[The Digital Patient: Advancing Medical Research, Education, and Practice], Edited by [C. Donald Combs, John A. Sokolowski, Catherine M. Banks].
ISBN 0-471-XXXXX-X

Chapter 12

Using Avatars and Agents to Promote Real World Health Behavior Changes

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Introduction

Fluid, dynamic, and infinitely replicable, virtual worlds have been an enticing yet prohibitively costly platform for health behavior researchers in the past decade. What difficulties that the researchers of the past have faced in incorporating virtual worlds in primary and secondary prevention and intervention programs have dramatically decreased in the recent years with unprecedented advancement in digital media technology [1] and virtual worlds are enjoying a newfound surge of popularity in both academic and clinical environments. Digital devices that simulate vivid sensory information, allowing users in virtual worlds to experience visceral environmental cues, have now become much more affordable and accessible, opening up new horizons for incorporating virtual reality technology in people's everyday lives, outside of sophisticated laboratories.

This chapter reviews the past and current trends of one particularly intriguing aspect of virtual worlds—virtual representations commonly known as avatars—in the context of health behavior change. Despite the growing interest in the influence of virtual representations on health behaviors, there has been a surprising dearth of research

exploring the use of virtual representations as a direct and central vehicle of behavior change. State-of-the-art findings on the use of virtual representations to promote behavior change will be discussed first, followed by a more detailed discussion of recent studies that specifically target health behavior change using virtual representations.

Avatars and Agents

The word "avatar" originates from the Sanskrit word *avatara*, which means "descent" to describe an incarnation or a bodily manifestation of an immortal being in Hinduism. In much the same way, users interact in the virtual world in the form of embodied virtual identities that mark their presence in the virtual environment [2]. In the past, avatars typically served as simplistic and static visual markers (e.g., a simple chat icon on AOL or Yahoo Messenger), much like the virtual equivalent of horses players use to represent themselves in board games. Over time, avatars have become significantly more complex, rendered in three dimensional forms with an extensive range of dynamic movements, photorealistic appearances, naturalistic language, and even the ability to mimic empathy when interacting with users. The avatars of today are still works in progress—the humanoids that have evolved to feel and express naturalistic emotions as are often depicted in popular media are yet figments of imagination. However, the speed at which avatars have gained technical sophistication forecasts that more realistic, natural, and affordable avatars may soon become a reality in the near future.

Agents are another form of virtual representation that shares similar features and capabilities with an avatar, but the two forms are distinguished by the element of control: avatars are controlled by human users whereas agents are controlled by computer

algorithms [3]. Although seemingly similar in their specifications, agents and avatars yield meaningfully different influences in their interactions with human users [4]. Research studies have demonstrated that the mere *perception* of interacting with another human (vs. a computer algorithm) meaningfully affects whether a virtual representation is successful at influencing an individual's attitude and behaviors even when the agents and avatars are performing identical tasks at the same level [5, 6].

A recent meta-analysis examining 32 studies that compared the influence of agents against avatars concluded that the mere perception of human control elicited stronger social responses from humans than the perception of machine control [7]. In particular, this agency effect was stronger when humans were required to form a certain degree of relationship with the virtual representations by engaging in a competitive or cooperative task, rather than a neutral task. The effect of agency was also stronger when the virtual representations were actually controlled by a human rather than a machine, regardless of perceived agency.

Designing Agents and Avatars for Health Programs

These findings have important implications for the design and implementation of virtual representations in health prevention and intervention programs. First, avatars that are controlled by humans are likely to have stronger impacts on health behavior change than agents that are controlled by machines. Thus, rather than an agent providing a heavily scripted intervention, an avatar delivering naturalistic responses is likely to be much more effective in changing health behaviors.

Having an actual person control a virtual representation may be useful in a variety of health contexts. For instance, a rich collection of literature points to the fact that individuals often judge others based on nonverbal cues such as physical appearance or behavior [8-10]. Indeed, people are often drawn to others perceived as similar to themselves [11, 12] or simply familiar (e.g., celebrities) [13, 14]. Because virtual representations afford labor- and cost-effective means of adopting almost a limitless option of physical appearances and behaviors that may be different from the actual self, human controllers behind the virtual representation may flexibly adapt to tailor their avatars for each respective interactant.

