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Appearance and Task Success in Novel Avatars

Abstract

Novel avatar bodies are ones that are not controlled in a one-to-one relationship between the user's body and the avatar body, for example, when the avatar's arms are controlled by the user's legs, or, when the avatar has a third arm. People have been shown to complete tasks more successfully when controlling novel avatar bodies than when controlling avatars that conform to the normal human configurations, when those novel avatars are better suited to the task (Won, Bailenson, Lee, & Lanier, 2015). However, the novel avatars in such studies tend to follow two conventions. First, the novel avatars still resemble biological forms, and second, the novel extensions of the avatar are connected to the avatar body. In the following study, participants operated bodies with three arms. We examined the interaction between biological appearance of the third arm and whether it was attached to the body. There was a significant effect of biological appearance on performance, such that participants inhabiting an avatar with a biological appearance did worse overall. There was also an interaction with biological appearance and an extension that appeared detached from the participant's body such that participants in this condition performed most poorly overall. We propose a relationship between self-reported presence and task success, and discuss the implications of these findings for the design, implementation, and use of novel avatars.

1 Introduction

When users inhabit an avatar of a different appearance than their own, they may change their attitudes and behavior (Yee & Bailenson, 2007). But what happens when users inhabit *novel* avatars, or avatars that diverge from the normal human template (Lanier, 2006)? The ability of humans to adapt to novel avatar bodies is important both as it informs a theoretical understanding of body schema and as it applies to the practical implications of avatar use. For example, changing the relationship between an avatar's movements and the movements of the user may be used in the treatment of pain. However, since mimicking the user's actual appearance is not possible in avatars that deviate from the normal human template, the question of how such novel bodies should appear remains open.

The effects of avatar appearance in other settings, especially virtual environments designed for therapeutic purposes, are beginning to be explored. This includes the effects on reported pain of changing the color of an avatar's hand (Martini, Perez-Marcos, & Sanchez-Vives, 2013), and how the way an avatar's movements are rendered may increase or decrease an injured patient's willing-

Presence, *Vol. 24, No. 4, Fall 2015,* 335–346
doi:10.1162/PRES_a_00238

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ness to move (Chen, Ponto, Sesto, & Radwin, 2014; Harvie et al., 2014; Won, Tataru, et al., 2015).

Recent research in virtual reality has demonstrated that people can adapt to novel avatar bodies and develop a sense of body ownership for these bodies. In a 2012 study by Kilteni, Normand, Sanchez-Vives, and Slater, participants inhabited avatars with arms of varying length, and reacted to threats to even very long arms with increased arousal. In a second study, Steptoe, Steed, and Slater (2013) allowed participants to inhabit an avatar with a long tail. Participants whose avatars' tail movements were synchronous with their own body movements reacted more strongly to threats to the tail than participants who inhabited avatars where the tail movements were asynchronous.

A 2015 study demonstrated that participants can use these novel avatars to succeed in a specific task when the avatars are better adapted to the task than the normal human configuration (Won, Bailenson, Lee, & Lanier, 2015). In this study, participants completed two target-hitting tasks in two different avatar bodies. One avatar body followed the normal human template with only two arms, so that participants had to step forward to hit targets in the most distant array. The second avatar body had a long "third arm" extending from the chest, controlled by rotation of the left and right wrists, such that participants could remain stationary while hitting targets in the most distant array. Participants were more successful at hitting targets when controlling the second avatar body.

In the following pages, we discuss some possible effects of appearance on avatar bodies during active task performance. We then describe an experiment replicating the "third arm" study just described, in which we maintained the same method of avatar control (wrist rotation) across conditions but altered how the avatar extension appeared in each condition. We discuss differences in task success between conditions and discuss the relationship between task success and self-reported presence across conditions.

1.1 Biological or Non-Biological Appearance

Recent research on body transfer indicates that, among other factors, a more realistic appearance (human skin texture and clothing) as opposed to a less realistic appearance (a neutral colored mannequin) can increase the strength of feelings of body ownership (Maselli & Slater, 2013). In a virtual pointing task, participants preferred a more realistic representation of a hand, and those seeing a very abstract "pointer" did worse overall (Pusch, Martin, & Coquillart, 2011). Other studies with implications for designing avatar bodies have investigated how appearance affects the perception of movement. One study investigated whether mirror neurons are differentially activated when participants observe the movements of a robotic-looking hand as compared to a biological-appearing hand, finding that biological appearance activates the premotor cortex (Tai, Scherfler, Brooks, Sawamoto, & Castiello, 2004). In a second study, participants reacted differentially to recordings of a coactor reaching with a human hand or a wooden hand (Tsai & Brass, 2007).

