Avatar Types Matter: Review of Avatar Literature for Performance Purposes

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Abstract. The use of avatars as learning agents is becoming increasingly popular in the sports, education and military domains due to the rapid advancement in distributive technologies (e.g., internet, virtual worlds, etc.). When it comes to military and sports, Simulation-Based Training has proven to be cost-effective, due largely to restrictions on time, costs and safety [1]. As virtual reality and virtual worlds have become cheaper and more powerful in computer terms, the subject of how an avatar relates to an avateer (the avatar's controller) is becoming increasingly popular. More precisely, interest rests on how an avatar's appearance may promote or disrupt training objectives, by affecting the behavior or the psychology of a user, and thus subsequently raising or degrading learning. Virtual simulations for training have often shared the aspect of avatars found in Virtual Reality, video games, and Virtual Worlds. This paper examines how avatar representation can provide insight into manipulating avatar appearance for training demands. Existing literature suggests avatars act as drivers for affective changes in attitude and motivation, and can be integrated into an instructional strategy.

Keywords: Agent · Avatar · Doppelganger · Virtual environments · Virtual reality · Instructional systems design · Motivation · Attitude · Simulation

1 Introduction

Simulation-Based Training (SBT) is often carried out through a Virtual Environment (VE), where a user (or learner) is situated in a synthetic environment for carrying out authentic tasks. Aspects of military training, due largely to restrictions on time, cost, and safety, have the potential to be cost-effectively enhanced by SBT [1].

As in other uses of digital and interactive media, such as video games, an avatar in SBT represents the learner as a virtual substitute. An avatar is a stand-in for the person, which may be represented by a human character, another animal, a vehicle, or any other image. Specific human examples include a generic virtual human, a subject matter expert (SME), and a doppelganger or look-alike - an avatar that realistically matches its owner's features (Fig. 1). A user typically inhabits an avatar in a Virtual Reality (VR) system, enacting as an entity within the environment. In contrast, a user's icon in a text-based Internet message forum also acts an avatar. Ultimately, a range of media can afford avatar

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usage. Avatars, for our research purposes, do not include digital actors, such as Digital Emily [2], or agents endowed with artificial intelligence, such as intelligent tutors and virtual assistants. As VEs have become cheaper and more powerful in computing terms, interest in how an avatar relates to an avateer (i.e., the avatar's controller) has spawned research questions in the natural sciences, social sciences, and arts. While other aspects of avatar behavior lag in development (e.g., nuanced and spontaneous facial movements correlating with a user), basic avatar appearance has been spotlighted as it can be flexibly customized. Namely, this paper's interest is in how an avatar's appearance may be manipulated to promote training objectives. Through changing the behavior and psychology of a user, avatars could aid in raising positive transfer to a real-world task. Virtual reality experiments consisting of virtually embodied avatars have elicited user behaviors, after experimental exposure, which corroborate the idea that avatar appearance can affect one's beliefs, attitudes, and perspective. Avatars manifested in other forms of VEs, too, can shape user performance. What follows is a brief review of how avatars' appearances affect behavior, and the consequent implications for SBT.

Fig. 1. Avatar types (from left to right): a generic avatar, a military SME avatar, and a doppelganger avatar (shown with corresponding avateer) (Doppelganger photograph replicated with permission from Hudson and Badillo-Urquiola [24]).

2 Avatar Appearance Effects in Virtual Reality

A VR system allows a user to be submerged within a synthetic space, or alternate reality. Key features of VR include interactivity within said space, displays (i.e., sensory dimensions of seeing, hearing, touching, and so on) providing feedback for interactions within that space, and a contrived world that allows for immersion, or the feeling of "losing oneself," in an experience [3]. Pure VR technology is concerned with constructing a replacement of real elements; a holistic illusion of some real or fantastical idea and/or environment. This type of virtuality is in contrast to forms of mixed reality: augmented reality, where virtual objects are injected into real-world environments; and augmented virtuality, where real-world elements are placed in a predominately virtual environment [4]. Researchers using virtual simulations have applied the strengths of VR to influence user behaviors.

Manipulating avatar appearance, in conjunction with VR capabilities, is a specific type of research that offers insight into facilitating performance. Avatar-appearance has been a factor for altering racial bias, exacerbating musical body-movements, and improving susceptibility for choosing long-term retirement savings. All these experiments involved immersive VR, where humans had some level of control over their embodied avatars. Additionally, improved exercise motivation has been attributed through vicariously watching a doppelganger run.

