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Medical Avatars—An Innovative Approach to Fostering Health Promotion and Lifestyle Change

The only way to keep your health is to eat what you don't want, drink what you don't like, and do what you'd rather not.

Mark Twain

Unhealthy behaviors are highly prevalent in the veteran population. Seventy percent of veterans are overweight or obese,[1] 27% are smokers,[2] 46% do not meet physical activity recommendations,[3] and 56% report binge or heavy alcohol use.[4] Healthy lifestyle interventions that change these behaviors can contribute to preventing chronic disease or to improving the effects of existing conditions. What does it take to change patients' behavior in a beneficial way? To answer this question, it is important to understand why people find it difficult to change their behavior even when faced with negative consequences. There are many barriers to health behavioral change—from those intrinsic to the individual to environmental barriers. Exposure to the health care system presents an opportunity for fostering health promotion activities through patient education and self-management. This is especially true since the challenges of symptomatic illness have not yet emerged to prompt the contemplation and implementation of needed behavioral change.

When health risks are noted, they are generally addressed by health care professional instructions on evidence-based approaches that outline desired actions and therapeutic goals. Counseling follows a directive approach that may involve written handouts, videos, audio, or multimedia Web sites. Thus far, none of these approaches have been proven effective on a population basis, in part, because of health literacy limitations and, in part, because of limited personalization and difficulties in addressing risks vs health problems. One of the research emphases at the Bruce W. Carter Miami Veterans Affairs Geriatric Research, Education and Clinical Center (GRECC) is discovering the best opportunities for medical avatar technology (also called embodied conversational agents, relational agents, and intelligent virtual agents) for promoting health for the many veterans who are functional and seem well but harbor significant health risks that could be reduced by behavior change.

HEALTH COACHING AND HEALTH PROMOTION

Health coaching is a behavioral health intervention that helps participants achieve health-promoting goals in order to change lifestyle-related behaviors, with the goals of decreasing health risks and improving chronic disease self-management and health-related quality of life.[5] Coaches take an active role in persuading patients to achieve their goals through active engagement and personal advising. A review of 15 randomized controlled studies of health coaching interventions found significant improvements in 1 or more of the behaviors related to nutrition, physical activity, weight management, or medication adherence.[6] As currently conceived and implemented, face-to-face health promotion programs are expensive to create and maintain. Training requires

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The VHA's Geriatric Research, Education and Clinical Centers (GRECCs) are designed for the advancement and integration of research, education, and clinical achievements in geriatrics and gerontology throughout the VA health care system. Each GRECC focuses on particular aspects of the care of aging veterans and is at the forefront of geriatric research and clinical care. For more information on the GRECC program, visit the Web site (http://www1.va.gov/grecc/). This column, which is contributed by GRECC staff members, is coordinated and edited by Kenneth Shay, DDS, MS, director of geriatric programs for the VA Office of Geriatrics and Extended Care, VA Central Office, Washington, DC. Please send suggestions for future columns to Kenneth.Shay@va.gov.

participants to attend multiple sessions at a specific physical location, on an individual or group basis, usually moderated by health care professionals or peers. Patients with limited transportation, work-related commitments, or caregiving obligations may not be able to attend these "in-person" instructional programs.

Moreover, health care providers or peers must have received training to be able to adequately coach patients. Internet-based e-health programs, which work well for motivated or obligated learners, can overcome some of the cost and access challenges associated with face-to-face instruction. However, text-based information and multimedia sources are less likely to be used or effect change when dealing with fully functional busy persons. Internet-based programs that improve knowledge, skills, and change behavior generally fall short when learners are not formally enrolled, motivated, obligated, or rewarded for the improvement.[7,8] A more accessible and efficient, yet personalized, approach is needed for patients to learn about their health conditions and risks in a way that gives them the confidence and competence for health promotion. Medical avatar technology offers such an approach to enhance health coaching.

Adding a medical avatar to online training creates an approach that merges the ease of access and lower long-term cost while engaging participants and sustaining their interest.

