



Development of Custom Assistive Technology for Alzheimer's Patients

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Abstract

There are several issues to be tackled caused by an ageing population, one of those being providing support and care for those with Dementia – more specifically Alzheimer's. There are limited technologies aimed at assisting Dementia and the ageing population, those that do, usually focus on the physical symptoms of patients.

This dissertation aims to research traditional methods and existing technologies for assisting with Dementia and taking a user-centred approach by working with caregivers to design and develop a personal mobile application, custom to users, to enhance reminiscence (recollect and reflect through memories or characteristics that are suggestive of another) and help our elderly and loved ones stay independent for longer. From the research and user studies, the application was designed to be accessible by using HCI principles and user evaluations to assess suitability. The app acts as a digital gallery of memories with the user's media formatted for readability and a simple quiz format to assist users with remembering names, relationships, and dates from their photos.

Declaration

I declare that this dissertation represents my own work except where otherwise stated.

Acknowledgments

Iris Barber and St. James Over 50s Club

Firstly, I would like to thank my grandmother, Iris Barber for the help as a gatekeeper to St. James Over 50s club and her help with the project research and user evaluation. In addition to the participants who took part in the survey, gave their stories, and opinions as loved ones and caregivers of people with Dementia/Alzheimer's.

Jordan Barnes

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1 Introduction & Motivation

1.1 Purpose: The Ageing Population & Alzheimer's Crisis

Many developed countries have rapidly ageing populations, where the average age of a population is increased due to higher life expectancies and lower fertility rates (see Appendix 1). With this comes an increasing ratio of elderly and retired citizens to the proportion of people that are working and providing care to older generations; “the number of pensioners is increasing faster than the number of working-age people – at a growth of 37%... compared to 13%” [1] (see Appendix 2).

The statistics support the need for change in many areas of society, especially within healthcare and the technology needed to support the elderly and help them stay independent for longer as there is an increasing demand in care homes and carers. One area that requires innovation and advancement in care is for people with Dementia.

In the UK, Dementia has been the number one cause of death since 2015 [2] – approximately 850,000 people have some form of Dementia (over 50 million worldwide [3]); this is set to rise to over 1 million by 2025 and 2 million by 2051. This includes 1 in 6 people over the age of 80, as well as 1 in 3 people born in 2015 onward, are estimated to develop Dementia in their lifetime: 60% of those cases being from Alzheimer's Disease (AD) [4]. As there is currently no cure for AD, the main purpose of treatment plans and lifestyle changes is to slow the progression of the patient's deterioration.

1.2 Technological Support for Alzheimer's

In a world increasingly revolved around computers and digitalisation, many older people struggle to keep up with the technology that is available to them, but many are becoming technologically literate too [5]. The problem with assisting elderly with Dementia/AD is that there is a wide variety of methods and products designed to help them in their daily lives but can be quite difficult to find/obtain especially for elderly users who may not know how to or have difficulty using the internet and e-commerce.

The products on the market are helpful but are often limited to assisting the physical difficulties that AD patients may face, such as rails and steps for use in bathrooms and equipment like non-spill cups. From brief research of the market, users, and personal experiences, it is clear there are very limited applications and accessible technology for AD/ Existing technologies are often broad and impersonal to users, so the large and increasing market will require new technologies to assist the population to stay independent for longer and ease the toll on their loved ones and caregivers.

1.3 Project Aim

This dissertation aims to explore how technology can assist AD patients and how personal and custom applications can assist in reminiscence and cognitive behaviour.

1.4 Project Objectives

Objective 1. To research some of the current methods and existing technologies for AD and the elderly in general.

This includes exploring traditional methods and evaluating existing technology used to assist with AD and the elderly. I will be reviewing past research in the development of specialised technology for AD and how I may improve upon what has been done.

Objective 2. To develop some ideas for an application's functionality and methods to assist AD with their memory and reminiscence.

From that research, I will develop several ideas for the possible functionality of a mobile app based on existing methods that may help improve the memory and cognitive functions of users. The goal of developing ideas before working with users is to design useful surveys for more optimal results with feedback on those ideas.

Objective 3. To reach out to relevant organisations and people with experience with AD on what they think helps them and what they would like to see.

I will be taking a human-computer interaction (HCI) approach by working with the users, in this case, by creating a survey and talking to caregivers and loved ones of people with AD to discuss what they currently use and do that helps them, what they would like to see and gather opinions on ideas for the app. From an analysis of the results, I will create user personas and stories to assist with the designs.

Objective 4. To design and develop a prototype for the application with core functionality that allows users to have personalisation to assist with their memory.

While keeping in mind HCI principles, accessibility, and the user personas and stories – I will design and develop a prototype of the app with relevant technologies, aimed at people with AD. I will be developing with an agile methodology, performing sprints to finish features in a desirable time, with the initial aim to complete core features from the designs.

Objective 5. To evaluate the effectiveness of my application for AD and whether it could be useful to users from feedback and HCI evaluations.

Finally, I will be evaluating the app following HCI rules/heuristics and user evaluations and feedback, as well as whether I met my objectives, looking back at where I succeeded and failed to meet initial expectations. I aim to explore the possible future development of the app and how it could be improved.

2 Background Research

2.1 The Focus of Research

There are many symptoms individuals can experience from AD including trouble with their speech, visuospatial skills (e.g. judging distances), concentration, and planning for simple tasks, which can get progressively worse in later stages to delusions and aggressiveness [6]. However, the most well-known symptom is memory loss – forgetting information that is personal and important to their everyday lives and relationships. The memory side of symptoms within the early to mid-stages of AD is what I will be focusing on, but other symptoms are relevant enough to be considered within the design of the mobile app.

2.2 Traditional Methods

Before looking into the existing technology used by people with AD, it is important to look at the traditional methods used to help patients remember information, reminiscence on the past, use their cognitive skills to solve problems and ease their mind through activities that they can handle without causing agitation.

The Alzheimer's society's website (*Alzheimers.org.uk*) provides many examples of memory aids/tools, activities, and methods for patients to keep their independence for longer [7]. As well as my own experience with helping care for someone with AD and from talking to others, the following are often found helpful:

- **Music therapy and singing;** a popular method throughout the world is to play music, including songs special to them e.g. from their wedding, childhood, hymns, and their favourite songs. Music can be used to ease distress, connect with others, encourage social interaction, initiate physical movement/exercise, and reminiscence on the past [8].
- **Photo books, scrapbooks, timelines** – picture-based and tangible reminders are commonly used to reminisce, with descriptions and names alongside photos for easy identification. These can preserve a patient's memories of family, friends, life experiences, and hobbies to provide a sense of pride and self-esteem as well as validation and a distraction to focus and celebrate their lives. This can also include videos.
- **Large-print and picture-based reminders** [9] including calendars, permanent signs around the home, Dosette boxes (medication organisers), and colour coding can all be used to simplify reminders and actions into icons and colours with large text.
- **Easy-to-understand** games such as large-piece jigsaw puzzles, crosswords, card games, and matching games.
- **Hobbies and art therapy;** activities that stimulate the mind are important for cognition, this can include reading, painting, gardening, writing, etc. and in general keeping healthy physically through exercise and mentally.

2.3 Existing Technologies & Products

Most of the existing technology used by people of all ages can be helpful to people with AD too, however, they are not always suitable due to interface designs and set-ups that are too complex or inappropriate for an older audience that is not experienced with technology. Technology that can help with their memory and safety include:

- **Mobile phones** can help in many ways with calendars, maps, apps for personal records, apps for relaxation, and automatic reminders. Tablet devices or computers can be used for larger displays.
- **Automated pill dispensers** that may be set off via movement nearby, time of day, or button and a noise alert.
- **Prompt and reminder** devices that detect movement or by time and play a voice message e.g. take your keys before you leave.
- **Locator devices** for frequently lost objects with a small tag that makes noise activated and GPS tags in clothes or jewellery to keep the wearer safe if wandering by alerting others of their location.
- **Video games** for entertainment or mental stimulation such as puzzles or Nintendo Wii sports – which is still used in many care homes to help cognition and movement.

Other ubiquitous technology:

- **Smart-home technology**, such as automatic lights, door/bed sensors, automated shut-off devices that can shut-off gas, cookers, and taps if they left running.
- **Virtual assistants** such as Amazon Alexa for asking questions with ease and the context-awareness to be able to control a product within a smart-home, for example, central heating, alarm systems, and electronic locks.
- **Telecare systems** that alert others when conditions are dangerous or an accident has happened, this can include smart-home and absence sensors, heart-rate monitors, and fall sensors.
- **Robotic technology** e.g. automatic vacuum cleaners.

2.4 Past Projects in this Area

While many scientists and research labs are attempting to understand the biological changes and develop new treatments for AD, the technological side is still developing. In a 2018 paper that reviews current technological solutions for AD patients [11], a total of 6,404 publications were selected according to keywords, those that contained at least 4 properties of their criteria were passed – resulting in 107 papers, but on manual inspection, just 17 papers were included in their review; the properties being that the paper was published post-2007, described technology solutions for people with Dementia, use of technology for everyday activities, and described the efficiency of technology used for patients. The 17 papers reviewed focused on the development of monitoring systems for safety and health, e-learning for caregivers, wearable technology, and telecare systems. From a table of characteristics, only 3 papers did not include monitoring, 5 were not related to activity detection, and 4 did not include ambient sensors.

Although these technologies are found useful, research is commonly centred around sensors, data gathering, and monitoring, with very little research into human-centred design and technology that is personal to the individual. The review failed to mention the lack of user-centred design but did highlight limitations such as the risk of negative reception by patients/caregivers, shortcomings in respective sociocultural differences, and privacy concerns.

Another review of studies developing supportive technologies reflected that few, but an increasing number of studies are involving the patients within the development of technologies. They concluded that patients could play an important role in the evaluation and generative phases of development and giving people with Dementia the “right sense of control”, gave designers/developers the gained

empathic understand which results in more meaningful and suitable technology. However, further research into appropriate methods and materials is needed as reports of methodology and evaluation of user-centred design is missing [12]. My project aims to bridge this gap by producing a product that does revolve around monitoring but an application that is personal and addresses what is important to the user, through the use of their own media and include the users throughout the design by knowing what they want to see and what they think helps them.

'Printer Pals', a project in 2019 by Newcastle University's Open lab and University College Cork Psychologists was the experience-centred design of a "receipt-based print media device" after a two-year ethnography (qualitative study of observing participants in their real-life environment), to encourage participation through engaging with the technology for shared experiences and meaningful interaction [13]. They discuss the concept of patients being 'passive' in the care they receive which can often lead to a 'loss of self' due to a lack of opportunity to take an active role in their care, this is an idea which I would like to tackle through the introduction of software that provides a platform for patients to practice self-care from the start of diagnosis.

Printer Pals was designed for a care home that was restricted by the lack of Wi-Fi and reluctance to use touchscreens, this is an issue in many places as healthcare and computer literacy struggles to keep up with modern technology. In 2016, the Office for National Statistics reported that 74% of people aged 65 to 75 were internet users and almost 39% of over 75s regularly used the internet [14] – yet Age UK found only 2,835 care homes out of almost 18,000 care homes in England had internet access and 60% of the 397,000 care home residents has never used the internet [15]. Although internet access may have improved since then, care homes are still limited to the technological help they can receive, so without huge improvement in care homes, technology is best designed to work without internet access or with limited Wi-Fi through offline services and other methods of connectivity such as BLE (Bluetooth Low Energy).

Though the design considerations concluded by this study still stand, the product produced will quickly be outdated and obsolete due to advancements and a generation that is experienced with computers and mobile devices will soon be the elderly that require care. I look to explore more into the methods of individual self-care for patients with early to mid-stage AD as a digital-native generation will be the ones supporting patients or have AD themselves, which challenges the negative perceptions of technology for the people with AD, just as Printer Pals succeeded by producing social connection and reflection through discussion and inclusivity.

Laird, Elizabeth A et al. developed a mobile application to provide personalised reminiscence for people with Dementia and their caregivers as an experiment to measure improvements in the carer-patient relationship and subjective well-being after 19-weeks of use [16]. The app hosts a variety of multimedia uploaded from the device or third-parties (YouTube, iTunes, etc.) into an SQLite database. The app uses images and icons with text to indicate functionality, which has proven to work well for people with Dementia, rather than one or the other (textual / icon buttons) [9]. However, although it brought multiple types of media together for reminiscence, they did not present how it has been adapted to be suitable for the patients, as the media lacks descriptions and acts more as a file system. A more user-friendly approach might require user or caregiver input such as names of the people in the photo/video and format the input in a way that communicates clearly what they are seeing by reminding the user of a person's name, a relationship, or a place to assist their memory.

Their quantitative methods of evaluating success using Likert scales for questions such as 'How attached are you to your caregiver?' may not be an accurate measure due to randomness. A statistical analysis may result in a negative reception by patients and carers due to the lack of user-centred design that other studies have proven less invasive and involving the users in the development of the technology and the evaluation methods may have proven more meaningful results [17]. The

results, however, involved a larger participant group than usual as they anticipated a 50% dropout rate and found participants statistically had increased quality of relationships and emotional wellbeing of patients from personalised reminiscence intervention.

3 Working with Caregivers

3.1 Method of User Research

To develop an application that people with AD and their caregivers would be interested in and useful to them in a personal way, I wanted to take a user-centred approach to come up with ideas for the functionality of the application. By gathering the views on what they believe helps them as caregivers and patients, including what they look would like to see and opinions on possible functionality of a mobile app aimed at assisting AD. Firstly, I wanted to find out what they currently use from my research on the traditional methods and existing technology and gather feedback on ideas for the functionality. By developing ideas on what the app might do before design, I can take note of their opinions and what features may be helpful or not to them.

I received ethical approval from the University Ethics Board and designed a short, printed, multi-choice questionnaire (see Appendix C) to understand their current situations and usage of technology and Likert scales for how helpful they think some ideas could be, with room to write additional information, feedback, and answers. The questionnaire is designed to non-invasive and quick to complete to not cause a burden on participants. An information sheet about the project's purpose and appropriate contacts was available to all participants, as well as a consent form to be signed by each participant. Only caregivers and the loved ones who have cared for people with Dementia participated in the questionnaire due to the sensitive nature of receiving content from people with Dementia [18].

3.2 The Participants

St. James Over 50s Club is a club open to people of all religions and backgrounds to socialise, take part in activities, and have lunch together, they meet every Friday at the Enfield Highway community centre and consists of around 60 members. The club does a range of activities suited for older members, including baking competitions and simple games like guessing objects from close-up photos (see Appendix D) and Bingo, as well as charity events, organised day trips, and talks. I approached St. James Over 50s Club through my grandmother, Iris Barber, as a gatekeeper; Iris organises the weekly events and bakes for everyone that attends.

I approached them due to the wide variety of ages with several members in their 90s, having created simple picture quizzes for them previously, and knowing many had experience caring and working with people who have Dementia. The questionnaire was completed (in January of 2020), by 14 people who are caregivers and close family of people with Dementia/Alzheimer's, who were very helpful in sharing their stories and what they have learnt over the years.

3.3 The Results

Once I had received the questionnaires back, I recorded each person's answers individually and anonymously to be able to view the spread on questions that allow more than one answer (see Appendix D). The first two questions to ensure participants are someone who has cared for people with Dementia or is close to someone who does so that they will be able to answer the questions accurately. The answers also give us an idea of how often the caregiver is a partner or relative and their methods of receiving care. The answers showed most people who have acted as a caregiver, were caring for someone who is close to them and many participants used a variety of options for the patient to receive care at all times, with most patients having been in a care home or assisted living part-time and cared for by family/friends, lived independently, or visited by paid caregivers as well. Due to participants being middle-aged to elderly themselves, some had known multiple people

with Dementia/AD as their family and friends have aged and Dementia is so prevalent, with one participant stating:

"I have had and lost a mother, sister, brother, close friends all from Alzheimer's. Also have a brother-in-law in a home now".

