RESD: STEPS TOWARDS IMPROVING THE DESIGN OF REMINDER SYSTEMS FOR OLDER ADULTS WITH DEMENTIA USING EYE TRACKERS

by

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CHAPTER I

Introduction

According to the Unites States (U.S) Census Bureau, 13 percent (40 million) of people were 65 or older living in the U.S in 2010. This is twelve times the number of older adults who were living in the U.S in 1990. By the year 2050, the number of older adults living in the U.S is expected to increase by 20.9 percent [1]. This projected increase is attributed to the fact that in the year of 2030 the last of the Baby Boomers will be turning 65. Baby Boomer are people who were born after World War II during which the birth rate of children increased temporarily.

In 2010 three percent of older adults lived in nursing homes, of the percentage of older adults who did not live in nursing homes, 33 percent (11 million) lived alone and this number is expected to increase within the next three years [1]. According to the American Association of Retired Persons [2], 90 percent of older adults reported their desire to live alone as long as possible. Living alone or with family allows older adults to maintain independent lifestyles [3, 4]. While many may choose to live alone to continue establishing their independence, living alone may not be the desirable option due to limited resources, lack of support, and difficult living situations [5]. Living alone can also lead to poor health due to missing doctors appointment, missing meals, and or forgetting to take medications [6, 7, 8]. Older adults who live alone may also become socially isolated and lonely, which puts these adults at risk of having poor physical and mental health. The feeling of loneliness and social isolation puts these older adults at risk for developing dementia such Alzheimers disease (AD), because of the poor cognitive performance which can increase cognitive decline [9].

I.1 What is Alzheimers Disease?

Memory is the process of storing and retrieving information about images, events, ideas, and skills after the original information is no longer available in the present state [10]. There are three types of memory: sensory memory, short-term memory and long-term memory. Sensory memory is a stage in memory that can hold information for a brief second or less. Short term memory can hold information for about 15 to 20 seconds. Long-term memory can hold information for many years. Over the years memories can become less retrievable due mild cognitive impairments and different types of dementia. Dementia, caused by changes in brain, is a general term for loss of memory and other mental abilities severe enough to interfere with daily life [11, 12].

AD, the most common form of dementia, is a progressive disease of the brain that causes long-term memory loss, confusion, irritability, aggression, and difficulty with speech. By the year 2050, an estimate of 88 million people will be diagnosed with AD [13]. As more people are diagnosed with AD, the need for caregivers will increase, but there will be more older adults than caregivers. Caregivers struggle to provide adequate treatment to patients as behaviors often attributed to AD patients may actually be symptoms of dementia and consequently, require different treatment [14, 15]. In the U.S. there are 16 million caregivers who provide unpaid care to people with AD and other forms of dementia. In the early stages of AD and other forms of dementia about 70 percent of these older adults live in long-term senior living communities, where 74 percent of these individuals live with someone and 26 percent live alone [13]. Surveys have shown that family caregivers of AD patients face numerous challenges, including lack of familial support, difficulty dealing with mood swings of the loved one suffering from the disease, and difficulty balancing care of their loved one with the demands of their career and personal life. This creates the need for easily accessible information and expert advice about the care of patients suffering from AD.

I.2 Assistive Technology

Assistive technology (AT) is technology used by individuals with disabilities in order to perform functions that might otherwise be difficult or impossible. It is a research area that aims to improve the quality of life for people with disabilities. J. Evan et al. [16] conducted a comprehensive literature review on 176 articles to explore the types of assistive technologies that are currently being designed, developed and evaluated for people with AD and other forms of dementia. From this study, they found 22 specific technologies to be mapped to six themes. The themes included safety devices, memory aids, preventing social isolation, supporting everyday tasks, and clinical devices. Memory aids were the most popular theme to be researched and developed and safety devices were the most common theme among technologies that have been developed. They found that many of the technologies were developed for the ease of living instead of the quality of life [17]. Information technology and assistive technology aims improve the quality of life for people with dementia and AD. The number of older adults between 55 and 77 who use technology is rising. In 2010, Internet usage among the older population was up 31 percent from a decade prior [1]. Older adults use technology to communicate with family either through email, text, video chat, to share photos, to socialize, and to play games such as solitaire and chess. Assistive technology for people with dementia can help with facilitating memory recall, successfully live alone longer, and reduce the stress of their caregivers [18].

I.3 Common Types of Assistive Technology

I.3.1 Music Therapy

Music Therapy is the clinical and evidence-based use of music interventions to accomplish individualized goals within a therapeutic relationship by a credentialed professional who has completed an approved music therapy program. In a research article by H. Fukui et al [19], the researchers reported that music therapy is effective in the treatment of AD. They found that the secretion of hormones that are supposed to have preventive effects on AD, such as 17-estradiol and testosterone, is significantly increased by music. In clinical settings, estrogen is used to treat post-menopausal women with AD disease and has shown its effects to improve their verbal memory and attention remarkably. This form of treatment has been increasingly used throughout the United States. One group of researchers [20] looked at the effects singing, as music therapy, has on people with AD. Instead of listening to the music, AD patients were allowed to sing in a group setting. In the research article by Nicholas Bannan et al [20], their focus was to find out if AD patients were able to participate in group singing of songs that were taught. Bannan also explored how group singing slows the progression of the disease, which resulted in finding out older adults with AD are able to participate in group singing. Due to these results, some longer-term benefits were shown. Researchers have also explored how listening to classical music, such as an excerpt of Vivaldi Four Seasons enhances attention processes, and that this can be demonstrated in people with AD [21]. These results support the notion that music therapy can improve verbal memory and attention in older adults with AD. Nursing homes and living communities implement music technology to assist in caring because music has shown improve cognitive functions and delay the progression of the disease.

I.3.2 Wandering

Wandering is the act of traveling aimlessly from place to place. People with AD usually present these behaviors during the moderate stages of AD due to the increase of being confused and not knowing where they are [13]. Researchers found that wandering was the most common result when someone searches for AD on Google search [16]. Behaviors of wandering in older adults with AD includes pacing, increased motor activity, touching different objects, and rubbing hands together. One may say these signs are related to being restless, but Lai et al [22] surveyed literature in aims of trying to accurately define wandering behaviors in people with AD. It was concluded that there are different types of wandering, the most common is elopement. This type of wandering has led people with AD to leave the home and become missing. Research has also shown that men are more likely to wander due to the fact that when they are faced with stress or pain they are more likely to be physical [22]. One researcher [23] actually videotaped to observe ten people with AD in the mild to late stages who exhibit wandering behaviors. The researchers found that people with AD tend to wander during unstructured hours, times when they are not being occupied with activities from health care providers.

