Foundational Paper

Suppression of Height Phobia through Induction of the Proteus Effect Using Dragon Avatars

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Reducing the Fear of Height by Inducing the Proteus Effect of a Dragon Avatar

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Abstract --- Existing studies have reported that the Full Body Ownership Illusion lets users perceive a virtual body as their own. It has also revealed the Proteus Effect, where avatars' appearance can affect users' behavior, attitude, and mental condition by inducing the Full Body Ownership Illusion. While many studies have focused on humanoid avatars and their psychological effects, a previous study reported that Full Body Ownership Transfer can be induced even with animal avatars. Inducing Full Body Ownership Transfer with an animal avatar is expected to produce psychological effects distinct from those of a human avatar. Therefore, this study examines whether a dragon avatar, which conveys an impression of a powerful body and flight ability, can reduce fear of heights as a Proteus Effect through Full Body Ownership Transfer. We conducted an experiment with scenarios where subjects transformed into a dragon and flew to a height, comparing this to operating a human avatar. The results showed that transforming into the dragon avatar improved both subjective scores and physiological reactions related to fear of heights.

Keywords: Sense of Body Ownership, Proteus Effect, Immersive Virtual Reality, Avatar

1 Introduction

With the increasing performance and affordability of virtual reality (VR) devices, a culture is emerging where even general consumers don avatars within the metaverse (a multi-participant virtual space built on the internet) and communicate with others in VR spaces.VR In psychology, it has been reported that when a user's movements are reflected and executed by an avatar, a phenomenon called body ownership transfer occurs, where the avatar is perceived as if it were the user's own body [1]. Furthermore, it has been reported that the appearance of the avatar being controlled influences the user's attitudes and behaviors.For example, transferring body ownership to a casual, dark-skinned avatar has been reported to lead to more rhythmic percussion playing compared to a salaryman-style avatar [2]. In other words, wearing an avatar not only provides a perceptual and cognitive representation that the avatar is one's physical body, but also alters one's body image–how one perceives themselves to be–and psychological

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It is also thought to influence psychological aspects. This effect, whereby avatars influence human psychological states, attitudes, and behaviors, is termed the Proteus effect [3]. With current social VR content enabling users to freely alter their bodies through avatars and thereby obtain corresponding psychological effects, we can say humanity has entered an era unprecedented in history where bodies can be freely changed.In this context, clarifying the scope of transferable body ownership through avatars and its associated secondary effects is expected to broaden the application range of avatar utilization in society and contribute to the realization of an avatar society.

Until now, investigations into body ownership and the Proteus effect have primarily focused on humanoid avatars.Existing research has reported that body ownership can arise for avatars with various appearances, regardless of age, size, gender, species, posture, or human-like appearance [4-8]. Consequently, studies have examined how human psychological states and behaviors change when modifying the height, physique, or apparent characteristics of humanoid avatars.On the other hand, recent studies have also shown that body ownership can arise when animal avatars are used [9,10]. Animals possess physical abilities not found in humans, such as the ability to fly in birds. When using animal avatars, if these differences in physical abilities or characteristics create a strong impression on the user, psychological effects corresponding to that impression manifest.

It is possible. If the Proteus effect generated by animal avatars, which has been scarcely explored until now, becomes evident, the scope of potential subjects for inducing the Proteus effect in future investigations could expand beyond humanoid avatars to include animal avatars. This could provide a potential solution to problems that cannot be resolved using humanoid avatars constrained by human morphology and capabilities.

Existing research on immersion in non-human avatars has reported that transferring a sense of bodily ownership to coral reef avatars and calf avatars enhances subjects' awareness of environmental sustainability [11].Furthermore, the authors' previous research has reported that the emergence of bodily ownership toward bird avatars enhances immersion during flight experiences [10]. However, no studies have yet been reported that utilize the influence of abilities not possessed by humans, such as flight capability, to affect subjects' psychological states, attitudes, and behaviors.