General Opinions on Current & Future Technology

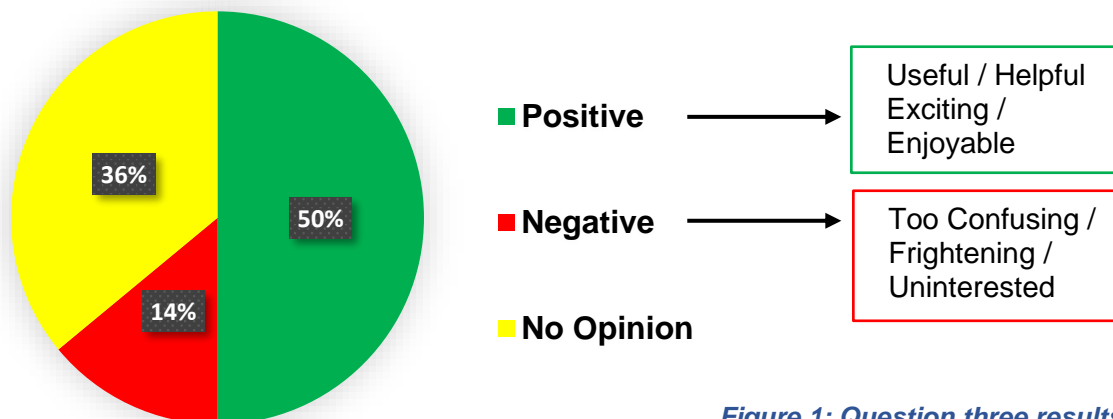


Figure 1: Question three results

To understand the participant's current feelings towards technology and their usage, I asked for their general opinions on current and future technology in general, half the participants choose positive feelings such as technology is 'useful, helpful, exciting, or enjoyable, while just 1 participant chose uninterested and another chose too confusing/frightening. This opposes common perceptions that older people might see technology negatively which has been covered in detail, but in most cases, older people may feel apprehensive but often eager to learn and fascinated by new technologies [19]. The remaining 5 participants gave no opinion, this may be due to mixed feelings or simply the lack of knowledge about current technology as one participant stated:

"I am unaware, or no knowledge of current/future technology hence cannot give an opinion."

Due to the Covid-19 pandemic, since the UK has gone into lockdown (March of 2020), many elderly citizens have had to utilise technology more by teaching themselves or have caregivers and family assist them. This includes using the internet for online shopping and using video-sharing platforms such as Zoom and Facebook Messenger to talk to relatives, friends, and attend their regular commitments safely from home. St. James' Over 50s Club has continued to meet every Friday on the platform Zoom and their local church (St. James Church) continue to have Sunday service, bible study groups, and nightly prayer sessions with over 100 attendants on Zoom, many in their 80s-90s, as most places of worship have done during the pandemic [20].

Situations such as this may have changed perceptions of all generations on technologies impact on elderly uses, provided increased confidence in their abilities, and given those who were apprehensive a better outlook on the benefits modern technologies can provide for them.

Technology Used to Assist with Alzheimer's

*From the 10 technologies listed,
people had used:*

Number of Products	People	
0	4	Most Popular Mobile / Tablet Apps Healthcare Websites Dosette boxes / Dispensers
1	3	
2	1	
3	2	Least Popular Voice Assistants Smart Home Tech Telecare Systems
4	3	
5	1	

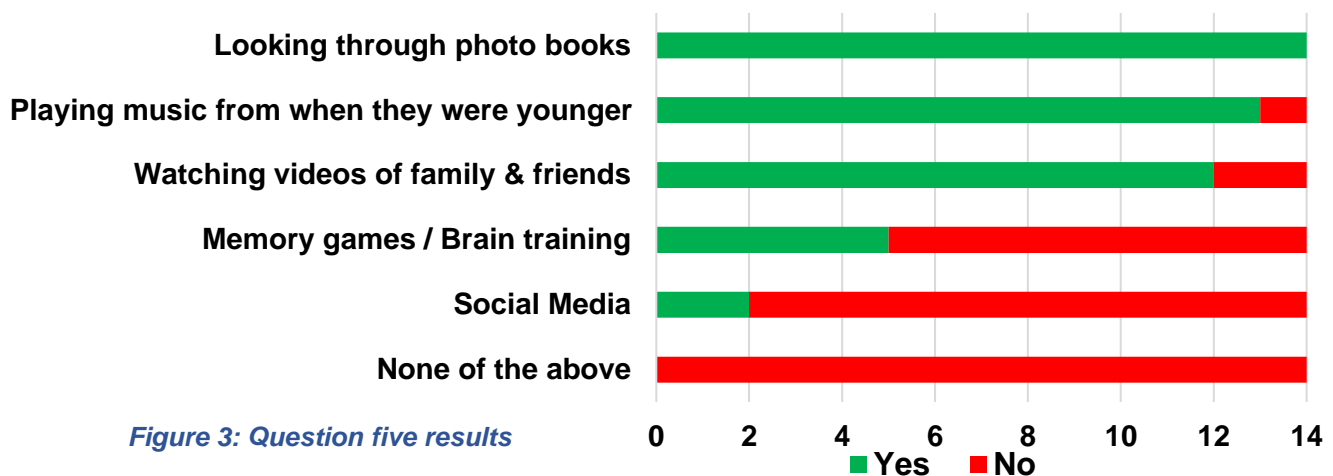
Figure 2: Question four results

The participants were given a list of 10 products/technologies that were identified to be useful to people with Dementia and asked which of the 10 they have used to assist them. 4 of the participants had used none of the technologies listed and none of the participants had used the more recent technologies such as voice assistants (VAs) and smart home technology. It is often found difficult for elderly users to learn new and innovative technologies due to multiple barriers, concerns, and lack of knowledge [19, 21] and technologies like VAs and smart-home technologies can be difficult to set-up and other difficulties such as knowing what to say to a VA. I believe these are issues that designers and developers must work around to design technology that is familiar and comfortable enough for the current elderly population, however, these are issues to be replaced due to a digital-native generation that is likely to be more pro-active as they are heavy adopters of new technology [22].

The most popular technologies were mobile or tablet applications, healthcare websites, and Dosette boxes/pill dispensers. This supports the development of a mobile application as a technology that many older people will have access to due to rapidly smartphone usage among ages 74+, which is a much higher majority for Gen X generations (55 – 73) [22]. It is common for people to give their old phones to their elderly parents when upgrading and older users of technology are most often taught by their children and other family members to use such devices.

This question helped highlight the lack of usage in more modern technologies and the rising usage of mobile applications amongst older generations. However, some technologies may have been better with examples to be clearer such as music therapy, automatic reminders, and locator devices due to the broadness of these technologies. To place Dosette boxes with automated pill dispensers may have caused inaccurate results as pill dispensers are much more recent and can use a variety of technologies for activation, while Dosette boxes have been around a long time and are widely used.

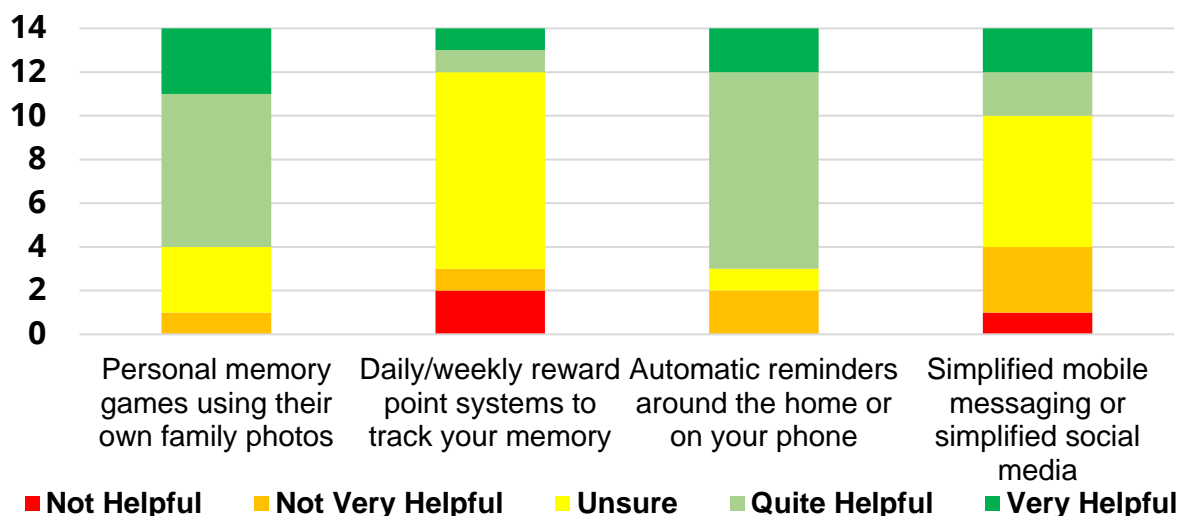
Which of the following methods do you think are helpful?



When asked to select which more traditional methods they think are helpful, all participants agreed with looking through music photos, 13 agreed with playing music, and 12 agreed to watching videos of family and friends. Memory games/brain training and social media were less popular, perhaps due to being newer technologies and more complex to use as previously mentioned. On the other hand, consoles like the Nintendo Wii are continued to be used in many care homes, with many loyal, elderly players due to the Wii Sports and Wii Fit games that have proven positive impacts on the physical and mental health of older people [10]. Brain training apps and games have also become a multi-billion-pound industry [23] as people are eager to ward off symptoms of Dementia and ageing, which in some studies have shown to be beneficial [24].

The popularity of playing music also contradicts the previous question where 3 people had chosen music therapy showing that the use of terminology causing inaccurate results. Overall, this question highlights which media may be preferred and seen more helpful in an application designed for people with Dementia.

How helpful do you think the following ideas could be?



The final multiple-choice question was used to gather feedback and opinions on possible functionalities of applications and how helpful the caregivers think they could be. I chose these concepts to get an idea of what features may be perceived more positively and lean my app designs towards those types of functionality with the patient's personal media incorporated. The results showed participants favoured the idea of memory games that used their family photos, which is promising - considering few people chose memory games/brain training as helpful and fewer have used them to assist with Dementia. Automatic reminders were also favoured, which can be implemented as a primary or secondary functionality to the application.

Most participants were unsure about daily and weekly reward point systems, this may be due to inexperience with such systems and dependability on how they are implemented (what is the activity). Feedback for simplified mobile messaging/social media was mixed with an equal amount of positive and negative votes, which may be expected due to social media being found less helpful previously and current platforms not targeted towards older users.

Additional information/comments

Space was given at the end to write down additional comments and anything else that they would like to see or think helps. Some participants were particularly helpful in sharing what has worked in their experience as caregivers:

"My father does not and could/would not use a mobile phone, I can and do show him pictures and play music that he recognises which gives him some pleasure."

"Anything that brings back childhood, using hands, they like to fiddle with things. They remember their homes and places from far back, something that families can fill in of photos over the years of homes, family, where they went to school, etc. Women like to cuddle dolls, brings back memories bringing up the family. Also, music, they sing along with the old songs they know and can remember the lord's prayer and creed."

"Talking about childhood memories, old photos, puzzles (with large pieces), colouring books, favourite music."

"Games & Activities e.g. match the shape, knitting & painting, dolls & stuffed toys, music & CDs of favourite songs. Comfortable clothes with Velcro ties."

"Something to share memories of a long time ago."

"I anticipate the usefulness of technological support will grow as the more digital native generation are those who are supporting loved ones with Dementia or have Dementia themselves"

3.4 Conclusion of Results

From the research, questionnaire results, and user quotes, there has been an emphasis on the importance of photos of loved ones and methods of treasuring memories from far back, including from feedback for traditional methods and ideas of functionality. I will be going forward to design an application that aims to have the following core functionality:

- A place to store photos (memories) into categories, with relevant details such as names, relationships, and dates.
- The creation of simple memory games using added photos and information.
- A secondary feature of automatic reminders for birthdates and anniversaries that have been added.

User personas and stories will be created from information gathered from the research and participants for continuous use throughout the design period, as well as an evaluation by participants of the designs and the application developed, if possible.

4 Design

4.1 User Personas

User personas are used to develop an understanding of the target users through realistic representations of the audience based on some user research that is quantitative through national statistics or qualitative from user studies [29]. They can express the needs and expectations of the users, how they would use a product, and their backgrounds as people, with goals and different skill levels. The identified potential users of such a mobile app are:

- People with early to mid-stage Alzheimer's
- Early-onset Alzheimer's (under 65s) [30]
- Caregivers & family/partners of people with Alzheimer's

Based on my research, questionnaire results, personalities, and the variation of people in the target audience, I have created 3 user personas to derive user stories and requirements from, which will aid my design decisions.

User Persona 1: Susan Jean Baker (Sue)

Wife/carer of user



Born: 1948 February 2nd (Age 72)

Location: Bournemouth, UK

Occupation: Retired Nurse

Gender: Female

Status: Married

Computer skills:



Low

Basic

Average

Advance

Expert

Figure 5: AI Generated Face [31]

Background & Daily life

Sue has lived with her husband Peter Baker in Bournemouth for the past 26 years and is now retired. They have been married 47 years and have a son and daughter who live in London and Cambridge respectively, so they only see them a few times a year. Sue describes her life as quite relaxed; they stay home most of the time but get out daily through dog walks and attend an over 50s club weekly on a Thursday afternoon.

Peter was diagnosed with Alzheimer's 3 years ago after noticing some repetitive and forgetful behaviour and has considerably deteriorated since. Sue must help Peter often as he easily forgets where their things are kept and sometimes forgets the names of close family members and has to ask what they work as or where they are, which can cause him to get frustrated quite easily with himself.

Experience with Technology

Sue and Peter both own smartphones that are a couple years old which their son and daughter taught them to use. Sue uses her smartphone to keep up-to-date with her family on Facebook and WhatsApp, knows how to use the app store, and uses various apps including her puzzle games, camera, notes, calculator, the internet, and calendar to set reminders.

Peter does not use his phone anymore, as any phone calls for Peter are through Sue's phone or their landline. Peter also struggles to type due to his arthritis so it can take him a while to type short messages – his family had also set up a Facebook account for him, but he has not used it as he often gets lost and confused with the interface. They also own a laptop and tablet; the laptop rarely gets used now but the tablet is used for video calls with family and playing puzzle games on a bigger screen. Sue opens apps on their devices and gets Peter to the correct screen to play simple games or read, then he has no problem for a while.

User Persona 2: Theodore Rowley (Ted)

Early-stage Alzheimer's User



Born: 1962 September 20th (Age 57)

Location: Stevenage, UK

Occupation: Accountant

Gender: Male

Status: Divorced

Computer Skills:

Low

Basic

Average

Advance

Expert

Figure 6: AI Generated Face [31]

Background & Daily life

Ted Rowley currently lives alone and has been divorced for 10 years but gets still gets along with his ex and three children who are all in their twenties with jobs relatively nearby around London. Ted commutes every day via the Thameslink to his accounting job in London – his expecting to retire soon as he has enough money to live comfortably. He spends his free time playing guitar, exercising, watching Netflix series and documentaries, or going to bars in town with some friends.

Ted likes to look after himself, so he exercises regularly and has a healthy diet, he visited his doctor for a regular check-up and mentioned that he has recently been having issues concentrating and planning his usual task at work. After conducting some tests, the doctor thinks it may be early-onset Alzheimer's. Ted is afraid of forgetting important information and wants to tackle this early by being prepared for any worsening of his memory through upkeeping his health, completing brain exercises, and with the help of technology.

Experience with Technology

At work, Ted uses complex specialist software on his desktop PC, as well as using the printer, scanner, and mobile tablets provided so he is efficient and well-versed in using various technologies. He uses his up-to-date smartphone regularly including watching YouTube, listening to music, and using health and finance trackers; however, he has not used his social media accounts in years.

Ted likes to keep his documents and information organised, so having similar data all in one place helps him a lot; he is also conscious about security and giving data up to third parties, by avoiding sharing too many details online and to online apps that he does not know whether they are completely secure.