However, other recent research has found that avatar realism slightly reduced the illusion of virtual body ownership in an active task (Lugrin, Latt, & Latoschik, 2015). A follow-up study to the wooden hand study indicated that participants who were led to assign agency to the wooden hand after watching an animation then coacted with it similarly to a human hand (Müller et al., 2011). In addition, other evidence suggests that observers apply Fitt's law, which captures the relationship between speed and accuracy of movements, to both robotic and biological-appearing arms (Grosjean, Shiffrar, & Knoblich, 2007). Finally, ownership has been found for nonhuman objects in active tasks, for example, objects such as balloons that change in size or cubes that change in color in synchrony with participant gestures (Ma & Hommel, 2015).

Another possible factor is that, given that novel avatars necessarily deviate from the human form, there may be an "uncanny" effect of an avatar that is designed to appear human but fails to completely achieve that illusion (Lugrin et al., 2015). Such a near-miss may distress or distract users. Thus, the question of whether biological appearance is advantageous or disadvantageous for novel avatars, especially in active tasks, remains open. Our first research question is, therefore, whether users controlling a novel avatar in virtual reality using body movements hit more targets when the avatar body has a biological appearance.

1.2 Attached or Detached Appendages

Whether and how tools are incorporated into body schema has been the subject of research in both animals and humans. Research on tool use in monkeys indicates that using a stick may cause the body schema to extend post-tool use (Cardinali, Frassinetti, et al., 2009) and, in humans, that this kind of first-order extension can extend to other objects that are grasped (Carlson, Alvarez, Wu, & Verstraten, 2010). Experiments on patients suffering from neglect and neurologically normal patients imply that effects are different for patients touching a distant target with a stick compared to those contacting it with a laser pointer, such that participants who touch distant objects with a stick include those objects in near space, while those using a laser pointer do not (Pegna et al., 2001; Longo & Lourenco, 2006). Alternatively, researchers have argued that tool use extends peripersonal space (Serino, Bassolino, Farnè, & Làdavas, 2007) or have proposed that the concepts of body schema and peripersonal space are intertwined and may possibly be considered as one (Cardinali, Brozzoli, & Farnè, 2009).

In a previous study, we used a novel avatar with an extension—a longer "third arm"—and demonstrated that participants had greater success using this avatar in a target-hitting task than using an avatar mapped to the normal human template (Won, Bailenson, Lee, & Lanier, 2015). Understanding how additions to the human body are perceived is important for the design of avatars, both to increase abilities in virtual reality, and when designing therapies for patients using novel avatars. For this reason, we used this template, previously identified as being advantageous for this target-hitting task, to investigate our second research question: whether users controlling a novel avatar in virtual reality, with an extension that goes past the bounds of their physical body, hit more targets when the extension appears to be attached to the avatar body.

To answer these research questions, we designed the following study to examine the effects of avatar appearance on users controlling a novel avatar body with a long extension from the chest during a target-hitting task. We compared four conditions in a two-by-two design, crossing whether the avatar extension appeared Attached or Detached (having an appendage that was or was not connected to the avatar body) and whether the avatar appeared Biological or Mechanical (whether the appendage resembled a human body part, including matching the user's skin tone, or looked like a mechanical substitute). The method of controlling the extension, by rotating the left and right wrists, was identical across conditions. We thus examined the effects of the different conditions on the number of targets hit by avatar arms and extension combined during a five-minute period.

Since the physical method that controlled the avatar was identical in all cases, and only the appearance of the avatars differed, we looked at participant attitudes toward their avatars by examining differences by condition in self-reported presence measures. These measures were as follows. Self-presence consisted of eight questions that measured the extent to which participants felt themselves to be present in the avatar body, which were averaged together to create one summary measure of self-presence. Identification consisted of six questions on the extent to which participants felt that the avatar appearance was acceptable and natural, which were averaged together to create one summary measure of identification. Environmental presence consisted of five questions on the extent to which participants felt themselves to be present in the virtual environment and able to interact with it. These questions were also averaged together to create one summary measure of environmental presence. All questions are described fully in Appendix A. Our third research question is thus whether there is a relationship between presence measures and success in the target-hitting task.