Such a scenario is then possible: an Asian female health care provider is controlling an avatar. A patient of different sex and ethnicity walks in. The health care provider may then select a male avatar of the patient's ethnicity and interact with the patient through the male avatar to elicit positive responses based on perceived similarity. Similarity is not necessarily confined to physical appearances; the health care provider may also mimic the behavior of the patient. Behavioral mimicry has been found to increase a host of favorable attitudes toward the interaction partner, including liking [15]. Alternatively, the avatar could take on the physical appearance of a well-known celebrity to deliver health messages, and the perceived familiarity triggered by the avatar may favorably impact persuasion as demonstrated in earlier studies [14].

Despite earlier findings that indicate the superiority of avatars over agents in a persuasion context, having human controllers positioned for each and every avatar is likely a costly option. A more labor- and cost-effective solution may be to implement computer controlled agents. Although the initial development and setup of the agent

might be costly, once the infrastructure is established, agents can continue to work at the same speed and efficiency without the need to eat or rest. These agents may be infinitely replicable, which would allow patients to receive equal and uniform care across all health care facilities. Also, for sensitive topics of discussion (e.g., sexual history), patients may prefer to interact with a machine controlled agent rather than a human controlled avatar for greater perceived privacy.

Thus, both agents and avatars are viable options for incorporation in health prevention and intervention programs and the choice to use one over the other should be made after a careful cost-effectiveness analysis [16]. Although research demonstrates that avatars are more effective in promoting desired behaviors than agents, the associated costs in employing a human controller may be prohibitive in a large scale program. On the other hand, if the program calls for strong and impactful interventions that are more likely to elicit behavior change, avatars may be well worth the costs. The following section discusses representative case studies on the systematic investigation of using agents and avatars in the context of health behavior change to consider the costs and benefits associated with each type of virtual representative.

Using Agents and Avatars to Promote Health Behavior Changes

Virtual representations offer a set of novel characteristics that allow researchers and practitioners to implement new strategies to approach health behavior change that were difficult or not possible with traditional tools and platforms. These characteristics include the virtual acceleration of time [17], wherein agents and avatars are able to transcend temporal boundaries of the physical world to digitally depict events in the past

or future from the present point in time. Another major characteristic that distinguishes virtual representations from traditional media platforms is high interactivity, or the medium's capacity that allows users to influence the form and/or content of the mediated experience in real time [18]. It is generally agreed that the best interactive medium mimics the interactive dynamics of face-to-face communication [19]. Using interactive virtual representations that afford naturalistic social interactions is likely to heighten users' engagement and involvement [20], as well as foster more positive attitudes or liking towards the interaction content [21].

The initial scientific foray into using agents and avatars to impact behavior in the physical world began with the Proteus Effect [22, 23], which found that when individuals are aware of the visual characteristics and traits of an avatar that he or she is embodying, and understand what others will expect of their behaviors based on those characteristics and traits [24], the experience of embodying that particular avatar will encourage them to continue to engage in the expected behaviors in the physical world. For example, when individuals were given tall avatars to embody in a virtual world, they were more aggressive during a negotiation task in the physical world than individuals who were given shorter avatars. This is likely a result of conforming to normative expectations that taller people are more confident and more likely to be in positions of power [25].

Combined with the novel media characteristics that afford users some experiences that were difficult or impossible with traditional media platforms, the ability of agents and avatars to influence behaviors in the physical world introduces new horizons for research on the incorporation of virtual representations in health promotion campaigns as vehicles of behavior change. The implication is that even the most creative and

fantastical virtual experiences with agents and avatars may yield effects that transfer into the physical world to affect individuals' attitudes and behaviors, giving researchers the freedom to explore any health context of their desires. Despite such potentials, few studies have systematically investigated agents and avatars in the context of health behavior change. Among the collection of literature on agents and avatars in the health realm, the following sections review some of the representative and state-of-the-art studies that specifically focus on how interactions in the virtual world with virtual representatives affect health behaviors in the physical world.