User Persona 2: Lilian Tay (Lily)

Daughter of user



Figure 7: AI Generated Face [31]

Born: 1978 October 14th (Age 41)

Location: Manchester, UK

Occupation: Business Teacher

Gender: Female

Status: Married

Computer Skills:



Low

Basic

Average

Advance

Expert

Background & Daily life

Lily Tay is a teacher, who teaches A-level business at a local sixth form in Manchester and lives with her husband and her two daughters – ages 11 and 14. Lily's mother, Vivian Tay, lives just around the block from them and often helps look after the kids after school. Vivian is 70 years old and lost her husband to cancer 4 years ago; her husband used to drive, take care of bills, and fix any technical issues around the home.

Since he passed, Lily (her only daughter in the country) takes care of her by driving her to the supermarket and such, but her Dementia has been progressively worsening recently as she has started to mix up her granddaughters' names, ages, and forget her family outside of Manchester. Meanwhile, Lily is worried about being able to balance her workload, looking after her mother, and spending time with her family amongst other things so she has started looking into new methods to help her mother stay independent for longer and remember important details about her loved ones.

Experience with Technology

Lily likes to have the newest phone and gives her mother her old phone when she upgrades, so Vivian has a quite up-to-date phone, but she only uses it for calls, which she prefers over messaging. Lily uses a lot of apps in her daily life and regularly searches the app store for apps that help her organise her busy life and help her mother out. However, her mother has not stuck with many apps as they are "not worth learning" as she prefers using physical reminders and paper to play games like sudoku and word searches.

Lily wants a way that her mother can remember their family's names and information like their ages and what they do work and school-wise so she can stay in touch with family and friends; without getting frustrated or lose interest due to complicated interfaces.

4.2 User Stories

From the personalities, goals, and issues faced by user personas, I have created some user stories that are supported by previous research into what makes technology accessible to a wide audience, particularly those with cognitive impairments. The user stories allow versatility in defining features that a list of requirements can be derived from during implementation, which can be changed when more detail is introduced in design options and constraints [32]. By focusing on the who, what, and why – I can list possible features and give them a level of priority to prevent the risk of feature-creep by prioritising core functionality and common needs to have a working prototype at the end of the project as an example of a personal application for people with Dementia/AD.

As a wife and caregiver to someone with Alzheimer's...



Susan Jean Baker (Sue)

My husband gets frustrated and gives up easily with technology, we would like a simple interface where he will not get lost or confused.

**High
Priority**

It would be nice to organise our digital photos by friends, family, and special memories like our wedding day to help him remember and reminiscence with me.

**Med
Priority**

My husband's eyesight is not great so clear text and larger buttons or settings to change those are a must in apps we use.

**High
Priority**

We prefer multiple choice answers as typing can be quite slow and my husband makes mistakes easily.

**High
Priority**

As someone with early-onset Alzheimer's...



Theodore Rowley (Ted)

I find address books difficult to use and update so having all the information together like birthdays, addresses, and contacts details that are easily changeable would be helpful.

**High
Priority**

I do not trust many companies to give them a lot of my information, so I prefer to keep my information very secure or offline.

**Med
Priority**

I would like to be tested and able to track my results so I know when my memory is worsening and what I should focus on.

**Low
Priority**

As a daughter of someone with Alzheimer's...



Lilian Tay (Lily)

I must keep reminding my mother of my family member's birthdays so having automatic reminders of upcoming birthdays and their ages would be great.

**Med
Priority**

I would like to store all the photos on my two daughters together, as well as my dad, so my mother can look at them all together when she wants – knowing who they are.

**Med
Priority**

My mother does not do well with timed situations as she struggles to be quick on mobiles so relaxed games where she can go back and forth between questions are better.

**Med
Priority**

4.3 Functional and Non-Functional Requirements

I then identified the following functional requirements from the user stories:

ID	Functional Requirement	Rationale
F1	Ability to add photos from user's device and information such as name, relationship, dates, etc. with the image via input forms.	The main functionality of the app is to store photos with relevant details and format the input in a way that friendly to users with Dementia. Adding from the user's devices provides the flexibility of using their existing digital photos and the information that is important to them.
F2	Photos should be categorised by what it is: family, friend, event, and place.	Categorising the photos allows input forms specific to that category, ability to generate questions about that photo, filter by category, and more accessible via colour coding.
F3	Ability to edit and remove photos and the information stored with them.	Users must be able to edit information to prevent mistakes being permanent and for when information changes, such as addresses. Users should be able to remove photos and information attached for the above reasons, customisability, and any personal reasons.
F4	Multiple-choice quizzes with no time limits using the photos and information added.	The second core feature – quizzes will allow users to test their memory of their loved ones, event and places. Quizzes will be multiple-choice by default with no time limit for accessibility reasons.
F5	The quiz should give feedback on the correct answers, total-score, and time taken.	The user must be told whether their answer was correct or not, and if not, they must be given the correct answer. Otherwise, the quiz may cause frustration for users and lose its usefulness. Other aspects like time taken to complete the quiz can be used to help users track their results if wanted.
F6	Automatic reminders via device notification for dates added to photos.	By using the dates (birthdates, anniversaries, etc.) that are entered, users can be assisted through reminders of the upcoming date and age of family/friends. This also allows daily notifications to encourage engagement with the app.
F7	Ability to turn off reminder notifications.	Notifications/reminders should be easy to turn off for several reasons, such as if they get too many notifications overall, they do not value the content, or find them distracting [33].
F8	Filters to view photos by categories.	Filters will allow the user to find family/friends/events/places more easily and allow them to only view a certain category which can help cause less confusion and focus on one thing at a time.
F9	Ability to add multiple photos to a single person/event /place.	Assist in organising digital photos by allowing multiple photos of a person to be added in addition to the main photo on a profile.
F10	Account creation and secure access to media.	In actual use, content including photos and personal details of family and friends should be kept secure via a log-in and applies GDPR standards [34]. This also allows access through multiple devices.

Table 1: Application Functional Requirements

Due to the aim of the project being a prototype of an application which will not be used commercially, some of the non-functional requirements may not be implemented yet but still considered. Non-functional requirements include:

- **Accessibility:** How accessible the software is for the users, implemented through appropriate interface designs and tools for the target audience.
- **Efficiency:** Features should take the smallest number of actions, with shortcuts where possible.
- **Privacy and Security:** Media and data are made secure through account creation and passwords; health data and tracking should not be stored without consent.
- **Maintainability:** A good standard of code and comments to add features and detect issues.
- **Portability:** Ensuring the app functions and appears correctly on all screen dimensions and devices.
- **Others include:** Quality, resilience, response time, effectiveness, and documentation.

4.3 Design Considerations for the Target Audience

It is important to follow design heuristics and guidelines which overlap with many of the non-functional requirements, especially when designing for older users and people with AD who may have several symptoms that make it difficult to use computer systems including deterioration of their eyesight, dexterity, and planning skills, in addition to often being inexperienced with modern technologies.

While designing the application, I will be evaluating my designs against several criteria, many of which overlap such as Nielsen's 10 usability heuristics [25] and Schneiderman's 8 golden rules of interface design [26]. I will be following the design process below, iterating this cycle until deciding on my final designs through evaluations.

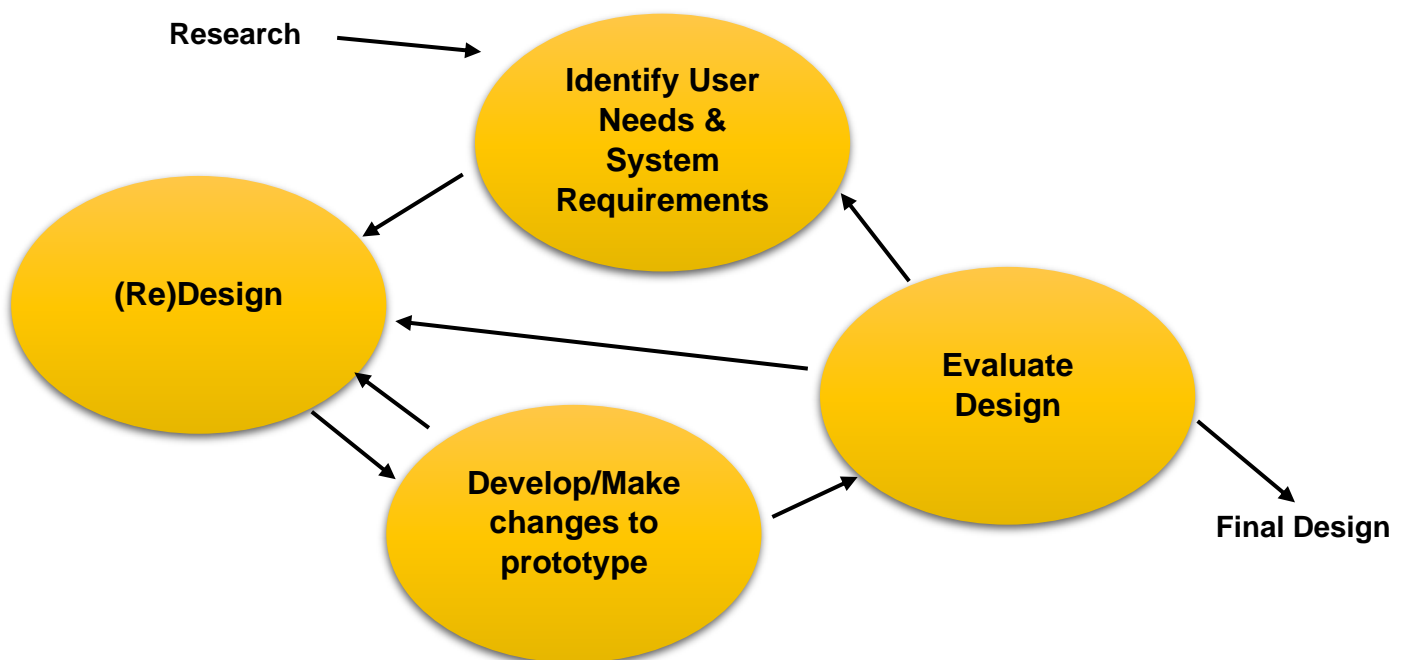


Figure 8: Design Cycle for Prototype

When designing technology for people with cognitive-impairments, it is crucial to take a HCI approach to work with the users to understand the difficulties they face and their skill level; this prevents the designer from looking from their point of view instead of the target audience's capabilities. For example, a novice user will respond better to step-by-step prompted actions that are constrained and clear, while an expert may want the flexibility to access multiple tools at once, with shortcuts. As the target audience will be primarily older and less experienced users, some design rules become more significant, which may limit the possibilities and flexibility of the design in exchange for learnability and memorability.

Other principles of design include that of pattern – proximity, continuity, symmetry, similarity, common groupings, and connectedness – are principles that ensure all users perceive the interface equally [27]. As well as designing for colour vision deficiencies by not relying on colours for messages, using icons and patterns to show contrast, and avoiding bad colour combinations that can cause confusion [28].

4.4 Colour Scheme, Logo, and Font

Colour within software design can be very subjective and colours can have different emotions for different people and cultures, but there can be some common themes. An example is how the colour blue is very common in technology and software brands such as Facebook, Samsung, Intel, IBM, Twitter, and Skype, as it is seen as a corporate colour that evokes trust and intelligence [35]. My app aims to be friendly, inviting, and calming with no bias towards gender or background. I have done brief research on these psychological effects of colours and colour usage in UI design such as creating a hierarchy of components, making text and important elements legible, and accessible colours [36].

#FFD966	#F4B183	#FCC0F5	#8FAADC
#FFF2CC	#FBE5D6	#FFEFFD	#DAE9F6

Figure 9: Colour Scheme Hex

I will be using the above colour scheme, each of the four main colours representing icons on the home screen and the four categories of photos for subtle but identifiable colour-coding. Each of the colours is roughly the same shade and has accent colours that are lighter versions of themselves to create hierarchy or differentiate sections. The app's colour scheme is used to incite nostalgia and calmness for reminiscence, inspired by the colours of a sunset. The colours will benefit the user's experience but not essential so that it is accessible to users with any colour vision deficiency.

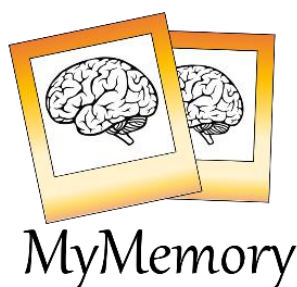


Figure 10: Application Logo

I have created a simple logo to be used in the designs, following some of the themes. The logo consists of a brain icon in a polaroid frame to suggest what the app might be about and the app name – My Memory in Gabriola font for a hand-written look.

I researched the most common fonts used in mobile apps and chose 4 that are easy to read but not too similar – Montserrat, Playfair Display, Open Sans, and Lato. I created a font-board (see Appendix E) to view the variations and decide what is the most appropriate for the target audience and use case. I decided on Open Sans for its readability and lack of decorative strokes (e.g. Serif fonts), but Lato would also work well.

4.5 App Navigation

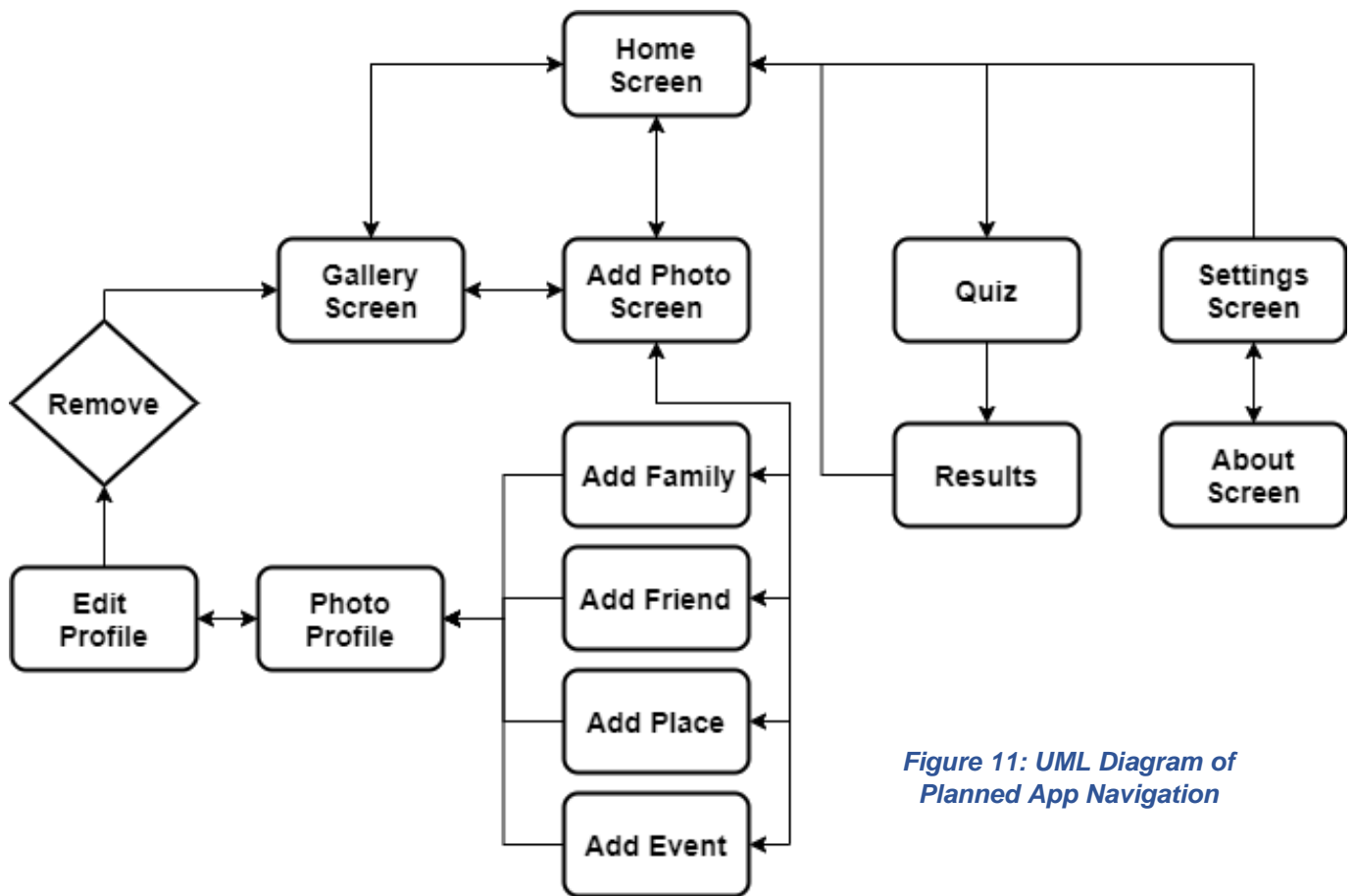


Figure 11: UML Diagram of Planned App Navigation

The above UML diagram shows the navigation plan for the app, every box is representing a screen to be displayed. On start-up of the app, the home page is loaded where the user can navigate to the four branches: gallery (where they can view their photos, which lead to profiles for each photo where the information is stored and can be edited or removed), add a new photo, play the quiz, and access the settings. Each category (friends, family, events, places) will have its input form and profile relevant to the information that would be stored for such photos and back-navigation to appropriate pages. Navigation will be through the most common actions of pressing buttons and scrolling so the app is easy to learn by avoiding complex actions.