2 Methods

In this between-subjects study, 84 participants were randomly assigned to one of four conditions, in each of which they attempted to hit targets using their hands and a third extension coming from their avatar's chest. All elements of the study were approved by the Institutional Review Board, and all participants signed informed consent documents.

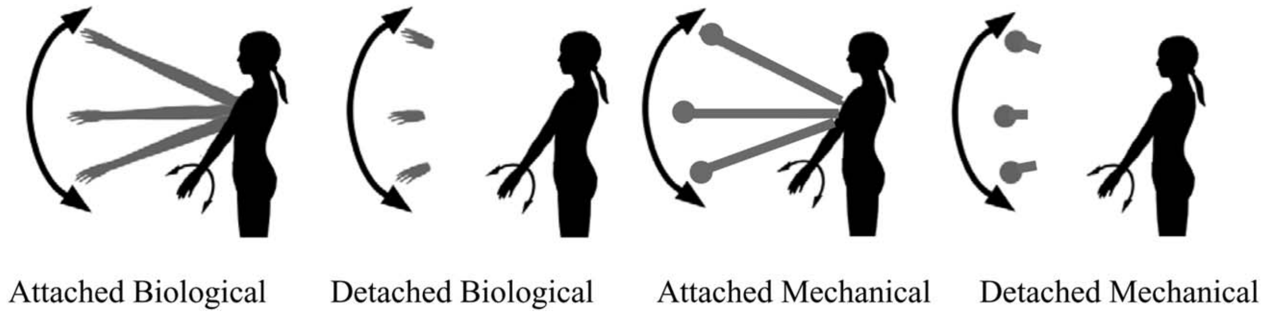

Figure 1. *The black figure represents participants' real-life tracked movements; the gray figure represents the corresponding avatar rendering of the third "limb."*

Fourteen participants were excluded for technical failures or for misunderstanding instructions. In addition, since the left hand always controlled the horizontal movement and the right hand controlled the vertical movement, hand dominance might differentially affect control. We tested whether being right-handed, left-handed, or ambidextrous had an effect on score, using a generalized linear model with a Poisson link, and found that left-handedness significantly decreased score across conditions ($z = -5.45, p < 0.001$, 95% confidence intervals -0.43, -0.20). Thus, six left-handed participants were also excluded, leaving 64 participants (24 males).

The first condition was Attached Biological ($N = 14$, 5 males) where participants controlled a third "limb" that resembled a human arm approximately 1.3 meters in length, with a texture matched to their skin tone. The second was Detached Biological ($N = 17$, 7 males) where participants controlled a floating hand that appeared approximately 1.3 meters in front of them, with a texture matched to their skin tone. The third was Attached Mechanical ($N = 16$, 5 males) where participants controlled a third "limb" that was a simple silver geometric rod shape approximately 1.3 meters in length, and the fourth was Detached Mechanical ($N = 17$, 7 males) where participants controlled a floating silver shape that appeared approximately 1.3 meters in front of them. In all conditions, the length of the arm or rod, or distance of the shape or floating hand, was controlled such that it was always at the same depth: that of the third array of cubes. The models were also designed such that for both Attached and Detached conditions, Mechanical models took up the same amount of space in the user's field of view as the Biological models. All four conditions are depicted in Figure 1.

In order to increase identity with the avatars and to avoid gender effects of either women or men controlling a nonmatching gender, we matched each participant by gender to a male or female avatar. Both avatars were modified from stock high-resolution digital avatars provided as part of the WorldViz Vizard character animation package. We scaled the avatars to each participant's height and matched the avatar skin color, and the color of the two biological extensions, to the participant's own skin color. The mechanical extensions were a neutral silver-gray color.

