Chapter 9
Psychology for Avatar Communication

Tetsuro Ogi

Abstract In recent years, avatars have been used for the communication in various situations including CG avatar used in the metaverse, robot avatar used in the real world and AR avatar used in the augmented reality world. In such avatar communication, several knowledge about the influence that the usage of avatar affects the user's feeling and behavior has been obtained. In order to use the avatar effectively for the communication in the avatar society, it is necessary to construct a discipline that organizes these phenomena as avatar psychology. In this paper, the psychological research about the avatar such as Proteus effect, embodied knowledge, co-actor effect, and sense of collaboration that have been conducted in our laboratory are introduced.

9.1 Introduction

Due to the spread of using the metaverse, avatars are attracting attention as a communication method in it. Avatars are used by the users in the metaverse to express their figures, and there are various methods to represent avatars, such as creating an avatar that looks just like the user, or creating a character that is completely different from the user. Furthermore, avatar communication, that includes robot avatar or AR avatar, can be used not only in virtual worlds but also in various situations such as real worlds and augmented reality worlds.

Avatar communication is used for various purposes, such as meetings, education, events and commercial business in the metaverse [1, 2]. And, avatar robots are also used to provide several services at airports, restaurants, museum, etc. [3]. Namely, avatar communities and avatar societies are currently formed in various environments, and avatar communication is becoming an important tool not only in the virtual worlds but also in the real worlds.

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When the avatars are used widely, it becomes necessary to understand the behavior of the avatar and the behavior of the remote user in order to perform effective communication among avatars or between avatars and humans. It is known that the behavior of the avatar is different from the behavior of the person who operates it and the influence that the avatar has on the other person also differs depending on what kind of avatar is used.

In the real world, psychology has been developed as an academic discipline to understand the characteristics of human's behavior and communication. Even in the virtual world and augmented reality world, academic research is necessary to understand the avatar's behavior and communication. In other words, research field of avatar psychology should be constructed [4]. Currently, several researches are being conducted on avatar's behavior and communication in various situations and conditions. But, these researches are fragmentary, and it is necessary to discuss these topics systematically.

In this chapter, we will introduce several research topics that were conducted in our laboratory regarding various types of avatar communication and avatar psychology.

9.2 Various Avatars

Avatar is a character that a user uses as an alter ego to express his or her figure, and it is used for communication between users. In the metaverse, avatar is an essential tool for users to participate in the virtual world. The avatar can be expressed in various ways according to the purposes and situations, such as using a realistic figure of the user, using an anonymous figure, or using a different personality from the user. In addition, robot avatar or AR avatar can also be used for the communication in the real world or augmented reality world. The following are the characteristics and usage of various avatars.

(1) Simple Shape Avatar

Simple shape avatar is an avatar that is provided by metaverse platform and it is expressed as relatively simple geometric model. When this type of avatar is used, since there is no need for the user to create an avatar by himself, many users use the same figure of the avatar, and they participate in the virtual world as anonymous users.

(2) Character Avatar

Character avatar is an avatar that is created by selecting and customizing the hairstyle, face shape, clothing, etc. by the user. Although the character avatar may represent the user's characteristics, it may be created as a character with a different personality from the user himself. Even if the avatar's character were different from the user's character, the avatar can represent an individuality because it has characteristics.

(3) Real Avatar

Real avatar is an avatar that has an appearance looks just like the user [5]. Real avatars can be created at various levels of reality, from using a standard body model with a photo of the user's face, to using a highly realistic model constructed by scanning the user's face and body with a 3D scanner. This type of avatar is often used for business purposes because it allows the user to communicate with other avatars as the same person with himself in the real world.

(4) Video Avatar

Video avatar is created by using the user's live video image that is captured in real time [6, 7]. As for the shapes of the video avatar, various models from simple two-dimensional model to 2.5-dimensional or three-dimensional model that is created by using stereo camera or multiple cameras are used. Since this method captures and reconstructs the user's figure in real time, the user's facial expressions and emotions can be expressed by the avatar.

(5) AR Avatar

AR avatar can be seen in the real world by the other user using AR glasses [8]. As for the expression of the AR avatar, computer graphics images of simple shape avatar, character avatar, real avatar, and video avatar can be used. This method is used for the communication between the remote user and the real world user.

(6) Robot Avatar

Robot avatar can be realized by remotely controlling a communication robot that is used in the real world [9]. The robot avatar exists as a physical robot in the real world and it can communicate with users in the real world. When robot avatar is used, there are cases where the robot communicates as its own character or cases where the robot acts as a substitute for the remote user by displaying the remote user's image on the monitor.