Wandering can be risky for older adults with AD who live alone or have unstructured time during the day. In aims to reduce the risk and keeps these older safe, researches have worked to ease the fear of wandering on caregivers through research with sensor [24, 25, 26, 27, 28]. Many of these systems that have been developed are tracking systems to know where the older adult with

AD is at specific times of the day. One researcher [24] developed a tracking system that would send requests to receive the location of the older adult with AD via a phone and the location would be sent back to the person who requested the location (e.g. caregiver, spouse, family member). The system was successful in sending and receiving location requests, but the bulkiness of the phone, the setup process, and the battery life caused an issue with the system. Voug et al. [25] developed and examined an algorithm for detecting wandering travel patterns using inertial sensors such as accelerometer and magnetometer. Monitoring systems were placed on the persons wrist, waist, and ankle. They were then directed to replicate directed walking (going to a specific spot with a purpose), lapping, pacing, and random patterns. The algorithm developed was shown to be reliable. They also found that the waist was the best to place for the sensor because they would soon forget about the sensor being there.

I.3.3 Cognition and Interactions

Cognition and interactions is an area within assistive technology that deals with keeping the older adult with AD active cognitively using different types of interactions, for instance brain training games or cogintive assistance technology. Fardoun et al [29] designed a prototype that allows an older adult with AD to use a smartwatch to take a picture of someone. The picture is then analyzed and the smartwatch tells the older adult who the person is in the photo.For instance, if an older adult takes a picture of their spouse, the system would analyze the picture and tell the older adult that the person standing in front of them is their husband, wife, daughter or son etc. The mobile watch application shown to be critically flawed, which proved the issues in the literature review [14]. Issues were mainly with regards to the usability of mobile devices by the elderly, such as 1) difficulties viewing the information on the mobile screen: many patients had vision problems and could not see the information on the screen, 2) interaction difficulties: patients were not able to angle the smartwatch correctly and others forgot steps. The network connectivity was also an issue and people had difficulties learning the information presented on the screen [30, 29]. A program was recently developed for helping patients with moderate AD disease engage in computer-mediated verbal reminiscence [31]. The first program was a virtual partner posing questions and providing attention and guidance. The second program showed photos and videos encouraging older adults with AD to talk. The results of this study showed that 99 percent of the participants had clear and lasting increase in verbal engagement in persons with moderate AD disease [31]. Creating assistive technology for older adults with AD comes with careful testing and improved design metrics.

I.3.4 Reminder System

Reminder systems are one of the less popular assistive technologies that are being developed for older adults in the early stages of dementia. A reminder system is a computerized system that aids in helping the user remember specific information (e.g. taking medicine, birth dates etc.). Many of these systems focus on how successful the system is at giving reminders. For instance, TAUT (Technology Adoption and Usage Tool) [32] is a reminder application that had three core functions, which included 1) assistive reminders that can be set the patient/sufferer, the caregiver, or family member, 2) Data collection, 3) Context aware sensor platform. The researchers concluded that the application did what it was supposed to do in terms giving reminders and collecting data, but the use of sensors is not the best to use. TUAT [32] aimed to do this by using accelerometer and gyroscope sensors to record how soon before or after the reminder was giver did the older adult acknowledge the reminder, but the sensors were not the best at recognizing if the phone was moved to acknowledge the reminder. There are no systems that successfully focus on how the older adult responses to the application, such as if the older adults accomplished the task successfully.

I.3.5 Objectives and Scope

The focus of this research is based on three research question including 1) are older adults able to accomplish more tasks with the help of reminders, 2) are reminders acknowledged by the older adult, and 3) has the older adult successfully attempted to complete the task the reminder gave? We aim to answer these questions by monitoring the attention and performance of older adults through an eye tracker and mouse tracker. This preliminary study was conducted with older adults, age 60 years and up, for a quality analysis to understand what older adults seek from reminders, so that we can inform the design of a reminder system for older adults with Alzheimers who are living alone.

CHAPTER II

System Design

II.1 System Architecture

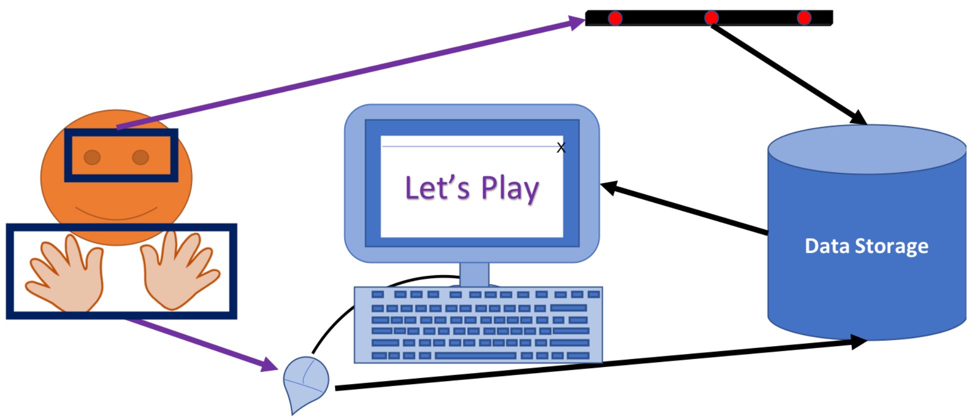


Figure II.1: System Architecture

RESD is comprised of a Windows computer with a 1920 x 1080 pixel display screen, a computer mouse, and a Tobii EyeX tracker, as shown in Figure II.1. Participants interact with a game that is stored on the computer. As the participant, is going through the flow of the game, the eye tracker and the mouse tracker collects and stores data on where the participant is looking and moving the mouse at specific times during the game. These trackers allow us to gather information on the attention and performance of the participants. Through this research we also what to see if there is a correlation between where someone is looking and where someone is clicking. The flow of the game is controlled by an finite state machine, which will be discussed further in the paper.

II.1.1 Tobii EyeX tracker

Tobii EyeX tracker is an eye tracker developed by Tobii Technology [33]. The eye tracker knows where the participant is looking and stores that information temporarily during game play. Tobii EyeX is comprised of projectors that create a pattern by projecting a light on the eye that is near infrared, sensors that take frame images of the participants eye and the pattern it creates, and algorithms that produce things such as the gaze point onto the screen. Using a Tobii EyeX for RESD allows us to know where a participant is looking during a specific time to possibly understand what the person is thinking. The temporary data allows us to understand if participants are paying attention to reminders and what types of reminders are participants acknowledging.

II.1.2 Game Structure

RESD is a system that aims to understand how developers and researcher can improve the design of reminder systems using eye tracking. RESD is a 2D computer game, developed in Unity [34], that is based on the card game called Concentration, also known as Memory or Matching. Concentration is a cognitive training card game where cards are faced down on a hard surface to hide the face value. Players take turns flipping cards over to see who can find the most matching cards. To be successful throughout the game, players must recall the exact location of cards that were previously flipped over by other players.