Before the task began, participants received a few minutes of instruction on moving their avatars' limbs, guided by the researcher. Because the gestures used to control the extension were the same in every case, the researcher was thus able to remain blind to participant condition. Participants' normal left and right arm motions moved the corresponding avatar's arms. Because elbow and wrist movements were not rendered, avatar arms remained straight and did not bend or twist with participant movements, but followed the movement of the trackers on participants' wrists. The extension was controlled by rotational motion of the wrists, such that rotating the right wrist moved the extension vertically up and down, and rotating the left wrist moved it horizontally from left to right. All participants' hands were placed in a starting position such that they could see their appendage centered in front of them, since the "detached" appendage in the Detached Biological and Detached Mechanical conditions were otherwise easier to

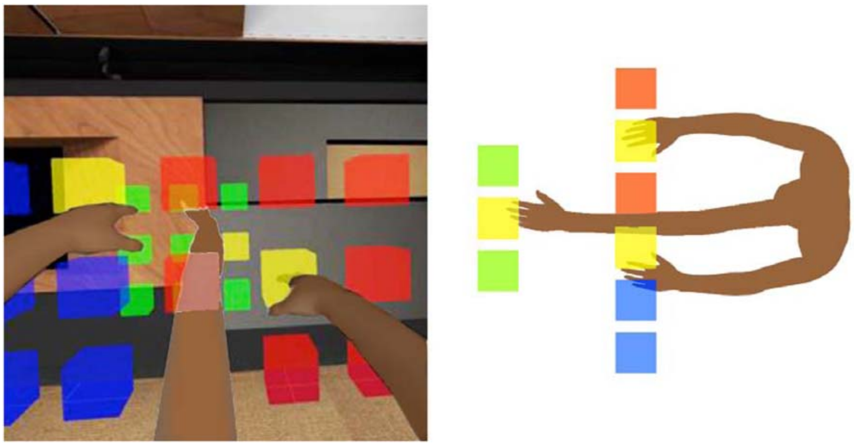

Figure 2. *This shows the three arrays of nine 7.5-cm cubes that appeared in front of each participant, from the POV of a participant in the Attached Biological condition. The position of the arrays was scaled to participant height. However, the length of the arm remained constant at 1.3641 m. The blue array appeared on participants' left, the red array appeared on participants' right, and the green array was centered approximately .5 m beyond them. Target cubes are shown in yellow. The left side shows the participant's POV. In this example, the "third limb" is visible, as are the two avatar arms. The right side shows a bird's-eye schematic.*

miss than their Attached counterparts. Participants saw their avatar from the first person perspective; that is, they were able to see their avatar's arms and legs only when they entered their field of view (see Figure 2, left side).

The target-hitting task lasted five minutes, and consisted of as many trials as the participant could complete in that time. To begin the task, participants hit a blue cube, which expanded to present the three stationary arrays shown in Figure 2, right side. In each trial, one target cube in each of the three arrays was white. To complete the trial, all three of these white targets were hit. Targets could be hit in any order, and when a participant successfully hit a target, a tone sounded, and the target cube turned yellow. Once all three targets had been hit, a second tone sounded, and a new set of targets lit up. Participants could hit the three targets in any order to reduce the cognitive load of keeping a specific order in mind.

2.1 Apparatus

Each participant wore an nVisor SX111 (NVIS, Reston, VA) head-mounted display (HMD) with an attached accelerometer (Inertia3 Cube) to track the pitch, yaw, and roll of the head and an infrared optical tracker to measure the X, Y, Z position of the head. One infrared optical tracker and one accelerometer were also attached to each wrist of each participant. Accelerometer orientations were updated at 180 Hz, 4 ms latency, and recorded with an accuracy of 1° yaw and 0.25° pitch and roll. The trackers were updated at up to 175 Hz, with less than 20 ms latency, capturing movement with an accuracy of .25 mm over a 3-cubic-meter volume.

Participants received three-dimensional visual feedback through two stereoscopic screens in front of their eyes. Each screen had a resolution of 2056×1024 pixels, and was refreshed 60 times per second. Participants also received audio feedback when interacting with stimuli in the environment. The audio feedback, provided by a 24-channel Ambisonic Auralizer Sound System, allowed participants to hear tones associated with cubes being successfully hit. At each successful hit, participants also received a small amount of haptic feedback through the floor of the room from low-frequency speakers.

2.2 Measures

During each of the five-minute sessions, we recorded each time that a trial was completed (a trial was considered to be completed when a participant hit all three targets), and defined the dependent variable "Total Score" as the total number of trials completed (as in Won, Bailenson, et al., 2015). Participants scored between 28 and 112 completed sets per session, with a mean of 73.7 ($SD = 22.5$).

