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Poster

Reducing the Proteus Effect in Virtual Reality: A Mental and Acting Approach

Erika Kimura[1], Adelaide Genay[2], Kizashi Nakano[3], Yutaro Hirao[1], Monica Perusquía-Hernández[1], Takuji Narumi[3], Hideaki Uchiyama[1], and Kiyoshi Kiyokawa[1]

[1]Nara Institute of Science and Technology, Japan, [2]University of Melbourne, Australia, and [3]The University of Tokyo, Japan

Abstract

The Proteus effect in virtual reality (VR) refers to how users' behaviors align with their avatar's appearance, often reinforcing stereotypes. While this effect can enrich VR experiences, it also risks unintended stereotype reinforcement. This study explores methods to enhance and mitigate the Proteus effect by applying a "Mental and Acting Protocol" before avatar embodiment, involving Introduction, Mental Imagery, and Acting stages. In a controlled experiment with 68 participants embodying elderly avatars, walking speed was used as a behavioral measure. Results showed no significant differences across conditions, underscoring challenges in consistently replicating the Proteus effect. These findings offer insights for refining VR priming techniques to manage stereotype-driven behaviors.

1. Introduction

Virtual reality (VR) enables immersive experiences where users embody avatars with various attributes that can shape behavior and perceptions through the Proteus effect. First described by Yee and Bailenson, the Proteus effect suggests that users adopt behaviors associated with stereotypes linked to their avatar's appearance [YB07]. For example, embodying a taller avatar may increase assertiveness, while using an elderly avatar can lead to slower movements, aligning with age-related stereotypes. While valuable for VR design, the Proteus effect also raises concerns about reinforcing negative stereotypes [DVP13].

Research on the Proteus effect has shown mixed results: some studies report behavioral changes consistent with avatar traits, while others find no significant effects [SKM14]. These inconsistencies suggest that factors like user familiarity or contextual cues may influence the strength of the effect. Recent studies have explored role-playing and mental imagery as strategies to increase user engagement in VR [HMS17], providing potential tools to manage the Proteus effect more reliably.

Building on this research, Genay et al. developed the "Mental and Acting Protocol," which uses mental exercises to enhance avatar embodiment [GKH*24]. Initially designed to amplify the Proteus effect, this protocol may also help reduce stereotype-driven behaviors by fostering greater awareness and control over avatar embodiment. In this study, we extend Genay et al.'s protocol to test its effectiveness in both reinforcing and countering stereotype-aligned behaviors, specifically using elderly avatars. By measuring walking speed as a behavioral indicator, we evaluate whether the protocol can modulate Proteus effects in VR.

2. Methods

2.1. Mental and Acting Protocol

The Mental and Acting Protocol was adapted to either align with or counter stereotypes of elderly avatars. In the stereotype-consistent condition (**EC** below), participants were primed with reduced mobility imagery, while the stereotype-contradicting condition (**EO** below) used active elderly stimuli. The protocol included three stages: an *Introduction* phase where visuals and videos introduced participants to avatars, either reinforcing or challenging stereotypes; a *Mental Imagery* phase with guided exercises that had participants imagine stereotypical (e.g., slow movement) or counter-stereotypical (e.g., vigorous) scenarios; and an *Acting* phase where participants performed actions ranging from slow movements to dynamic gestures to enhance embodiment.

2.2. System and Avatar Stimuli

The VR system used an HTC Vive Pro headset with foot and hand trackers in a Unity environment. Avatars, created using Character Creator4, represented elderly and younger individuals.

2.3. Measures and Participants

Figure 1 illustrates the experimental procedure. Walking speed before and after VR exposure was recorded in the straight segment of 18.5 m near Room B. Participants also completed the Virtual Embodiment Questionnaire (VEQ) to assess Sense of Embodiment. Sixty-eight participants aged 18–63 participated in the study.

