Games for Health: Design Cognition-Focused Interventions to Enhance Mental Activity

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Abstract. Older adults want to proactively protect their aging cognition with various possible ways. Cognitive intervention has been proposed as an effective way to improve memory loss problems. In this paper, we present the CogStim Game, an iPad application for older adults to exercise their memory. For example, by practicing name-face matches through the medium of a game, older adults would have a chance to stimulate their cognition. Together with the game description, we will also present our design rationale behind the game development. The CogStim Game would provide a more accessible and effective way to address our society's concerns due to an increasing aging population.

Keywords: Games for Health, Senior Friendly Design, Cognitive Stimulation, Alzheimer's Disease and Related Disorders (ADRD), Brain Exercise, Memory Enhancement Activities, Dementia.

1 Introduction

Aging is one of the highest known risk factors for Alzheimer's [1]. The chance to develop Alzheimer's doubles about every five years after age 65 [2]. As there is no known cure for Alzheimer's Disease and Related Disorders (ADRD), many older adults are concerned about their mental health and would like to proactively monitor their aging cognition [3]. Alternative treatments from both pharmacological and non-pharmacological approaches have shown to either slow down symptoms or preserve the patient's current cognitive status [4]. Older adults tend to prefer cognitive interventions because they are usually safer and without side effects, compared to medications. They would like to seek help from non-pharmacological methods such as brain exercises, cognitive stimulation, and memory rehabilitation to delay the onset of ADRD [5].

The current practice of cognitive intervention conducted by special therapists requires a series of one-on-one or group meetings; thus, not many people would have a chance to try or receive the therapies. Besides these therapy approaches, research shows that active engagement with stimulating brain activities such as riddles or puzzle-solving may prevent age-related cognitive dysfunction [3, 6]. However, some people may stop doing these activities once they become mundane and boring. Studies show that in order to enhance the effectiveness of the intervention, the activities

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should be regularly practiced rather than performed on a short-term trial basis [7]. In this paper, we present our unique approach to integrate cognition-focused interventions as a computer game, the design rationales, and the Face Name Game as an example module of the CogStim Game.

2 The CogStim Game

To increase accessibility and enhance personal engagement with cognitive intervention, we have designed and developed a technological intervention called the CogStim Game. The goal of the CogStim Game is to provide older adults with cognitive exercises that not only can improve cognitive outcomes, but can also provide predictive value in detecting cognitive impairment. The CogStim Game would encourage older adults to use their brains through diverse and fun mental exercises while actively monitoring their game play outcomes. If the outcome of a brain exercise is found to be worsening, it may be a timely detection of initial cognitive decline. Furthermore, with the CogStim Game, older adults concerned about their cognitive health may self-administer cognitive intervention games, similar to what they can do at the gym to exercise and monitor their weight in order to prevent cardiac-related disease. Figure 1 shows an initial screen shot of the CogStim Game, in which a user can choose one of the four different game modules.

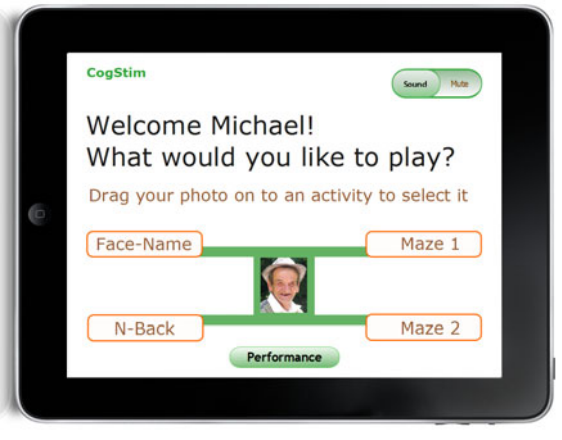

Fig. 1. A screen shot of the CogStim Game including four independent modules

In order to understand the technological potential to support cognition-focused intervention for cognitive impairment, we took the approach of gaining contextual knowledge, such as understanding the intervention process, interactions between therapists and patients in the intervention process, and their interactions with the intervention materials. Based on this knowledge we developed three design rationales, described in the following section.

3 Design Rationales

Based on user-centered design principles, we took an iterative design process to develop a series of game modules in CogStim. The design and development of the CogStim Game modules should meet the three design rationales below.

3.1 Developing Clinically Proven Game Contents

The CogStim Game would support personalized, engaging, and stimulating cognitive activities through extensive game playing. There are three approaches to designing cognition-focused interventions: cognitive stimulation, cognitive training, and cognitive rehabilitation [5, 8]. Despite the conceptual differences in the definitions, the terms *stimulation*, *training*, and *rehabilitation* are used interchangeably. Our CogStim Game includes all of the three techniques. Since our goal is to provide learning through games, we can incorporate any technique to develop reasoning, memory, and speed of cognition.

