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Exploring the use of augmented reality in fitness on innovation, embodiment, and communication

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Abstract
Virtual representations of humans have been explored heavily and used widely in the realms of game development and virtual reality. Motivated by a desire for convenience and privacy in an age of pursuing a healthy life and self-improvement, many augmented reality (AR) and virtual reality (VR) technologies are used for developing better fitness products (e.g., smart fitness mirror). This research aims to investigate the potential for the usage of AR in smart fitness mirrors to affect emotions, assist embodiment illusions, and accordingly influence cognitive function by applying it to the domain of innovative thinking. In addition, the research wants to further evaluate how the perception changes that results in distinct linguistic functionality with the long-term interaction with virtual characters and staying in the cross-boundary space. Our final goal is to develop an AR system which could empower learners to benefit from both cognitive learning and the effective fitness exercises, encouraging the innovation while taking the courses.

Keywords:
Augmented Reality (AR); Virtual Reality (VR); Design Artefacts; User-Created Personas; Participatory Innovation; Co-Design; User Involvement; Physical Performance; Self-perception; Embodiment; Creativity; Human-centered Interaction.

1 Introduction
The boundary between virtual and real is blurring with the introduction to AR and VR technology used in our daily life. Such virtual depiction can influence the way we feel, think, and behave. These technologies have surged in prevalence and popularity, coupled with promotion of "home automation". In particular, the COVID-19 pandemic was an earthquake for the fitness industry, moving workouts outside or into the home. Many homes fitness equipment flourished, for instance, smart bikes, smart fitness mirrors, wearables. Most of equipment is consistent with the AR to allow livestream and workout with others digitally, while remaining safely and conveniently at home.

Companies like PhotonLens[16] offer AR headsets for many fitness applications. This app offers VR boxing, ping pong, and yoga. This gamification approach of users' fitness routines is the trend but also reflects how we now perceive the virtual world and real world. Many studies, particularly in the domain of VR and gaming have shown that the digital representations of ourselves and space can influence our sensory perception and alter our behavior, which in turn impact our cognitive abilities [1,2,3].

Motivated by the fact that more and more interactions between human and technology through AR/VR products, the research seek to find out a desire for convenience and privacy in an age of pursuing a healthy life and self-improvement, many ARs are used for developing better fitness products (e.g., smart fitness mirror). This research aims to study the potential for the usage of AR in smart fitness mirrors (see Figure 1) to affect emotions, assist embodiment illusions, and accordingly influence cognitive function by applying it to the domain of innovative thinking. Besides, the research wants to probe how the possible perception change will further impact the way people interact with real person and VR characters. With the result of the research, we hope to design an AR system which could empower learners to benefit from both cognitive learning and the effective fitness exercises, motivate the innovation while taking the courses.

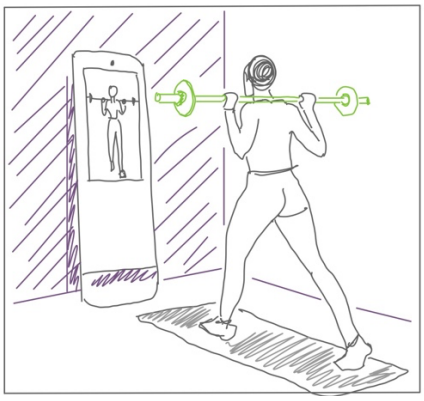

Figure 1. Smart Mirror bring live fitness class to your home

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2 Related Work

For our investigation into the effects of AR fitness equipment (e.g., smart fitness mirror), we consider prior works relating to AR/VR usage, physical embodiment illusions, self-perception, and creativity.

2.1 Success of Gamification of fitness

According to neuroscience research from Teknoloji Universitesi, people easily get bored with repetitive tasks, but they are more likely to make habits of activities that they enjoy [5]. Studies suggest that 44% of inactive people do not exercise because it is not fun [6]. Because of the pandemic, studies show that people did 32% less physical activity. One strategy the fitness company came up with is to corporate VR and AR technology while designing their product to simulate activity by making the experience more fun.

2.2 Smart Mirrors

In the fad of smart mirrors, several studies [4][17] having been done to evaluate the effectiveness of the mirror from augmentation or information utilities. They normally show the user itself on a standard screen and display information at the same time. Some machines used in the research includes a display device, color camera, depth camera and the Microsoft Kinect v1 from the Xbox 360 gaming console. When the user stands in front of the display, the mirror can load the user's computed tomographic visualizations, giving the user "the illusion to look into his body". Moreover, the user can change the slices or zoom in and out by changing their hand-gestures just like how iron man controls his console. Further magic mirrors such as Raspberry Pi use single board computer technologies.