Like this, various kinds of avatars are used depending on the environment and the purpose of communication. Figure 9.1a shows the video avatar used in the shared virtual world, and Fig. 9.1b shows the real avatar used in the AR environment. In the avatar psychology, it is necessary to investigate the behavior of the avatar and the influence of the avatar on other users in various situations.

9.3 Avatar Representation and Psychology

Avatars are used by users to express their figures, act, and communicate with other avatars or humans in the virtual world, augmented reality world, and real world. In this case, it is the remote user operating the avatar, rather than the avatar itself, who senses the situation, thinks about it, and decides on actions. Therefore, avatar psychology in avatar society is not the psychology of the avatar itself, but the psychology of the user who operates the avatar and communicates with other users.

(a) Video avatar used in share virtual world (b) Real avatar used in AR environment

Fig. 9.1 Various avatars used in virtual world, augmented reality world, and real world

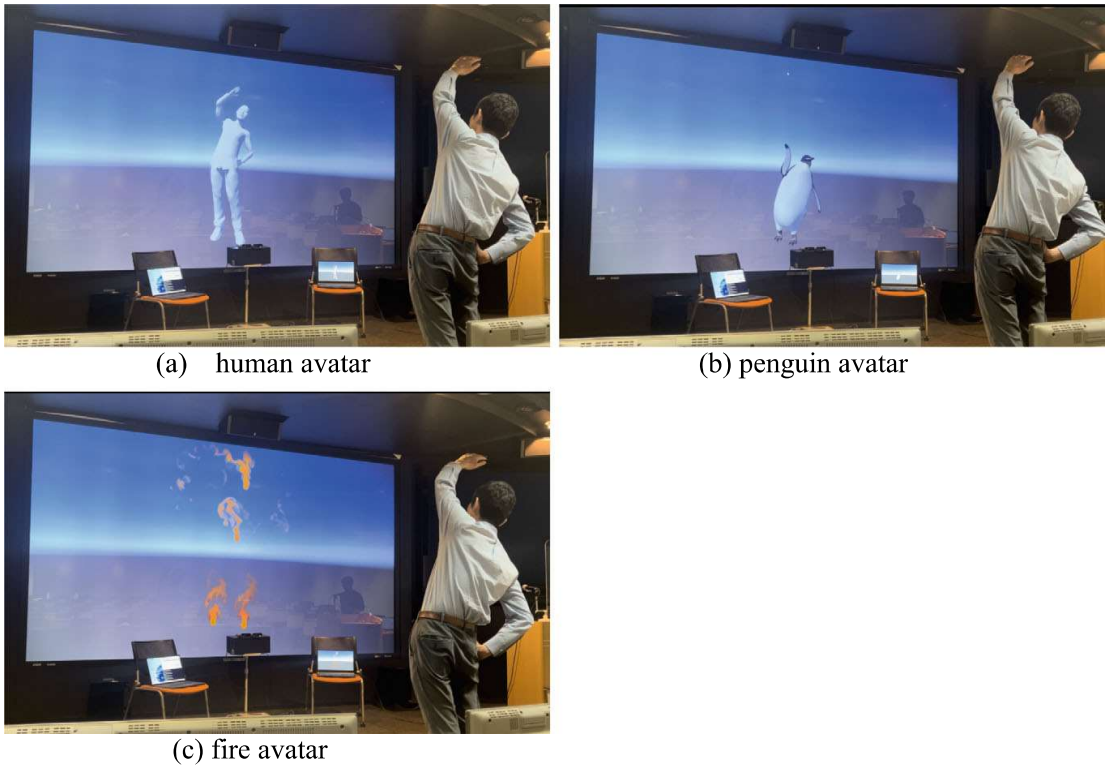
Examples of issues in the avatar psychology include how a user feels when controlling an avatar, and whether this feeling is influenced by what kind of avatar is used. In the real world, it is known that people feel braced themselves when they straighten their backs, people relieve stress when they smile, and people change their feeling depend on the clothes. The relationship between posture, facial expressions, clothing, and the mind is being studied in the fields of body psychology and clothing psychology. Even in an avatar society, the appearance of the avatar that the user uses might affect the user's mind. Some examples of the research that we have conducted on these issues are introduced.