Vicariously Experiencing Future Negative Health Consequences through Agents and Avatars

Individuals are likely to hold a "rosy" view of distant futures, conceptualizing their futures in a positive light. Kahneman and Lovallo [26] attribute this overly optimistic assessment of future outcomes to an isolation error: people tend to think of the future as an isolated event, independent of past and present events, and base their forecasts of the future on plans and scenarios of success rather than on accurate past results. Greater temporal distance of an event, relative to the present, enhances the perceived positivity towards it [27]. Because future negative health consequences may take some time to manifest following present behaviors, the large temporal distance is likely to encourage unrealistic and inaccurate levels of optimism in thinking about the health issue. For instance, smoking a cigarette today will not immediately lead to lung problems the next day; rather, the detrimental effect of smoking may require years to manifest. The temporal distance between the cause (smoking) and effect (lung problems) renders this relationship abstract and opaque, leading individuals to assume an optimistic outlook for

their own health in the future. Consequently, this "rosy view" phenomenon is one major barrier to successfully communicating health risks and changing present health behaviors.

One solution to the rosy view phenomenon is personal experience. Studies have demonstrated that going through the actual experience at the moment reduces the unrealistic level of optimism that individuals perceive about future events [28] and that recent experiences are given more weight in deciding one's susceptibility to risk than distant experiences [29]. However, with future negative health consequences, it would be unrealistic to prescribe personal experiences of negative health outcomes (e.g., lung problems) to reduce overly optimistic future forecasts. These negative health outcomes are often irrevocable or fatal.

Using agents and avatars to digitally render future negative health consequences allows individuals to vicariously, but vividly, experience negative outcomes without having to incur actual damages to their physical and mental health. In the virtual world, time becomes a more fluid concept; once created, an agent or an avatar may be digitally manipulated to dynamically shift their appearances. For example, a virtual representation of an individual in his or her 20s may be created and then rapidly aged to depict the same person in his or her 60s [30]. Although 40 years has passed in the virtual world, this may take only a few seconds in the physical world. More importantly, these virtual experiences are sufficiently realistic to influence behaviors in the physical world.

In one of the first studies to observe how using agents and avatars to virtually depict future negative health consequences may influence health relevant behaviors in the physical world, participants were asked to watch a virtual simulation of an agent with photorealistic resemblance to themselves gain weight by eating candy or lose weight by

eating carrots [31]. After watching the virtual simulation, participants were subjected to an unobtrusive measure of candy consumption in the physical world. Candy consumption was influenced by an interaction of two variables: sex and *presence*, or the degree to which participants felt that they were right there in the virtual world [32]. Male participants who felt high presence ate more candy whereas female participants who felt high presence suppressed this behavior and ate less candy. The authors posited that this finding was a result of virtual imitation, wherein participants modeled the behavior he or has observed from his or her agent, particularly when the perceived presence was high. However, as the agents were shown to eat both candies and carrots, it was not clear which observed virtual behavior was affecting candy consumption in the physical world.

Building on these preliminary results, a recent set of studies investigated the transfer of virtual world effects to physical world behaviors in the context of soft drink consumption [33-35]. If the earlier study posited that individuals would model and imitate the behaviors observed by the agent, this set of studies argued that agents and avatars may be used to reduce two types of psychological distances—temporal and social. Reducing the perceived temporal distance between the present health behavior and the future negative health consequence is likely to render the causal relationship concrete [36]. Also, reducing the perceived social distance between the individual and the given health issue is likely to promote perceived personal relevance and involvement with the issue [36].

The results from this set of studies revealed that perceived social distance could be successfully reduced by tailoring the information to the audience [33]. Tailoring may be as simple as changing the verbiage in a traditional pamphlet to create the illusion that

the pamphlet was created specifically to target an individual. In virtual worlds, an agent or an avatar may be tailored to bear photorealistic resemblance to an individual, so that the individual may feel as if the vicarious virtual experiences are actually happening to him or her. Tailoring in both modalities reduced social distances, increased levels of involvement with the health issue at hand, and ultimately led to greater intentions to adopt the desired health behavior (i.e., reducing soft drink consumption) immediately following experimental treatments [33].