2.3 Social Cognitive Theory

According to the social cognitive theory [7], it illustrates and explains the effectiveness of VR- and AR-enhanced exercise program on physical activity and performance [8]. And the product we are going to study in this research is smart fitness mirror which allows individuals to learn behavior by observing others' behavior on the mirror while doing their own workout. Two mechanisms suggested by the theory can be applied to explain the impact of VR/AR-exercising. A study showed that individuals who viewed their virtual self-exercising in the virtual environment exercised more than those viewed virtual others by reinforcement and identification [9].

2.4 Embodiment illusion & The Proteus Effect

The brain's representation and perception of the body is malleable. The use of virtual reality (VR) can manipulate Our experience of having a body, or our sense of embodiment [10]. According to the Rubber Hand Illusion [6], an embodiment illusion can extend from a virtual limb to a full-body avatar. The strength of such illusions is influenced by multiple factors including one's sense of ownership, agency, and location of an avatar [10].

The Proteus Effect [11] describes the phenomenon wherein people's behaviors conform to their digital self-representations. It can be considered as a driving mechanism behind the behavior changes in performance. The self-perception theory [12] demonstrates that people may deduce their internal characteristics from external cues. However, while the implications of altering self-perception via the embodiment illusion in VR is strongly established, the use of AR in fitness equipment (e.g. smart fitness mirror) presents an inventive avenue for exploration.

2.5 Creativity

Creativity as one of popular topics of study in psychology and cognitive science, is often mapped to divergent thinking abilities [13]. It can be considered as a measure to assess one's creative thinking abilities [13, 14].

In human-computer interaction (HCI), the prospect of augmenting one's creative abilities has spurred many unique research efforts [15]. The research is going to investigate how VR/AR interaction between human beings impacts the outcome of collaborative brainstorming. One mean to study the computational prime can be done through the assumption of different roles coupled with affective stimulation via images, boosting creativity when one runs out of ideas. VR/AR can offer a creative boost by increasing feelings of self-identification and positive affect or it can be the obstacle of innovation. We plan to perform a novel investigation into the potential for VR/AR to alter self-image, by allowing subjects to see themselves as an inventor-like figure or as a child

3 Motivation & Research Questions

As mentioned, studies have shown that virtually embodying someone who we perceive as having greater abilities than our own may have a positive impact on our own capabilities. Ongoing research, particularly in AR technology used in fitness equipment, continues to study the acceptance of distinct manipulations to their subsequent behavioral, perceptual, and social impacts. Building on this and taking inspiration from how virtual real-time mirror reflections in VR and AR can drive a sense of embodiment of a virtual avatar.

Since the COVID-19 pandemic breaks our standard community and normal interaction with people. It challenges our perception towards space and time. How we can take advantage of the AR which mixes real and virtual environments by establishing a user-centered world through devices such as a smartphone camera or motion tracker to reconstruct the workout system for individuals in COVID-19. In this case, several problems need to be concerned. What is the difference between this virtual coach and the real-person training coach? Whether we want to promote such a virtual coach and finally replace the real training coach. Then, will virtual interaction automatically change human perception in the long term?

4 Method

4.1 Online Survey of Online Communication

The onset of the COVID-19 pandemic quickly unearthed the need to segregate in their own house. We were interested in understanding people's experiences with using smart fitness mirrors or other AR/VR based exercise equipment to work out and conducted an online survey. We plan to deliver the survey to all ages which ranges from 17 - 80. They included people working in different sectors (e.g. finance, health, science and technology, education), such as accountants, bankers, physicians, therapists, software designers and developers, team leads, scientists and researchers, teachers and students. We can ask questions regarding the types of AR/VR equipment they used, and their experiences in the public and private environment.

4.2 User Study

The engagement of smart fitness mirrors and users face unique challenges with regards to embodiment. During a regular training session, the personal coach guides the training and talks with the trainer in person. The trainer must pay attention to both the coach and their figures in the mirror. This is a process of communication

and learning between trainer and coach. It is a one-sided reception and learning by using the smart fitness mirror, but the advantage is that attention does not dissipate, and the trainer can be more focused. (see in Figure 2)