MEDICAL AVATARS

Medical avatars are digital representations of patients or professionals for health care purposes. Medical avatars offer patients an animated, personal, and more engaging encounter. The avatar addition to patient instructions over the Internet introduces the advantages of improved motivation and persuasion for behavior change. Avatars, both human (anthropomorphic) and nonhuman, are already widespread in Internet environments that provide social networking, distance learning, teleconferencing, or e-commerce. These digital agents have demonstrated the ability to facilitate engagement, communication, and social interactions in these virtual environments.[9]

Humans treat avatars as capable of social interaction. This phenomenon is based on the Media Equation Theory, which suggests that people interface with and respond to media as if those media were human.[10] In other words, they respond automatically (reflexively) to media using the same intrinsic neurologic and behavioral pathways governing responses to in-person communication. The corollary of this concept is that, while we can adopt strategies to alter those response patterns, this intentional action represents a challenge for the individual. Thus, we should take advantage, rather than thwart, these response pathways to promote health within an interactive media instructional environment.[10]

Adding a medical avatar to online training creates an approach that merges the ease of access and lower long-term cost while engaging participants and sustaining their interest. This approach could evolve into an effective system for personal training and an alternative to face-to-face health promotion interventions. A 2010 National Institutes of Health workshop, "Virtual Reality Technologies for Research and Education in Obesity and Diabetes," opened several avenues for discovering the potential of virtual reality (VR) technologies for behavioral studies and provided justification for their continued use to improve regimen adherence as well as nutrition, physical activity, and other behavioral lifestyle changes associated with diabetes and obesity.[11] Among the technologies most cited for further development is the personalized medical avatar interacting as an instructor or guide to behavior change.

Medical Avatars as Health Coaches

In learning environments pedagogical avatars are animated, lifelike digital characters embedded in computer-based instruction systems that facilitate social interaction and learning. The rationale for the use of pedagogical agents is their potential for social interaction that, according to social cognitive learning theories, may contribute to learning.[12] Interactive, animated pedagogical avatars may become patient coaches in health care environments. The pedagogical avatar is an important consideration, because its appearance may be crucial to promoting social interaction (See Figures 1 and 2 for examples of avatar coaches).

Humans Prefer Medical Avatars That Look Human

In the real physical world, humans form internal representations of others based largely on what they see and hear. According to the Media Equation Theory, these same sensory modalities readily apply to digital representations of humans in virtual environments.[13] Anthropo-

morphic avatars are rated higher in realism, credibility, and attractiveness, with greater potential for social interaction than are nonhuman avatars.[14] The visual presence of the avatar is essential, resulting in medium to large effect sizes in affective outcomes, such as self-efficacy, credibility, and motivation, compared with voice alone.[15] A talking, anthropomorphic avatar establishes a relationship with an online participant that current theory predicts will not only be more engaging, but also more motivating and longer lasting in moving that individual into behavior change. Animated avatars increase engagement and perception as humanlike compared with static versions.[16] These studies suggest the potential of highly realistic, animated, and talking anthropomorphic avatar-enhanced interventions to foster health promotion activities.

Medical Avatars May Persuade Humans

Dual-process ("central" and "peripheral") models provide a theoretical framework for understanding message reception and attitude changes needed for behavior modification.[17] These models propose that if individuals are able and properly motivated, they will systematically evaluate the strengths and weaknesses of persuasive arguments. In central processes, if the message is well analyzed, arguments that are solid will persuade; if arguments are weak, they will fail. Peripheral features of the context will have little influence on these outcomes. But if individuals are not motivated, willing, or able to process a message centrally as a result of a sensory impairment, cognitive impairment, mental illness, or low health literacy, peripheral features can become influential.[18] In these cases, peripheral cues, such as an authority figure, an attractive messenger, or heuristics (eg, "my wife wants me to

Figure 1: The avatar coach (not visible) explains (narrated) the occurrence of nocturia as a symptom of overactive bladder. The program shows the patient avatar suffering nocturia.

From Virtual Avatar Coaches for Behavioral Therapy of Patients With Overactive Bladder Program.