9.3.1 Proteus Effect

The Proteus effect is known as a phenomenon in which the appearance of an avatar used by a user affects the user's psychological state and behavior. For example, it has been shown that when the user uses a muscular avatar, he feels stronger and behaves as a strong person, and when the user uses a tall avatar, he feels more confident and his negotiation skill improves [10, 11]. Furthermore, it is known that the Proteus effect occurs not only for human avatars but also for animal avatars or fictional character avatars such as dragons [12].

In these examples, it can be considered that the user's consciousness of what kind of avatar is being used was expressed as a change in the avatar's behavior. In our experiment, we investigated the influence of the avatar's appearance on the user's behavior under the condition where the user was not clearly conscious of the avatar's appearance during short-term tasks [13].

In the experiment, 10 subjects were asked to perform the three basic movements of radio calisthenics for 10s each, for a total of 30s, using three kinds of avatars in non-immersive environment. The avatars used in the experiment are a human avatar, a penguin avatar, and a fire avatar, as shown in Fig. 9.2. Compared to the human avatar, the penguin avatar lacks elbow and knee joints and has less freedom



(a) human avatar (b) penguin avatar

(c) fire avatar

Fig. 9.2 Avatars used in the experiment on unconscious movement

of joint movements. And the fire avatar has no joints visually, and has fireballs at the positions of head, hands, and feet, representing an overall human-like figure. Since the subjects had completely memorized the movements of the radio calisthenics and operated each avatar only for 10s, they did not have enough time to get used to the movement of each avatar.

In the experiment system, the movements of the subjects were measured using an Azure Kinect sensor, and the subjects directly controlled the avatars' movements using their bodies. After exercising using each avatar, subjects were asked to answer a questionnaire regarding their consciousness when operating the avatar using seven-point Likert scale. The questions include the sense of body ownership whether the avatar was felt like your own body, the sense of agency whether you felt controlling the avatar's movement, and the consciousness whether you felt the movement of your body was influenced by the avatar. In addition, in order to investigate the differences in movement when using each avatar, the position of the arm when it was raised and the speed of the arm when it was swinged were measured.

Figure 9.3 shows the results of the questionnaire, and Fig. 9.4 shows the results of the measurement of the motion. As a result, the sense of body ownership and the consciousness of the influence on the body movement by the avatar were not so high, though the sense of agency of controlling the avatar was high, because the subjects know the movement of the radio calisthenics well and the exercise time was short. On the other hand, the position of the raised arm was significantly lower when using the penguin avatar, and speed of the swinged arm was significantly faster when using

