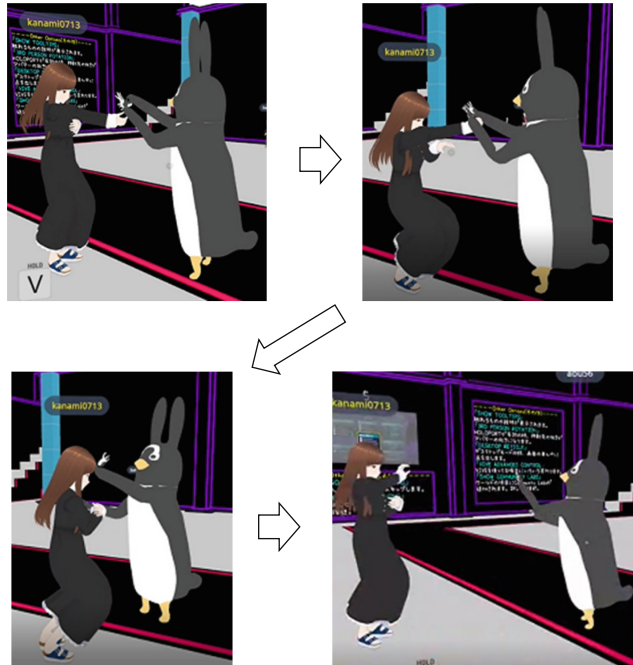


**Fig. 10.** Typical interaction in which the user spoke with their natural voice. After an initial wave of the hands (left), they exchanged a light greeting and then transitioned to a more conversational interaction. In this example, the confederate held out their hand to the user; however, the user did not respond (right).

#### 6.4 Conditions for Higher Contact Frequency: [Actual Gender of Partner is Female] × [Without Use of Natural Voice]

Sections 6.1–6.3 indicate that a user's physical contact is more frequent when the actual gender of the interaction partner was female and when the user did not speak with their natural voice. In addition, not only was the quantity of contact greater, but the quality of contact was also more substantial, and the following were observed: longer duration of contact, continued physical contact after the initial handshake, and more intimate contact such as hugging, patting the head, and touching the feet (Fig. 11).

Interaction partner (confederate) whose actual gender is female      User who did not speak with their natural voice



**Fig. 11.** Typical interaction in which the actual gender of the interaction partner (confederate) was female and the user did not speak with their natural voice. After shaking hands for the first time (upper left), the user made contact with the partner’s arm (upper right) and then made contact with various points, including the head (lower left), to interact intimately. Finally, they parted with a wave (bottom right).

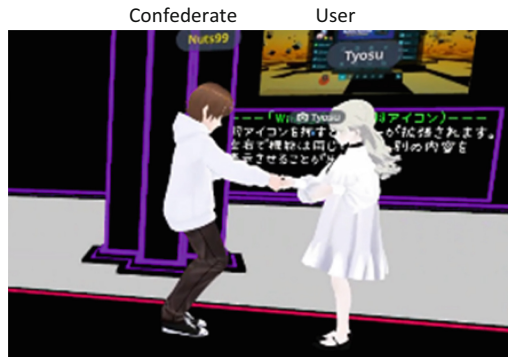
### 6.5 Effects of the Body Part in Contact

The body part with which contact was made affected the contact frequency. The order of contact frequency was hand, arm/shoulder, head, leg, torso, and upper body (hug). This order reflects the implicit social norms by which people interact in the real world.

We will discuss the reasons why the contact frequency via hands was high. In this field study, the confederates repeatedly held out their hands to (but did not make contact with) the users (Fig. 3). Most users responded by holding out their hands, and a handshake often followed (Fig. 12). A high hand-contact frequency probably resulted from this study procedure. While no statistically significant difference in the total frequency via all body parts existed ([total] in Table 2), only in the case of hands, the contact frequency was significantly higher when the apparent gender of the avatar of the interaction partner was female than when it was male. ([hands] in Table 2).

We will next discuss the bottom three contact frequencies: upper body (hug), legs, and head. In all three cases, the contact frequency was significantly higher without the use of a natural voice (Table 2). When a user does not speak with their natural voice, anonymity is high and the risk of identification is low. It is not surprising that users in

such a situation made contact with the upper body (hug), legs, and head, which in the real world would only come into contact with each other in the case of extremely close relationships. In addition, when a user does not speak with their voice, the only means of interaction is nonverbal behavior. Therefore, the user might be attempting to add variety to the interaction by making contact with various body parts.



**Fig. 12.** Hand-to-hand contact (handshake) with the highest contact frequency.

## 7 Conclusion

We observed the physical-contact behaviors of 168 general users in VRChat, a social VR platform. We analyzed the user contact frequency based on the apparent gender of the avatar of the interaction partner, the actual gender of the interaction partner, and whether users spoke with their natural voices. We found that the contact frequency was higher when the actual gender of the user's interaction partner was female and when the user used their natural voice. Contrary to expectations, the apparent gender of the avatar of a user's interaction partner did not affect the contact frequency. These results suggest that the actual gender of the partner affected user behavior more than the apparent gender of the partner's avatar. These results also suggest that not only the representation of the avatar's appearance, which has been extensively explored, but also the representation of the avatar's voice will be important topics for future studies. We also found that users in the virtual world made contact body parts not typically made contact in the real world.

This study used the Tutorial World of VRChat, which has a wide range of Japanese users, as the target of observation. In the future, we must investigate whether similar trends can be observed on other social VR platforms. Because physical contact varies significantly by culture, users from cultures other than Japan must also be investigated. Physical contact is less common in Asian countries, including Japan, than in Western countries. This is particularly true in Japan, where people rarely engage in physical contact in public places. Using this field study, we confirmed that even Japanese people actively engage in physical contact in virtual spaces. In cultures where physical contact is a habit, this result may be more prominent.

**Acknowledgments.** We wish to express our gratitude to the VRChat users who cooperated with us as users of our field study.

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