Our self-report measures included eight questions on self-presence and five questions on environmental presence (following Won, Bailenson, et al., 2015). In addition, six questions on identity with the avatar body were added. All questionnaires were administered at the end of the experiment. All scales except for one visual scale on self-presence were from 1 to 5, and were averaged together to create three summary measures. The alphas, means, and standard deviations for each measure were as follows: Self-Presence (Cronbach's alpha .78) was 2.82 ($SD = 0.59$), Identity (Cronbach's alpha .80) was 2.65 ($SD = 0.63$), and Environmental Presence (Cronbach's alpha .82) was 3.13 ($SD = 0.77$). For the exact wording of the questions, please see Appendix A.

3 Results

Our research questions were as follows. First, we examined whether biological appearance is advantageous or disadvantageous for users completing a physical task in virtual reality by controlling a novel avatar using body movements. Second, we examined whether the appearance of attachment is advantageous or disadvantageous for users completing a physical task in virtual reality by controlling a novel avatar whose bounds extend beyond that of the physical body. Third, we wanted to see if differences in task performance might be linked to differences in self-reported avatar identification, self-presence, or environmental presence.

3.1 Comparing Task Success Across Conditions

We first examined the total number of target sets completed in each condition. Because this was non-normally distributed count data, we used a two-way ANOVA for total counts over time, using a generalized linear model with a Poisson link. There was a statistically significant negative effect of Biological condition on

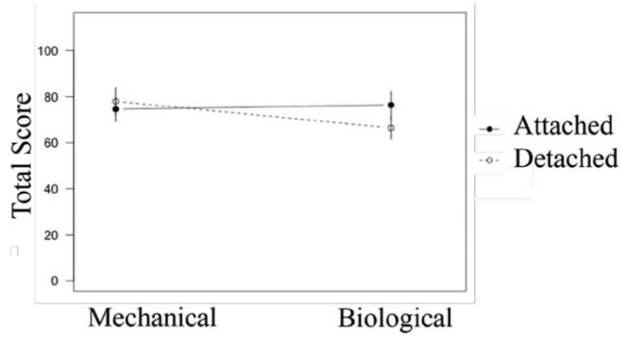

Figure 3. *The above plot shows the interaction of the Mechanical/Biological and Attached/Detached Conditions; error bars show one standard error of the mean.*

score ($z = -3.95$, $p < 0.001$, 95% confidence intervals -0.24, -0.08). There was also an interaction between Biological and Attached conditions, such that participants overall did worst in the condition that was both Biological and Detached ($z = -3.15$, $p = 0.002$, 95% confidence intervals -0.07, -0.30), as shown in Figure 3.

3.2 Presence in Novel Bodies

To further investigate these results, we turned to the self-report measures to look for possible explanations for differential task success. Using linear regression, there was no main effect of condition on Self-Presence, Environmental Presence, or Identity (all p's greater than 0.05). Again using a generalized linear model with a Poisson link, we found a statistically significant relationship between Self-Presence and Total Score ($z = 6.67$, $p < 0.001$, 95% confidence intervals 0.12, 0.21), such that Total Score increased as Self-Presence increased. Identity showed a similar positive relationship with Total Score ($z = 5.54$, $p < 0.001$, 95% confidence intervals 0.08, 0.17). There was no statistically significant relationship between Environmental Presence and Total Score ($p > 0.05$).

Figure 4 shows how conditions may influence task success. These plots show the relationship between Total Score and Self-Presence, Total Score and Identity, and Total Score and Environmental Presence, for each of the four conditions. The means and standard deviations of each variable by condition, as well as the correlations of each variable with Total Score, are shown in Table 1. In the categories of presence that refer to the avatar (Self-