4.6 Storyboards

I designed the mobile app through storyboards, demonstrating each screen's appearance, navigation, and functionality, to seek feedback from the users to see what they want and do not want. The storyboards were made in Microsoft PowerPoint had most elements hyperlinked to act as a prototype to test the usability and whether it fits the conceptual model that users may have (actions do what they would have expected), which saves time by exploring the design space instead of making changes after implementing the design. Here are the main pages, others can be seen in Appendix F. All photos of people included in design and implementation are AI-generated [31].

This is the **home page** that the user will be presented with when the app is opened. A simple and minimalistic page that shows the logo and main menu.

The main menu uses icons and text, so each page is easily identifiable with large hitboxes for the target audience of older users.

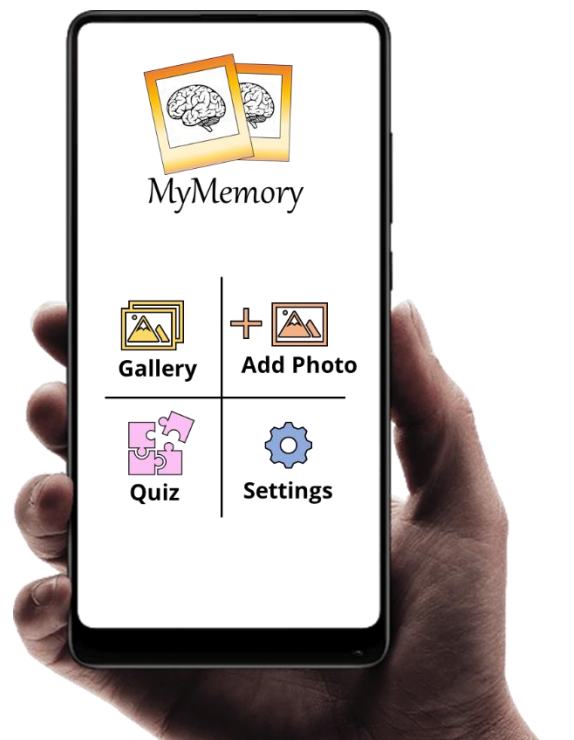


Figure 12: Home Screen Design [41]

The **gallery page** is the screen that users will spend most of their time on. It shows a grid of the photos that have added to their gallery.

Each photo gives the most important information underneath in a readable format that is natural to the user. For example, for family this would be their name, age, and relation to the user.

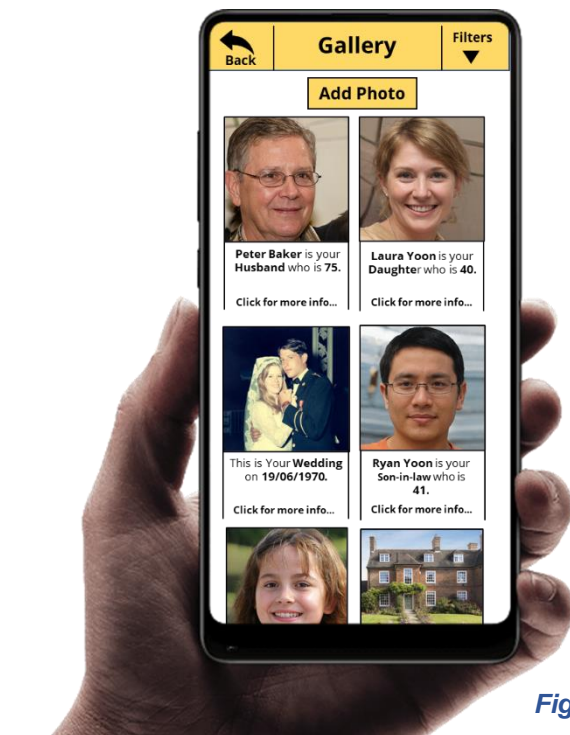


Figure 13: Gallery Screen Design

On the gallery page, the photos can be **filtered** by the categories of family, friends, events, or places. This allows the user to only see the photos they want and shorten their search.

In the case of the app being opened for them by family or carers, it allows them to avoid the user getting confused between photos and focus on family or past events/places accordingly.

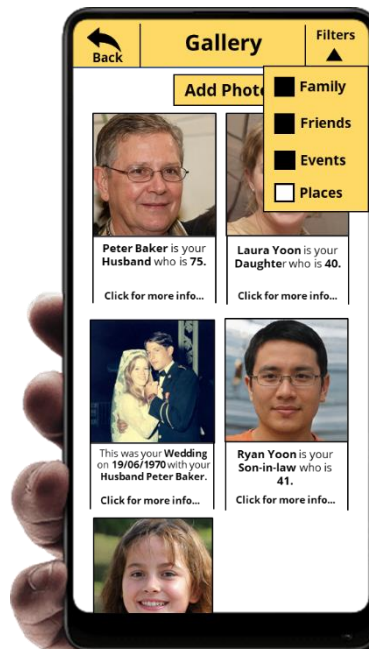


Figure 14: Filters Design

From the gallery, users can press photos for more information (**photo profile**). The information is listed below with a relevant icon and format to make it easier to understand and look for specific information. The user can edit the photo and information from the header.

More photos of the person/event/location can be added which are listed below where the user can scroll through.



Figure 15: Profile Screen Design

New photos can be added the gallery via selecting the category that they are adding, which leads to the corresponding input form.

The icons follow the same colour scheme and shades as previous pages, which are used in the photo profiles, add, and edit pages.

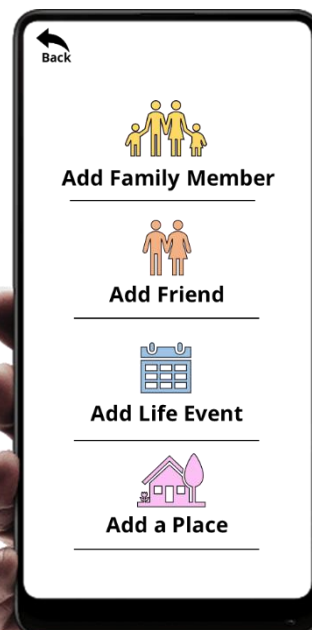


Figure 16: Add Photo Screen Design 31

Figure 17: Add Family Screen Design

On **submission** of add/edit pages, the required fields will be checked that they have been filled and that fields like birthday are correctly filled. If not, the user will be given a message to indicate what they have missed.

All edit/add pages will have a submit details button at the bottom which submits the new data/photos and takes the user to the profile page of the photo.

Figure 18: Add Friend (Error Checking) Design

Figure 19: Edit Profile Screen Design

The **edit page** is the same input form as adding a new photo and information but the photos and data that has been entered will already be filled in.

When the **delete** option on the header is pressed the user will receive a pop-up to confirm they want to delete the person/event/location. This prevents accidental mis-clicks that permanently deletes information so they would have to add it in again.

They will be returned to the gallery page once deleted or stay on the edit page if they press no.

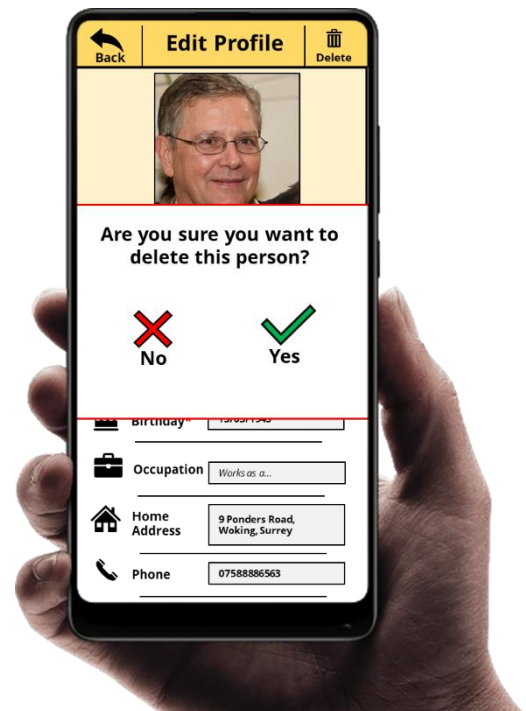


Figure 20: Deletion Confirmation Design

The **quiz** will have 4 questions (open to change and additional quiz modes), the quiz will random pick a category and photo, then have a couple questions that it can ask by taking the information attached. The quiz is made to be minimalistic and accessible, with large hitboxes for the four possible answers.

The quiz keeps track of the current question number and number of correct answers.

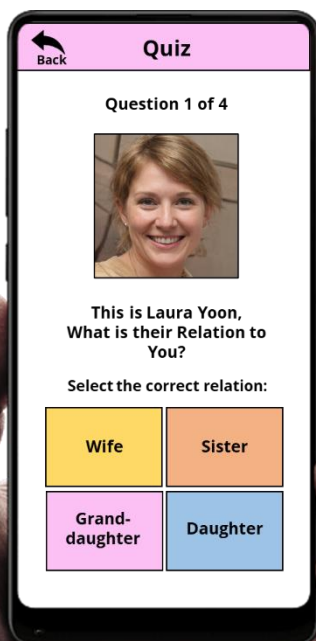


Figure 21: Quiz Question Design

On press, the user will get congratulated if correct and asked to continue or return to home page, if incorrect, the user will be given a friendly message with the correct answer and the same options.

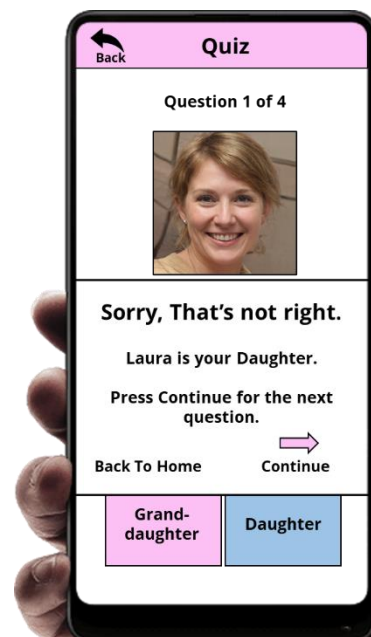


Figure 22: Quiz Incorrect Answer Design

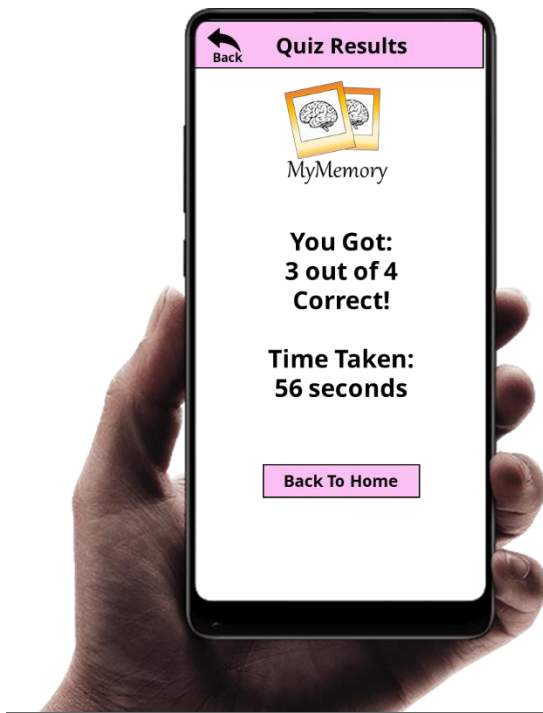


Figure 23: Quiz Results Screen Design

The settings screen accessed via the home page gives the option to toggle notifications which include daily notifications to use the app and reminders on upcoming birthdays and anniversaries that have been entered with photos. They can access an about page for information of the app's purpose.

Other settings and links on this page could include terms of service, adjustable fonts, and ability to send feedback/rate the app.

Once all four questions are answered, they will be shown their results – how many they got correct and how long it took, allowing them to track themselves if wanted.

The results could have additional features of how long it took on each question, a summary of correct answers, or links to the profiles they got incorrect.

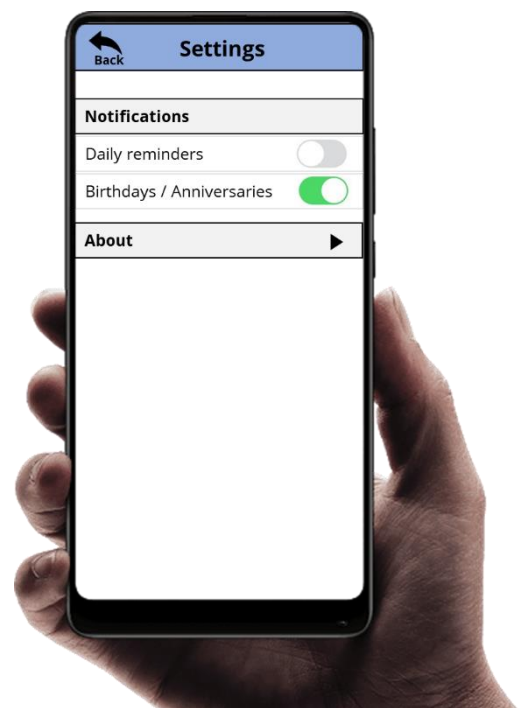


Figure 24: Settings Screen Design

4.7 Evaluation of Designs

In these designs, I have attempted to cover every screen and action that will be implemented, however, a limitation of the prototype is that I do not quite know how much I will be able to implement, the constraints of the technology I will be using, and usability factors that are difficult to visualise until testing of the mobile app. I have evaluated my designs through HCI principles/heuristics, developer guides, and user feedback.