2.1 Racial Bias

Employing VR, negative bias towards African-Americans was lowered for users that embodied a dark-skinned avatar, in comparison to wearing the “skin” of either a Caucasian person or a purple alien [5]. Importantly, one experimental group had black-skinned avatars that matched each user’s coincident real-life body movements, as shown in a virtual mirror. However, another experimental group had black-skinned avatars that lacked the mimicking features of the virtual mirror. This type of interaction had a significant difference, where those with reciprocating body movements having a higher drop in bias than the same skin-tone avatars without the mirror effect. Here, the maxim of “seeing is believing” is reinforced, where the non-reciprocating avatars may have created a break in the illusion of the VR system.

2.2 Retirement Savings

The effects of embodying a different version of a human were also replicated in an experiment by Hershfield et al. [6]. Users who spent time embodied in a photo-realistic, elderly version of themselves, and accessed aforementioned aspects of mirror-matching, reserved more money for retirement. A hypothetical task given before and after the VR intervention served to detect changes in monetary savings behavior. The condition where users did not view an elderly version while in the VR had little effect on this task.

2.3 Musical Body Movements

Finally, again adopting a mirror-matching paradigm, users who embodied a dark-skinned and casually dressed avatar were more likely than other avateers to have a wide range of body movements while playing a djembe drum [7]. The other avatars consisted either of a light-skinned person wearing a formal suit, or a pair of opaque, white, floating hands. This experiment suggests social cues are inferred and internalized during body ownership.

2.4 Exercise Motivation

Attitudes toward exercising have been a source of interest in terms of avatar manipulation. In two experiments, highly realistic doppelgangers and generic avatars were viewed in three conditions: a doppelganger running, a generic running, and a doppelganger loitering [8, 9]. In the first experiment, users who watched their avatar double run were the most likely to perform more exercise within 24 h after the experiment. A second, companion experiment inspected these conditions (with an added fourth condition of a generic loitering), with objective, physiological measures of arousal serving as variables. The highest rates of arousal were found in doppelgangers exercising and generics loitering. The doppelganger effect may point to imagining oneself running from previous experience, or perhaps higher engagement by vicariously watching oneself exercise. The generic loitering may have raised nervousness and lowered comfortability.

2.5 Implications for Training from Virtual Reality

The central question to our research was, “Does avatar appearance effect learning?” To answer this, we review the evidence built from the foothold of VR avatar literature. The associations, bonding, and/or empathy elicited in some of the VR experiments can cascade into behavioral changes. Specifically, perspective and attitudes have been altered due to the control, feedback, and illusion of an avatar, in what Slater and Sanchez-Vives term “body semantics” [10]. Further, a learner watching their doppelganger avatar running impacts the user to increase exercise. The act of “becoming” a different race, an elderly version of one’s physical self, or an athletic self (indirectly), resulted in changes within a value system. If a learning objective is to teach one to exhibit a certain behavior that is attitudinal in nature, avatar usage appears appropriate. Ultimately, supporting motivation can be integral for any objective. The terms attitude and motivation are used in the sense of being part of the user’s affective domain. According to Hays [11], affective behaviors can play a role in orienting the learner’s system to receive content: affective behaviors “primarily influence interactions among the learner’s decider subsystem, input transducer, associator, and memory to open the input screen to the material to be learned” (p. 208). In common terms, learning occurs because one is open to learning, or is in an accepting mood for learning. If a student does not want to learn, the process for learning becomes arduous.

The requirements of time, personnel, space, and equipment can drain project resources for a VR experiment or training setup. Clark [12] proposes a replaceability challenge to compare differing types of media, and decide if a cheaper or more convenient avenue is available. The experiment where users interacted with their digitally-aged doubles had an impact on saving behavior, yet came with hefty technology. The authors thus decided to simplify their results using only a 2-D aged-self or present-self on an online application [6]. The aged avatar would smile if money was reserved for retirement, or frown (in gradations) for placing less amounts of money in retirement. The opposite facial features roles existed in the present-self condition. The aged-self participants, as in the original VR experiment, placed more money in a retirement fund. Here, an avatar still exists (if in the abstracted form of a floating head), while retaining avatar-appearance effects for effectively considering future finances. Practical use of a VR may be limited, thereby inviting innovation with other forms of media and VEs for behavior modification.