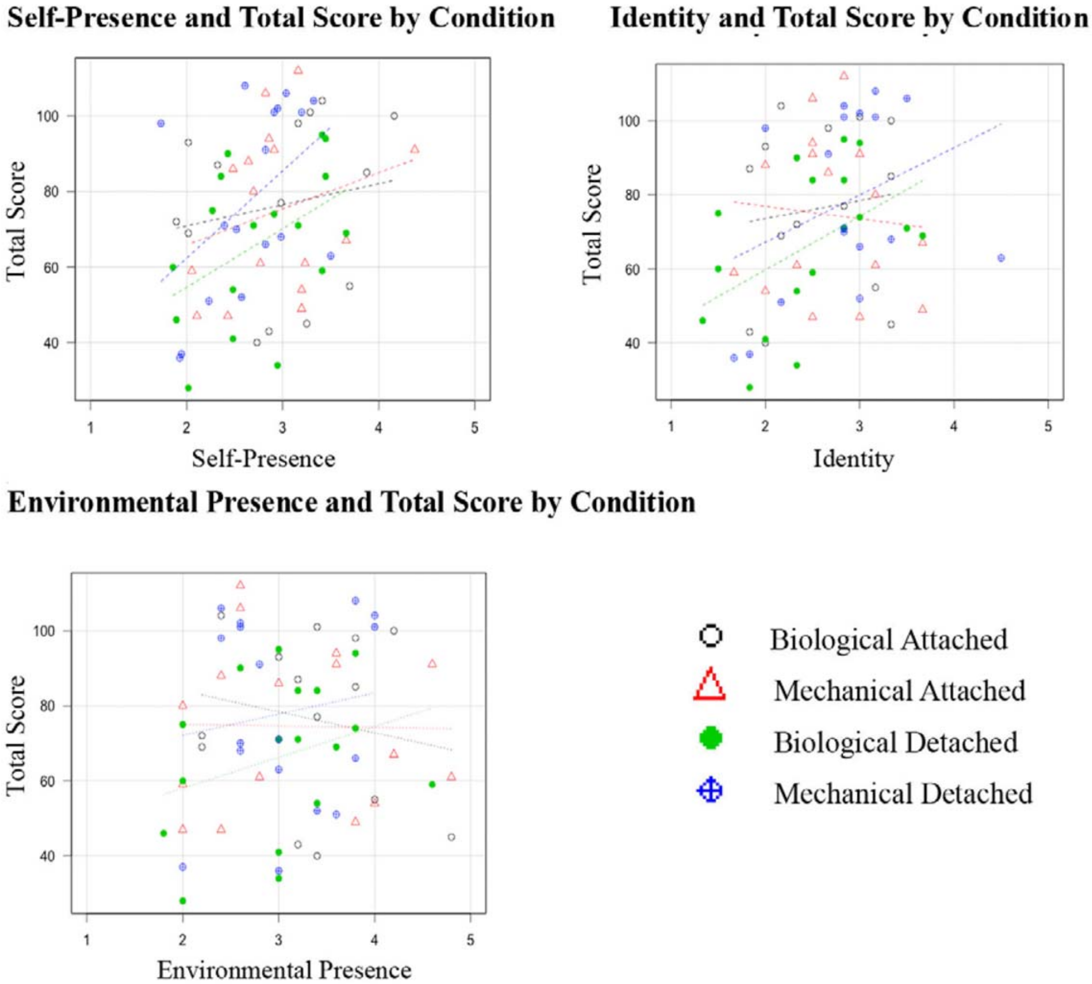

Figure 4. *The relationships between the self-reported measures of Self-Presence, Identity, and Environmental Presence and Total Score.*

Presence and Identity) greater presence may be linked to greater success in the target-hitting task more strongly for participants in the Biological Detached condition, who also scored lowest overall. While we do not claim causality for this relationship, it bears further investigation. The fact that there is not a corresponding statistically significant effect of environmental presence may also lead us to focus on avatar appearance as a potential cause of these effects.

4 Discussion

In the study described here, we found differences in task success between Biological and Mechanical appearing conditions, and interactions between appearance, task success, and self-presence and identification with an avatar. Further investigation into these apparent differences may be informative in the design of novel avatar bodies.

Manipulating the biological appearance of these avatars by matching their skin tones to each user and using a digital model of an arm for the extension appeared to decrease participants' task success. This may be due to the fact that a novel avatar can never appear truly human, and so attempting to adhere to the normal human template produces feeling of dissonance, akin to the theory of the uncanny valley (Mori, MacDorman, & Kageki, 2012). Such an "uncanny valley" effect may reduce task

Table 1. *Means and Standard Deviations by Condition*

	Biological Attached	Mechanical Attached	Biological Detached	Mechanical Detached
Identity	2.57 *(.59)* .12	2.70 *(.57)* −.09	2.46 *(.68)* .54 ($p = .054$)	2.84 *(.68)* .34
Self-Presence	2.98 *(.71)* .17	2.91 *(.58)* .26	2.76 *(.59)* .45 ($p = .072$)	2.67 *(.50)* .47 ($p = .060$)
Environmental Presence	3.36 *(.75)* −.18	3.15 *(.94)* −.02	3.02 *(.76)* .30	3.04 *(.62)* .14

Means are shown first, followed by the standard deviation in parentheses. Correlations between each presence variable and Total Score are last.

success, as has also been proposed by Lugrin et al. (2015). In such circumstances, achieving presence in a novel avatar body may have more to do with other affordances, such as tracking (Cummings & Bailenson, 2015), and biological realism may actually be best avoided.