RESD was designed to have similar rules and attributes of Concentration, the differences are RESD is simulated on the computer, has three levels that varies in difficulty, is implemented using a finite state machine to control the flow of the game, and incorporates reminders to remind the older adults of the tasks they should complete. Each of these differences will be described later in the paper. According to the Alzheimers Association[9], non pharmacologic therapies such as cognitive and computerized memory training activities can possibly serve as a way to maintain cognitive ability and prevent further decline.

While playing participants were able to view their time, current score, how many matches were made, and how many turns/chances it took to get the correct answer. This allow participants to know how successful they are within the level.

II.1.2.1 Level One

Level 1 (L1) consists of nine cards, six memory cards and three choice cards, as shown in Figure II.2. At the start of the game, the six memory cards were flipped up for three seconds to reveal the face value (see Figure II.3a). During the three seconds the participant was instructed to remember

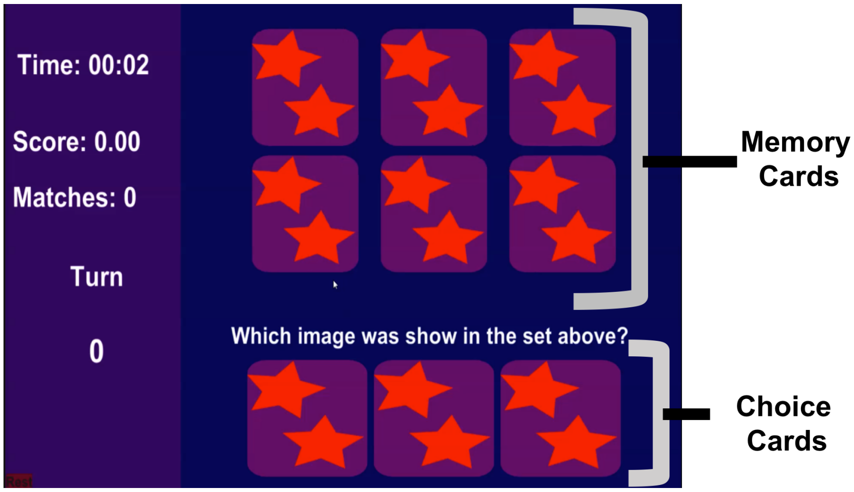
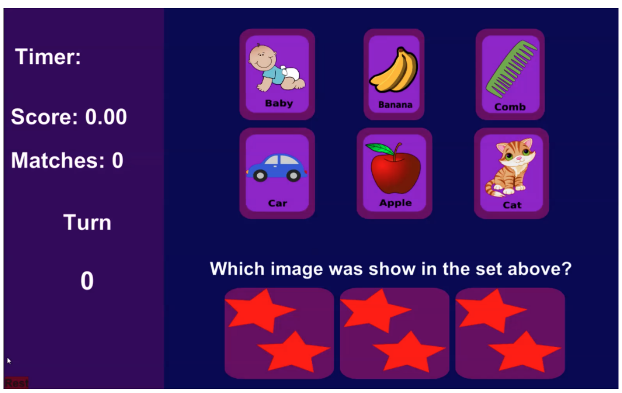


Figure II.2: Level 1 Display of All Cards Flipped Down



(a) Memory Cards Flipped Up

(b) Choice Cards Flipped Up

Figure II.3: Level 1 Game Play

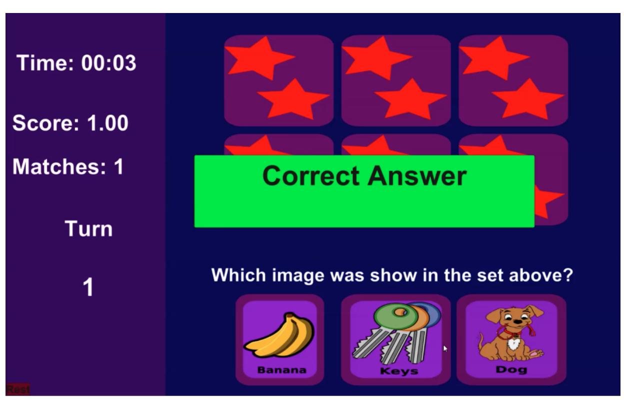


Figure II.4: Correct Answer Notification all six cards. Once the three seconds were up, the six cards were flipped down to hide the face value and choice cards were flipped up to reveal the face value (see Figure II.3b). The choice cards consists of two cards that were not shown in the memory card set and one card, the answer, that was shown in the memory card set. The goal of L1 was to choose the one choice card that was shown in the memory card set. Once a card was chosen a notification appeared to notify the participant if the selected card was incorrect or correct, as shown in Figure II.4. Participant had two chances to get the correct answer. If no choice card was selected within 1 minute the memory cards were flipped up for 2 seconds, so the participant could get a quick look at the cards.

II.1.2.2 Level Two

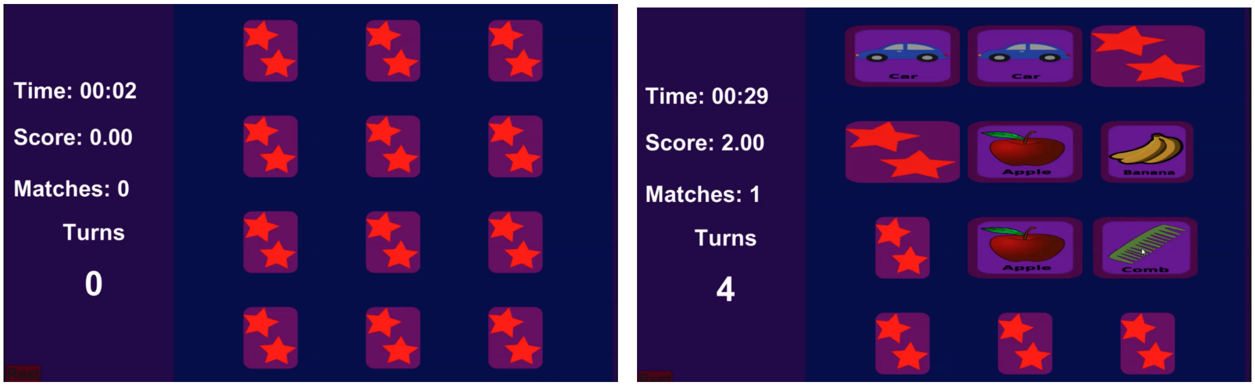
(a) Level 2 Start

(b) Level 2 Correct Answer Notification

Figure II.5: Level 2 Game Play

In Level 2 a layer of challenge was added to the game. The goal of L2 was to find the card in the set that does not have a match. This task required the participant to remember the exact location and face value of each card. At the start of the level, the cards were flipped up for five seconds (see Figure II.5a,so participants could store the information into their memory. After five seconds, the face values are hidden and a prompt appeared at the top of the screen to tell the participant to “Click the card that does not have a match”. If the participant chose the correct card a green box notification appeared showing the word “Correct”, as shown in Figure II.5b. If the participant chose an answer that was incorrect the participant saw a red box with the words “Incorrect, Try Again.” Participants were given three chances in this level to choose the correct answer.