2.4. Conditions

Participants were randomly assigned to four conditions:

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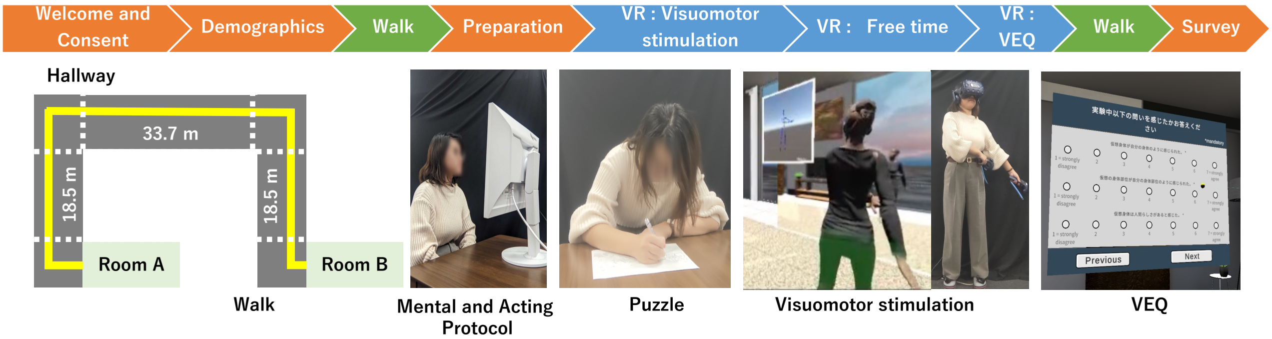

Figure 1: *Participants started near Room B, walked to Room A to complete consent and demographic forms, and wore motion sensors. After a baseline walking speed measurement on the way back to Room B, participants engaged in VR immersion with visuomotor stimulation. Finally, they walked back to Room A, where post-experiment walking speed and Sense of Embodiment (SoE) measurements were recorded, followed by a final questionnaire.*

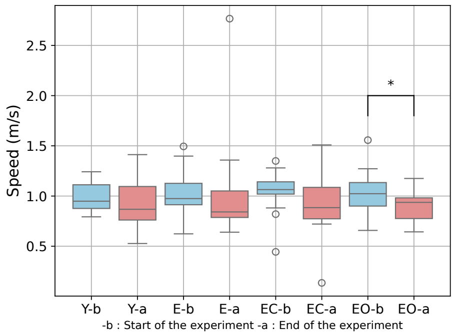

Figure 2: *Walking speed measurements before and after VR exposure across conditions. "-b" and "-a" denote walking speed before and after VR exposure, respectively.*

- **Y (Young) / E (Elder):** Embodiment of a young or an elderly avatar, followed by a neutral puzzle-solving task.
- **EC (Elder + Consistent):** Embodiment of an elderly avatar after stereotype-consistent imagery and mental exercises.
- **EO (Elder + Opposite):** Embodiment of an elderly avatar with stereotype-contradicting imagery and mental exercises.

3. Results

An aligned rank transform (ART) ANOVA found a significant effect of the two measurement timings at which walking speed was measured, $F(1,126) = 14.2, p = 2.47 \times 10^{-4}, \eta_p^2 = 0.101$. On the other hand, the main effect of the four conditions of the experiment was not confirmed, $F(3,126) = 0.383, p = 0.765, \eta_p^2 = 9.04 \times 10^{-3}$. No significant interaction between the timing at which walking speed was measured and the four conditions of the experiment was found, $F(3,126) = 0.882, p = 0.882, \eta_p^2 = 5.23 \times 10^{-3}$.

VEQ scores showed no significant differences across conditions either, indicating minimal impact on VR embodiment.

4. Discussion and Conclusion

These findings reveal challenges in eliciting Proteus effects solely through avatar stereotypes, as no significant changes were observed in either walking speed or embodiment. A likely factor is the perceived age discrepancy, with participants reporting avatars appearing younger than expected in VR. Additionally, cultural factors may play a role; in Japan, elderly avatars might be viewed as more active, potentially influencing results and diminishing stereotype-consistent behaviors typically linked to elderly avatars.

Furthermore, the experimental setup may have affected outcomes, including experimenter presence during walking speed measurements and post-VR assessments. These observations suggest that refined protocols and nuanced priming techniques are needed for reliably modulating Proteus effects in VR. Future studies should consider cultural perceptions' impact on behavior and explore alternative measures for more accurate assessment.

This study tested whether a Mental and Acting Protocol could modulate Proteus effects in VR using elderly avatars to manage stereotype-driven behaviors. Although no significant behavioral changes were observed, the findings highlight key factors influencing the Proteus effect, such as cultural perceptions, avatar realism, and procedural aspects of the experiment. These insights underscore the need to refine VR study designs, focusing on avatar representation and protocol variations. Future research should prioritize refined avatar designs, larger sample sizes, and cultural considerations to improve understanding and control of Proteus effects in VR, potentially leading to more targeted applications.

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