Connected to My Avatar:

Effects of Avatar Embodiments on User Cognitions, Behaviors, and Self Construal

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Abstract. Mediated experience increasingly involves some representation of ourselves, so-called avatars. Avatars are used to facilitate the interaction with others in social media or are integrated as part of interfaces, used for interacting with 3D spatial environments and objects in games and simulations. These avatars vary in the degree to which they are realistic, representative of our sense of self or social status, or embodied, that is connected via the computer interface to the user's body via sensorimotor interaction. We review some of psychological effects of avatar identification and embodiment including evidence of the effects of avatar identification and embodiment on changes in behavior, arousal, learning, and self-construal. Furthermore, some avatar based changes in perception, cognition, and behavior may carry over and extend into changes into user's real world perception and behavior.

Keywords: avatar, human computer interaction, presence, embodiment.

1 Communication and Interaction Using Virtual Representations of Our Selves

Mediated experience is increasingly a large part of everyday experience as media use extends to more platforms, activities, and parts of day. The average American spends over 250 hours a week interacting with media [1]. Interactive media increasingly require representations of ourselves to mediate the interaction with others and to interface with the virtual environment. Social media, for example, are used by over 73% of internet users. So many of the over than 3.5 billion internet users will have some representation of themselves interacting with the virtual environment. Among American social media users, 64% report using some form of social media every day [1].

These representations and interfaces involve some representation of ourselves that can be static or dynamic, real or imagined. But the representations do play a role in mediating our interactions with others and with spatial interfaces. Often the representations of ourselves are created to have a communication and psychological effect on other users. They are used strategically to represent our bodies, our "look," or some aspect of our identity, personality, or social status. While these representations are the

interfaces used for impression management, our avatar representations can in some cases significantly interact with our own psychological states and behaviors.

1.1   Avatar Forms

Digital representations of our selves are commonly referred to as avatars, a word borrowed from Hindu myths regarding embodiment of gods, or divine intelligence, in human form. In the digital realm avatars are virtual entities or representation controlled by a human being or human intelligence. Avatars are contrasted with computer agents. Agents are virtual entities, anthropomorphic or seemingly sentient and intelligent, controlled entirely by a computer program.

Avatars vary in the representational and technological dimensions that connected them to the user. Within the range of avatar presentations there is a wide continuum of forms and interface embodiments. At the extremes avatars can vary from simple illustrations or pictures, such as individual's image use to represent and interact with others in social media to fully articulated, 3D body representations fitted to our actual bodies like those that might be found in high-end simulations or games.

Along the interface dimension of avatar control and interactivity, avatars vary to the degree to which they are passive, non-interactive representations or interactively controlled or embodied. Passive representations include a full host of pictures and images used in variety of social media and some games. These are representations of the self-presented to others.

In dynamic media a 2D or 3D avatar may be controlled directly by our body in some way. This creates a level of sensorimotor connection to the avatar, or to put it another way a level of sensorimotor embodiment [2]. By embodied avatar we mean that some body based action, a motor action of hand, head, or full body, is linked directly to movement of the avatar and experienced in some visual or multisensory feedback or stimulus. In the physical world this direct sensorimotor connection, the link between perception and action, is how we experience our own bodies and the sense of our interaction with physical space [3, 4].

But the link between perception and action can be mediated by some technology. As in the rubber hand illusion even simple perceptual motor coupling (in this case the synchronous stroke of a brush on our real and extended rubber hand) can lead to distortions in the perceived morphology of the body and a projection of the perceived locus of the body and sensation into a technological extension, the rubber hand [5-7].

Low level embodiment might include the control of an avatar via a basic hand interface such as mouse, joystick, or game pad. This form of avatar control is a kind of puppeteering. Higher levels of embodiment might include the three dimensional embodied avatars seen in virtual reality systems and in certain game systems such as those using high level of 3D body sensing and representation provided by devices such as the Kinect.

Avatars regardless of level of embodiment are designed, socially-constructed entities. The selection of images, body types, clothing, or other aspects of representation

involve some conscious investment of our identity into the representation. The resulting avatar may vary in its level of resemblance to our physical identity in terms of morphology and appearance. It may also vary in its resemblance to our psychosocial identity such as visual cues of social roles, gender, personality, and behaviors. While any representation of the self is possible, there is tendency in most avatar systems for representations to become more anthropomorphic over time and to resemble in some ways the physical or ideal traits of body morphology and psychosocial identity of the user.

   The degree to which the body is embodied and psychologically connected to the avatar has significant implications on the degree and range of psychological responses to virtual environments and stimuli.

2   Psychological Effects of Avatar Embodiment

As in embodied cognition within the physical world [8, 9] even simple avatars can influence cognition and behavior in the virtual environment. As these involve changed in embodiment, they effects persist and extend into cognition and behaviors outside the virtual environment.

2.1   Identification with the Avatar

At the lowest level of psychological effect the simple inclusion of avatar inside a medium or virtual environment can change our perception of the environment. It is widely reported in environments where users construct an avatar such as multiplayer games, that users report high level of identification with their avatars. The simple addition of an avatar representation of the self to a game and virtual environment can increase user enjoyment and motivation [10, 11]. The environment becomes more personally relevant.