II.1.2.3 MatchAll



(a) MatchAll Start Screen (b) Matching Cards

Figure II.6: MatchAll Game Play

RESD Level 3 is called MatchAll, which is the basic game of Concentrations. The cards start in a flipped down state hiding the face value, as shown in Figure II.6a. The participant had to initiate play on this level by randomly clicking on any two cards that were faced down. A reminder was given if the participant did not initiate play with five seconds of the level starting. Once both cards were flipped up, they were analyzed to see if those two cards were matches. If the two cards were not matches then the cards were flipped down and the participant must try again until he or she matched all of the cards. If the two cards were correct, then those cards would stay flipped up. For instance in Figure II.6b, the blue car cards and apple cards are two different matching sets that were successfully found. Also in Figure II.6b, on the participants current turn they chose the banana and the green comb, because those cards are not matches they will be flipped back down. The goal of this level from the game point of view was to see how fast older adults made matches.

II.1.2.4 Finite State

A finite state machine was implemented to control the flow of RESD. As seen in Figure II.7, there are four states, Level 1, Level 2, Level 3 (MatchAll), and EndGame. The flow is determined by the score a participant has at the end of a specific state and the number of chances used during that specific state. State Level 1 is the starting state for all participants and EndGame is the final state all participants will interact will. When a participant is in state Level 1 or Level 2, if the

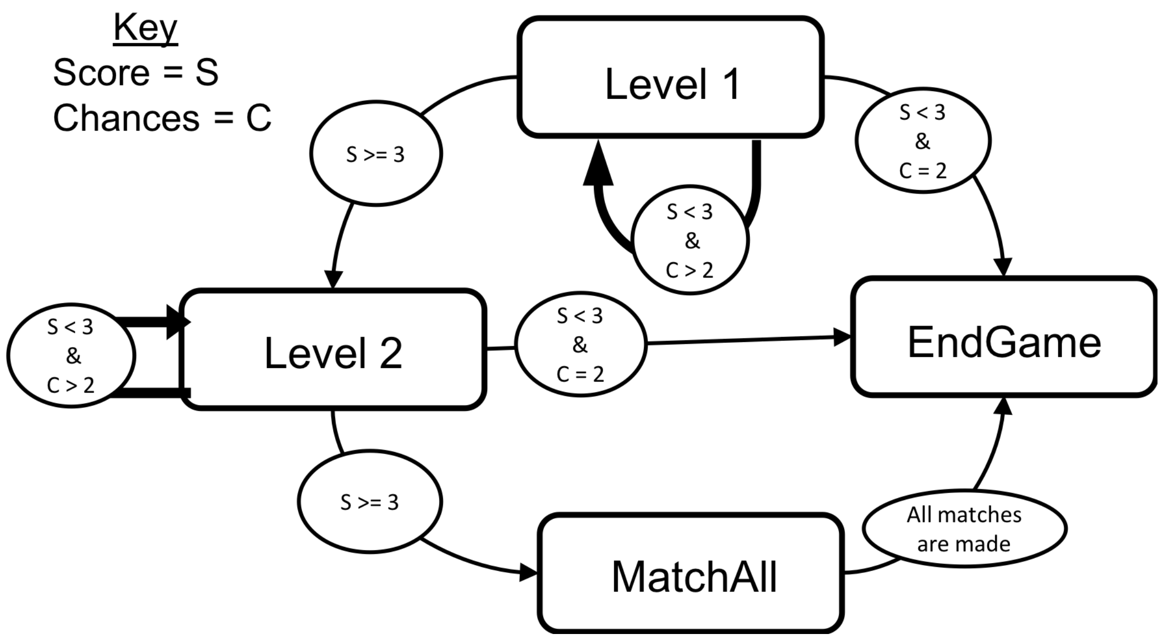


Figure II.7: RESD's Finite State Machine Flow

score is greater than or equal to 3 the participant will be sent to the next state, respectively state Level 1 goes to Level 2 and state Level 2 goes to MatchAll. If the participant has a score less than three and chance is less than two, then the participant will repeat that specific state and chance will increase by one. If the participant has a score greater that three and chance equal to two, the state will change to state EndGame. When the participant is in state MatchAll the only way to get to the end state is to make matches for all of the cards in that level.

II.1.2.5 Reminders

As participants played through the levels they received reminders throughout each level to reminder them what task needed to be accomplished.In L2, after five seconds the directions that appeared above the memory cards in L2 were hidden, so the reminders appeared when the correct answer was not yet selected or during idle times determined by the mouse tracker. Reminders appeared in random locations on the screen, see Figure II.8. If a reminder is not acknowledged by clicking on it then the color of the notification box would change. Every ten seconds a yellow reminder box would appear and every fifteen second a red reminder box would appear in a random location.