An example of how I have evaluated my app designs is through Nielsen's Heuristics[25]:

Nielsen's Heuristics & How they apply	My Prototype
<p>1) Visibility of system status: The user should always know where they are on the app, have direction of the next step, and be given confirmation that their actions were successful or unsuccessful.</p>	<p>The back-button in the header is always visible for users to navigate back, the page name is always in the header, and the next action is clear through buttons and prompts to continue or go back. Submission or deletion of photos are given warnings to validate the user's action and confirmation on whether they were successful through pop-ups and navigation to the screen where the new information is</p>
<p>2) Match between system and the real world: The app should not use jargon and wording that is unfamiliar to the target audience so actions and navigation are clear.</p>	<p>I have kept page names to familiar words to avoid jargon, rather than 'Memory Bank' or 'Add Memory', as well as icons that make pages or input clearer.</p>
<p>3) User control and freedom: The user will be able to return to previous pages and undo changes to the state of the app.</p>	<p>The user can edit or delete photos and information at any time from the app and always be able to return to previous pages.</p>
<p>4) Consistency and standards: Labelling and actions will be consistent through all screens.</p>	<p>Page names and similar actions are kept consistent throughout.</p>
<p>5) Error prevention: Error checking in forms and actions will be implemented and confirmation required for changing the state of the app.</p>	<p>The input forms will have validation to ensure the required fields have been entered.</p>
<p>6) Recognition rather than recall: Icons, colours, and labelling should make navigation and actions clear, so the user should not have to remember or guess what the app might do.</p>	<p>Icons are used for navigation buttons and input forms, the colour scheme is designed to assist with navigation and categories, and labelling is made clear.</p>
<p>7) Flexibility and efficiency of use: Shortcuts and secondary buttons on relevant screens may be helpful if the app is clear and does not cause confusion.</p>	<p>There is a shortcut to add photos from the gallery, text input is flexible (the user is not given a limited choice), forms are unique for the categories – excluding irrelevant fields, and filters available for the gallery.</p>
<p>8) Aesthetic and minimalist design: The app should contain irrelevant information or decoration that does not add to the purpose of the app, as it can cause distraction and confusion if it is not assisting the user to complete tasks.</p>	<p>The designs have attempted to be minimalistic with plenty of white space and section lines to prevent mis-clicks. Type faces are Open-Sans and black.</p>

<p>9) Help users recognize, diagnose, and recover from errors: If errors are made, they should be made clear and easy to recover from by stating the change that is needed and methods to make those changes. Error messages should avoid words such as BAD, ILLEGAL, ERROR, FATAL, as these may cause worry and confusion that they have done something wrong, but instead use positive tones to solve issues.</p>	<p>Correction messages in the quiz are friendly and provide the correct answer. Required fields that are not entered have been highlighted on submission.</p>
<p>10) Help and documentation: Tutorials on the first start-up of the app would be helpful to new users and available help guides found within the app and online.</p>	<p>The settings page would need more content if the app is made available to the public and tutorial on start-up of the app will need to be made.</p>

Table 2: Nielsen's Heuristics Evaluation

I used the design prototype to complete a user evaluation with my grandmother, Iris Barber, age 79. Iris owns an up-to-date smartphone which she uses frequently through the day for social media and mobile games, she has also been a caregiver for someone with Alzheimer's for decades and has a lot of experience helping others in their over 50s club.

I explained the concept of the application and its functionality then we ran through each of the screen designs. I asked for any feedback for improvements on how it can be more accessible for people with Alzheimer's and an elderly audience on each page and asked how she would complete actions, for example, "How would you go about adding a photo of a family member?" and I would press the prototype for the outcome. The evaluation was mostly successful, with positive feedback focusing on the colours, icons, the quiz, and use of personal photos, the following constructive criticism was also given:

Gallery: "One photo at a time might be better, this can be too much for them. The text could be bigger too."

Adding a photo: (Was not sure how to add a photo in the input form) "That could be clearer as I didn't get that." regarding the 'Upload Photo' text.

Editing a photo: "Does this delete the photo from my phone?" "Remove photo would be a better." regarding how to delete/remove a photo from the app.

Quiz: Suggested a description of what the quiz is on before starting.

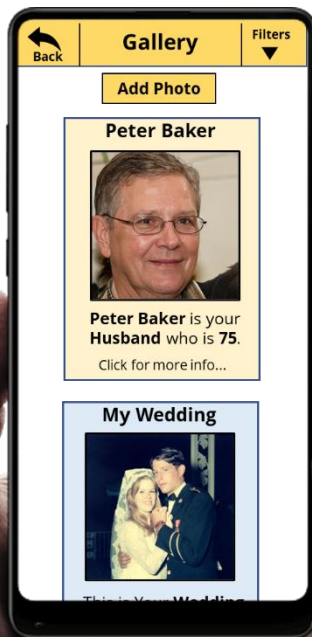


Figure 25: Second Gallery Screen Design

I have changed the 'Upload Photo' text and icon to 'Add a Photo' which may be clearer for the target audience, I have also made it into a button as wide as the photo frame so it has a larger hitbox and clearer that it can be pressed. This text will change to 'Change Photo' within edit pages. I have changed 'Delete' to 'Remove' for clarity.

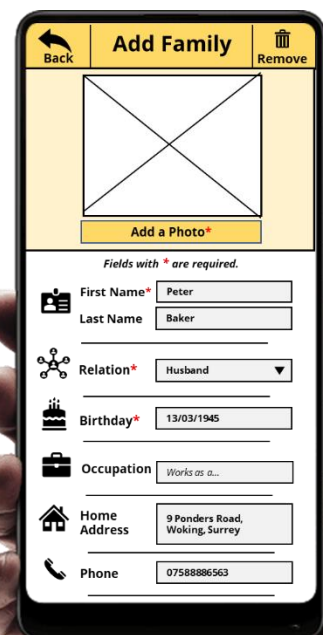


Figure 26: Updated Add Family Design



Figure 27: Quiz Introduction Screen Design

An about page for the quiz has been added, in the same style as the quiz results and about the app pages. This page is given when pressing quiz icon from the home page.

5 Implementation

5.1 Technologies Used

With little experience developing mobile apps before, I knew the steps but not which technologies I wanted to develop with. I explored the various mobile developments frameworks/languages that are available including Flutter, Ionic, PhoneGap, Xamarin, and React-Native (RN), I shortened the list to choose between Ionic and RN, deciding on RN for the following reasons [37]:

- RN is a JavaScript framework, a common language which I would like experience with
- Popular in industry, having been developed by Facebook and used to build the Instagram, Facebook, Discord, and Skype apps
- Easy to start due to components format that works a lot like CSS
- 'Hot reloading' - instant refreshes of the app with any code editor
- Open-source with plenty of materials and libraries
- Easy to make IOS-compatible in future

I will be developing for Android, but RN can be compatible for IOS with just a few changes, instead of going full native with Swift and Java which requires building two apps from the ground up. I am using my Android device as well as emulators on Android Studio, which requires installing the correct dependencies and configuring with Android studio. The app can be run from Android Studio or from the Node.JS command line, which is then kept live and automatically reloads the app any time the code is changed. I chose not to use React Expo (a simplified experience of React-native) as it does not allow native modules written in other languages and the app would have a large size as it is built with SDK modules even if they are not used [38] – both which may cause limitations in future. After setting up, I learnt RN basics such as components and properties including views, images, states, constructors, and layout components, before starting development.

I will also be using Google's Firebase Realtime Database to store the images the information, for this purpose any database would work well including MySQL and MongoDB. I have chosen Firebase as it is easy to set-up, data is synced on all devices in real-time, and allows offline persistence [39]. I will be using Visual Studio Code as the code editor.

5.2 Development Methodology

I am developing with an agile methodology where I complete increments of the designs in week-long sprints with a test-as-you-go strategy. This works well for this project as I have not used the technologies before and cannot estimate an accurate time-scale for development. While testing components of the app as they are developed allows me to immediately identify any errors that have occurred by reverting changes I have made, rather than a build-up of issues where I may not know the root cause. The 'hot reloading' ability assists in me with this approach as I do not have to waste any time re-compiling the app.

The order of development priorities the core functionality identified in the designs so that I have a functional application in time that presents the key ideas behind the project, any leftover time will be spent implementing extra features and improving code quality. I aim to complete the app within the following 6 week-long sprints:

1. **App Structure & Navigation:** Setup up the structure and navigation between pages before adding further functionality.
2. **Input Forms & Database:** Create the input forms to add photos and data which are sent to the database.

3. **Gallery & Profiles:** Receiving data from the database, following designs to correctly display the data in the Gallery and photo profile pages.
4. **Edit & Deletion of Database:** Ability to make changes to information and remove photos and data.
5. **Personal Quiz:** Develop the quiz section of the app using the user's photos and data.
6. **Extras:** Focus on implementing extra/non-essential features including notifications, filters, and ability to add extra photos to profiles.

5.3 Development Process

The first sprint was spent setting up the screens in the UML diagram and designs; creating the basic views, buttons, and icons I had made for navigation by making the icon images into Touchable components. I installed the Open-Sans font and placed it in my assets file where it can be called as any other font would be. RN uses style-sheets, just like CSS, I have used a single organised file to contain all styling and layout properties which are then called in the screen classes for much cleaner and readable code that promotes maintainability. It took me some time to figure out how to implement navigation between screens as React Navigation 5.0 had just been released so documentation and guides were not up-to-date except the official website for the release [40]. The app is run from the App.JS file, where a Stack-Navigator returns the home page and every screen class is imported. Class files inherit the navigation props through the constructor so any action can call a screen component.

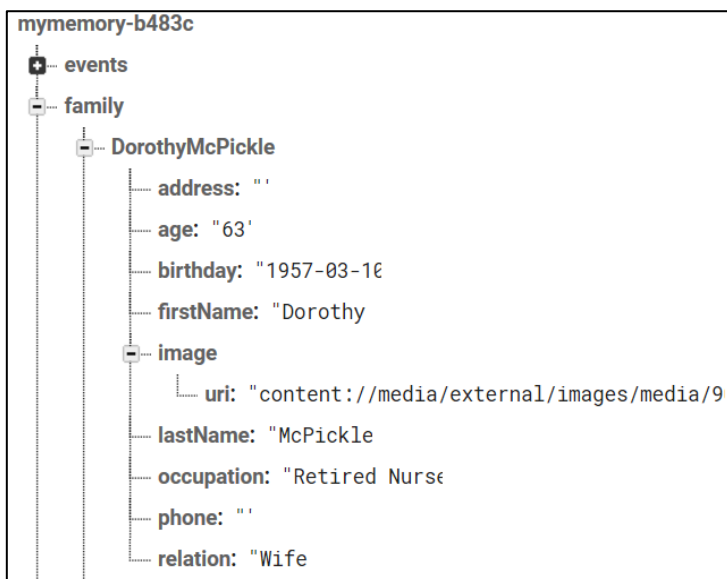


Figure 28: Firebase Realtime Database Format

The second sprint consisted of creating the input forms, starting with the family category. This included using Android's date-picker (calendar) to choose dates, text, and number input, and an image picker to take the URI of photos from the user's device. Eventually, I got Firebase's real-time database to take the input by using handler methods to set the state of variables in the constructor, which are passed to a method that adds the data under a unique ID formed by concatenating data that were required fields. A person's age is calculated from their date of birth and is also submitted to the database, figure 28 shows how the data is stored.

To display the data and images in the database in the gallery, I created arrays for each of the categories, a snapshot of the referenced database is taken, which is used to convert them into objects with the data as keys. I then created the 'printer' methods to display the content as per the design's polaroid frame with the photo and a caption for the category, using the data given (see Appendix H for example code). Each frame and its content are Touchables that pass the object to their respective family/friend/event/place profile. In the profiles, photos and data is used the same way but filling in text captions with the variables, alongside relevant icons. Only fields that have been entered will be displayed, otherwise, they are replaced with an option to add that bit of information, which would lead them to the edit profile screen. To implement other categories, the only changes that need to be were the colour scheme, captions, icons, and database references.

I implemented the ability to edit pages, this works from pressing the edit button in a photo's profile which leads to an input form that has fields and photos already filled in by passing the object to the form. From the edit screen, users can press remove which will delete the photo and data from Firebase. For some reason, the profile would not be removed from the gallery if navigated to after deletion, so, for now, the user is sent to the home screen after a profile is deleted, as the gallery refreshes when accessed again. Error checking and confirmation dialogue boxes are implemented, these pop-ups appear when required fields are left empty, confirmation to edit or remove a profile, and confirmation when a user attempts to exit an edit or add photo input form.

The quiz part of the app follows the designs accurately, with some limitations to how it has been implemented that require further development before official usage. Photos and data are pulled from the database in the same way as the gallery, the photo is displayed and a question generated with the data, as shown in figure 29. The answers are made with an array of possible answers, with one of the four answers being the correct answer from the database. As a temporary solution to making the quiz, the questions and answers are not randomly generated but simply pick the first object from the category in the databases, the incorrect answers are fixed, and the order of the answers is always the same. With further development, this should be easy to randomly generate through randomising category choice and profile picked, randomising answers and placement (ensuring no two answers are the same), verifying content has been added to categories, and generating a variety of questions and a larger set of answers. The quiz keeps track of the number of correct answers and time taken to complete the quiz; the time taken is calculated by starting a timer once the question appears and stopping when an answer is picked, both variables are passed on and totalled for the results page.

I looked to create filters for the gallery through a drop-down menu in the header-right but solutions seemed impractical and difficult to implement, handling push-notifications was also an extensive task. I have added toggle switches within settings to store preferences for notifications, however, these features will be implemented in the future and instead I wanted to further test and optimise the app's code with the time I had remaining.

5.4 Changes from Designs

The core functionality of the application was completed, with subtle differences in the interfaces compared to the designs, mostly caused by issues implementing certain features. The menu screens, including the home and add photo (categories) screen both match designs due to their simplicity to implement (see Appendix G for screenshots from the app). I was able to implement the gallery screen's redesign with subtle changes including the whole caption being bold (rather than just the data inserted) as I believed this to look better as it was less distracting, especially when caption lengths can differ. The caption also states 'Press for more info about them' rather than 'Click for more info...' as it provides more information about what the action provides. I did not have time to implement the filter menu in the header, so this will have to be a future 'quality of life' feature to be added, so all photos that have been added are displayed alphabetically and by category naturally.

Very little changed in the profile and edit screens, I was unable to implement custom header icons at the time so the edit and remove buttons are placed just below the original locations but function

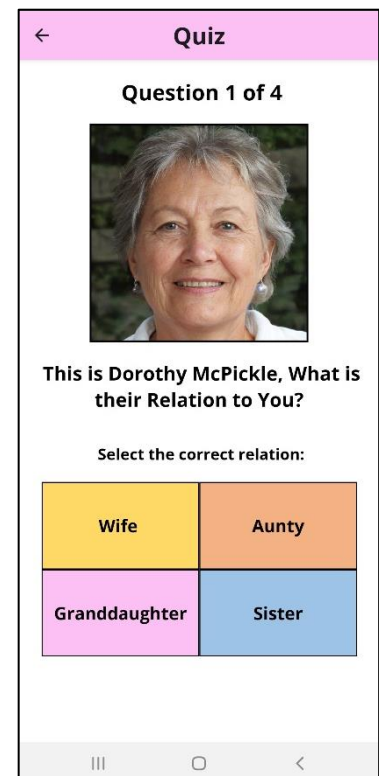


Figure 29: Quiz Question Generated from the App

the same. During implementation, I had the choice of simply not displaying captions where the corresponding data had not been entered or keep the icon and replace the caption with the ability to add the relevant information. I implemented the latter as this lets the user know what information they have added or have yet to add, providing visibility of system status and flexibility of use as per Nielsen's Heuristics. The icons displayed in menus, input forms, and profiles are provided by Microsoft packages and React-Native icons library, some of which may differ from the original designs. I abandoned the remove button from new photo input forms as they are obsolete due to the ability to return to the previous page and confirmation alerts are implemented where appropriate to prevent user error.

Alert boxes do not follow the original designs as React's Alert component does not allow for customisation, with alerts being limited to a title, main text, and up to 3 options without icons. However, the text remains the same as designs in the application; one issue that I had are the messages a user receives when giving an incorrect answer in the quiz – the Alert component did not allow for variables within messages so the correct answers have been temporarily hard-coded.