   A key feature may be identification with the avatar. Neuroimaging studies of interaction with our avatar self-representations support the role of identification. Ganesh and colleagues [12] studied neural activation (fMRI) of gamers and non-gamers in response to personality trait ratings of themselves, their avatar, or familiar others. Neuroimaging results revealed greater activation in the left inferior parietal lobe, a region associated with self-identification from a third person perspective and regions (rostral anterior cingulate gyrus) indicative of emotional self-involvement with the avatar. Memory for avatar traits covaried with the length of time a user was involved in gameplay, suggesting that this identification with the avatar increased with the use and interaction.

   The process of identification begins in the vary act of selecting or constructing an avatar in low embodiment interfaces. It is automatically activated when the level of embodiment is higher, stimulated by the sensorimotor coordination between ones perception (sensory feedback) and action (motor movements) linking the user's body to the virtual avatar event [13].

2.2   Avatar Identification and Increasing Arousal and Motivation

Identification with one's avatar may increase the level of arousal and motivation in a virtual environment. This is evidence that users may differ in their levels of arousal depending on their degree of psychosocial connection to an avatar or avatars varying in their level of embodiment.

Bailey and colleagues [10] had children play a simple game that involved an avatar that was either assigned, chosen by the child from a pool of avatars, or designed (customized) by the child. Arousal during game play, as measured via skin conductance, was higher for chosen avatars and higher still for designed avatars. Similarly, Lim and Reeves [14] report that simply having a choice of avatar in a game significantly increased arousal, as measured by heart rate, and this effect was higher for males.

The effect on arousal can increase with level of embodiment. Kim and colleagues [15] report that higher levels of embodiment, that is degree to which the body is connected to an avatar, had significant effect on arousal, heart rate, and behavioral effort in an exercise virtual environment. Users with higher levels of embodiment also reported higher levels of presence, the sense of their body being spatially "there" in the game [15].

As the level of embodiment increases, the level of identification with the virtual body and the perceived threat to this body in virtual environment can increase. In the notorious 'virtual pit' experiment, Meehan and colleagues [16] placed users in full body, highly realistic virtual reality environment with a first person, head centered viewpoint using a head-mounted display. The environment included significant level of sensorimotor embodiment include head-coupled virtual reality system linking head motion to spatial cues from the virtual environment, free body locomotion around the environment, and low level haptic feedback in form of spatially co-located chair and the cue of an floor edge to shoeless feet of the participants. Participants were asked to drop bags on targets over a virtual pit. A gap suggesting a large hole in the floor opened precipitously to a realistic room one floor below.

Participants exhibited high levels of arousal and behaviors suggesting fear. Few participants could walk out over the open space, even though this was the easiest way to carry out the task. Increased levels of embodiment were related to increased arousal, heart rate, and reports of feeling present in the virtual environment. Although not explicitly tested, walking over an "open" virtual space would not be very fear inducing for users playing in the same environment using low level interface embodiment such as mouse and computer screen.

2.3   Changes in Self-construal and Social Behavior

Avatars often do not match the body of the user directly, but may vary in their morphology on dimensions such as attractiveness, height, or size or in social cues such a gender, group, or status symbols. While identification with an avatar is in itself a significant effect of avatar embodiment, there is the question of whether changes in the virtual avatar body can affect the behavior and self-construal of a user. Modification or compliance in the direction of the perceived avatar features would be evidence for

particular kind of behavioral and identity plasticity.   Bailenson and colleagues have labeled some of these phenomena, the Proteus effect [17], after the Greek god of the sea who seemed like water ever changing and flexible.

Adoption of Social Rules. Changed in body morphology can elicit psychological and behavioral changes. It appears that users may unconsciously adopt attitudes and behaviors associated with the avatar's physical morphology or social role and status.   Yee and Bailenson   [17] changed the attractiveness and height of avatars in a virtual chat room. They predicted on the basis of social psychology studies that the individuals would behave according to the physical characteristics of the avatar and not necessarily their own physical morphology.   Individuals provided with more attractive avatars were more likely to more intimate in self-disclosure and use less interpersonal distance than those with unattractive avatars. Similarly, individuals with a taller avatars exhibited more dominant and negotiating behavior in a negotiation tasks, a behavior consistent with height advantages in the real world.   This latter phenomenon is also supported in studies of avatar performance in multiplayer games. Taller avatars consistently outperform shorter avatars in these games.

2.4   Attitudes to Objects and Environments Associated with the Self or Ones Avatar

Self-reference plays a role in constructing attitudes towards objects, positions, or groups in the environment. Avatars interact with objects and items in the environment. These can become associated with the avatar, and indirectly with the identity of the user.

In a study of persuasion, avatars were shown to a user in a picture holding and endorsing a product in a virtual ad. Users were more likely to respond favorable to products that were self (avatar) endorsed.