The results also revealed that perceived temporal distance could be successfully reduced by coupling traditional health pamphlets with virtual simulations that feature agents and avatars depicting future negative health consequences [33]. A virtual simulation was created to show an agent dynamically gaining weight as it continued to consume soft drinks in a virtual world, wherein two minutes of virtual time was equivalent to two years of physical time. By accelerating the passage of physical time in the virtual world, participants who were exposed to the virtual simulation perceived shorter temporal distances between their present health behaviors and future health consequences. The reduced temporal distance, in turn, increased the perceived imminence of risks related with soft drink consumption, ultimately leading to lower consumption of soft drinks one week following the experimental treatment compared to participants who were not exposed to the virtual simulation. At this point, the effect of tailoring that was observed immediately following experimental treatments dissipated and only the effect of watching the virtual simulation remained influential.

A following study explored the effect of *virtual doppelgängers* [37], agents with photorealistic resemblance to individuals, to investigate the underlying mechanisms

driving health behavior change in the same context of soft drink consumption [34]. Virtual doppelgängers create an interesting social phenomenon wherein a virtual entity that has photorealistic resemblance to an individual may look like an individual but not act like him or her because the agent is being controlled by an algorithm. Participants in the study were exposed to a virtual simulation showing either virtual doppelgängers or an unfamiliar agent gaining weight as a result of consuming soft drinks regularly for two years, depicted in two minutes in the virtual world. Results indicated that virtual doppelgängers were more effective than unfamiliar agents in increasing the perception of presence as well as self-relevant thoughts in the virtual simulation. Watching an agent that looks like the self consume soft drinks and become obese made participants feel as if he or she were truly undergoing the experience and encouraged them to think about themselves in the context of soft drink consumption. Heightened presence and self-relevant thoughts, in turn, led to increased personal relevance to the issue of soft drink consumption and obesity.

Finally, different modalities used to deliver a health message about soft drink consumption and obesity were compared to determine the most effective message modality in the promotion of health behaviors [35]. Results indicated that compared to strictly statistical information, print narratives, and pictures, the virtual simulation of an agent gaining weight as a result of soft drink consumption over the years was best able to highlight the risks involved with soft drink consumption and actually reduce consumption one week following experimental treatments.

Taken together, these studies indicate that agents and avatars may serve as a powerful vehicle of health behavior change by depicting future negative health

consequences. Without incurring actual harm to personal health, individuals are able to observe sufficiently realistic simulations of what the future might have in store for them if they were to continue their present health behaviors. The observation of accelerated changes in the virtual representations' health is able to meaningfully reduce the temporal and social distances perceived between the health risk and the self. Consequently, individuals feel that the risk may be more imminent and more personally relevant than they had originally thought, and ultimately adopt desirable health behaviors in the physical world.

Interactive Agents and Avatars for Health Behavior Change

If merely observing the vicarious experience of future negative health consequences occurring to agents and avatars are powerful enough to change health behavior, the ability to directly interact with the agent or avatar is likely to amplify these favorable effects. In one of the earliest studies looking at how interactions with avatars could lead to differences in health behaviors in the physical world, participants were given either a photorealistically similar self avatar or an unfamiliar avatar to interact with in a virtual world [38]. When the participants exercised in the physical world, the avatar exercised with them using synchronous head and body movements in the virtual world. Results indicated that when participants interacted with a self avatar that exercised with them, they engaged in more exercising than when they interacted with an unfamiliar avatar. These effects persisted for up to 24 hours following the experimental treatments.

In the past, such studies had to be conducted in a highly controlled laboratory setting to deliver interactive experiences with a virtual representation because the

experimental set up required state-of-the-art digital devices to track and render participants' movements. Recently, however, the development of consumer grade electronics, such as video game consoles, has gradually increased the accessibility and affordability of interactive media, allowing individuals to interact with virtual representations in the comforts of their own living rooms [39]. The newer video game consoles such as the Microsoft Kinect Xbox and the Nintendo Wii are equipped with sensors and accelerometers that allow players to use naturalistic body movements to control their avatars in the game. This development has introduced a novel genre of gaming called exergames, which require players to use body movements to progress through the game [40]. Several recent studies have demonstrated that interacting with the avatars in these exergames results in increased physical activity [41] as well as weight reduction [42], particularly when playing with others rather than playing alone. Although exergames still contribute to the overall number of hours individuals spend in front of screens, which is positively linked to negative health outcomes [43], they help to substitute what would otherwise have been completely sedentary screen time with low to moderate levels of physical activity [44].