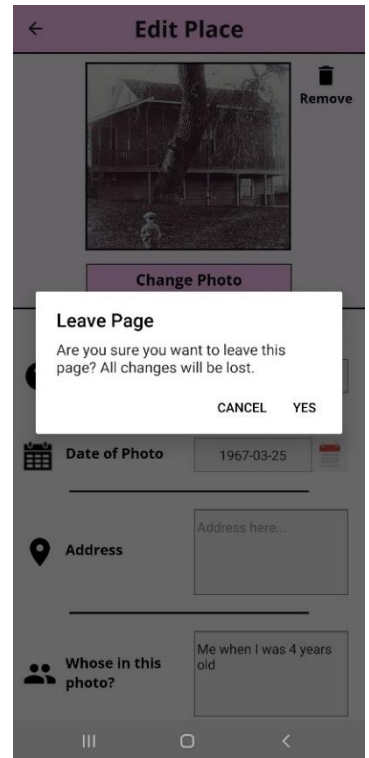


Figure 30: An example of a confirmation alert.

5.5 Navigation and Dataflow of MyMemory Application

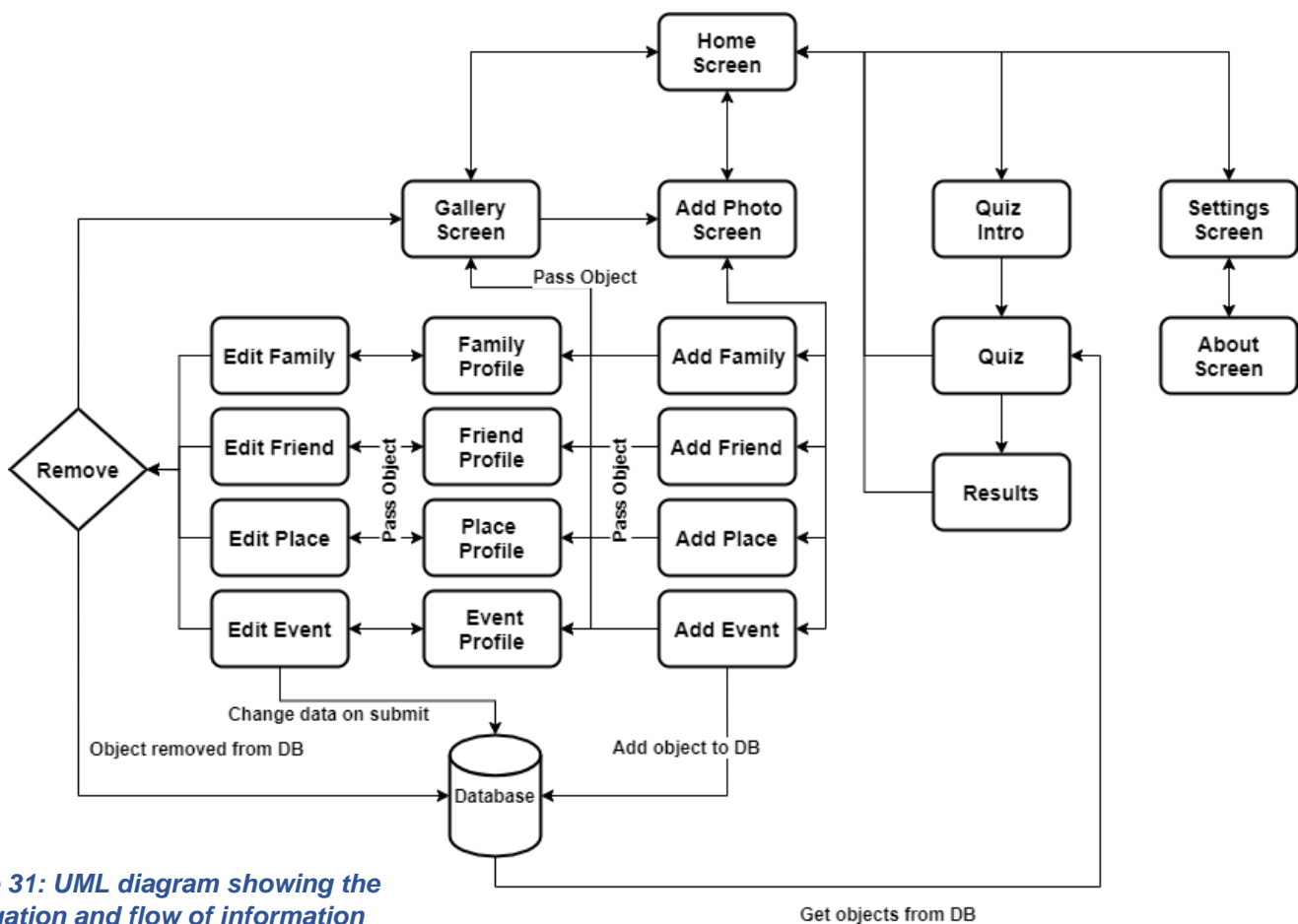


Figure 31: UML diagram showing the navigation and flow of information between screens.

6 Project Evaluation

6.1 Overview

In this evaluation, I will be evaluating key sections of the project through how they have strengthened my project, how they can be improved, and what I would do differently. This includes an evaluation of the effectiveness of the user research, the application produced and user testing, as well as the tools and methods used to complete the project.

6.2 Background and User Research

The initial aim of this project was to work with potential users (or caregivers) to help in the design process towards an application that they would want to use, while also investigating other technologies that they found helpful. For user research to be effective, questions should be designed to form an understanding of who the participant is, their experiences (in this case with technology and caring for people with AD), and use this information to analyse the results with follow-up questions involving their opinions and feedback on ideas.

The questionnaires completed by the caregivers were quite successful in helping me understand the media formats that they have found the most useful and directly impacted the concept and functionality of the developed application by providing their feedback on possible features. It was also helpful in validating previous background research, confirming views on technology and how they may be apprehensive, and technologies that are more commonly used to assist with AD. The quotes provided by participants are important in particular, as they provide unique advice and experience from some of those who may know the topic best. This allowed me to create user personas and stories which were referred to throughout the design process.

Nevertheless, there are a few improvements that could have been made to the questionnaire and methods of research to have gained better results. I wanted the questionnaire to be short and easy to complete by participants, however, an extended questionnaire with more effective questions would most likely be accepted as most participants are keen to share their experiences. A weakness I perceived in the results had shown some of the technologies listed in questions were too ambiguous or used uncommon terminology without examples, such as music therapy and locator devices. As the subsequent questions may contradict some of the previous answers and technology uses are often higher due to not realising what is included in that category (locator devices – GPS tagged jewellery/clothes, location-tracking apps, item-finders, etc) so I believe clearer examples would have worked better. The following question topics may have also been effective:

- Participant age-range (statistics on technology uses and opinions with age)
- What they believed their computer skills are like (does confidence match experience)
- Asking which technologies they would be open to using if provided
- Opinions on controversial areas including data privacy and health-tracking
- Their views on apparent barriers to technologies (accessibility, apprehensiveness, awareness of technologies, etc.)

If given the time and resources, a more in-depth study into the everyday lives of people with Dementia such as that done in the development of Printer Pals [13] would benefit similar projects. The sensitive nature of working with patients around consent and ethics requires a study in itself to understand methods that are compassionate and considerate to participant's privacy but still effective in analysing technology usage and abilities. This may be more acceptable and easier with early stages of Dementia and a generation that has been using technology for a few years now,

which this project is aimed at, with varied and larger participant groups for accuracy in the research stage.

6.3 Usability Evaluation

Designs of interactive systems like mobile applications can be difficult to evaluate with users due to there being several ways of interacting with the app and not being able to certain nuances that add to the experience, such as feedback from touches and text input. I will be evaluating the app's design elements and usability through a 'think aloud' observation method [42], where I ask a representative user to complete a set of tasks using the app while voicing what they think about the interface, their difficulties, and criticisms. This allows me to gain an insight into how a user might think while using the app and view any difficulties they face as a first-time user that I am unaware of as the designer.

Task	Comments
Add a photo of a family or friend	<ul style="list-style-type: none"> ✓ Likes how information is made readable ✓ Colours are good and easy to tell the difference between family, events, etc. - Was confused by having to press twice to submit details due to having to close the keyboard first (android issue) - Additional messages to show what fields are missing is needed (e.g. text and highlighting) as the user was not sure what she missed - Agreed that a tutorial is needed to show how the app works and navigation before first usage
Go to the person's profile and edit their date of birth	<ul style="list-style-type: none"> - Android calendar was difficult to see how to change the year and the "year is not always necessary"
Add a photo of an event	<ul style="list-style-type: none"> - From Gallery was not sure how to get back to add photo – add photo should be in the header so it is always on screen - Back buttons should be labelled to tell user where it leads
Find and delete the event you just added	<ul style="list-style-type: none"> - Struggled to find delete option, needed help – non-experienced users may not have natural sense for navigation of technology to go into edit then remove.
Go to settings and turn off daily reminders	<ul style="list-style-type: none"> ✓ Completed easily
Play the quiz till the end	<ul style="list-style-type: none"> ✓ Very good and easily guided navigation (users respond better when actions are clear)
Extra Comments	Believes the app would be useful and likes the overall concept, would use it if a tutorial were given so navigation was clear to prevent confusion.
Participant: Iris Barber Age: 79	

Table 3: Notes from Cognitive Walkthrough of the MyMemory Application

The participant had previously seen the designs and understood the purpose of the app; the participant was given an album in the device which to pick randomly generated photos from. In the first task – to add a photo of a family member or friend, the participant successfully got to the correct input form, entered most fields, then attempted to press the submit button but was confused when nothing happened. This was because the virtual keyboard was still up and requires pressing elsewhere to close it before a button press, this is an android design issue that I am not sure I can change. The input of data is the most challenging area of design as typing can become difficult for the target audience, but other methods such as speech can often be more difficult and fail to be a natural user interface through rigid commands and problems understanding some speech [21]. Another input method I would like to integrate is the ability to add profiles from social media like Facebook either through an existing account or searching to automatically add data, as well as suggest new people, mitigating some of the typing required.

One required was left empty and the participant was unsure of what they missed; the error message I implemented only mentions that required fields need to be implemented, this was because the React Alert component only allows fixed messages, so I will have to use other methods. I could have also implemented conditional views that display red crosses by fields when a user tries to submit without entering the information. This is an important design element to be able to provide helpful messages and feedback, which will need to be implemented. After successful submission, the participant mentioned that she likes how the information is made readable (formatted), and *“colours are good and easy to tell the difference (between categories)”*.

I then asked the user to edit a profile and change the user's date of birth. This was successful, however, I had to tell the participant how to use the calendar; the app uses Android's default date-picker, it is especially difficult to edit the year as it is not clear and has a small hit-box. A custom calendar component would have to be developed to fix this issue while keeping the general ease of use or a formatted number pad (dd/mm/yyyy). The user also commented that a year may always be necessary (only needing day and month for friends), this another potential but low priority feature to add.

Another issue I had during development was getting header-right buttons to navigate (back-navigation is default), which would have made buttons such as add photo, edit, and delete more consistently placed in a header that does not move. This became apparent in the third task was not sure how to add another photo to the gallery until I asked them to scroll up to find it, it may also have been helpful to label the back-button to the page that it returns to, for example, 'Back to Home'. Tab navigation may also be more friendly as users can swap between pages easily.

From the gallery, the participant was to delete a profile – they struggled to find the delete option, not realising they would have to go to edit first to see the delete options. People who don't have a lot of experience with technology or mobile apps may not be familiar with concepts that are intuitive to others. This becomes a difficult area that requires further testing and asking what they would naturally think to do in unsupervised situations, understanding the conceptual model they form of systems so I as the developer can create an 'intuitive design' [43].

By the fifth task, the participant seemed more comfortable with the app, as they easily navigated to the settings and pressed the toggle switch to turn off notifications. They also easily navigated and completed the quiz portion of the app, stating it was very good and easily guided, showing how older

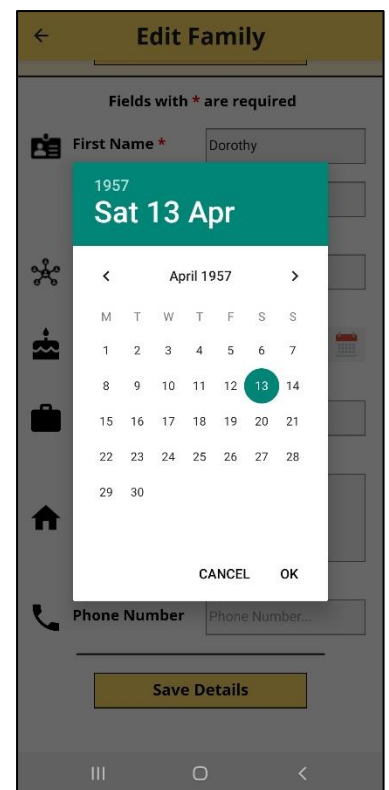


Figure 32: Android Date-picker

participants may respond better to one-way navigation and limited functionality due to a lack of options to confuse them and clear instructions to progress. Overall, the participant believed the app could be useful and approves of the idea – they agreed that a tutorial on first start-up of the app would be helpful, so the user knows what they are doing.

6.4 Tools and Methodology

Due to limited previous experience in mobile development, I underestimated, to an extent, the time investment and difficulties that I would meet during app development. React-Native abstracted from JavaScript to be more like HTML and CSS than I expected. Also, being just a few years old and still in its beta phase; I found the main issues for me were caused by the number of outdated guides as the framework is updated monthly, so guides that were only a few months old were obsolete and it took me a while to find the most recent releases of components such as Navigation 5.0, as their websites continue to show older versions of components. Another aspect I had difficulty with was implementing the database using Firebase, having never used Firebase, and the guides for RN being outdated. It was a struggle to get the easily-created input boxes to add their content to the database as well as receiving data and making it into a format to display.

However, I am happy to have used RN as basic components like Views were easy to use and components became enjoyable to replicate once figured out which provides a straightforward start to app development. I would use it again; however, I think other languages/libraries would be better for the more complex functionality. These problems have taught me to search version histories for the most up-to-date versions and I also improved the structure of my code greatly when having to start from fresh, which made it more accessible and easier to maintain/develop on.

The code could be reduced and improved by using class inheritance through base classes, such as for screens like input forms that have similar methods to handle state changes, adding to the database, passing objects between screens, and image selecting, and input boxes that differ in the input variables they use or access to the class' state. These changes will come with more experience in RN and learning how to use inheritance with components to make these changes that I would have implemented from the start. A class diagram would have been helpful but not knowing how RN would work and what I would need to implement I decided against it. I could have saved time by knowing what methods and components were required to follow designs.

Following an agile methodology worked well as expected as core functionality has been completed (adding photos, relevant information, the ability to edit or remove, and using user input in a quiz format) as well as the design aspects for a minimalistic interface with larger text and buttons for the audience. By testing that functionality worked as they implemented, I avoided spending too much time fixing issues, by knowing immediately what caused them so I could revert changes. This has left me with a functioning app that may have inadequate if I focused too much time on 'quality of life' features like filters.

6.5 App Improvements and Long-Term Evaluation

The user evaluation and ideas from testing have helped me identify some of the immediate improvements that can be made to the app, including functionality, which was planned but not executed, these include the following:

- Some user input implemented as drop-downs that auto-complete text such as relationships, reducing the amount of typing and possible mistakes
- More conditional changes for captions to allow flexibility dependant, such as showing the number of months if an event was less than a year ago.

- Changing dates for readability (1999/21/03 to 21st March 1999).
- Place buttons in the right of the header for consistency (edit, delete, and add photo).
- Randomise quiz answers and answer placements, permanent solution to incorrect answer messages
- Improve validation messages for input forms
- Explore tab navigation as an alternative design

The design and accessibility of the app can be evaluated further with more participants of a variety of ages and abilities, and if possible, people with AD/Dementia would also provide the most reliable results. The methods discussed are effective as a short-term form of assessment for design, however, long-term evaluations of the app are needed to determine whether it can be helpful for AD. This could be through qualitative studies by having target users use the app for longer periods (weeks to months) and asking them or their caregivers to complete short questionnaires throughout or after the study, on the helpfulness of the app in terms of emotions such as an improved sense of independence, improved short-term memory, boosted self-esteem, reminiscence, and other attributes that make them want to continue usage.