Therefore, this study investigates the Proteus effect on non-human avatars using dragon avatars as subjects. Specifically, based on the impression of a dragon's robust physique and flight capabilities, we hypothesize that it can improve fear of heights and proceed with the research. Existing studies have used head-mounted displays.
Even when artificially recreating heights using immersive devices such as HMDs, it has been reported that humans experience fear of heights [12]. This indicates that fear of heights is a latent physiological phenomenon for humans.Furthermore, it has been reported that in environments inducing such fear, the ability to judge distances to objects and perform specific tasks deteriorates [13]. In recent years, technology is being established that allows operators on the ground to control flying drones as if they were their own bodies by transmitting the drone's camera footage to their HMD [14].If this study's hypothesis–that the impression of a dragon possessing flight capability and a robust physique manifests as a Proteus effect suppressing fear of heights–is supported, it could be applied to techniques for overcoming the fear that arises when moving to high places while operating a drone in first-person view.Furthermore, drones are emerging not only for aerial exploration but also for investigating environments likely to induce fear in humans, such as the deep sea and outer space. If this study clarifies the Proteus effect during dragon avatar use, the research domain could expand to investigating animal-type avatars to obtain psychological effects applicable to various environments.

To summarize, the contributions of this study are to expand the applicability of the Proteus effect
and demonstrating its efficacy in suppressing the potential physiological phenomenon of fear of heights in humans.

Chapter 2 reviews related research on body ownership and the Proteus effect to position this study. Chapter 3 describes the experiment verifying the Proteus effect of the Dragon Avatar. Chapter 4 presents the results of the experiment in Chapter 3 . Chapter 5 discusses the obtained results, and Chapter 6 summarizes the findings of this study.

2 Related Research

The sensation that a given body is one's own is called body ownership. Typically, one does not recognize anything other than one's own body as oneself. However, in VR ( ) psychology, it has been reported that body ownership can be experimentally transferred to an avatar by synchronously presenting multisensory information between the avatar and the user (e.g., visual-somatosensory synchronization [1], visual-self-containment sensation synchronization [4]).Specifically, visual-proprioceptive synchronization, where the user's movements are reflected and controlled by the avatar, has been reported to induce body ownership even when there are differences in physical appearance between the avatar and the subject. For example, body ownership can arise even with avatars that are clearly different from the real body, such as child avatars, avatars of the opposite sex, or robotic avatars [4-8].

When operating an avatar, the user interface changes according to the avatar's appearance.
The psychological state, attitude, and behavior of the avatar are affected. This psychological effect is called the Proteus effect [3]. Initial research on the Proteus effect reported that the more attractive the avatar, the greater the enthusiasm for negotiation-related games. The Proteus effect has been reported to influence not only user behavior but also cognitive functions and perceptual abilities, as users internalize the impression given by the avatar's appearance.It has been reported that when performing a percussion task, a brown-skinned avatar wearing casual clothing struck the percussion instruments more rhythmically compared to an office worker-style avatar [2]. Furthermore, it has been reported that the emergence of body ownership toward a child-sized avatar leads to a larger estimation of the surrounding space size compared to when using an adult avatar of the same size [4].Furthermore, it has been found that subjects with low self-esteem who develop a sense of body ownership toward an Einstein avatar show improved performance on cognitive function tests [18]. It has also been reported to influence empathy toward others.Experiences that induce body ownership toward avatars of different races have been reported to reduce latent biases toward those races [7]. These findings indicate that the image users hold of their own bodies becomes closer to the image evoked by the avatar's appearance through the induction of body ownership toward the avatar.Furthermore, it has been reported that not only body ownership but also the scenario conducted under VR experiences influences user attitudes. Although not in the context of body ownership toward avatars, it has been reported that a task involving flying through the air to deliver medicine to a child promotes prosocial behavior depending on the condition [19]. In the condition where participants flew as a superhero, compared to the condition where they flew as a helicopter pilot, the experimenters after the experiment

After deliberately dropping a pen holder, it has been reported that individuals actively assist in picking up the pen. This suggests that not only does it evoke a sense of bodily ownership, but strongly reinforcing one's identity and capabilities may be crucial for transforming cognition and behavior. However, the Proteus effect has primarily focused on humanoid avatars.

On the other hand, it has been reported that body ownership can also arise for avatars with body structures different from humans, i.e., non-human-like avatars. For example, body ownership has been reported for avatars with tails [15], hands that are 2–3 times longer than in reality [16], and avatars whose size dynamically changes with breathing [17].This indicates that creating a mechanism where the avatar's movements provide feedback to the user's actions is crucial for eliciting body ownership.Building on existing research regarding body ownership for non-human avatars, recent studies have reported that body ownership can also be elicited for animal avatars such as tigers, bats, and spiders [9,10]. Furthermore, our research has reported that body ownership can be elicited for bird avatars.If an avatar possesses body parts corresponding to human limbs, it can be operated using the same manipulations as one's own human body, enabling the generation of body ownership comparable to or even exceeding that of humanoid avatars.