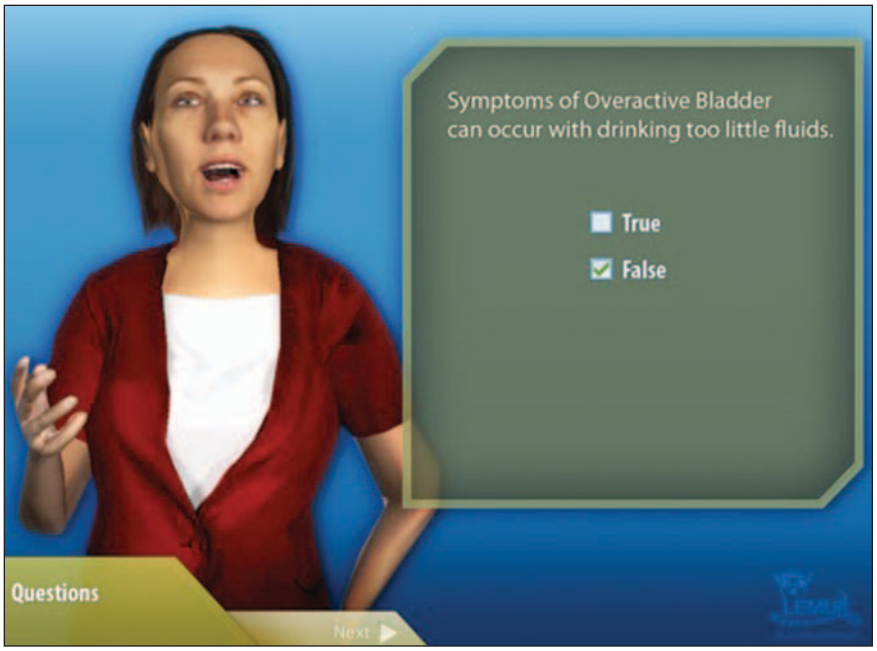

Figure 2: The avatar coach asks the participant a question (narration) followed by the appearance of the same information in text format and the true and false options.

From Virtual Avatar Coaches for Behavioral Therapy of Patients With Overactive Bladder Program.

exercise") have influence in forming an attitudinal response. Although such attitudes are more susceptible to counterarguments, unstable, and less likely to force behavior than are those formed as a result of central processing,[18] this pathway can serve as the target for examining persuasive avatars to foster health promotion.

Manipulating the Avatar Appearance May Increase Persuasion

The manipulation of avatar characteristics can help us enhance their persuasive effect. According to Transformed Social Interaction (TSI), we can use innovative multimedia and VR techniques to manipulate social interaction by enhancing or diminishing interpersonal communication with avatars.[19] In its original conception, TSI involved the manipulation of avatar appearance so it can be more physically appealing to patients with respect to race, gender, ethnic group, and even language and accent. This manipulation may occur at the level of the avatar coach or the actual patient avatar. The avatar coach is the computer-generated representation of a "human" coach, whereas the patient's avatar is the digital representation of the patient in the virtual environment.

Manipulating the Medical Avatar Coach

Facial and behavioral mimicry can make avatars more persuasive. In the "chameleon effect," the tendency is for mimickers to gain social influence and increase individuals' positive social behavior toward other people.[20] Individuals were more likely to vote for an "unfamiliar" political candidate whose photograph was morphed to resemble their own face.[21] Individuals immersed in a virtual environment seated opposite an avatar who mimicked their head movements were more likely to pay attention to the avatar and agree with its argument.[19] Individuals displayed more social bonding and familiarity toward an animated avatar that mimicked their patterns of stress and intonation of their voice.[22]

