Toward A Reality-Based Interaction Gaming Experience for Older Adults

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Abstract
Serious games on mobile and desktop devices often target older adults for the development and maintenance of cognitive skills; however, there is little evidence that these games are effective at transferring those skills to real life [9]. We are interested in using reality-based interaction to investigate whether tangible user interfaces and augmented reality can improve the transferability of divided attention skills from electronic devices to real life while also providing opportunities for engaging entertainment. We plan to design an interface for older adults who wish to play cognitive development games that are both dynamic and physical.

Author Keywords
Augmented reality; tangible user interfaces; serious games; cognitive skills.

ACM Classification Keywords
H.5.m. Information interfaces and presentation (e.g., HCI): Miscellaneous.

Introduction
Divided attention is the ability to process different information from multiple tasks simultaneously. This is an important skill for adults to have since it allows us to multitask and thereby increase our productivity levels. For example, cooking a large meal may require a

person's attention to be divided between several physical dishes requiring regular attention. Without the ability to divide attention, the dishes would burn. Many people, particularly in older generations, turn to serious games to improve their divided attention and other cognitive skills [9]. While users make noticeable improvements the more they play the games, the problem is the skills gained in these on-screen activities have not been shown to transfer to real-life situations. Reality-based interaction [6] utilizes our intuitive understanding of the physical world to interact with computer systems; it may improve the transferability of divided attention skills from computer screen to real life by making use of realistic interactions with tangible user interfaces in augmented reality. We aim to develop an application that uses reality-based interaction to practice those same skills while providing the same level of entertainment that currently appeals to both older and younger adults alike.

Related Work

In [9], the authors studied the transferability of skills developed in a serious gaming application to users' regular lives. Their work states that participants had a self-reported increase in attention abilities after playing these games. This shows the potential of this skill to transfer from game to reality, but there is a lack of significant research about whether and how tangible user interfaces can improve divided attention. Similar to this, we have seen prior work that uses mixed reality and tangible user interfaces to improve spatial cognition [1] as well as enhance learning through mind-mapping [3].

Other research has shown that players of action video games have stronger abilities in visuospatial attention [2], enumeration accuracy and multiple object tracking [4], and task-switching [5] compared to non-players, even when these tasks are extended to non-game activities. Participants in these studies were mainly older adolescents and young adults. These works serve as examples of cases where skills learned and developed in a game can transfer off-screen and to non-gaming situations, although they did not use tangible user interfaces or reality-based interaction.

Design

We hypothesize that practicing divided attention in a physical environment with tangible objects and without the consequence of failure could allow for a more realistic skillset to be developed than by clicking buttons on a screen. This is why we propose an augmented reality game using a tangible user interface. Using augmented reality will keep the game grounded in the user's real environment while adding dynamic game objects that users can react to, unlike physical games with static elements. The tangible interface will provide reality-based interaction, improving upon traditional GUI interactions that are less relevant to real life tasks.

Therefore, the question we are asking is *can a tangible user interface improve transferability of divided attention skills from games to real life situations?* To answer this, we will need to create and test a tangible user interface for a game that requires divided attention.

The interface will be designed using an examination of games similar to Lumosity's Train of Thought or Trouble Brewing [7] which target the skill of dividing attention. The sketch in Figure 1 illustrates an application in which

Figure 1: A sketch example of how someone might use a physical bucket to catch holographic water spouting dynamically from various faucets "on" the wall. In this image, black represents reality while red represents holograms. This sketch is meant to represent preliminary interaction ideas.

the user would interact with holographic spouts using a physical container. The player would be required to divide their attention amongst the spouts and react accordingly. This is meant to be a concept sketch; our game may be similar to what can be seen in Figure 1, but we are exploring alternate options including gamified realistic tasks.

Ultimately, we are designing an interface which will be used with an augmented reality application for the Microsoft HoloLens [8]. Users will move physical objects to interact with multiple simultaneous holographic entities in order to divide the users' attention. The decision to design the application for the HoloLens, a see-through head-mounted display, is to maintain the real-life setting in which users could apply their practiced divided attention skills.

We will evaluate our interface's ability to transfer divided attention skills to reality using user studies. To do this, we will design a study that will firstly measure participants pre-existing divided attention abilities, followed by a period of regular interaction with the application to practice the skill, and finally concluding with a measurement of post-study divided attention abilities. Participants may be older adults, who are the target market for most cognitive development games, or younger adults who may enjoy the games for cognitive development or simply entertainment. We expect to find that people who have interacted regularly with the application using the game will experience an increased ability to divide their attention in real life due to the hypothesized higher transferability of the skill compared to users of on-screen games. Transferability will be measured via task completion time and accuracy.

Conclusion

The results of this work will have impact for the target users, generally older people, of serious gaming applications for cognitive development; the proposed testbed could itself become a tool for cognitive development or entertainment. Using tangibles is similar to other non-digital activities that older generations are used to, making the interaction more relatable to their daily activities.

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