If a patient feels like the app has been successful in helping them to some degree and they have kept up continuous usage, this may be enough evidence to say personal/custom assistive technology can help patients. A quantitative analyst could show a much clearer conclusion to whether there are any positive effects, however, these methods can be intruding with many questions on the ethicality of health and personal data being collected for research. The least sensitive but still effective methods can include tracking time spent on the app and at what times – which can also help dictate timeliness of notifications, and the censored results of user quizzes to show whether performance increases (this would be especially helpful with more questions and quiz modes).

7 Conclusion

7.1 Satisfaction of the Objectives

This project aimed to look at how technologies can assist AD patients currently and explore how a personal and custom application could assist in reminiscence and cognitive behaviour; these behaviours include present thinking and communication that help with the psychological distress that patients face. This aim was broken into five objectives to complete in order, following a usual development process of research, design, implementation, and evaluation.

- 1) I identified some of the traditional methods that are the most common amongst patients and caregivers, as well as several technologies from basic devices like pill dispensers to the more advanced like smart home technologies. I was able to understand where computer science studies have ventured and where they are still developing that requires further research and highlighting the practise of user-centred design, including where it succeeds and falls short.
- 2) From the research, I was able to formulate some options for the functionality of an application, focusing on using the user's media and existing methods. The research and ideas allowed me to create questionnaires effective enough for the results to assist me throughout the project. A more in-depth evaluation of the ideas could include making basic designs and more information about how they work to discuss with users where they think it could be improved reasons why they may not like the idea.
- 3) I was able to have caregivers of people with AD/Dementia complete the questionnaires which experiences. This shaped the functionality of the app and helped me create the user personas and stories capturing the personas from different perspectives of the target audience quite well while identifying their needs.
- 4) The storyboard designs and hex colour codes were continuously used throughout the development and adapted with scaling to be appropriate for touches such as text-input standards being a width of 40 pixels and large hitboxes for an elderly audience. I was able to implement a majority of the functional requirements, with the core features built to have been able to evaluate the app properly.
- 5) I evaluated the app through a cognitive walkthrough during design and after development, with an older user who knows the difficulties the target audience face, which has helped me identify some of the improvements that need to be made. I also followed HCI heuristics and advice from sites like the Alzheimer's society to ensure designs are as accessible as possible. Finally, I know what I would do differently in terms of user research, designs, and development, as well as how the custom assistive technology could be assessed long-term.

7.3 Future Development

In addition to the improvements listed in the evaluation, several future developments are important if the app were to be made commercial or features that could vastly improve user experience including:

- Account creation for a secure data-access and offline availability so that internet access is not required
- Family/friend accounts with permissions to add entries to someone's account from their phone
- Ability to choose what information to be tested on, with difficulty levels (e.g. multi-choice vs typed and relaxed vs timed)
- Facial tagging so photos of multiple people are identifiable
- Improved image manipulation – ability to enlarge and fit-to-views
- Additional settings to customise the interface (font and icon size, colours, etc.)

I am pleased with the app overall as it fits its purpose as a digital photo book and personal quiz aimed at people with AD/Dementia, being able to meet most of the user stories, or have thought about how I may implement them. With quite an extensive list of functionality and improvements, I would be interested in developing further and pursuing research in user-centred technology for people with AD/Dementia, as well as how technology can help an ageing population in general.

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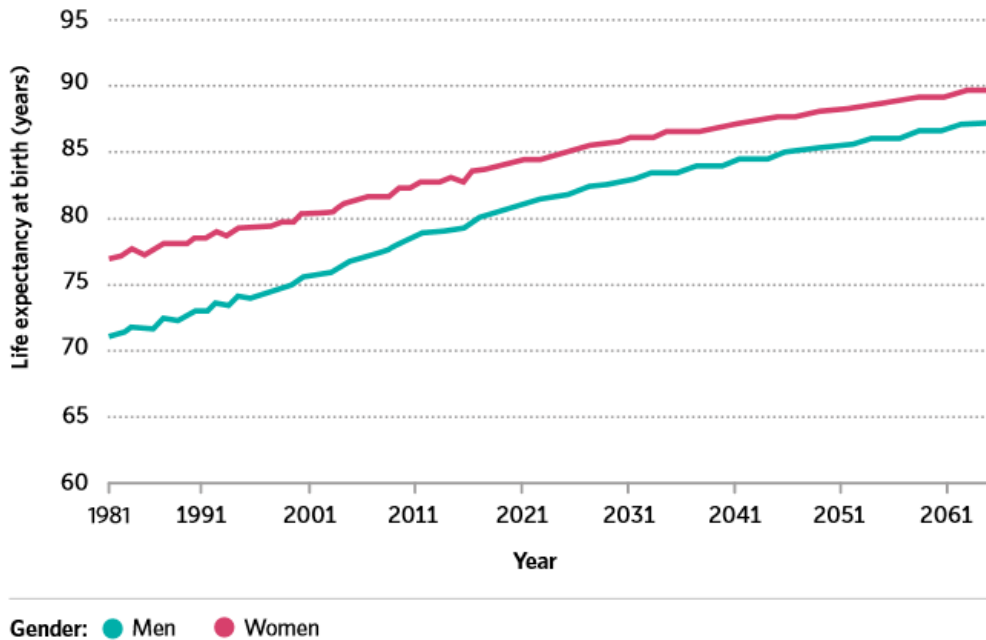
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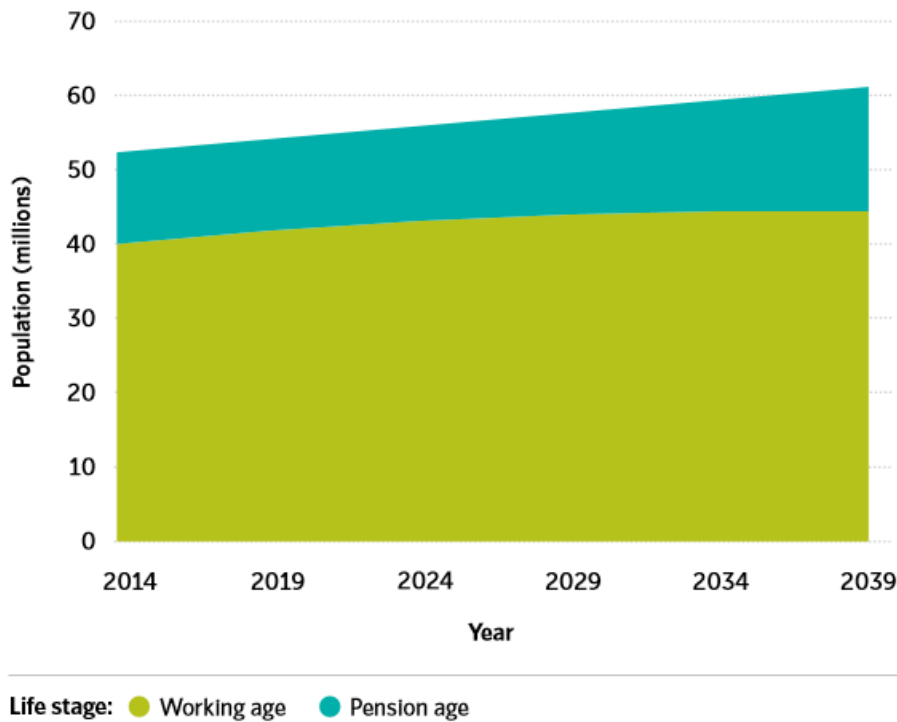
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9 Appendix

Appendix A: Historic and projected period life expectancy at birth in the UK 1981-2064 [1]



Appendix B: Estimates and projections of UK working and pensionable age populations, 2014-2039 [1]



Appendix C: Questionnaires for caregivers at St. James Over 50s Club



Dissertation Questionnaire Research

Technology and Methods used in Assisting with Alzheimer's/Dementia Symptoms

Hello, my name is Charlie Leopard – I am currently studying Computer Science at Newcastle University. I am conducting research into what technologies and methods people who have or currently do care for people with Alzheimer's or have Alzheimer's themselves. The purpose of the study is part of a dissertation project to explore current approaches for Alzheimer's care and develop new methods and custom technologies to assist in improving reminiscence (memory), the ability to retain information, and upkeep daily routines in the early to mid-stages of Alzheimer's, with the goal of keeping our loved ones independent for longer with the use of technology that is helpful and enjoyable.

The following questionnaire consists of 6-8 questions and should take no longer than 5-10 minutes. All responses are kept anonymous and no one will be identifiable in the research. An information sheet is available if you wish to learn more.

1. Has someone close to you (partner/relative/dependant) ever been diagnosed with Alzheimer's/Dementia or have you cared for someone with Alzheimer's?

Tick one or more:

- ☐ Someone close to me had/has Dementia/Alzheimer's.
- ☐ I have cared for someone with Dementia/Alzheimer's.
- ☐ I have no experience with Dementia/Alzheimer's. *(No need to continue questionnaire)*

Other:

2. Do you or the person receive help from the NHS or other services?

Tick one or more:

- ☐ Independent
- ☐ Only family/friends

- ☐ Care home / assisted living
- ☐ Paid carer
- ☐ Community nurse visits

Other:

3. What are your opinions on current/future technology in general?

Tick one or more:

- ☐ No opinion
- ☐ Too confusing or frightening
- ☐ Uninterested
- ☐ Exciting / enjoyable
- ☐ Useful / helpful

Other:

4. Have you ever used any of the following technology/products to assist yourself or someone else with Alzheimer's?

Tick one or more:

- ☐ Mobile/Tablet Applications
- ☐ Healthcare/Help Websites (e.g. Alzheimers.org.uk)
- ☐ Music Therapy
- ☐ Video Games / Memory games (Nintendo Wii, Nintendo DS, mobile games, or others)
- ☐ Automatic Reminders
- ☐ Dated pill boxes or Automatic Pill Dispensers
- ☐ Locator Devices
- ☐ Telecare Systems
- ☐ Voice assistants (Like Amazon's Alexa, or Apple's Siri)
- ☐ Smart home technology (Automatic lights, sensors, smart heating, smart locks, etc.)
- ☐ None of the above

Other:

5. Which of the following methods do you think are helpful for Alzheimer's?

Tick one or more:

- ☐ **Playing music from the when I/they were younger**
- ☐ **Looking through photo books**
- ☐ **Watching videos of family & friends**
- ☐ **Memory games / Brain training**
- ☐ **Social Media**
- ☐ **None of the above**

6. How helpful do you think the following ideas could be? :

Tick one or unsure if you don't know:

a. Personal memory games involving photos of family, friends, and places

- ☐ **Not Helpful** ☐ **Not Very Helpful** ☐ **Unsure** ☐ **Quite Helpful** ☐ **Very Helpful**

b. Daily/weekly reward point systems to track your memory

- ☐ **Not Helpful** ☐ **Not Very Helpful** ☐ **Unsure** ☐ **Quite Helpful** ☐ **Very Helpful**

c. Automatic reminders around the home or on your phone

- ☐ **Not Helpful** ☐ **Not Very Helpful** ☐ **Unsure** ☐ **Quite Helpful** ☐ **Very Helpful**

d. Simplified mobile messaging or simplified social media:

- ☐ **Not Helpful** ☐ **Not Very Helpful** ☐ **Unsure** ☐ **Quite Helpful** ☐ **Very Helpful**

7. (Optional) Is there anything else you would like to see or use that you think could help?

--

Thank you for participating.

[illegible]

2. Do you or the person receive help from the NHS or other services?

Independent														
Only family/friends														
Care home / assisted living														
Paid carer														
Community nurse visits														
Other					"Partly in care home"									

Quote: "I have had and lost a mother, sister, brother, close friends all from Alzheimer's. Also have a brother-in-law in a home now"

3. What are your opinions on current/future technology in general?

No opinion														
Too confusing or frightening														
Uninterested														
Exciting / enjoyable														
Useful / helpful														
Other														

Quote: "I am unaware, or no knowledge of current/future technology hence cannot give an opinion"

4. Have you ever used any of the following technology/products to assist yourself or someone else with Alzheimer's?

Custom Assistive Technology for Alzheimer's Patients

Mobile/Tablet Applications														
Healthcare/Help Websites (e.g. Alzheimers.org.uk)														
Music Therapy														
Video Games / Memory games (Nintendo Wii, Nintendo DS, mobile games, or others)														
Automatic Reminders														
Dated pill boxes or Automatic Pill Dispensers														
Locator Devices														
Telecare Systems														
Voice assistants (Like Amazon's Alexa, or Apple's Siri)														
Smart home technology (Automatic lights, sensors, smart														

Custom Assistive Technology for Alzheimer's Patients

heating, smart locks, etc.)														
None of the above														
Other														

5. Which of the following methods do you think are helpful for Alzheimer's?

Playing music from the when I/they were younger														
Looking through photo books														
Watching videos of family & friends														
Memory games / Brain training														
Social Media														
None of the above														

6. Which of the following methods do you think are helpful for Alzheimer's?

	Not Helpful	Not Very Helpful	Unsure	Quite Helpful	Very Helpful
a. Personal memory games involving photos of family, friends, and places	0	1	3	7	3
b. Daily/weekly reward point systems to track your memory	2	1	9	1	1
c. Automatic reminders around the home or on your phone	0	2	1	9	2
d. Simplified mobile messaging or simplified social media	1	3	6	2	2

7. (Optional) Is there anything else you would like to see or use that you think could help?

"A talking robotic carer that could assist on dialog and that doesn't get fed up of repeated conversations. Whilst ensuring their safety and meeting their needs basically. A full-time assistant to help the carer. But not be in total control. If it was possible to get a robotic carer - there may not be such a demand in care homes."

"My father does not and could/would not use a mobile phone, I can and do show him pictures and play music that he recognises which gives him some pleasure"

"Something to share memories of a long time ago"

"Games & Activities e.g. match the shape, knitting & painting, dolls & stuffed toys, music & CDs of favourite songs. Comfortable clothes with Velcro ties"

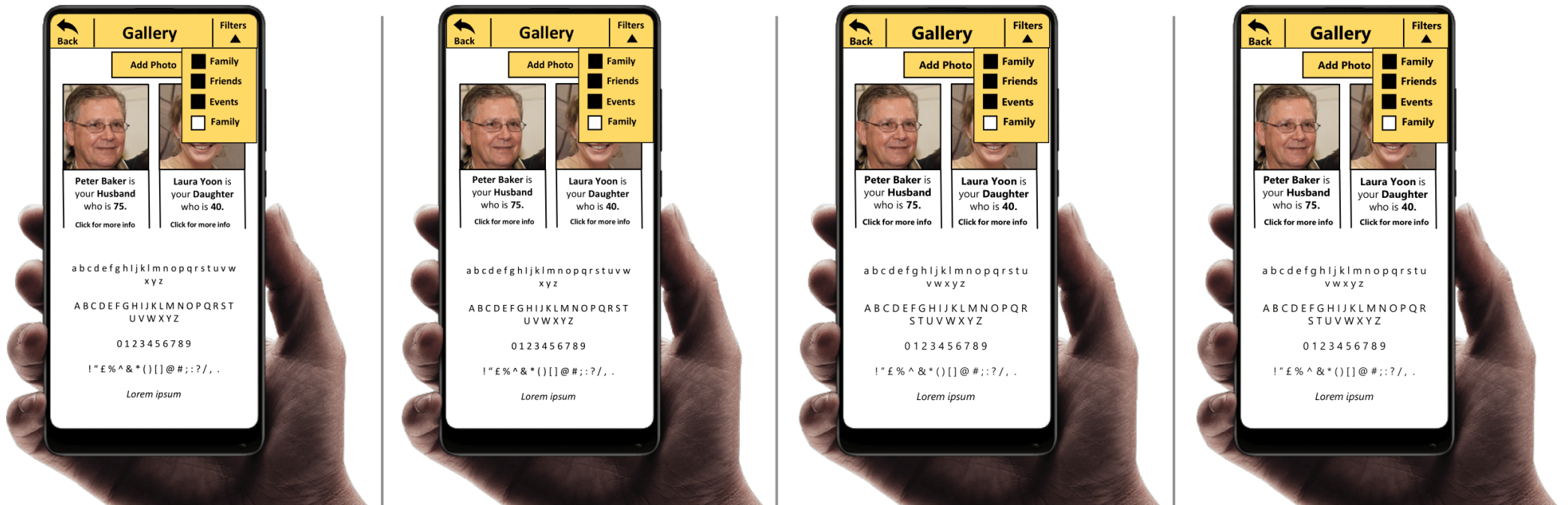
"Anything that brings back childhood, using hands, they like to fiddle with things. They remember their homes and places from far back, something that families can fill in of photos over the years of homes, family, where they went to school etc. Women like to cuddle dolls, brings back memories bringing up the family. Also, music, they sing along with the old songs they know and can remember the lord's prayer and creed."