3.2 Interacting with Technology

The CogStim Game would be easy to use for older adults who are not familiar with computer use. Many older adults may have low computer literacy, with limited or no computer usage experience. If they cannot use computers, or if they have difficulty in interacting with technology, it could result in unexpected or adverse outcomes. In our previous research on a computerized dementia-screening tool, we learned that pen input is accessible, even for seniors who lack computer experience [9]. Furthermore, an 85-year-old study participant expressed that it was fun to draw using a stylus on a Tablet PC, and that drawing with a stylus on a smooth tablet was much easier than drawing with a pencil on a piece of paper. Some participants wanted to finger paint. Therefore, we designed interaction methods using touch or pen input for the CogStim Game.

3.3 Motivating Users

The CogStim Game would motivate older adults to play every day as a routine exercise. We investigated ways to incorporate reward schemes to increase motivation and encourage game participation. For example, a personally motivating reward could be an automatic direct dial to a grandchild if they complete the daily game session. Another example would be putting an algorithm into the game so that if a user completes a certain session, their family members will then be notified by an instant short message or an email. The reward structure could also be accumulating points to exchange for coupons or gift cards that could be redeemed at participating local businesses.

4 The Face-Name Game

As one of the CogStim Game modules, the Face-Name game is developed based on Cognitive Stimulation (CS). One of the CS exercises includes tasks such as recalling

recently learned items [5]. The Face-Name game has two modes: a training mode and a testing mode. In the training mode, users will be trained to associate a particular name with a particular face, while in the testing mode, the user will have to match names with faces. The interfaces provided by the game for each of these will vary, depending on the user's particular stage of cognitive impairment. In the training mode, the game will try to reinforce memory by providing the user with multi-modal cues about a person's name for users with Mild Cognitive Impairment (MCI) or the early stage of Alzheimer's. For example, a user will be presented with images in groups of 7 and will be allowed to spend as much time as he or she wishes on each face-name pair. The interface for the current version has a photo of a person, along with a name in large letters. The interface says the name presented on the screen and prompts the user to say the name out loud while looking at the image. Figure 2 shows an example screen of the game which provides the three different pictures and a user need to select the right name that she had learned.

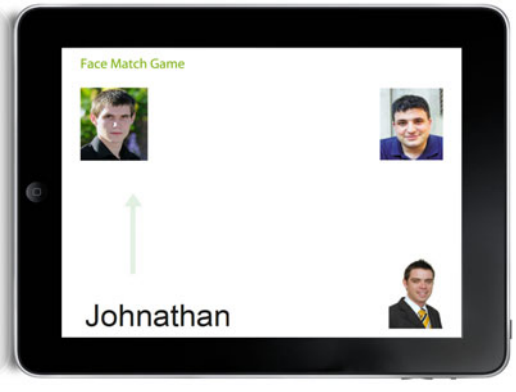

Fig. 2. A screen shot of the Face-Name Matching module in the CogStim Game

Only after the user has said the name out loud will he or she be allowed to navigate to the next image. The interface for users in advanced stages of Alzheimer's will be slightly different. In this case, the interface (a) will have no audio component, (b) will have smaller sets of images (3 per set) and (c) will change the face-name pairs, according to pre-decided timing. The interval for which the user will be allowed to see the face and read the name will be very brief (<2 seconds). This interval will allow the user's implicit memory to associate the face and name pair, while the user's explicit memory may not be able to make the association. This is deliberate on our part to enforce the user to tap his or her relatively undamaged implicit memory, even while the explicit memory is being eroded due to Alzheimer's. The testing mode of the game will provide users with a name and multiple faces per level. The users must drag the name to the correct face. As such, the interface for this mode will almost be the same for all users. The only difference will be the number of faces shown per level. For example, the number of faces shown to users with MCI will be more than the number of images shown to users in advanced stages of Alzheimer's.

5 Conclusion and Future Work

Early intervention is crucial in cases of MCI. Treating individuals with Mild Cognitive Impairment (MCI) may delay the progression of the disease and prevent it from developing. With CogStim games, older adults would be able to practice cognitive exercises anytime and anywhere. Once we complete the development of other modules, we plan to conduct randomized, controlled trials to evaluate the effectiveness of the CogStim Game. Ultimately, our research may contribute to understanding how computing technologies can advance our understanding of early cognition-focused intervention, the impact to the prevention and progression of disease, and quality-of-life issues for the aging population.

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