In the virtual environment objects or others can be entwined with the avatar self in unusual ways. In a manipulation only possible in a virtual environment, the face of the user was morphed into hybrid presentations of the faces of unknown political candidates. Viewers were more likely to be persuaded by candidate whose face looked a little more like their own.

Bailenson and colleagues took this further to show that individuals can be influenced by the bejavioral example of their avatar [18]. An avatar seen as losing weight reinforces one's exercise behavior. In a similar way an avatar engaging in exercise, as opposed to leisure, motivated the user to exercise as well, even outside the virtual environment.

2.5   Changes in Perceived Physical Identity: Changing the Recognition of Ones of Own Face

Embodiment increases perceptual information from sensorimotor links to an avatar. This can lead to different kinds of changes in perceived identity.

A dramatic example of this is the instability of identity is the recognition of one's own face. In an extension the rubber hand illusion Tsakiris [19] altered the user's recognition of their own face in the direction of an avatar. This was accomplished using a simple visual tactile link to an avatar. Participants' faces where stroked with a soft brush while they watched the face of a morphed avatar being synchronously stroked. The sensorimotor coupling of the visual and tactile sensation produced a significant effect in self, face recognition.   When presented with a series of morphed images blending their face with that of the avatar's, the manipulation produced a bi-ased shift in self-recognition in the direction of the avatar's face.   That is when presented with an array of pictures that included their real picture and a series of pictures morphed with the face of the avatar, participants reported that an image that blended their face with that of the avatar was their actual face.

Multisensory integration of stimuli appears to trigger changed cognitive representations of one's body. Although the face is something we see in the mirror for decades and is a key feature linked to our identity, it can still be shifted slightly by embodied links (sensorimotor coupling) to avatar representations. So if a feature of identity as seemingly anchored as the recognition of one's face can be shifted, this suggests a certain malleability in self construal and identity via embodied avatar identification.

3   Sensorimotor Changes in Embodied Avatars

With higher levels of avatar embodiment or identification, there can be some significant perceptual illusions created regarding the environment and ones body

3.1   Presence and the Sense of Spatial Displacement towards the Environment of the Avatar

Identification with an avatar representation, especially with interactive and embodied avatars can create the illusion of spatial displace or presence, the sense being there in the virtual environment and feeling less in one's actual physical location in the physical environment [2, 20, 21]. The feeling of spatial presence in a virtual environment is widely reported to increase with more immersive and embodied interfaces.

The ability to feel as one is in a different location, seeing the world from a different spatial perspective, may be part of set of evolutionary cognitive tools for modelling the viewpoint of another or modelling another position in space than the one currently occupied. This is supported in part by research showing that avatars can assist a user in priming the perception of other viewpoints on a scene.   When avatars are present in the scene, they help prime an observer's ability to model that viewpoint and perspective a viewpoint in a scene [22], even if that is not their current perspective.

3.2   Sensory Suppression of Sensation in One's Body

High levels of presence and avatar identification can reduce the level of sensations in one's own body.   In the rubber hand illusion it has been reported that the actual

temperature of one's own hand drops as individuals shift their sense of the location of their hand to the rubber hand.   Similarly in clinical settings virtual environments and avatar manipulations have been used to reduce self-reported pain during procedures [23-25]. Hansel and colleagues [23] increased visual tactile stroking such that the user experiences significant changes in presence (self-location) and decreases in reported pain.

3.3   Sensorimotor Recalibration

Virtual environments often provide a virtual body and can sometimes recalibrate the coupling between the sensory and motor systems. This kind of sensory recalibration is well known phenomenon which can be triggered by any distortions or changes the relationship between motor output and sensory input [26-28].   Interaction in embodied, highly coupled virtual environments can alter the relationship between motor action (interface inputs) and sensation (interface display outputs).   Users can experience a recalibration of sensory and motor systems. For example Biocca and Rolland [29] demonstrated that displays that alter the relationship between the felt location of the user's eyes and their hands can experience some sensorimotor miscalibration such that they under-or-over reach for objects when emerging from an augmented reality system that altered the morphology of the body by shifting the location of the eyes.

4   Conclusions

Representations of oneself in the form of avatars has more than effects on our representations and communication with others. An avatar may do more that signal shifting personal status or affect.   Avatar representations appear to connect to individual identity through the identification, the representation of social roles, and though sensorimotor coupling in the cases of more embodied avatars.

The representations of the self in the form of avatars appears to a user can invoke psychological effects on user arousal, attitudes, and behaviors in virtual environments. Some of these behaviors and attitudes may extend beyond the interaction in the virtual environment influencing judgments or behaviors in the physical world.

Inserting the self into the virtual worlds, designed and self-referencing avatars can increase arousal and motivation to engage in these worlds.   Avatars can play a role in triggering attitude and behavioral change via identification with avatar characteristics or morphology.

Although highly embodied avatars are still rare, we see evidence that the can significant support unusual perception illusions about body morphology, location, and identity of one's body.   These phenomena have implications for the design of virtual environments and the use of avatars and virtual environments in systems design for cybertherapy, persuasion, learning, and behavioral modification.

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