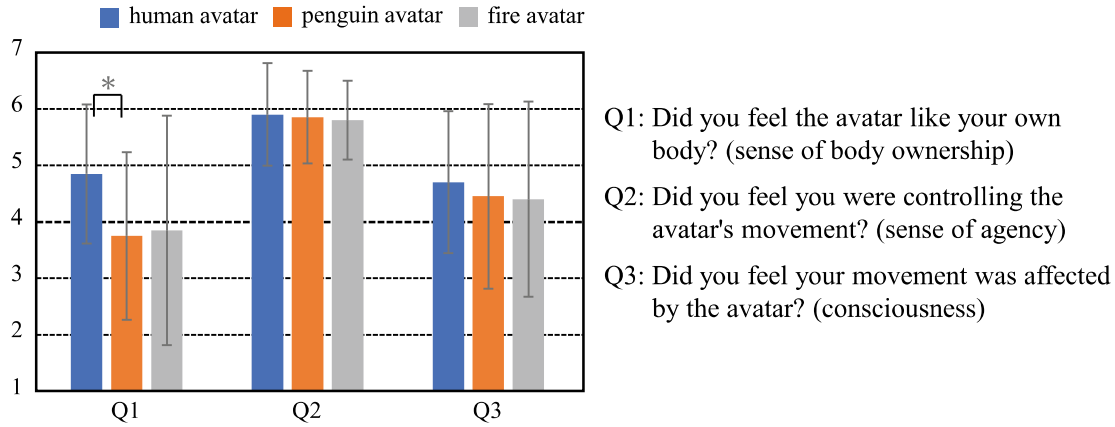


Fig. 9.3 Results of questionnaire in the experiment on unconscious movement

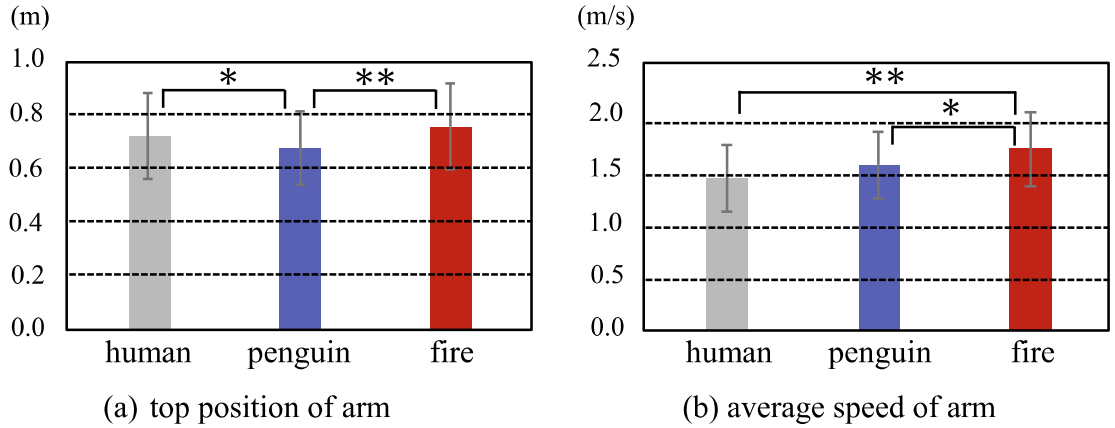


Fig. 9.4 Movement of user's arm when using various avatars

the fire avatar. This result suggested that even for a short period of time when the avatar's appearance does not affect the user's consciousness, the user's movements are unconsciously influenced by the avatar when the user feels the sense of agency of being controlling the avatar. In other words, the Proteus effect affects not only the users' behavior based on the consciousness but also their unconscious movements.

9.3.2 Embodied Knowledge

From the above experiments, it is expected that the use of avatars will effectively influence the acquisition of embodied knowledge, since the movements of the user are unconsciously influenced by the avatar's movements. Embodied knowledge is knowledge that is rooted in the human body such as actions learned with the body rather than knowledge memorized with the brain as text information, and it is obtained through the somatic senses, like tips and tricks. For example, a child learns how

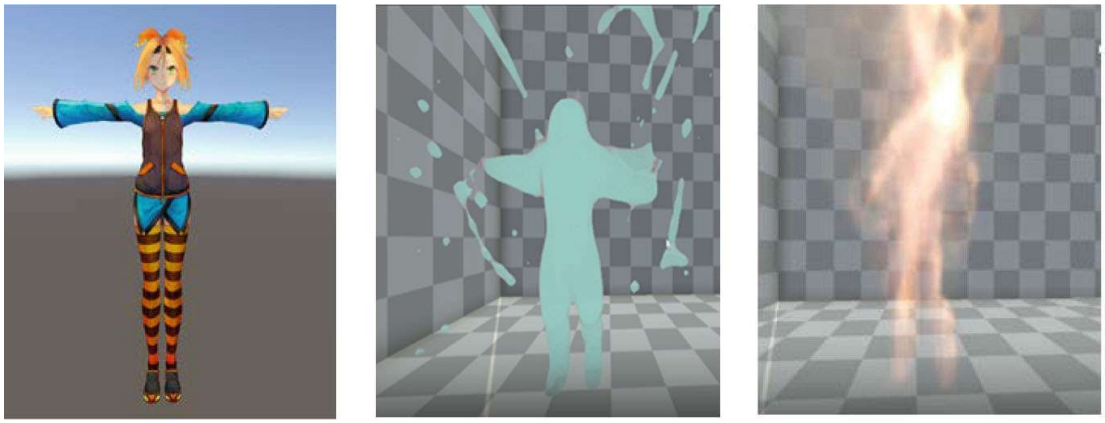
to ride a bicycle and an athlete learns effective physical movements, as embodied knowledge.

Research on the process of acquiring embodied knowledge is conducted in the field of cognitive psychology, and it is considered that in general acquiring embodied knowledge requires an objective viewpoint of observing one's own movements and a subjective viewpoint based on one's own somatic senses. When using an avatar, both an objective viewpoint of observing the movements of avatar and a subjective viewpoint of controlling the avatar exist simultaneously. Therefore, the use of avatars can be expected to be an effective method for acquiring embodied knowledge. In particular, since the characteristics of avatar affect one's own movements unconsciously, it is considered that using an appropriate avatar affects the acquisition of embodied knowledge effectively.