There was also an interaction between biological appearance and attachment, such that participants in the condition that featured a biologically realistic and detached extension had a lower total score. In Figure 4, it appears that the correlations between the self-reported measures of Presence and Total Score are strongest in this Biological Detached condition. It is thus possible that participants with low self-reported measures of Identity and Presence in this condition may be the ones who drive the low scores overall, providing us with a tentative mechanism for what may drive differential success in the target-hitting task according to avatar appearance.

4.1 Limitations

Our first limitation must be the relatively small sample size of each condition, and the fact that although statistically significant, the effect sizes of the different conditions on total score were generally small. Thus, these findings should be taken in the context of other work on task success in novel avatars.

Second, while we propose that the "uncanniness" of the avatar may cause the lower scores in this condition, we did not ask questions specifically relating to this quality, so this interpretation of the results must remain speculative.

Third, while this study attempted to compare biological and non-biological avatars by customizing the skin tone of the avatar to the user, and making the shape of the avatar look more or less organic, none of the avatar shapes can be said to be truly "biological." This is true for two reasons. First, all were novel avatars, and second, all were digital approximations and not photorealistic. While the ability to render more detailed and realistic virtual environments may alter the second factor, the fact that these novel avatars are not seen in nature remains an issue.

Fourth, while we discuss a possible relationship between self-reported presence and task success, we cannot determine causality from this study. It is also possible that low task success may create distaste for and a wish to disassociate from the experience, changing participants' self-report ratings post-task.

Finally, despite our best efforts to design equivalent conditions, there are still some differences between conditions that may also have affected success. First, in the biological conditions, the extension was colored to approximately match the participants' skin tone, while in the mechanical conditions, the extension was always a silver color. It is possible that some skin tones may have been less visible than the silver color. While we found no relationship between avatar skin color and task success in the Biological conditions, we cannot discount this possibility. It is also possible that the extension may have served as an anchor point, an aid not available in the Biological detached condition.

4.2 Presence in Passive and Active Avatar Use

While previous studies dealing with novel avatar bodies have not always explicitly distinguished between active and passive self-representation, this is a distinction that may be important. Many studies on creating a sense of body transfer rely on more passive methods of integrating the avatar body with the user, for example, by simultaneous touch. Other studies, in particular those that focus on tool use, have the user complete a task, for example, a target-hitting task. As Haans and IJsselsteijn point out (2012), second-order extension (incorporation into the body schema) is necessary for transparent use of an avatar body, but third-order extension requires the user to identify more deeply with the avatar form. Riva and colleagues (2011) propose that people engaged in a task at a higher level goal may actually be less conscious of their body than someone grappling with the simple mechanics of taking action. For these reasons, we propose that while users appear to be able to rapidly learn to use a novel avatar body, a sense of identification with such an avatar body may be both more difficult and more risky.

This may be relevant to other research on using games, including virtual reality games, as distractors from pain. Such therapies often provide patients with a fun task in a virtual world; for example, in Hunter Hoffman's SnowWorld (Hoffman, Patterson, Carrougher, & Sharar, 2001) burn patients undergoing painful treatment throw snowballs at snowmen while riding a train through a snowy landscape. One proposed mechanism is that the user is engaged in a virtual task that is so immersive and engaging that the patient forgets the real world, including his or her own body. In this case, fostering a sense of self-presence in an avatar body may be helpful insofar as it replaces the patient's sense of presence in his or her actual, injured body, or alternatively, allowing the patient to remain "disembodied" may be more helpful in some instances.

Other interventions, however, alter the relationship between how a patient moves, and how his or her movements are represented. For example, designing a virtual world where an avatar's leg moves at a greater range in response to a small movement of a patient's physical leg may encourage movement (Won, Tataru, et al., 2015). Conversely, reducing the amount of gain from a patient's movements may help to prevent guarding, for example, by showing the avatar moving less than the actual patient is moving (Harvie et al., 2015). There are many instances where these distortions might be advantageous. However, to the extent that it disturbs the patient, or reminds the patient of his or her injury, a sense of self-presence in a non-normal body might be better left unprompted.