Thus, a sense of body ownership is also observed in non-human avatars.

While it is known to be possible, the Proteus effect in non-human avatars has not yet been sufficiently demonstrated. Effects related to empathy have also been reported in non-human avatars.For example, an experiment inducing body ownership in a coral reef avatar reported increased awareness of environmental conservation and preservation among participants after the experiment [11]. In this study, participants placed themselves in a VR space of an ocean undergoing oxidation as a coral reef avatar, ultimately experiencing the cracking of their own coral reef avatar due to oxidation.While this demonstrates that first-person experience as a coral reef can change environmental awareness, it does not discuss how actively controlling a non-human avatar affects perception or cognition.

Regarding uses other than human abata, changes in behavioral patterns and

Changes in the perception of VR experiences have been reported.For example, when operating a monster avatar, changes in gait have been reported compared to operating a humanoid avatar [20]. Furthermore, in the author's previous research, it was reported that when experiencing flight in VR after developing a sense of body ownership toward the avatar, immersion in the flight experience was enhanced when flying with a bird avatar compared to flying with a humanoid avatar.Furthermore, it has been reported that inducing body ownership toward a robotic avatar provides a representation of a more robust body, thereby suppressing fear of heights [21]. It has been reported that it is possible to give the impression that one's cognitive functions are altered even when interacting with avatars possessing non-human appearances.

However, to the best of the author's knowledge, no reports exist of the Proteus effect–where an animal avatar's unique characteristics influence attitudes or psychological states–being observed in humans. Animals often possess physical abilities humans lack, such as birds' flight capabilities. It is conceivable that perceptions of these abilities shape impressions of the avatar, thereby generating specific Proteus effects.Therefore, this study focuses on dragon avatars, aiming to achieve a Proteus effect derived from impressions unique to humans. Specifically, it seeks to mitigate negative impressions associated with heights, such as fear of heights or anxiety about falling, by leveraging the dragon's characteristics: its robust physique and flight capability.While previous studies have reported that the Proteus effect with robotic avatars can improve fear of heights [21], these studies did not demonstrate significant differences in physiological responses. This research will evaluate subjective fear assessments—such as anxiety about falling and perceptions of heights–from multiple perspectives, alongside objective evaluations through physiological responses.

3 Experimental Study on the Effect of Avatar Appearance on Perceptions of Heights

This study aims to improve fear of heights and resolve limits based on innate human reactions by enabling subjects to perceive the dragon's robust physique and unique flying ability–traits absent in humans–as belonging to themselves through an avatar.To this end, the experiment investigates how reactions to heights differ between dragon avatars and human avatars when subjects are exposed to the high-altitude environment in the VR game " " ( ).

3.1 Experimental Environment

The experimental program was created using Unity 2018.3 . The PC used to run the program was equipped with an OS Windows 10 Home Edition , CPU Intel(R) Core(TM) i7-7700K (4.20GHz, 4.20GHz), GPU GeForce GTX1080, and 16.0GB of installed memory.For the head-mounted display (HMD), the HTC Vive Pro (resolution: 2880x1600, refresh rate: 90Hz, field of view: 110) was used to present visual information to the subjects.To capture the subjects' body positions, we used the XSens motion capture suit (manufactured by MVN, latency 20ms, tracking a total of 16 points on both hands, both feet, both wrists, both ankles, both elbows, both knees, both shoulders, the waist, and the head, and reflecting them in the avatar).

3.2 Experimental Conditions

Existing studies have shown that the Proteus effect manifests not merely through the simple transfer of body ownership to a specific avatar, but also through progressing a scenario aligned with that avatar within the VR experience [11,19]. Therefore, in this study, participants operated the dragon avatar (Figure 1, left) to embody a dragon in the Dragon Scenario condition and a human scenario condition where participants operated a human avatar (Figure 1, right). The experiment employed a within-subjects design. To eliminate the effect of viewpoint differences, the height of the dragon avatar was adjusted to match that of the human avatar. Human avatars were presented according to the participant's gender.