Although the bulk of studies looking at agents and avatars fail to reflect this, not all virtual representations are required to take on human forms. In one of the few studies that explored the effect of non-human virtual representations on health behaviors in the physical world, researchers investigated the potential of using a virtual pet to promote physical activity in children [45]. The American Heart Association released a scientific statement in 2013 regarding pet ownership and cardiovascular risk [46], noting that

owing a pet, a dog in particular, significantly increases physical activity levels of the pet's owner, thereby reducing the risks for cardiovascular diseases and obesity.

Guided by the framework of social cognitive theory [47], the virtual pet was a dog designed to systematically promote physical activity in children through goal setting, vicarious experiences, and positive reinforcement. In the study, children's physical activity was measured with an activity monitor that was synchronized with each virtual dog so that each child was paired with a unique pet displayed on a television screen mounted on a kiosk. The kiosk set up allows for the virtual pet to be mobile, following the children wherever needed rather than the children having to come to a specified location to participate in the program.

The underlying logic was that as children engaged in physical activity in the physical world, the virtual dog would also stay active with them in the virtual world, reaping the health benefits. When compared with children in the control group who were given an identical computer system with the same functionalities but without the virtual dog, children who interacted with the virtual dog engaged in approximately 1.09 more hours of physical activity daily. Self-report survey data revealed that interacting with the virtual dog led children to feel confident about their abilities to set and meet physical activity goals, which in turn, heightened their beliefs that physical activity is good for them. The increase in physical activity belief ultimately led to an increase in physical activity.

Conclusion

In an era of digital media technology, people consume health information in ways that are very different from the past. For young people, in particular, the Internet is one of the most sought out sources for health information [48]. Atkin [49] argues that choosing a channel appropriate for a specifically targeted audience will maximize the effect of health information. With the increasing ubiquity of interactive and mobile digital technology in our homes, it may be a timely endeavor to reexamine not just the content of health information but also *how* it is being disseminated.

Agents and avatars offer a dynamic yet highly controllable means to deliver health information in a novel, involving way. Offering a wide range of strategic tools that take advantage of novel media characteristics, such as the virtual acceleration of time and interactivity, agents and avatars yield powerful impacts in the virtual world that transfer to the physical world to change health behaviors. Observing and interacting with these virtual representations allows individuals to feel as if they are genuinely present in the situation [31, 34, 35], heightens their confidence about achieving health goals [45], and encourages them to think of the health risk as a personally relevant, important, and imminent event [33, 34]. Ultimately, these underlying mechanisms drive desired health behaviors that persist longer over time than the same health information delivered through more traditional channels, such as statistical information, print, or pictures [31, 33-35, 38, 45]. These efforts may even be combined with gaming mechanisms to replace overall sedentary time with physical activity while playing video games [40-42].

As agents and avatars offer different strengths and weaknesses, researchers and practitioners should administer an extensive analysis of cost-effectiveness to select the

more appropriate form of virtual representation in the given context. An alternative option would be to consider an agent-avatar hybrid, which capitalizes the strength of programmable features and algorithms of agents while still being guided by a human controller [50, 51]. This crossover design would offer health interventions that have greater impact on human behavior but remain cheaper to operate and manage.

There is still much work to be done to harness the dynamic flexibility that agents and avatars offer to implement systematic primary and secondary prevention and intervention programs. However, the state-of-the-art research introduced in this chapter confirms the potential of virtual representations to serve as a vehicle of health behavior change. Health issues often involve an intricate and complex web of individual and environmental factors, and avatars and agents may not be a panacea for all these issues. Yet, with the rapid advancement of digital technology transforming our traditional norms and patterns of communication, these virtual representations, whether they are human or animal form, hold much potential in the realm of health interventions that has yet to be discovered.

Key Terms

agents	virtual representations	health behavior
avatars	interactivity	physical activity
presence	acceleration of time	exergames

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