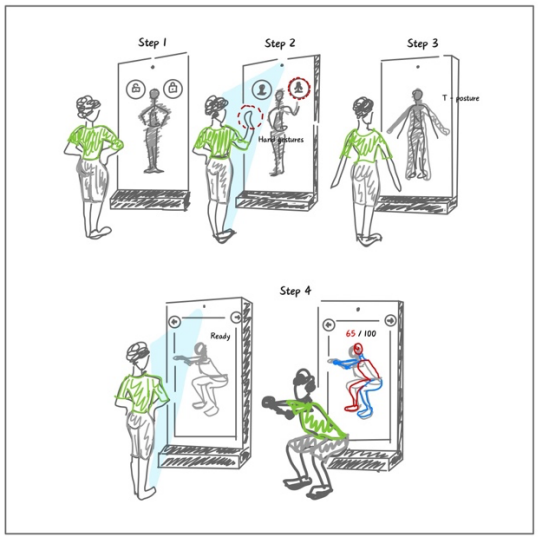

Figure 2. Smart-mirror-based personalized training system

Comparing these two different learning models, we can understand how VR and AR technologies will affect people's ability to learn and communicate and innovate. In this study, we will conduct an online experiment over Zoom to explore the impacts of virtual interaction on creativity and communication. Major cognitive and affective factors, such as feeling, mood, and embodiment, were examined to understand potential underlying mechanisms and processes. This is going to be a long-term study; we may schedule the meeting with participants weekly to record their possible change. We will set the control group to make comparisons as well.

4.3 User Tasks

First stage observation

We set up two groups, one is the control group which are a group of ten people who continue do the normal exercise with the real person trainer. The other group, on the other hand, are a group of ten people who do the fund exercise with smart fitness mirror. The total research periods are ten days, one month, and three months. We keep track with the user's emotion after they finish the daily training work. And we ask them to draw some pictures on the given canvas with a simple geometric image. We can evaluate the color usage, where they start their first painting and other properties to record their creative thinking process.

Second stage observation. In this stage, we are going to investigate the weight of visual stimuli in human-centered interaction design. Two group of participants with ten people are asked to use different fitness system. One of the groups will used the app with more visual illustration and stimulation. And the research periods are ten days, both groups are asked to do the same creativity test as the first stage.

Third stage observation. Sound can be another perspective for incentive our perception and generate the ideation. So, in stage three, the fitness system on the smart fitness mirror focusses on its sound. In this case, other settings are similar to stage two that we can compare the result of the second and the third stages.

5 Discussion

Because of the COVID-19 pandemic, people are asked to separate themselves from the society, their friends, and be alone. This will undoubtedly lead to many changes in our living habits. As we mentioned in the introduction part and the research question part, we want to study how technology affects people's thinking: whether there will be some incentives to motivate people for doing something benefit to them. And this is most research did and end. However, our final goal is to investigate how to generate more incentives to know whether this kind of motivation have some impacts or connection with people's creativity and communication skills.

In some degree, the results of the use of the smart fitness mirror confirms or partially prove our hypotheses. Users do feel motivated to do sport by using the smart fitness mirror. The results relating to the different levels of gamification. Indeed, it implies the fact that adult users are more likely to engage in the fitness routine if the products include more gamification in their design of course. Delivery. When we compared the mood changes after normal exercise and fun exercise training with the imagination tests, we cannot definitely say that fun exercises made the participants happier, but participants who have fun exercise produce a various of different drawings than the other group. Further, in later studies, we can use this brain stimulation to design products that interact with people and improve the natural ability to interact with people and help.

6 Conclusion

The research conducts a novel investigation into the potential impacts of introducing virtual coach to trainers and how it might change the way people perceive and learn. With the small sample of pilot test, we compared the effects between the standard teaching and training system versus the virtual teaching. Although the results of the pilot study various from each participant to the different conditions with respect to affect and embodiment. We, as a whole, can somehow get the hint that such new approach slightly increases the creativity scores. Participant become more focused and self-motivated. However, it shifts the normal system of communicating with input – mind processing - output to merely intrinsic communication. People talk with themselves in their mind.

Consequently, we believe that research into the constructive and productive use of AR and VR products in our daily life warrants further research. Due to the COVID-19 pandemic, we are challenged by the traditional human interaction and activities to keep safe distance. We believe that the AR and VR products can serve as a useful mean for stimulation and improvements in cognition. As we learned that the advantage of using it is to encourage the innovation and self-motivated, whereas the drawbacks is some people have the tendency to show anxiety while interact with the coach in person. It would be interesting

to explore whether the use of such AR and VR product in short term and long term by all members in a collaborative session would amplify any effects. Additionally, the future study with more participants can conduct the research of the impact of various virtual interaction and examine how this approach compares to real-time filter of camera. It would be an interesting idea to consider the possibilities of combining the AR smart mirror with the real-time filters as assistive technology, providing more services such as the new online education program, and the new concept of fitting room. Indeed, we see lots of opportunity to explore this wide array of

potential applications and extensions. Deeper exploration into the psychology of users when using the AR and VR products is particularly interesting in the case that such approach is great customizable and scalable.

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