Each condition proceeds based on a fundamentally common experimental scenario.First, immediately after the experiment begins, the subject moves their avatar to confirm the synchrony between their actual body movements and the avatar's movements. Furthermore, the experimenter presents tactile information to the subject's body while simultaneously displaying information that visually appears as if the avatar's body parts are being touched. These procedures are based on existing research, aiming to strongly induce a sense of body ownership toward the avatar through synchronized movement and the synchronous presentation of multisensory information [4-8].Subsequently, following the experimenter's instructions, the subject navigates the VR space ( ). During this navigation, the subject interacts with characters (dragons or humans) that share the same appearance as the avatar being controlled, while traversing the VR environment. Since actual walking movement alone would be insufficient for covering the required physical distance, the flight movement method described in Section 3.4 was made available during the experiment.This also served to reinforce the impression that the dragon possesses flight capabilities. Note that flight movement was also possible with the human avatar. This was simply to provide a flight experience, independent of the avatar's visual appearance.

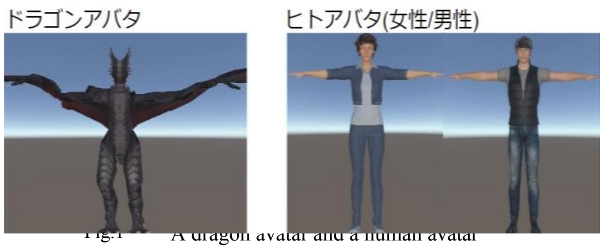

Fig.1 A dragon avatar and a human avatar

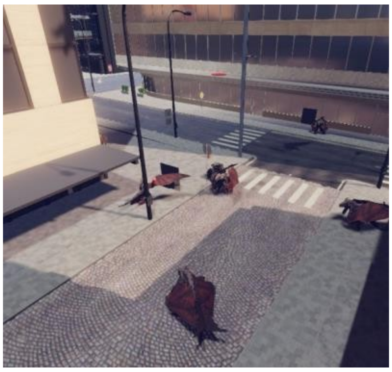

Figure 2 VR space used in the experiment

(Image shows the dragon scenario condition)

Fig.2 Virtual environment for an experiment (This picture is under the dragon scenario condition)

Repeated exposure may reduce fear of flying, so this was done to prevent differences in flight experience between conditions. At the end of the VR experience, participants were instructed to board a lift within the VR space. When this lift ascended to a high altitude and stopped, they were asked to rate their subjective level of fear. This task, designed to induce fear of heights, was based on existing research [21].

In the Dragon Scenario conditions, the Dragon Avatar was controlled, with Dragon characters placed around it. Communication with characters in the Dragon Scenario involved using wings or the head to gently stroke the other party for about 5 seconds, as if preening them. After performing this physical interaction with all Dragon characters, a shout was recognized via voice recognition, triggering the function to breathe fire. This was designed as the scenario for transforming into a Dragon.

In the human scenario condition, participants controlled a human avatar and were surrounded by human characters. Communication in this condition involved approaching a character, raising a hand, and greeting them. The system recognized the sound "Yes" as a greeting, prompting the character to respond accordingly. Participants could not breathe fire in the human scenario condition.

3.3 Experimental Procedures

Upon arrival at the laboratory, subjects signed the informed consent form after providing consent. Subjects were fitted with the motion capture suit XSens , and suit calibration was performed. After completing calibration of the XSens , subjects were fitted with the Vive Pro, the VR space used in the experiment was displayed, and the experiment was explained.At this time, adjustments were made to the fit of the HMD and to align the positions of the avatar's body parts with the subject's perceived self-body position. After adjustments, the subject was instructed that the task of this experiment was to approach the surrounding characters and engage in communication.We also explained the method for flying movement and had them practice by moving approximately 5 meters within the VR space at . After completing the equipment and avatar adjustments and the experiment explanation, the actual experiment began as soon as the subject was ready. The experimental conditions were presented in a counterbalanced manner.

Immediately after the experiment began, the VR space shown in Figure 2 was presented to the subject.

A mirror was positioned in front of the initial location, allowing subjects to verify the synchrony of their own movements and those of their avatar through both their subjective viewpoint and the mirror. The experimenter instructed subjects to operate their avatar using the following procedure:

1. Raise one hand and wave it, then confirm this action using both the first-person view and the mirror. Once finished, lower the hand and perform the same movement with the other hand.