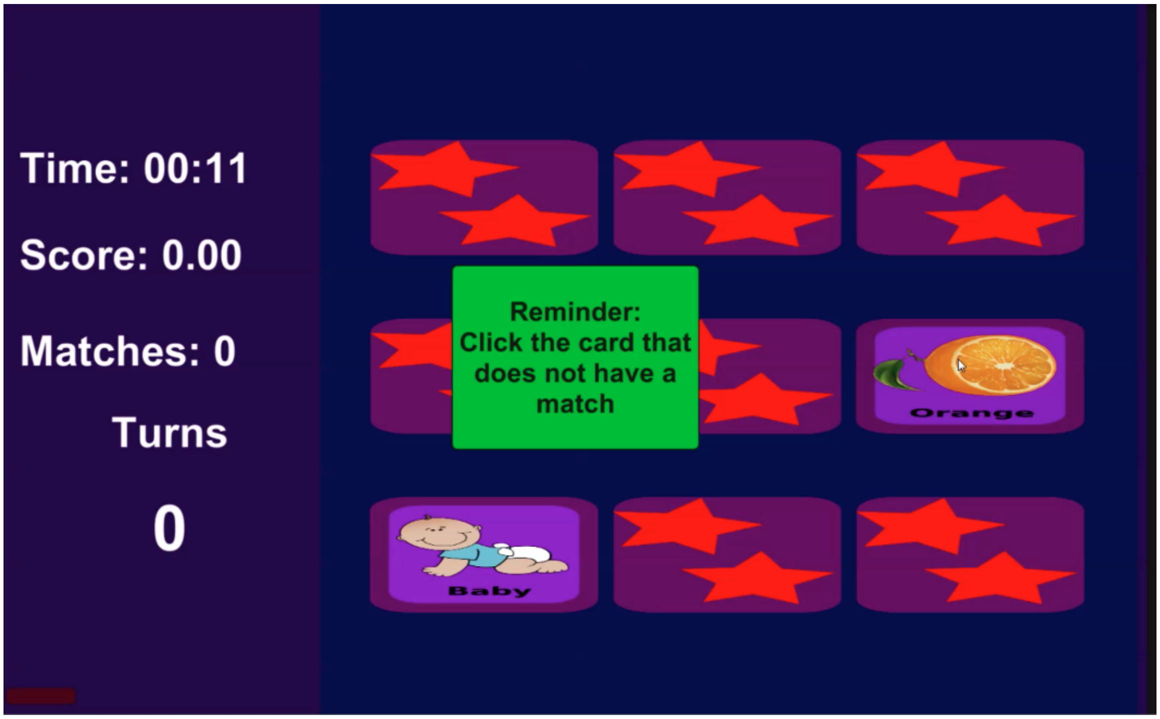


Figure II.8: Reminder Box After 11 secs

When the red reminder box appeared the choice cards in L1 and memory cards in L2 were disabled, so the participant had to acknowledge the reminders to continue through the flow of the game.

CHAPTER III

User Study

III.1 Evaluation

We conducted user studies to better understand how reminder systems can be design in the future. This study was approve for the Vanderbilt University Institution Review Board (IRB) for healthy older adults. The study aimed to answer the three research question of 1) are older adults able to accomplish more tasks with the help of reminders, 2) are reminders acknowledged by the older adult, and 3) has the older adult successfully attempted to complete the task the reminder gave? Attention was monitored using the Tobii EyeX tracker to reveal if the older adult acknowledges the reminder by looking at it and to see where older adults were focusing their attention at specific times during game play. Performance was monitored using the mouse tracker to figure out 1) if the older adults clicked the reminders when they appeared on screen, 2) the time it took for the reminder to be acknowledged, and 3) if the older adult accomplished the task given by the reminder.

III.2 Participation

(a) Participant Playing Level 1 (b) Participant Playing MatchAll

Figure III.1: Participants During Game Play

We recruited ten older adults 60 years and older from the Nashville, Tennessee area using mass email distributions to people who have previously participated in research with our lab and expressed interest in being notified about other research opportunities and we also sent emails through various Vanderbilt University listservs. Participants who expressed interest through email or phone, went through an initial screening phone call to be sure that they were able to perform basic computer task such as moving a mouse and clicking icons on a computer screen. For the study, participants came to our lab for a half an hour to one hour long session. For participating, each participant received a $25 gift card. The age range of participants were from 61 to 75 years old (mean = 66.5), and 80 percent of participants were identified as female and 20 percent identified as male. 90 percent of participants expressed that they use their computer daily either for personal use or for work, yet many of them (70 percent) were not confident in their basic computer skills. 70 percent of participants use reminders or alarms to accomplish tasks, while 30 percent of participants expressed that reminders were never used in their daily life to accomplish task. One participant state, I never considered it. Of the participants who use reminders, 90 percent expressed that they use them either once a week or daily, for remembering upcoming meetings, appointments shopping, grocery lists, birthdays, and as a wake up alarm. One participant expressed that they use remembers, but as needed.

III.3 Protocol

Participants came to the lab for one session that lasted 30 minutes to an hour. An informed consent was signed at the beginning of the session by the participant. After signing the consent form, the research was explained in further detail, with much explanation talking about the Tobii Eye X tracker [33] that was tracking their eye movement. The participant were then instructed to complete a pre-study survey that consisted of demographic questions (e.g. age, gender), questions about their level of experience with reminders, and questions about the types of tasks they use reminders to help them accomplish. After the initial eye tracker calibration, the participant were able to interact with RESD. At the beginning of each level the participant was given instruction on how to complete the level, as seen in Figure III.2. Before participant pressed the Ready button they had the option to ask any clarifying questions.

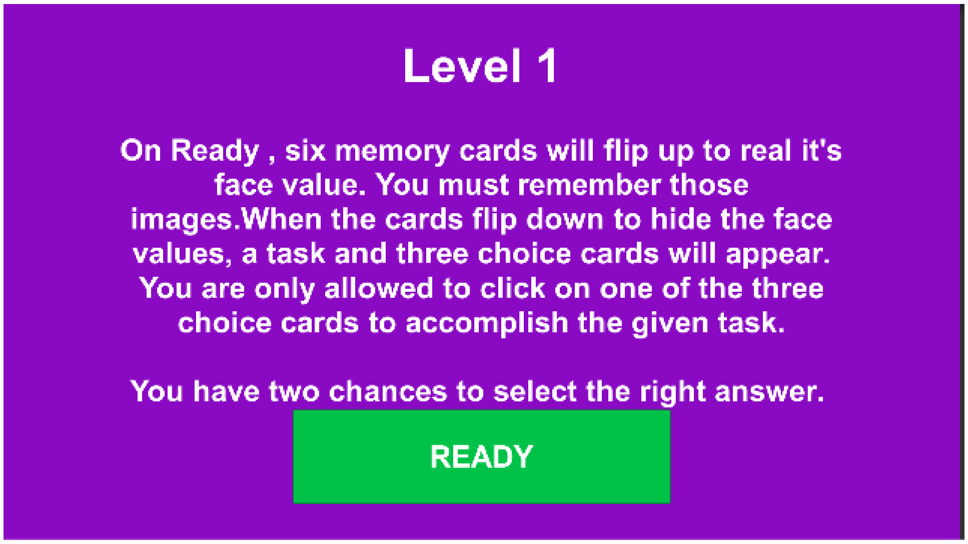


Figure III.2: Instruction Screen for Level 1

During Level 1 and Level 2 participants went through three trials. Each card was randomly generated from a list of 29 common images that older adults would recognize in their daily life (e.g. cars, keys, TV, apple), see Figure III.3 for a the complete list of cards used. Each participant had the same cards for a trial, but the locations of the memory cards and choice cards were different for each participant because of the randomization. At the end of the session, the participants completed a post survey to answer System Usability Scale questions (SUS)[35] and questions related to designing reminder systems for older adults.

III.4 Findings

Here, we report on the finding from the evaluations, organized by the types of data gathered. For the post survey we used likert scale questions and open-ended responses.

III.4.1 Performance

Performance was monitored using the mouse tracker. Through data analysis and observations we found that many participants only clicked on objects when they were ready to select the answer.