"Talking about childhood memories, old photos, puzzles (with large pieces), colouring books, favourite music"

8. (Optional) Additional information/comments:

"I anticipate the usefulness of technological support will grow as the more digital native generation are those who are supporting loved ones with Dementia or have Dementia themselves"

Appendix E: Font-Board of Potential Fonts



Montserrat

Playfair Display

Open Sans

Lato

Size: 28
Bold

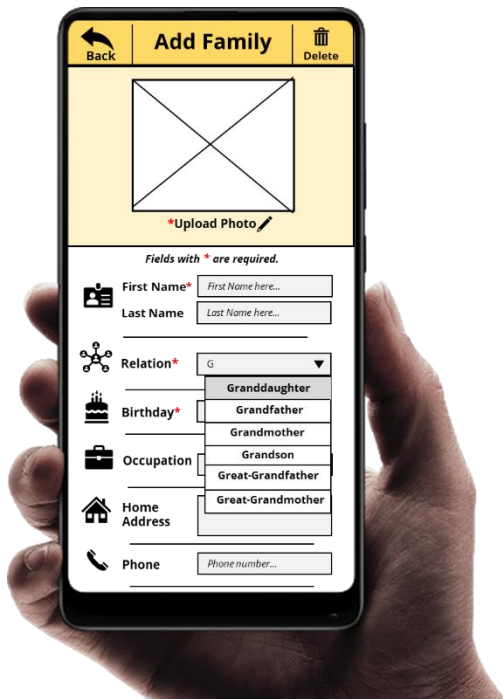
App Font size: 6
Header title size: 11
Header, buttons, keywords: **Bold**

App Font size: 6
Header title size: 11
Header, buttons, keywords: **Bold**

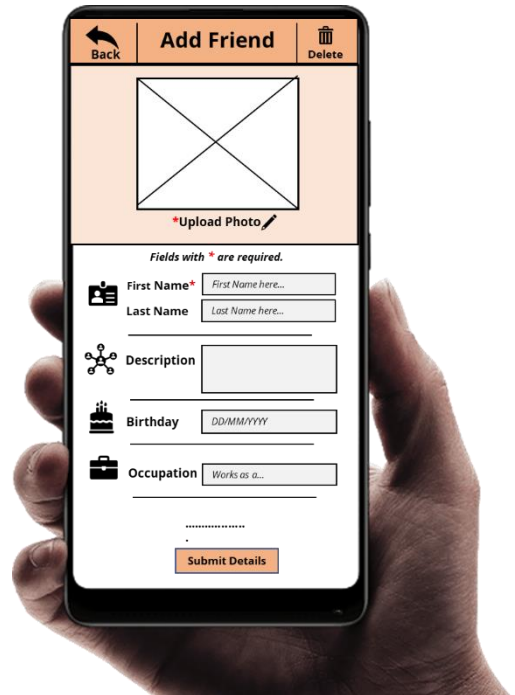
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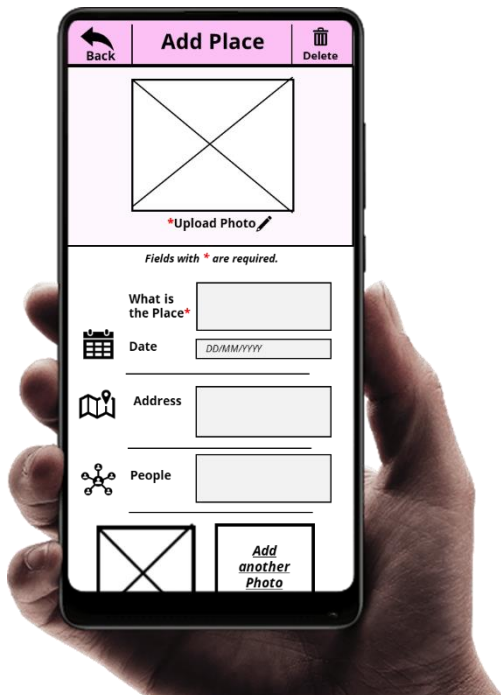
Appendix F: Further Designs of the Application's Screens [41]



Add Family (Relations) Screen Design



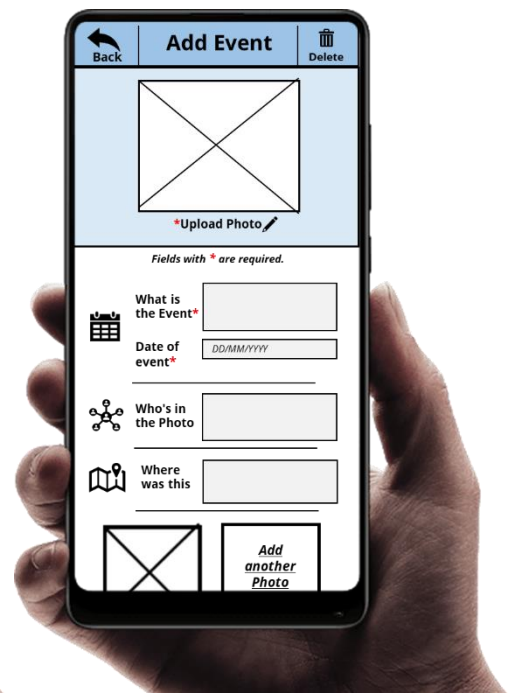
Add Friend Screen Design



Add Place Screen Design

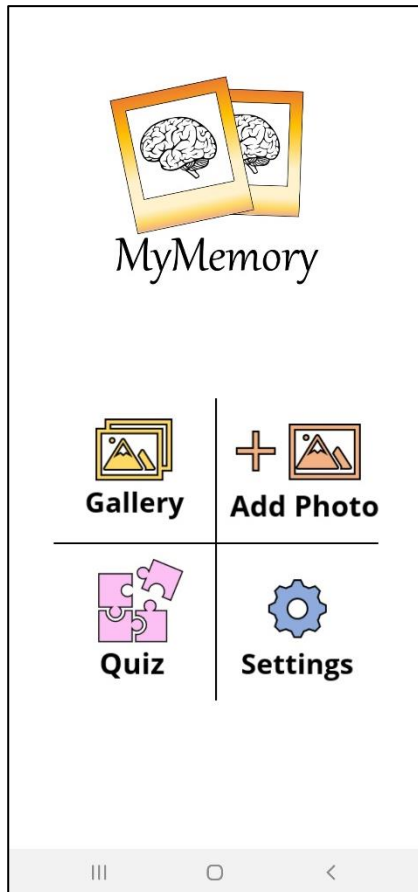


About Screen Design

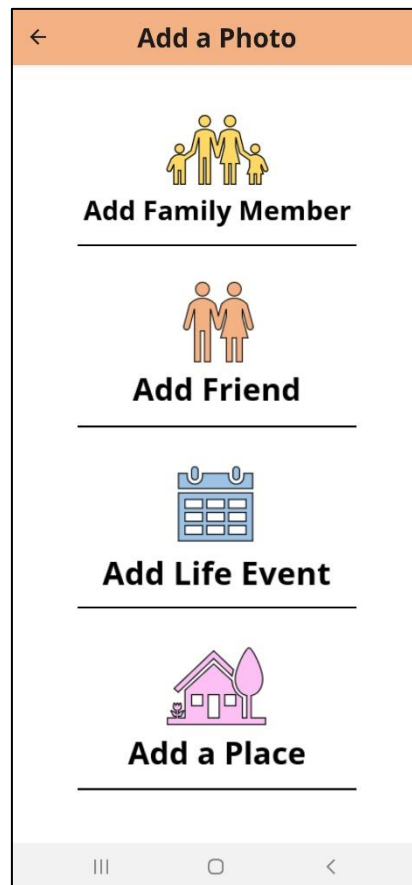


Add Event Screen Design

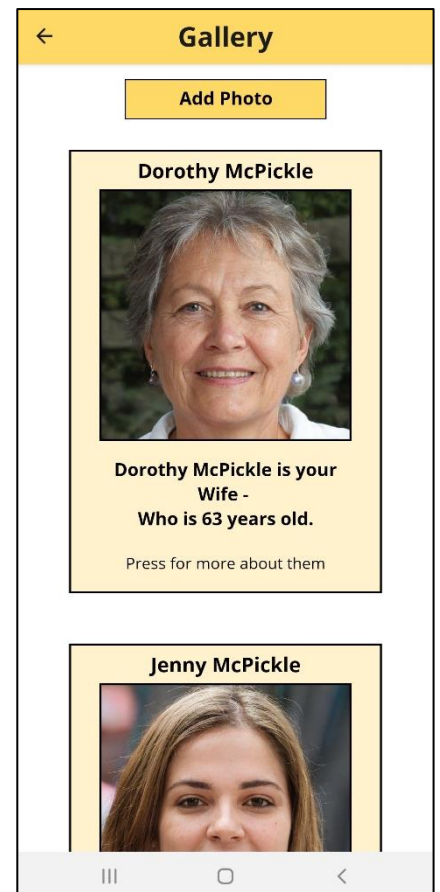
Appendix G: More Screenshots from the MyMemory Application



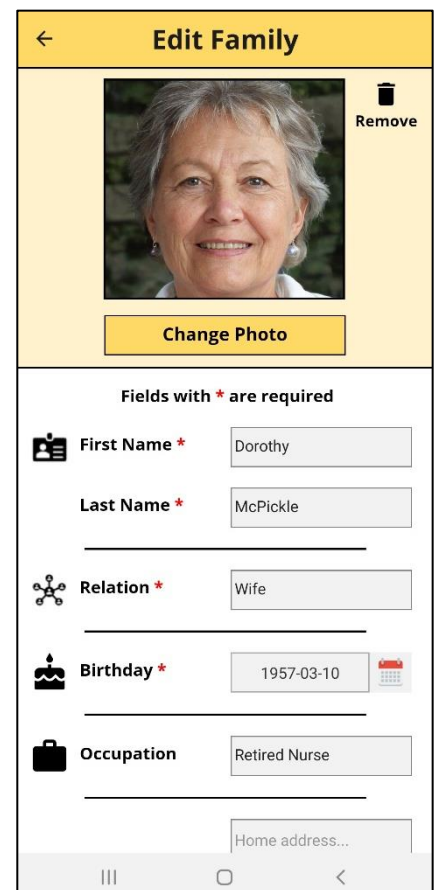
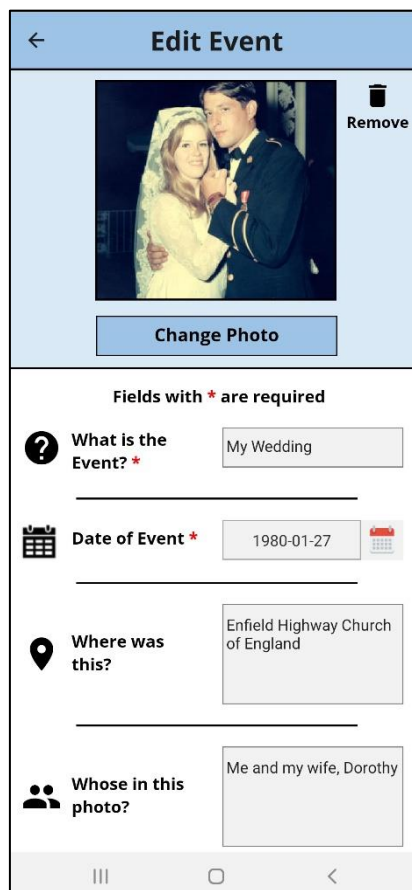
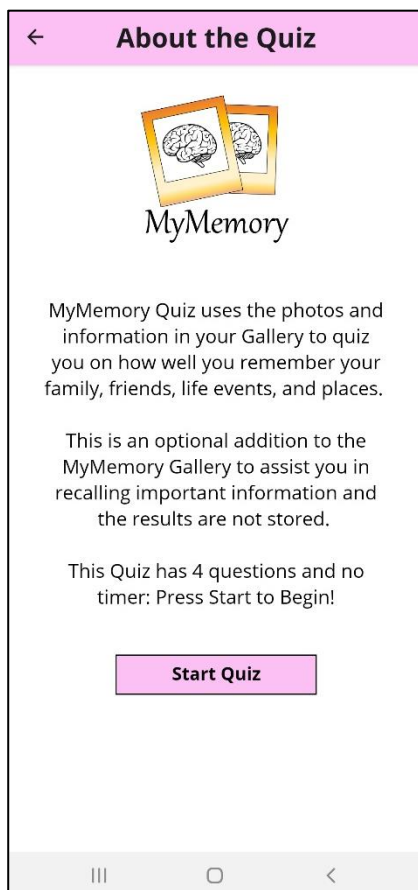
*Above: Home Screen
Below: App Intro Screen*



*Above: Add Photo Screen
Below: Edit Event Screen*



*Above: Gallery Screen
Below: Edit Family Screen*



Appendix H: Example Code for MyMemory Gallery

(See Supplementary Material for full code)

```
// take all data from family database into object array
var familyArray = [];
db.ref('/family').once('value', (snapshot) => {
  snapshot.forEach((snap) => {
    var item = snap.val();
    item.key = snap.key;
    familyArray.push(item);
  });
  this.setState({ familyArray: familyArray })
});
```

*Code A: Example of data being pulled from
Firebase Realtime Database*

```
// printer methods iterate through their corresponding object array, placing the data in a polaroid-style v
familyPrinter() {
  let { navigate } = this.props.navigation;

  return this.state.familyArray.map(function (family, i) {
    let familyImage = family.image;
    return (
      <TouchableOpacity onPress={() => navigate('FamilyProfile', { family: family })}>
        <View style={[[styles.galleryFrame, styles.lightGold]]>
          <View key={i}>
            <Text style={[[styles.galleryName]]> {family.firstName} {family.lastName} </Text>
            <Image source={familyImage} style={[[styles.galleryImage]]} />
            <View style={[[styles.captionsTextBox]]>
              <Text style={[[styles.galleryCaptions]]>
                {family.firstName} {family.lastName} is your {family.relation} -
                {'\n'}Who is {family.age} years old.{'\n'}
              </Text>
              <Text style={[[styles.galleryCaptions2]]>Press for more about them</Text>
            </View>
          </View>
        </View>
      </TouchableOpacity>
    );
  });
}
```

*Code B: Printer method
for family object*

```
// display button to add photo screen and each photo from printer methods
render() {
  return (
    <ScrollView style={[[styles.background]]>
      <View style={{ alignItems: 'center' }}>
        <View style={{ flexDirection: 'row' }}>
          <TouchableOpacity onPress={() =>
            this.props.navigation.navigate('AddPhoto')}
            style={[[styles.gold, styles.galleryAddPhotoButton]]>
              <Text style={[[styles.submitButtonText]]>
                Add Photo
              </Text>
            </TouchableOpacity>
          </View>
          {this.familyPrinter()}
          {this.friendPrinter()}
          {this.eventPrinter()}
          {this.placePrinter()}
        </View>
      </ScrollView>
    )
  )
}
```

*Code C: Render method for
the gallery screen calling
printer methods*