Perform the same movement with the other hand.

2. Look down at the torso, step forward with one foot at a time, and confirm the movement using both the subjective viewpoint and the mirror. After completing this, perform the same movement with the other foot.
3. Lean forward and confirm the posture in the mirror.
4. Squat down on the spot and check your posture in the mirror.
5. Walk one step to the left, right, front, and back.
6. After turning your body to the right, turn it to the left, and finally face forward toward the mirror.
7. Move your body freely for 20 seconds to check movement synchrony.

In the experiment, as shown in Figure 3 (top), the avatar could be manipulated in response to the subject's body movements. After confirming movement synchrony with the above instructions, the subject was instructed to spread their arms. The experimenter then touched the subject's spread arms using controllers for the Vive , simultaneously presenting visual information showing a red sphere touching the avatar.At this time, the red sphere was programmed to move to a pre-set position in response to the controller's trigger input (see Figure 3(bottom)).

After confirming both movement synchronization and visual-tactile synchronization,the subject was instructed to fly to the character in the VR space and engage in physical contact. After engaging in physical contact with the five characters placed in the VR space, the subject was instructed to move to the position shown in Figure 4(left), just before boarding the lift. After moving to the instructed position, the subject was instructed to board the lift.At this point, a platform matching the size of the lift was placed at the corresponding real-world location.

After that, subjects observed the lift they were riding gradually ascend to greater heights in increments of 5 meters ( ) (Figure 4 (right)). When the lift stopped, subjects were instructed to look around and evaluate their subjective fear at that moment.Existing research indicates that human fear of heights saturates at 40m [22]. Based on this finding, the lift ascended from ground level (0m) to a final height of 40m . After assessing fear at 40m, the trial ended, and subjects were instructed to complete the questionnaire described in Section 3.5 . Subsequent trials followed the same procedure under different conditions.

Figure 3 Visual-Autoreceptive Sensory Synchronization and Visual-Somatosensory Synchronization

Fig.3 Visuo-proprioceptive stimulus synchronization and visuo-tactile stimulus synchronization

Figure 4 Lift-assisted movement to elevated positions

Fig.4 Locomote to upward using a lift

3.4 Flight Method

In the VR environment used in this study, users can navigate the VR space not only by actual movement but also by flying. This section explains the flying method.

First, subjects ascend into the air by performing a flapping gesture. The flapping gesture involves raising the hands above the shoulders and then swinging them downward within one second. Furthermore, subjects could move forward in the direction of their gaze by leaning forward. This flight method was designed to mimic how a dragon flies through the air.Additionally, the altitude reachable by flight is limited, with a maximum ascent height of 3 meters from the ground. This restriction prevents subjects from intentionally moving to higher altitudes via flight, thereby avoiding habituation to height stimuli.

3.5 Evaluation Method

3.5.1 Subjective Evaluation

Subjects were instructed to complete the pre-experiment questionnaire shown in Table 1 to assess their impressions of heights prior to the experiment. Impressions of heights were measured using the Attitude Toward Heights Questionnaire (ATHQ) [23] ATHQ is a 6-item questionnaire assessing attitudes toward heights based on the Semantic Differential method. For each question, responses were requested on a scale from 0 (positive attitude) to 10 (negative attitude). 1 After the trial, participants answered a similar questionnaire to investigate how impressions of heights changed with different avatar use. Analysis utilized the difference between the evaluation in Trial 1 and the pre-trial questionnaire evaluation.

During the experiment, as subjects gradually ascended to greater heights, they were asked to rate their Subjective unit of disturbance (SUD).
[24] The SUD ( ) is a measure of subjective anxiety. In this study, after ascending and gradually stopping, participants were asked to rate their subjective fear of the height situation immediately after looking out over the high elevation on a scale ranging from 0 (not afraid at all) to 10 (extremely afraid) on the .For subjects who could not tolerate the height and withdrew mid-task, all subsequent SUD ratings after withdrawal were scored as 10 (extremely fearful).

1 Immediately after the trial ended, the HMD ( ) was removed, and participants were asked about their sense of body ownership and transformation.
(as if transformed into an avatar), sensation of flight (as if flying through the air), sensation of invincibility (feeling unaffected even after falling from the lift), fear of heights, and anxiety about heights.
Each question item used a 7- p o i n t Likert scale, where "1" indicated "did not feel at all,"
and "7" indicating a very strong feeling.