Figure III.3: Face value of all cards used in the study

The number of clicks per trial were the same as the number of chances a participant used to get select the correct answer. Many participants moved the mouse in circles, as seen in Figure III.4, or squiggly or curved , as seen in FigureIII.5 ,lines seven seconds before clicking on an object.

III.4.1.1 Level 1

The performance data within Level 1 shows that five participants received a perfect score of five without receiving any reminders or extra chances to select the correct answer in a trial. For this research perfect score refers to participants who received did not receive and reminders or extra chances to select the correct answer. Participants who did not receive a perfect score in Level 1, four of five participants received reminders. The average amount of reminders received per trial was one reminder with the most reminders received in a trial are three. All of these participants received at least one reminder in the first two trials. There were two participants who acknowledged the reminders by clicking on them. These reminders were acknowledged in the second trial and one participant did not acknowledge the reminder until they were forced to because the answer

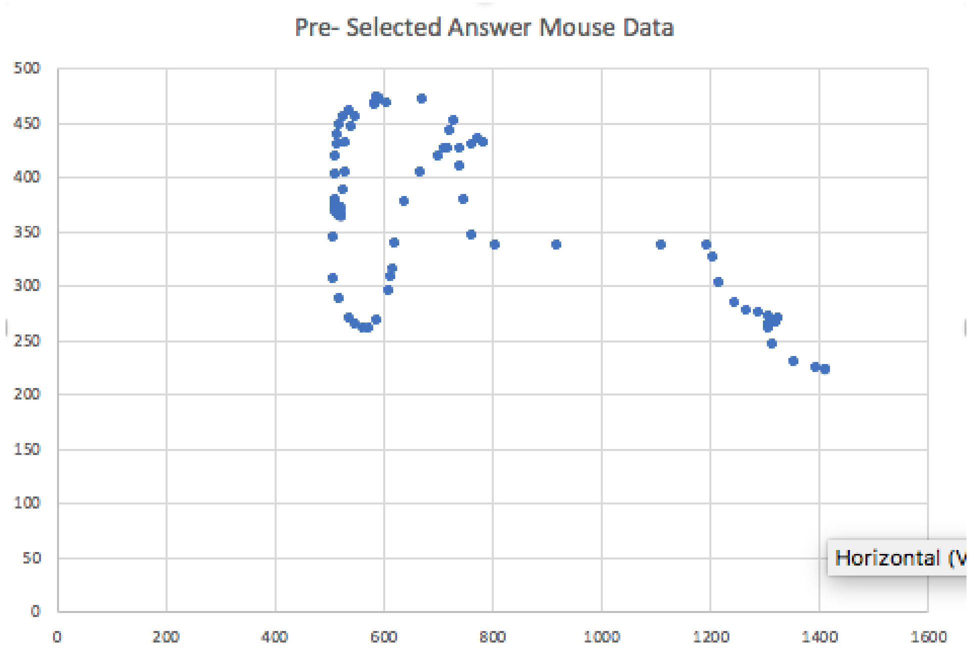


Figure III.4: Pre-Selected Answer Mouse Tracker Data: Non-Perfect Score in Level 2

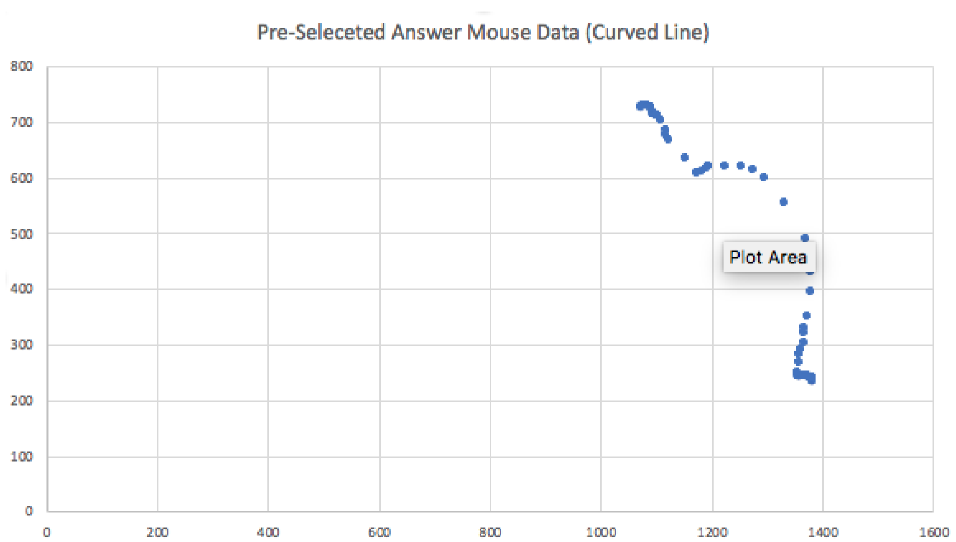


Figure III.5: Pre-Selected Answer Mouse Tracker Data: Perfect Score in Level 2 choices disappeared. In Level 1 participant received two chances to select the correct answer. The amount of chances the participant made were similar to receiving reminders. The average amount of chances per trial were 1.8, with 2 being the most tries a participant received in a trial. In Level 1 if participants received a score less than three they were able to try again on that level. No participants received an extra try for Level 1, which means all participants received a score of 3 or above for Level 1.

III.4.1.2 Level 2

Performance in Level 2 decreased, with three participants receiving a perfect score without help from reminders or extra chances. Of the seven participants that did not receive a perfect score, all seven received reminders. The average amount of reminders received per trial was 1.46 with the most being three. One participant received at least one reminder in each of the first three trials. Three participants received at least one reminder in the first two trials. With one receiving another reminder in the fourth trial. Another three participants received two reminders in only the first trial. Only two participants of the seven acknowledged the reminders, but they were only acknowledged for both participants in the second trial. Through observation it was clear through vocalization that the reminders in level two helped the participant accomplish the task. The reason is attributed to the fact that the older adults did not have enough time to process the instruction at the top of the screen before they disappeared.

Within the seven participants without perfect score five participants received extra chances to select the correct answer. The average amount of chances per trial was 2.56, with three being the most a participant received in during a trial. Most participants received at least one reminder in trial 2. 1 participant received three reminders in trial three.

III.4.1.3 Level 3

In Level 3 the average time it took a participant to complete the level was 64.8 seconds. The lowest time was 39 seconds and the highest times was 102 seconds. Participants who scored a perfect score in both Level 1 and Level 2 receive a time of 58 seconds or below.

III.4.2 Attention

Attention was monitored using the Tobii EyeX tracker. The gaze data for participants who received a perfect score in Level 1 showed that their focus and eye movement was distributed across the card display (see Figure III.6). The gaze points for participants who did not receive a perfect score without reminders seemed to be scattered over the screen, as shown in Figure III.7.