Manipulating the Patient's Avatar

Individuals may not only interact with an avatar coach through a first-person view (ie, they do not see their own avatar), but also select or be assigned an avatar in a third-person view (ie, they see their avatar). In exergaming platforms (ie, those designed to promote exercise, such as the Nintendo Wii, Xbox Kinect, or Sony Project Natal), individuals may interact with a medical avatar or other "peer" avatars. The influence of avatars may go beyond interacting with persuasive medical avatars. Participants represented by avatars may conform to the expected behaviors of the avatar, a process referred to as the "Proteus effect." Participants represented by attractive avatars walked closer to and disclosed more information to a stranger. Taller avatars negotiated more aggressively in a bargaining task than participants in shorter avatars.[23] Users who controlled the taller avatars continued to negotiate aggressively outside the virtual environment. This suggests that the Proteus effect persists outside the virtual environment.[24]

Technological Challenges

There are still several challenges to the wide use of medical avatars in health care education: Basic computer skills may represent a problem for older individuals or those with low health literacy. Bickmore et al demonstrated that older, minority patients with low health literacy were satisfied with these applications and were able to obtain benefits from their use.[25] Strict attention to design issues for these populations could minimize some of these challenges. Access to programs using medical avatars requires computers with graphics and sound cards as well as processing speed to deliver these resource-intensive applications. Such computers may be out of reach for many patients. When delivered through the Web, additional challenges, such as broadband access, come into play. These applications will undoubtedly find their way to mobile devices. However, these devices will at first only be able to manage relatively low-fidelity applications and, although ubiquitous, introduce another set of challenges. Small screens may strain the eyes of older patients or those with limited visual acuity. Sound quality and volume are also problems with small mobile devices.

The Evidence of Medical Avatars in Health Promotion

Recent studies have shown the potential of using avatar coaches for promoting positive behavioral change in patients. In a randomized trial, college students received counseling about exercise through an avatar with and without relational, emphatic verbal and nonverbal behaviors, and nonintervention controls. The intervention groups increased the amount of physical activity from moderate to vigorous.[26] A randomized trial compared elderly participants, who interacted with an avatar coach, with controls who received pedometers and educational handouts about exercise. The participants with an avatar coach found the system easy to use and were very satisfied with the intervention. At 8 weeks, the avatar group significantly increased their physical activity compared with controls.[25] An avatar-mediated system for tracking exercise increased the submission of more accurate data by the participants.[27]

There are concerns associated with the long-term effectiveness of anthropomorphic avatars. Although engagement increased over time, these studies did not reveal increased adherence to exercise over 3 months.[28] Mobile devices with animated avatar advisors that automatically record measures of physical activity from accelerometers may provide such a long-term approach.[29] Participants who created an avatar representing their ideal selves in the exergaming Wii platform perceived their avatar to be more physically attractive and have greater perceived interactivity than participants who created an avatar that resembled their actual selves.[30] Manipulation of self avatar appearance that depicts physical changes may motivate those individuals to make a significant change in lifestyle.

Subjects observing their self represented by an avatar being rewarded through apparent weight loss for performing physical activity and then punished (through apparent weight gain for not exercising) encouraged exercise behavior.[31] However, participants observing their self lose and gain weight when exposed to healthy and unhealthy choices, respectively, did not affect eating behavior.[31] Investigators randomized college students to 1 of 3 conditions: avatar representation of self running, self loitering, or another individual running. Seeing oneself exercising encouraged the individual to exercise, whereas seeing oneself loitering or an unrelated individual running did not encourage exercise.[31]

College students observed photorealistic avatars, resembling themselves, eat either candy or vegetables. While completing postintervention surveys, men were more likely than women to imitate their avatar eating more candy from a bowl.[31] Subjects seeing avatars that resembled them endorsing a soft drink as part of a photo advertisement demonstrated favorable attitudes toward the brand.[32] Implications of these 2 studies illustrate the possibility of enhancing participants' behavior toward healthier nutrition. An evaluation of an avatar-mediated motivational interviewing approach to promote physical activity and fruit and vegetable consumption is currently underway.[33] For his clinical trial in smoking cessation, named Project COMBAT, Prokhorov has developed a multimedia program of an arcade game for soldiers, which depicts facts about tobacco use as well as an avatar guide modeled after the user. Players walk through conflicts such as resisting peer pressure, coping with withdrawal symptoms, and preventing relapses.[34]