4.3 Future Directions

The relationship between presence and function in a novel body may also relate to the way that the user's natural movements map to the avatar movements. As Bowman and colleagues point out (2012), increasing the naturalness of a control technique without making the technique fully natural may actually harm performance in a task. If, for example, we had a control schema that more closely matched human joints, and if wrist rotation moved the extension side to side but wrist flexion moved the arm up and down, perhaps a biological appearance would not have had a negative effect. It is an interesting question for future research whether the naturalness of control technique may interact with natural appearance.

How and whether users may achieve a sense of presence in, and identity with, a novel avatar body is important for several reasons. It is necessary to understand when presence and identity may be helpful for the purposes of specific tasks in virtual reality. It is also important when considering how such bodies can be used therapeutically, to aid people in living comfortably in their actual physical bodies.

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Appendix A. Wording of Post-Task Questions

For all questions, unless otherwise noted, participants were asked to select from the following:

1. Not at all
2. Slightly
3. Moderately
4. Strongly
5. Very strongly

Identification Questions

To what extent did you feel that. . .

I identify with my avatar's appearance.
When your avatar succeeded in hitting all three target cubes, to what extent did you feel successful?
To what extent did the movements you used to hit the target cubes feel natural?
To what extent did you like the appearance of your avatar?
To what extent did you feel that your avatar resembled you?
How human-like did your avatar appear to you?

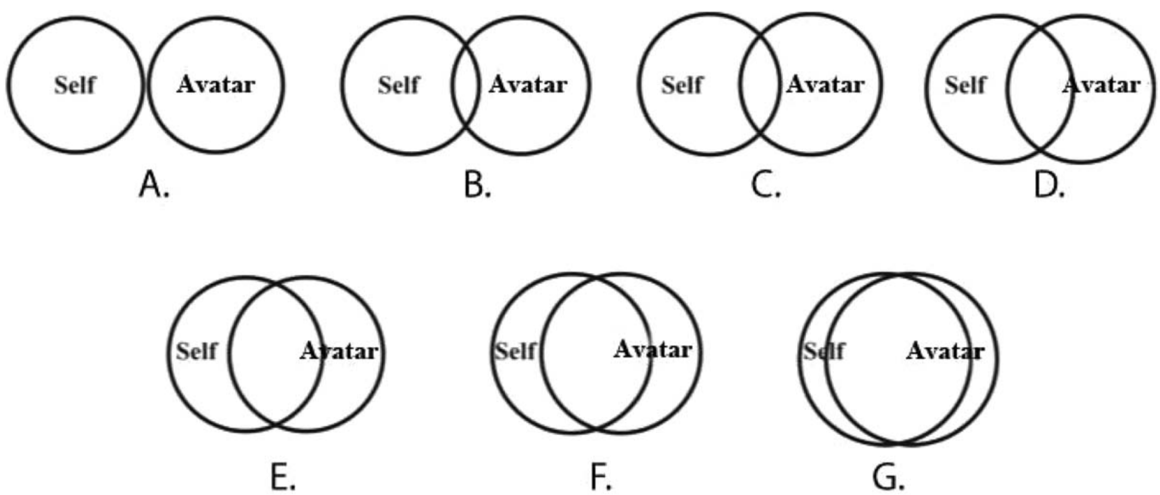
Environmental Presence Questions

To what extent did you feel that. . .

I was really inside the virtual lab.
I felt surrounded by the virtual lab.
I really visited the virtual lab.
The virtual lab seemed like the real world.
I felt like I could really touch the cubes in the virtual lab.

Self-Presence Questions

Please indicate which image best corresponds to the relationship between you and your avatar:



To what extent did you feel that. . .

If something happened to the avatar, it was happening to me.
The avatar's body was my own body.
I was in the avatar's body.
The avatar was an extension of me.
The avatar was me.
If someone ridiculed the avatar I would feel irritated.

If I watched someone else perform the same task with the same avatar, I would feel*

1. Awful
2. Rather bad
3. Neutral
4. Pleased
5. Delighted

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* this question was reverse coded