We conducted an experiment on the acquisition of embodied knowledge using various avatars [14]. The experiment focused on learning the water-like body movements that are often referred to in Oriental martial arts. Water-like body movement means soft movement of the body, but it is difficult to express specific ways to move the body in words. Then, subjects practiced body movements using three kinds of avatars, such as a human avatar, a water avatar, and a fire avatar as shown in Fig. 9.5.

In the experiment, 10 subjects were asked to practice body movement using each avatar for 3 min each, and after practicing using each avatar, they answered a questionnaire. In the questionnaire, questions about objective and subjective viewpoints, such as "Did you feel observing water-like body movement?" and "Did you feel controlling water-like body movement?" were asked on a five-point scale.

Figure 9.6 shows the results of the questionnaire. From this result, we can see that when water avatar and fire avatar were used, scores of both observation and controlling were higher than using human avatar. Namely it is considered when using water avatar and fire avatar, objective viewpoint and subjective viewpoint functioned effectively and learning of embodied knowledge about water-like body movement progressed successfully. This is because the water avatar and the fire avatar emphasized the user's soft movements, which increased the user's awareness



(a) human avatar (b) water avatar (c) fire avatar

Fig. 9.5 Avatars used in embodied knowledge experiment

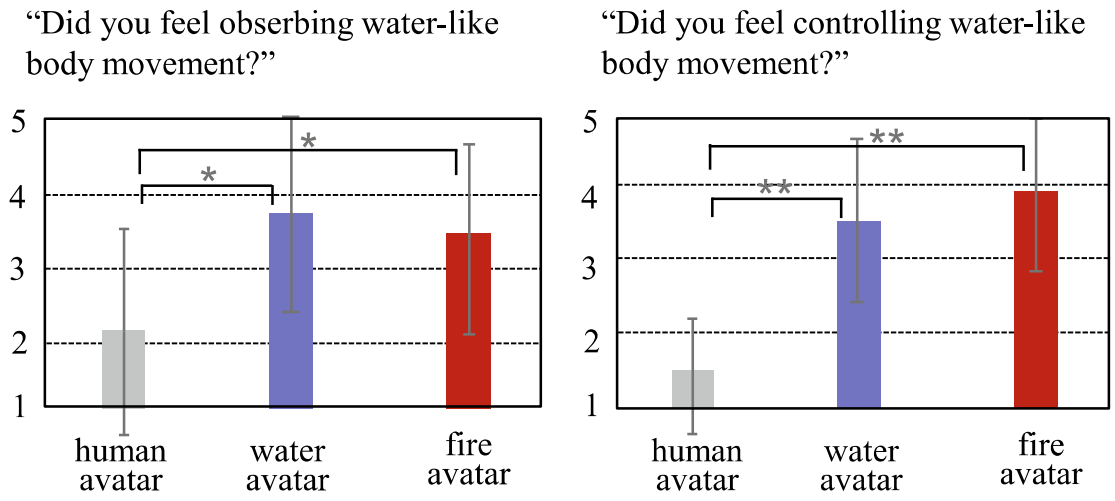


Fig. 9.6 Results of questionnaire in the experiment on embodied knowledge

of water-like body movements that the user had not noticed before, and resulted in effective learning. In other words, it can be suggested that when learning the embodied knowledge using avatar, the efficiency of learning depends on the characteristics of the avatar, and effective learning of the embodied knowledge can be achieved by using an appropriate avatar.

9.4 Avatar Society and Psychology

The topics of the above research are the influence of avatar expressions on individual's feelings and behavior. Avatars are used for communication between avatars or between avatars and humans in the virtual world, augmented reality world, and real world. Psychology in such an avatar society includes issues such as how the user feels when facing other users' avatars, or how the presence of other users' avatars affects the user.

In the real world, it is known that our thoughts, feelings, and actions are influenced by being aware of the existence of others. For example, when studying in a library, the presence of others improves one's concentration, or when training at the gym, the presence of others improves one's performance. This kind of influence from others is called social facilitation, and these issues are investigated in the field of social psychology. Here, some examples of research on the social psychology in avatar society are introduced.

9.4.1 Co-actor Effect

In the social psychology, as social facilitation that the others' existence affects one's behavior, co-actor effect that causes one's competitive consciousness when others are acting together and audience effect that causes one's consciousness of doing best when others are watching are known. We conducted an experiment to evaluate whether the existence of other person's avatar in a virtual environment has a co-actor effect that influences one's own consciousness and behavior [15].