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Research Agenda

The main direction for research should focus on elucidating the features of medical avatars that contribute to achieving patient learning, adherence, and behavioral change. Exploring the addition of prerecorded human voices vs computer-generated voices is an area that has received extensive attention outside of health care. Most studies have shown that participants prefer prerecorded voices, but computer-generated voices allow for flexibility in personalization and customization of content. However, which visual features of anthropomorphic avatars contribute to better health outcomes and whether static avatars would achieve comparable health benefits as more expensive animated avatars are areas needing further investigation. For animated avatars, features that display emotions—lip synching, facial expressions, blinking, and other nonverbal behaviors—deserve more study.

Under what circumstances do characteristics such as gender or age matter for health promotion activities? These variations may also include clothing, type of health care professional, and accompanying digital environments. Manipulation of skin color and racial characteristics may make anthropomorphic avatars more culturally and ethnically concordant and potentially more effective for behavior change. Concordance between patient and physician has been shown to influence patients' perceptions of a shared identity and ratings of physicians' decision-making styles as well as participation in and satisfaction with their care.[35] Race-concordant visits lasted longer and had higher patients' ratings.[36]

We are aware of no studies matching patients with race-concordant health care professional avatars, but a recent study suggests that avatars can elicit racial bias from health care professionals. White medical students were less empathetic to patient avatars of dark skin tone than they were to those, otherwise identical, with white skin.[37]

Studies outside of health care showed mixed results with regard to

the preferences of subjects for avatar ethnicity.[38,39] We need more research to reconcile these findings with patients in health care settings.

FUTURE DIRECTIONS

Our team at the Miami GRECC Laboratory of E-learning and Multimedia Research (LEMUR) has received funding to conduct innovative projects using medical avatars for health care professional education. The VA Office of Patient Centered Care and Cultural Transformation has recently funded a demonstration project entitled "Avatar Health Coaches for Positive Lifestyle Change: Cyberceuticals for Reducing Cardiovascular Risk." The purpose of this project is to use medical avatar coaches and gaming techniques to improve veterans' engagement and adherence to positive lifestyle change with the goal of reducing cardiovascular risk.

Our GRECC investigators have also received industry funding to develop an avatar-based program to improve primary care physicians' competencies in smoking cessation. The title of this project is "An Avatar-Mediated Simulation CME Program: Improving Primary Care Physicians' Smoking Cessation Competencies." The program will consist of computer-based tutorials, interactive problem-solving exercises, and game-based simulations with debriefing by instructional avatars. Other projects include the industry-funded "Virtual Avatar Coaches for Behavioral Therapy of Patients With Overactive Bladder." We plan to test the effectiveness of avatar coaches for behavioral management of overactive bladder with the goal of improving quality of life and symptoms in older adults. GRECC investigators will evaluate a wide range of educational and clinical outcomes using a variety of metrics, including validated survey instruments.

Advances in artificial intelligence methods and insights into assessing and engaging at the appropriate level of health literacy would open the way to a future in which all veterans would have their own health coach. Especially challenging is the development of natural language processing and speech recognition technologies that allow a natural conversation flow to occur similar to human interactions.[40] Affective computing refers to technologies that deliberately influence emotion.[41] Development of avatars that sense, measure, and respond to users' affective information promises more engaging, caring, and long-lasting interactions beneficial for health promotion and chronic disease self-management. Augmented or virtual reality combined with conversational multimedia can be added to enhanced scenarios in which patients can interact with health care professional avatars appearing in 3-D virtual environments.[42] Photorealistic immersive environments, haptic, and other sensory enhancements, such as virtual interpersonal touch, can further augment these interactions, blurring the differences between "real" and "virtual" worlds.

CONCLUSIONS

Medical avatars are animated, lifelike digital characters that can serve as health coaches to foster health promotion and lifestyle change in veterans. These innovative computer-based technologies can enhance persuasion and motivation, potentially assisting patients in adopting healthy behaviors.

Author disclosures

The authors report no actual or potential conflicts of interest with regard to this article.

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