3.5.2 Objective Evaluation

Humans increase sweating when exposed to threats, so existing research uses galvanic skin response as a stimulus indicator during threat exposure. Galvanic skin response is also used as an indicator of fear response in tasks measuring fear of heights [21]. Based on existing research, this study also analyzed data using galvanic skin response as an objective indicator.The galvanic skin response rating value was calculated by subtracting the average resting value at ground level from the maximum response value obtained between reaching a specific height and moving to the next height.

Table 1 ATHQ Questionnaire Items
Table 1. Questionnaires in ATHQ

0	Good - Bad	10
0	Pleasant - Unpleasant	10
0	Pleasant - Terrifying	10
0	Safe - Dangerous	10
0	Non-threatening - Threatening	10
0	Harmless - Harmful	10

Table 2 Post-Questionnaires
Table.2 Questionnaires in post-questionnaire

Q1	Sense of Body Ownership (Subjective)	To what extent did the avatar appear as if it were your own body from a subjective perspective? ?
Q2	Body Ownership Sense (Mirror)	To what extent did you feel the avatar reflected in the mirror as if it were your own body? as if it were your own body?
Q3	Sense of Transformation	To what extent did you feel as if you were (Dragon/Human Avatar) as if you were transforming into
Q4	Fear of falling	When looking at heights, to what extent did you feel anxious about falling?
Q5	Fear of Heights	During the experience, how strongly did you feel fear of heights? How strongly did you feel the fear of heights during the experience?
Q6	Sense of Flight	When flying, how much did you feel to the extent that you felt like you were flying
Q7	Sturdiness	Even if you fell from the lift, you felt like you'd be fine. .

4 Experimental results

Thirty-one participants ( ) participated in the experiment after receiving informed consent and signing the consent form. One participant reported VR sickness and discontinued the experiment. Additionally, two participants withdrew due to an inability to tolerate the fear of heights. However, since the participants expressed a willingness to continue the experiment, the trial was halted at that point and proceeded to the next trial.For participants who withdrew due to heights, their SUD ( ) ratings were assigned a value of 10 (extremely fearful) for all heights reached up to the point of withdrawal, as described in Section 3.5. Physiological responses from these participants could not be compared and were therefore excluded from analysis.

4.1 Subjective Evaluation

Figure 5 shows the changes in ATHQ (Table 1) after each trial. Figure 6 shows the results of the post-trial questionnaire (Table 2). Figure 7 shows the SUD results. All were analyzed using paired t-tests (significance level 5%).

Regarding the ATHQ, for all evaluation items except "Good-Bad," for the Dragon Avatar group (e.g., "pleasant-unpleasant": t = -3.462, p = 0.0020, "fun-scary": t = -3.2262, p = 0.0036, "Safe-Dangerous": t = -5.9167, p = 0.0000, "Non-threatening-Threatening": t = -3.8189, p = 0.0008, "Harmless-Harmful": t = -5.4944, p 0.0000). This indicates that manipulating the dragon avatar improved attitudes toward heights, shifting them toward more positive evaluations.

Regarding the post-event questionnaire, significant differences were observed between avatar conditions for anxiety about falling, fear of heights, and sense of robustness (Anxiety about falling: t = 3.7911, p = 0.0007; Fear of heights: t = -5.5482, p = 0.0000; : t = 5.2976, p = 0.0000). This indicates that operating the dragon avatar reduces negative impressions of heights more than operating the human avatar.

For SUD, significant differences were observed between avatar conditions at all heights except 10m (5m: t = -3.2625, p = 0.0033, 15m: t = -3.7039, p = 0.0011, 20m: t = -3.4641, p = 0.0020, 25m: t = -4.3296 p = 0.0000, 30m: t = -4.8614, p = 0.0000, 35m: t = -5.5 p = 0.0000, 40m: t = -5.547, p = 0.000). This indicates that operating the Dragon Avatar suppressed subjective fear of heights.

Additionally, two participants retired due to an inability to tolerate the fear of heights. One participant retired at the 20m stage in the human scenario condition, while they were able to continue the experiment to the end in the dragon avatar scenario. The other participant retired at 15m in the human scenario and at 30m in the dragon scenario.