In the experiment, 10 subjects performed hammer curl training using dumbbells in the following four conditions: (1) alone in real world, (2) face-to-face with other person in real world, (3) facing a character avatar in metaverse world, and (4) facing a video avatar in metaverse world, as shown in Fig. 9.7. In the conditions of facing a character avatar or a video avatar in the metaverse world, subjects wore an HMD while training. For evaluation, subjects were asked to answer a questionnaire after each training session.

Figure 9.8 shows the results of the questionnaire, in which participants rated how they felt based on the feeling they felt when training alone as reference (3 points).

1) alone in real world

2) face-to-face with other person in real world

3) facing a character avatar in metaverse

4) facing a video avatar in metaverse

Fig. 9.7 Conditions of hammer curl training experiment

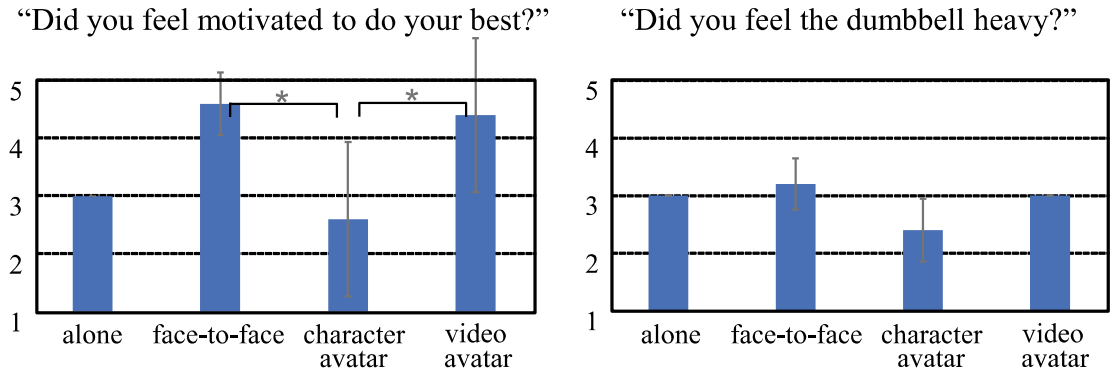


Fig. 9.8 Result of co-actor effect experiment

The left graph shows the answer to the question "Did you feel motivated to do your best?". This result shows that under the condition of face-to-face in real world, evaluation was higher than when training alone and it indicates the co-actor effect. On the other hand, there was no effect under the condition of facing a character avatar in metaverse, but when facing a video avatar in metaverse, an effect equivalent to the face-to-face condition in real world was shown. The right graph shows the answer to the question "Did you feel the dumbbell heavy?". From this result, it can be seen that there were no significant differences according to the conditions, and there was no change in the feeling of weight compared to when training alone.

Namely, it is considered that when using a video avatar, it did not affect the user's physical sense of weight, but the co-actor effect appeared on the mental motivation of doing one's best. In addition, although there was an effect with a video avatar, there was no effect with a character avatar. That means the co-actor effect depends on the appearance of the avatar, and when a realistic appearance of the video avatar was used, the user might feel the presence of a person rather than a character object.

9.4.2 Sense of Collaboration

Next, as a problem in the communication using avatars, we selected issue of how user feels for the avatar or remote user when he or she is facing the avatar. Whether the user feels talking with the avatar itself in front of him or her, or the user feels talking with a remote user beyond the avatar? We conducted an experiment to evaluate the user's consciousness of whom he or she is talking with and what elements of the avatar affects the user's consciousness [16, 17].

As for the experimental task, the subjects in the real world were asked to move files according to the instruction by the avatar, assuming the collaborative work between user and avatar in the augmented reality world. In the experiment, the appearance and physical existence of the avatar were changed under the following four conditions: (1) face-to-face with a person in real world, (2) facing an AR real avatar of remote user using AR glasses, (3) facing a robot avatar in real world, (4) facing an AR