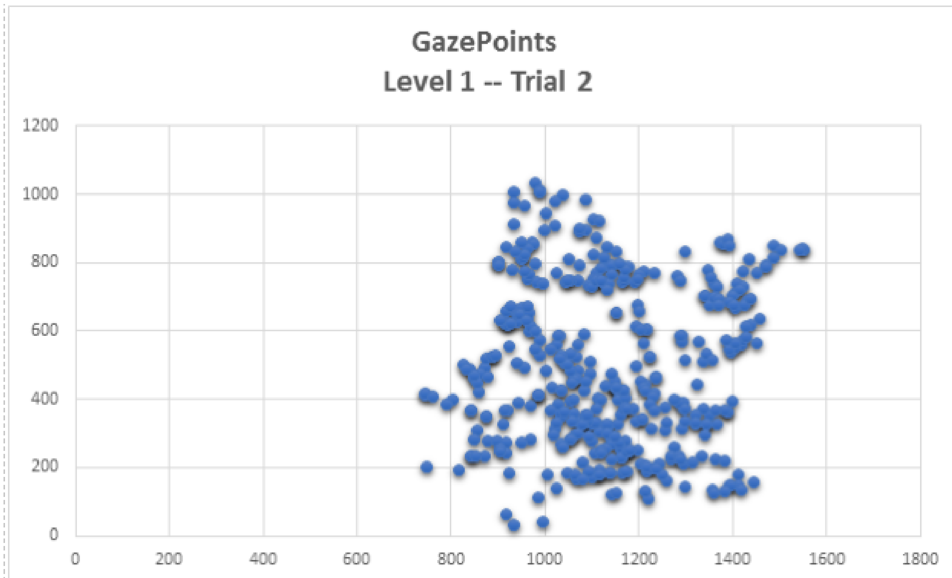


Figure III.6: Gaze Point Data for Perfect Score

Figure III.6, shows how data looks for a participant that received a perfect score of five without reminders or extra chances to select the correct answer. This Figure shows how the data is clustered with in the area of the memory cards and choice cards. Not much focus was given to the side panel with the participants score, time, and the chances. The participants were moving there gaze a lot during trial one.

Figure III.7, shows the data of a participant who received a score of five, but received reminders in trial one and trial 5. The data points are more scattered compared to the perfect score participant. The points in this data set shows that the participant did not make much eye movement and instead focused on specific points on the screen. During this trial a reminder appears (see Figure III.8), but it is inconclusive based on the eye gaze data if the reminder was looked at by the participant. Due to the fact that the reminder appears in the top right-hand corner and covers one of the memory

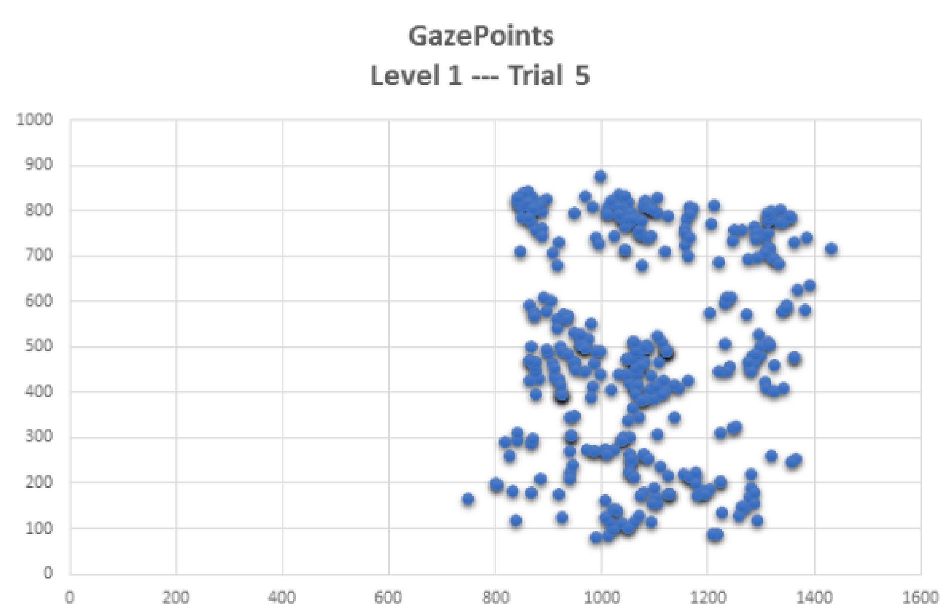


Figure III.7: Gaze Point Data for Perfect Score using Reminders

Figure III.8: Level 1 Trial 4: When reminder appears cards.

In Level 1 one participant scored three points and received two reminders for trial 1 and trial 2. In Trial 2 the participant acknowledged the reminder by clicking on it. The gaze data in Figure III.9 that is boxed in red shows that the participant looked at the reminder box that appeared in Figure III.10. With this data we can also see that some of the same patterns with the gaze data is shown among many of the participants who did not receive a perfect score, which is that the points are more scattered with less eye movement happening on the screen.

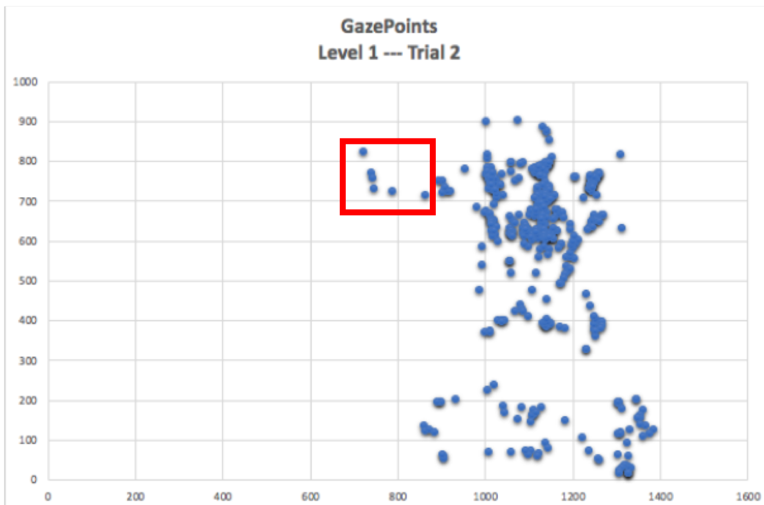


Figure III.9: Gaze Point Data: Acknowledged Reminders

Figure III.10: Image Correlation: Acknowledged Reminders

III.4.3 Post-Survey

After interacting with RESD, participants complete a two part post survey. The first part of the survey asked questions about the systems usability and the second part of the survey asked about their current views of reminders after interacting RESD.