In summary, it was found that using the Dragon Avatar improved ratings (reduced fear of heights) across all subjective ratings of impressions related to heights compared to using the Human Avatar.

4.2 Objective Evaluation

Data from 23 als, excluding corrupted data and data missing due to retirement, were used for analysis. The analysis revealed significant differences between avatar conditions for galvanic skin response at 5m, 10m, 25m, and 30m (5m: V = 61.5, p = 0.03356, 10m: V = 59.5, p = 0.02815, 25m: V = 60, p = 0.03012, 30m: V = 55, p = 0.03426).

This indicates that the use of Dragon Avatar can suppress the fear felt at specific altitudes not only in terms of subjective reactions but also in terms of physiological reactions, i.e., at the latent level.

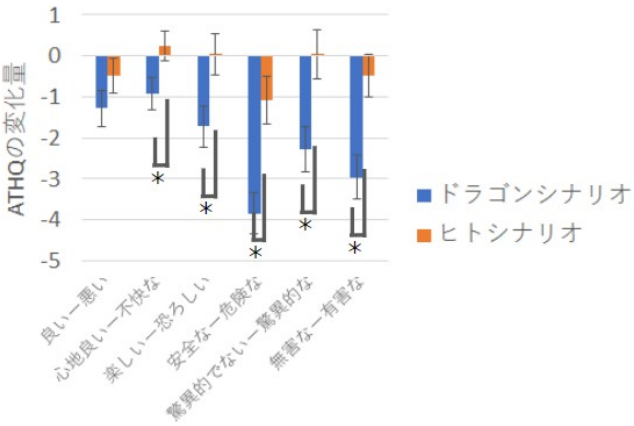

Figure 5 ATHQ results (error bars indicate standard error)
Fig.5 Results of ATHQ (Error bar shows standard error)

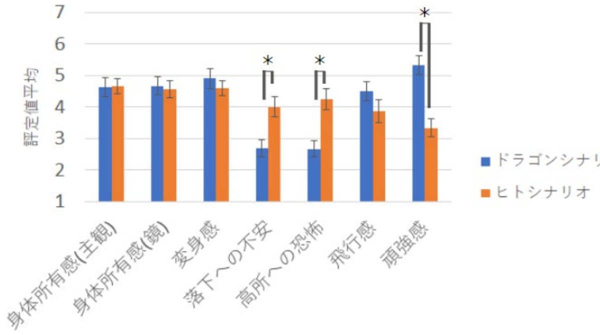

Figure 6 Post-Event Survey Results

(Error bars indicate standard error)
Fig.6 Results of post-questionnaire (Error bar shows standard error)

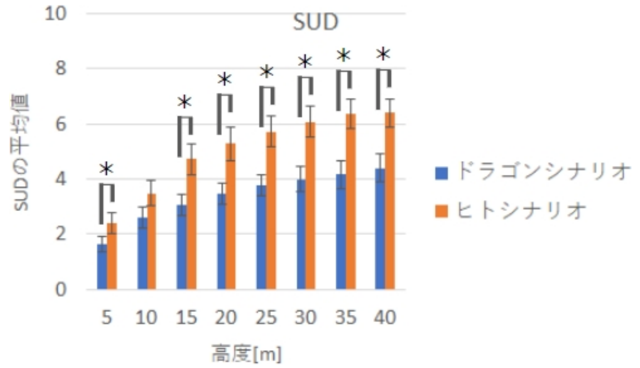

Figure 7 SUD results (Error bars indicate standard error)
Fig.7 Results of SUD (Error bar shows standard error)

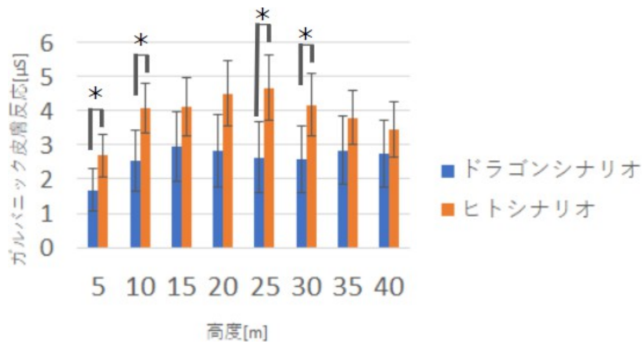

Figure 8 Galvanic skin response results

(Error bars indicate standard error)