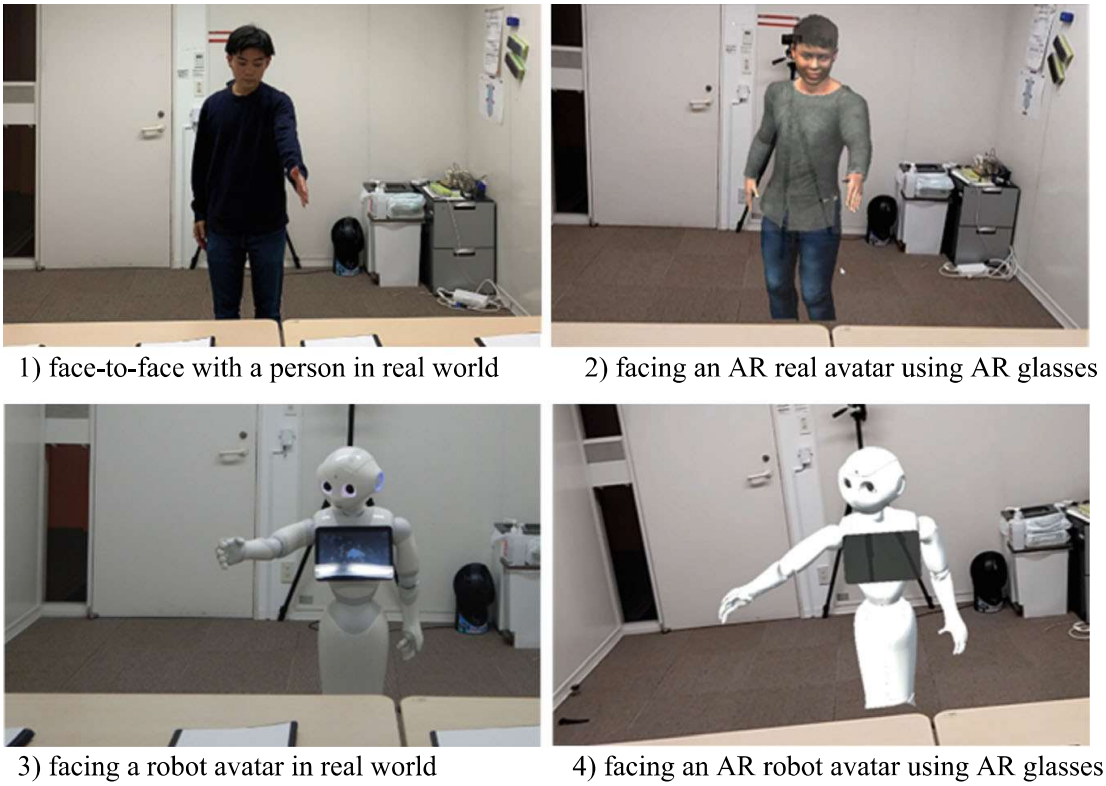


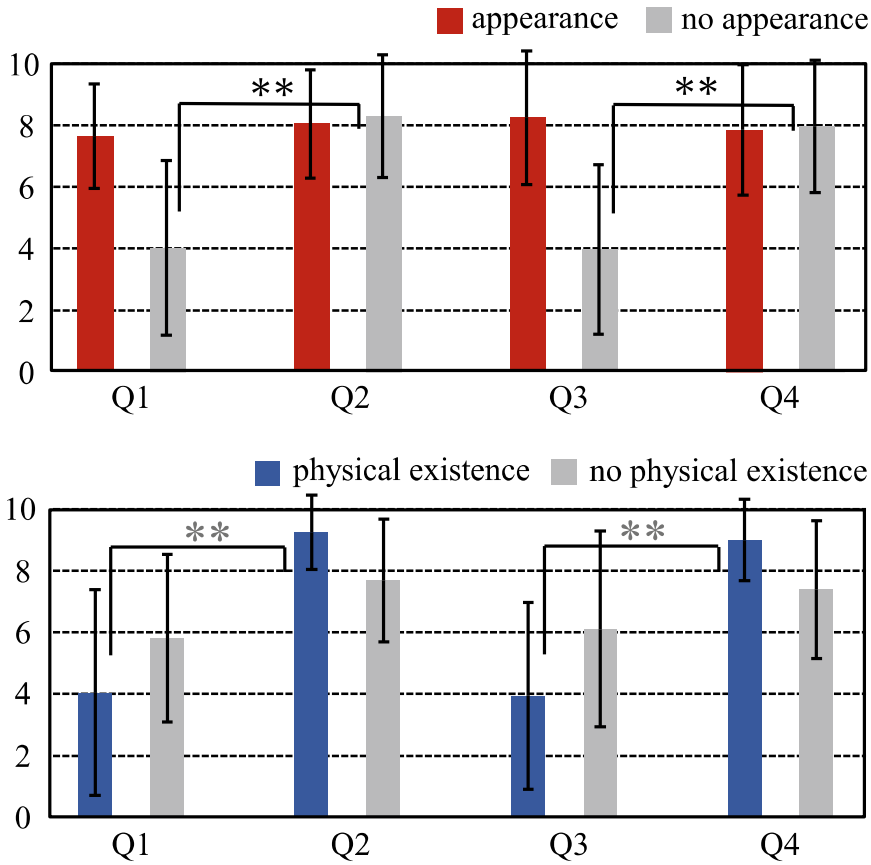
Fig. 9.9 Conditions of collaboration experiment with avatar

robot avatar using AR glasses, as shown in Fig. 9.9. As a robot avatar, Softbank's communication robot Pepper, which was remotely controlled as a tele-immersion robot was used [18].