3 Avatar Appearance Effects in Other Virtual Environments

Virtual Reality is one type of VE. To give adequate depth to avatar research, other VEs involving avatars deserve mention. These include video games in a broad sense (entertainment-oriented or learning-oriented), and Virtual Worlds (VWs). A recent game-based turn in training has caused serious games to be criticized for their potential benefits [13, 14]. Since serious games blend aspects of entertainment with formal instruction, one part of these games' efficacy may rest on avatar appearances.

3.1 Video Games

Given an endless runner game, users who played as an avatar that resembled themselves had more intrinsic motivation than users who played as a random avatar for their character [15]. The former group identified highly with their avatar, a sign of character attachment that aligns with Banks and Bowman's [16] view of users creating an "avatar-as-Me" projection.

Applying a serious game for math and programming skills, an experiment by Kao [17] allowed users to be represented either by a geometric shape, or by a human cartoon character. The cartoon character was extracted from the Nintendo Wii's mii catalog to resemble a user's likeness. The abstract shape group outperformed the other group, which might signal that the mii group was over-attached to their likeness avatars (attributing failure to themselves), that the avatars were distracting, or that the avatars reinforced stereotypes (given that the game used was a programming and math game, females may have subscribed to the stereotype of being bad at math).

3.2 Virtual Worlds

Virtual sandboxes, or VWs, are another type of VE where avatar appearances are connected to human behavior. These systems are sandboxes in the sense of being coordinated by user and community guidelines, rather than the necessarily enforced rules of games. In Second Life (SL), avatars socialize, play, learn, and shop via avatars. Within SL, many users feel less inhibited, choose preferred body sizes, and don virtual drag that portrays their ideal identity [18].

3.3 Implications for Training from Other Virtual Environments

There are signs of avatar appearance effects on learning within types of VEs, but the avatar functions can be contradictory. For example, doppelgangers helped performance in the endless runner game, yet were connected to hindering performance in the programming game. Even proposals for avatar utilization clash: Fox, Bailenson, and Ricciardi [9] believe using a doppelganger to show ideal behaviors may improve self-efficacy (i.e., the learner's belief they can complete a task), but Yim and Graham [19] contend that an ideal doppelganger would lower self-efficacy. The difference is that the ideal behavior in the former is for social anxiety (the avatar would perform social behaviors), whereas the latter is for exercising (where a thinner version of the self would induce negative feelings of inadequacy, and lead to demotivation). Ultimately, the task and how an audience would react to an avatar should be analyzed. To illustrate, an ideal-weight self may be appropriate in SL for socializing or shopping, but questionable in a work-out simulation. Additionally, a work-out simulation may circumvent building a negative sense of self by removing both a 3rd-person and mirror-image view of the avatar completely, or by adapting a non-human character.

4 Limitations and Future Directions

Instead of a global review, this paper investigated a few crucial points, in an economical look at existing avatar phenomena. The Proteus Effect, for example, is a topic warranting substantial consideration as a driver of performance in future research. The Proteus Effect explains that a person will change their behavior in accordance with the expectations a community places on that person's avatar appearance [20].

As a limit, the experiments discussed involved short periods of avatar use in experimental settings. This artificial setup ignores that avatar-relations can develop over long periods of time, and strengthen with investment in a character. There are also many combinations of avatars, and therefore many variations are ignored for the sake of an experiment. For instance, clothing has had effects in the real-world on improving cognition [21], begetting investigation for changes in avatar clothing. Another future tangent is determining if, and when, avatar appearance does not significantly matter.

Tweaking avatar appearance suggests a suitable vehicle for improving motivation. Baylor [22] has noted the important link between motivation and avatar appearance. In the realm of instructional design, instilling motivation in a trainee serves as a critical step in the learning process. The Attention, Relevance, Confidence, and Satisfaction (ARCS) Model of Motivational Design was developed by Keller [23] to address motivational needs. This model serves as a starting point for mapping types of avatars to types of motivation. Hypothetically, a goal in a serious game may be more relevant to a person if the avatar is a doppelganger, and student attention may be gained by a soldier SME avatar in a VE for warfighter tasks. Such applications would require testing for their effectiveness. A next step towards understanding avatar-appearance training factors is to find the ways avatar types map to a motivational framework.

5 Conclusion

This paper addressed whether avatar appearances can function as a tool for improving performance. Various studies on VR and other VE applications have shown that avatar appearance can change behaviors, such as attitudes and motivation. These types of applications suggest avatars as part of a larger instructional strategy. That is, changing an avatar may support performance, rather than completely predicting performance. The early stage of research on avatar types leads to pertinent illustrations and strong evidence, rather than a complete concrete framework, for adapting avatar appearances towards a learning objective.

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