Fig.8 Results of Galvanic Skin-conductance Reaction
(Error bars show standard error)

4.3 Comments

The following comments were obtained from the experimental participants

- Even after the flight simulation, I couldn't believe it would be okay to move to a high place because the human avatar has the ability to fly... 11 cases
- Because they have wings, I thought they could just fly away, so I wasn't worried about falling or anything like that... 17 cases
- The Dragon Avatar felt more realistic... 6
- The realism of the experience was about the same... 6 responses
- The human avatar provided a more realistic experience... 3 responses
- With the human avatar, my legs froze and my body shook toward the end
- The human avatar gradually became more afraid of the height
- The level of fear when boarding the platform with the human avatar and when ascending to the highest point with the dragon avatar was the same.
- With the Human Avatar, I couldn't look around
- With Dragon Avatar, I subjectively felt the fear was about half as intense compared to Human Avatar
- With the Human Avatar, I felt that if I fell, I wouldn't survive... 2 cases
- With the human avatar, the surroundings appeared smaller... 2 cases
- With Dragon Avatar, the larger volume makes it feel more powerful... 2

5 Analysis

Based on subjective evaluations, improvements were observed for all questionnaire items in the Dragon Avatar except for the "good-bad" impression in ATHQ ( ). Additionally, regarding SUD (Subjective Units of Distress), a fear-suppressing effect was observed except at a height of 10m. Post-experiment questionnaires showed improvements in anxiety about falling, fear of heights, and a sense of resilience.

Comments suggest that when facing high altitudes, positive opinions about the dragon avatar were common, while negative opinions about the human avatar were frequently observed. Interestingly, despite both conditions involving flying through the air at low altitudes, no subject imagined flying with the human avatar when facing high altitudes. Conversely, many subjects commented that the dragon avatar's wings made it easy to imagine flying.This suggests that when facing high altitudes, even if one experiences superhuman abilities exceeding human physical capabilities in the VR world ( ), if it is a standard human avatar, one remains constrained by the mental model of human capabilities and physical limitations. This suggests the possibility that, despite having lived in a human body throughout their life and operating the avatar for only a short time, their mental model may no longer be human. Summarizing the comments, it becomes clear that their body image was corrected by the impression given by the dragon, strongly influencing their attitude toward heights.

Objective indicators showed significant differences in galvanic skin response between the avatar and the subject at specific heights (5m, 10m, 25m, 30m). This indicates that the Dragon Avatar suppressed fear even in unconscious, subliminal aspects.

In summary, Dragon Avatars were shown to significantly suppress fear of heights compared to Human Avatars. Comments also suggested that this suppression may stem from dragons having wings, making it easier to associate them with the image of flight capability.

6 Summary

This study investigated whether animal-specific abilities not possessed by humans manifest in the impression formed when operating avatars, enabling the acquisition of a Proteus effect unique to animal avatars. Specifically, we hypothesized that the impression of a dragon's flight capability and robust physique would suppress fear of heights. To test this, we conducted a VR experiment involving confronting heights.In the experiment, participants controlled either a dragon avatar or a human avatar. Following the experimenter's instructions, they flew around the VR space while communicating with characters. After completing the specified tasks, subjects were instructed to board a lift within the VR space. The lift ascended in 5m increments , ultimately reaching 40m . After the lift stopped at each stage, subjects evaluated their subjective fear levels.

Experimental results demonstrated that compared to human avatars, dragon avatars

At specific altitudes, the Dragon Avatar also showed significantly lower physiological response ratings than the Human Avatar, indicating that the Dragon Avatar's effects were also active at a subconscious level.

The results of this study demonstrate that Dragon Avatar is effective when confronting high places.The findings suggest that human avatars may activate a mental model where humans are inherently incapable of flight. However, the real world features motifs like superheroes—humans who fly. Comparing experiments with dragon avatars to test whether the Proteus effect on such figures also improves fear of heights could clarify the role of animal avatars. Future experiments exploring this will build upon the present findings.

We will continue investigating whether the findings obtained are unique to animal avatars.

Acknowledgments

Part of this research was supported by the Leading Program for Doctoral Education at Toyohashi University of Technology, "Cultivating Brain Information Architects for Advanced Processing of Massive-Scale Brain Information."

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(September 2, 2019)

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