In the condition of face-to-face with a person in real world, there are appearance and physical existence of the other user, but in the condition of facing an AR real avatar of remote user, there is appearance of the remote user but no physical existence. In the condition of facing a robot avatar in real world, there is physical existence but no appearance of the remote user, and in the condition of facing an AR robot avatar, there are no appearance and physical existence.

After performing the experimental task with each avatar, the subjects were asked to answer a questionnaire about their feelings of collaboration. In the questionnaire, pairs of questions such as "Q1: Did you feel remote user was in the same room?" "Q2: Did you feel avatar was in the same room?", and "Q3: Did you feel doing collaborative work with remote user?" "Q4: Did you feel doing collaborative work with avatar?", were asked.

Figure 9.10 shows the results of the answers. These graphs show the results divided into whether there is appearance of the remote user or not, and whether there is physical existence or not. From the results, we can see that when there was no appearance of the remote user on the avatar, users could not feel much that the remote user was in the same room and they were doing collaborative work with the remote user. And it was also found that when there was physical existence of



Q1: Did you feel remote user was in the same room?
Q2: Did you feel avatar was in the same room?
Q3: Did you feel doing collaborative work with remote user?
Q4: Did you feel doing collaborative work with avatar?

Fig. 9.10 Results of questionnaire according to appearance and physical existence

the avatar, users felt more that avatar was in the same room and they were doing collaborative work with the avatar in front of them.

Namely, the appearance of the avatar as the remote user strengthens the feeling of being collaborating with the remote user, and the physical existence of the avatar strengthens the feeling of being collaborating with the avatar in front of the user. This experiment was conducted in the augmented reality environment. But, this result can also provide a guideline for the issue what kinds of avatars should be used when users participate in not only the real world or augmented reality world but also the metaverse world as avatars with their real names or anonymously.

9.5 Conclusions

Avatars have attracted attention with the development of the metaverse, and now avatars are used not only in the virtual world, but also in the real world and the augmented reality world, as robot avatars or AR avatars. In this paper, several experiments that we have conducted to investigate the influence of the avatar on users' consciousness, feeling, and behavior when using avatars in such environments were introduced. These findings regarding avatars relate to the influence on the users themselves who operate the avatars and the influence on the opponents who communicate with the avatars, and these issues can be considered as problems in body psychology and social psychology in avatar society. In the future, in order to use avatars effectively for the communication in various situations, it is important to develop research on the psychological knowledge in avatar society as avatar psychology.

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Chapter 10
Value Co-creation Through Communication Between Producers and Customers in Gastronomic Sciences

Tomomi Nonaka

Abstract In this chapter, we consider value co-creation through communication between various stakeholders in the food value chain and consumers based on two research studies. One examines communication and value co-creation in restaurant services from the perspective of service engineering, focusing on employee satisfaction and value co-creation in a chain of Japanese restaurants. The other case study explores the design of value co-creation spaces that promote mutual understanding between producers and consumers through an online workshop connecting people and regions around a specific food ingredient. From these two cases, we aim to understand how communication between producers and consumers can further develop to create value in the deliciousness of food and achieve a rich food culture and strong primary industry.

10.1 Introduction

The deliciousness of food is composed of various elements, including not only the ingredients themselves but also the environment, information, and culture surrounding the ingredients. To create deliciousness in food, it is essential to consider how these diverse elements contribute to the overall experience and understand their structure and relationships. The taste of food is influenced by various factors such as sensory stimulation, the physical and psychological state of the eater, ambiance, environmental conditions, eating habits, and traditions. There are several definitions of deliciousness, which can be classified into: (1) physiological satisfaction, (2) alignment with food culture, (3) information-driven taste, and (4) taste that stimulates the brain's reward system with certain ingredients [1]. The design of deliciousness involves a wide range of targets and attributes (Fig. 10.1) [2]. Understanding the structure of deliciousness, which is composed of various elements, requires a holistic

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