III.4.3.1 System Usability and Functionality

For the system usability question, participants were asked to rank there answer from 1 to 5 with 1 being strongly agree (sa) and 5 representing strongly disagree (sdis). When participants were asked about the ease of use 100 percent of participants agreed on some level that 1) the system was easy to use (70% sa and 30% agree), 2) people would easily learn how to use the system without the help of a technical person (70% sa and 30% agree). When asked if a participant would use this system frequently 80 percent (50% sa and 30% agree) agreed on some level and 20 percent neither neutral about this statement. 90 percent of participants agreed that 1) the functions of RESD were integrated well and 2) they felt confident using the system. This data shows that high percentage of the participants were satisfied with the functionality and usability of RESD.

III.4.3.2 Reminders Design

This part of the post survey was a mix of likert scale question, yes and no question, and open ended questions about the reminders design and the participants view of future designs of reminder systems. Participants were first asked if they were able to accomplish tasks without reminders. The results were split, 40 percent (20% sa and 20% agreed) of participants agreed on some level, and 40 percent of participants disagreed. 80 percent of participants found the reminders were helpful when interacting with RESD. 10 percent of participant disagreed with the previous statement because they do not like using reminder in their daily life in general. Participants would benefit from reminders that change in position and color based on the users attention, 80 percent of participants said yes, while 20 percent of participants said no. The types of systems participants felt would be best for changing state (color and position) would be best found on a computer calendar, for appointments, for “anything that has a time limit”, special dates, and it can also be used on a car dashboard. The 20 percent of participants who disagreed accounts for the two participants who stated in the pre-survey that they do not use reminders. Participants who responded yes to having change state reminders explained that "[I] have eye problems and its easier [for me] to see changes in colors or positions than having to read something", others stated that this will help them keep the reminder in their mind longer. 60 percent of older adults in this study stated that they would likely use reminder systems that allow users to look at the reminder to acknowledge it. Participants who responded likely to acknowledging reminders with eye movement felt that it would be something that was simple. A participant who responded that they were less likely to use this type of reminder stated that, "I'm already using a visual reminders and I am able to ignore it or just click on it for it to go away, [but] then [I do] NOT follow up on what the reminder is telling me to do."

We asked the participants to describe the types of features they would prefer in a reminder system, many of the participants stated that reminders with loud noises, heavier vibrations, flashing colors, and something that is simple to use and simple to set up. Some participants went into greater detail in explaining a reminder system that would "Freeze the reminders until you actually complete what the reminder is telling you to do.[For instance, with] Fitbit - to take 250 steps, the visual reminder does not go away until the Fitbit tells the reminder the task is complete." Another participant explained a reminder system that are "Interactive units where the unit tells one another when the reminded task is complete and then the interrupted task can be returned to and be completed. (I would hate this but would respond to this reminder better.)". This information is helpful in understanding the types of reminders older adults would like to use in their daily lives.

III.5 Discussion

This research is first step towards enhancing the way reminder systems for older adults with AD are developed. RESD embodied news ways of representing and interacting with reminder systems when designing for older adults. The data gathered from the eye tracker and mouse tracker and the user feedback about RESDs reminders yields insight into how we can best design reminder systems in the future. In this section we discuss the design implication of this work.

As older adults memory is not the only thing that start to decline sometimes, vision, and hearing does as well, so a design system that can vary in sound or add a heavier vibration for older adults with AD who also have hearing impairments. For older adults with AD who have vision impairments, such as low vision or has peripheral vision loss, could benefit from having reminders that change in color and position when the reminder is not acknowledge.

Design specifications that aims at enhancing the attention older adults give to reminders, could include adding brighter colors or a color to rank the type of reminder. For instance if the reminder is for a meeting that is tomorrow the reminder can appear yellow, which means it needs some attention, but if the meeting is today the reminder can turn red, which means it need your attention now. Other features that would promote gaining attention to reminders, would be to disable or in the words of a participant "freeze" the screen, so the user is forced to attend to the reminder. This would be important for older adults with AD to be reminded to take things such as medications, exercise, stretch, and eat. This helps promote a healthy lifestyle and established the persons independence.

When designing for older adults in general it is important to keep things simple and functionality or physical interaction should be at minimal. Using an embedded eye tracker would be helpful in acknowledging reminders. To do this the system must learn the average time it takes for the user to read and comprehend the tasks that wasF given, so the eye tracker tell the reminder to disappear after the reminder was completed.

III.6 Conclusion/Future Work

In this research we argued that an eye tacker can help in improving the design of reminder systems of older adults with dementia. We collected attention and performance data of the participants responses to reminders in RESD and feedback from participants about reminders. With the data collected and feedback from participants we suggest design implications for the first step towards designing reminder systems for older adults with dementia. We tested RESD with healthy older adults, instead of other adults with dementia for the first systems validation because older adults between the ages of 60 to 75 is the range in which people start experiencing decline in memory and they experience normal age related decline. Also due to the time limit it was more rewarding to test with healthy older adults. The next steps of this work would be to implement and test the reminder system using the design metrics described in this paper with older adults with early stage dementia or mild cognitive impairments. We will also close the loop of the system to allow the eye tracker to 1) present reminders when attention is idle and 2) allow the reminder to disappear by looking at the reminder.

CHAPTER IV

Contributions

IV.1 Technical Contributions

In the area of assistive technology for older adults with dementia, reminder systems as cognitive assistance has not been heavily researched. This works is steps towards designing reminder systems for older adults with dementia using eye trackers. We developed a reminder game system that incorporates an eye tracker to monitor the attention of older adults when reminders appear on the screen. We aimed to understand how older adults attended to reminder and how they accomplished tasks with the help of the reminder. Previous research on reminders for older adults with dementia, has been focused more on how reminders were successful at delivering the reminders, but less on how the user acknowledges them and successfully completes tasks. To our knowledge, a reminder system that incorporates an eye tracker to understand attention has not been performed yet. Cognitive training games for older adults would also benefit from this research due to the ability to monitor attention to make sure the older adults are attending to the games being played, which could possibly increase the result of such games.

IV.2 Social Contributions

This work will allow older adults with early stages of AD to establish their independence longer by being able to live alone longer with a tool that will monitor their attention level using an eye tracker that delivers and follows up on unique reminders about taking medicine, eating, going to appointments and more. This work also contributes to the area of AD by aiming to understand attention from the lenses of an older adult with AD because it is currently difficult for many nurses to detect their patients attention level [36]. There are three types of attention, including selective attention which is the ability to focus on a particular stimulus while filtering out other stimuli; divided attention which is the ability to focus attention between different stimuli; and sustained attention which is the ability to maintain focus on stimuli over time [10, 36]. In AD, selective attention and divided attention are affected early in the disease process, whereas sustained attention is relatively preserved until later [37].

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