Integrating Daily Rituals into the Design of Technologies for People with Dementia

Rupsha Mutsuddi

A Thesis submitted to the Faculty of Graduate Studies
in Partial Fulfillment of the Requirements for the Degree of Master of Design.
Graduate Program in Design

York University
Toronto Ontario
April 2024

Abstract

Dementia is a family of diseases which cause cognitive impairments and impede the engagement in everyday activities. For people living with dementia (PwD), technologies can facilitate the process of engaging in these daily activities. However, many of these technologies are poorly adopted by PwD, as they are often designed without their input or involvement. This thesis aims to understand daily rituals and map those rituals into the design of technologies. This thesis uses Human-Centered Design (HCD) approaches, such as contextual inquiry, to understand daily rituals for PwD and identify ways to integrate rituals into technology design. Research data was collected through semi-structured interviews with 14 participants (8 informal caregivers and 6 people living with dementia). The interview data was then analyzed in *ATLASTi* to generate insights informing the design and development of several prototype iterations.

Acknowledgements

Thank you to my supervisory committee, Dr. Shital Desai and Dr. Melanie Baljko, for their support, advice, and feedback throughout this process. I would also like to thank the community organizations AGEWELL, Alzheimer's Society of Ontario, Alzheimer's Society of Peel, Alzheimer's Society of York Region, Alzheimer's Society of Huron County, and the Ontario Caregiver Organization for their support of the study. I would like to acknowledge my gratitude to Mona Lancaster at Memory Lane Home Living for the invitation to exhibit and recruit at the World Alzheimer's Day Event in 2023. Thank you to CVR and VISTA for the opportunity to demo prototypes at the New VISTAs in Vision Research Conference in 2023.

I am so thankful to my fellow lab members at the Social and Technological Systems Lab (SaTs) Lab, especially Joey Wong, Vyjayanthi Janakiraman, and Eve-Lareine Dandan. A big heartfelt thank you to my Master of Design and Master of Design Research Colleagues: Emma Hodgson, Jessica Kim, Ashley Richmond, and Serina Uncao for their support through this entire process.

Many thanks to the Social Sciences and Humanities Research Council (SSHRC), Natural Sciences and Engineering Research Council of Canada (NSERC), and the York University Academic Excellence Fund for funding this work. I am incredibly grateful to all the participants who participated in this study without you, this work would not be possible.

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1. Introduction

The family of dementia-type diseases are associated with neurodegenerative impairments such as memory loss, executive dysfunction, and communication difficulties (Centres for Disease Control and Prevention, 2022). The most common type of dementia is Alzheimer's Disease (AD), which affects 73% of people 75 years or older and 10.9% of people 65 years or older (Alzheimer's Disease International, 2023). While AD primarily effects older adults, there are other forms of dementia that may affect younger populations. For example, early-onset dementia can affect people from their early twenties to their late fifties and accounts for 2-8% of all dementia cases (Alzheimer Society of Canada, 2024). While this thesis prioritizes the experiences of older adults living with dementia, it should be noted that AD and other dementia-related illnesses are not the natural results of aging (Bond et al., 2004). It should be noted 61% of older adults living with dementia in Canada are community dwelling (Canadian Institute for Health Information, 2024). Since dementia affects such a large population of older adults outside of care institutions, it is of utmost importance that designed interventions support people with dementia in the context of their everyday lives and support their desire to age in place (Brittain et al., 2010; Chokkanathan et al., 2015).

Due to cognitive decline, people with dementia (PwD) frequently experience disengagement with everyday activities (Okazaki et al., 2009; Phinney et al., 2007). This is because PwD often have trouble sequencing tasks that make up the finite steps in daily activities (Roll et al., 2019). Additionally, PwD may struggle to maintain focus and track progress during certain stages of activity completion (Calderon, 2001). Over time, these cognitive impairments related to task sequencing and memory may cause PwD to disengage from everyday activities; this withdrawal then impacts individuals' quality of life (Andersen et al., 2004; Smit et al., 2016). The term "quality of life" (QoL) describes an individual or population's overall well-being relative to multiple factors such as personal health, social environment, freedom, and autonomy (Phillips, 2006). By facilitating daily activities, technologies can help satisfy PwD's needs for freedom and autonomy and improve their overall QoL (Löbe & AboJabel, 2022); such facilitation occurs when technology makes an activity easier to accomplish.

In the context of dementia, technologies generally fall into three categories: communication aids, prompting technologies, and robotic technologies (Asghar et al., 2017;

Begum et al., 2013; Czarnuch et al., 2016; Yusif et al., 2016). Some technology designs focus on supporting activities of daily living (ADLs). ADLs comprise essential tasks like dressing, teeth brushing, and eating; often, these activities serve to measure an individual's basic functioning and mobility (Katz, 1983). ADL measures address basic functioning but exclude a plethora of ancillary everyday activities, such as those done for leisure, personal satisfaction, and socialization (Law, 1993). Technology can help facilitate a wide range of everyday activities and mitigate potential disengagement due to debilitating cognitive impairments (Czarnuch et al., 2016; Roest et al., 2017). For instance, prompting technologies can generate action-inciting prompts to help guide people through daily activities such as hand washing, preparing meals, or doing their morning routine (Braley et al., 2019; Mihailidis et al., 2008). Other technologies can facilitate communication, provide helpful reminders, or provide navigation support when a PwD is going for a walk in their community (Asghar et al., 2018; Diks et al., 2021; Thoolen et al., 2022). Despite the potential of these technologies, PwDs often abandon them due to a lack of suitability for daily use – this outcome is known as "poor adoption" (Yusif et al., 2016).

Poor adoption for PwD and their informal caregivers occurs when technologies are difficult to use; more specifically, difficulties arise when technologies are not adapted to the degenerative prognosis of dementia, feature overly-complicated interfaces, and do not align with how an individual likes to perform their daily activities (Guisado-Fernández et al., 2019). Additionally, caregivers and PwD often take on the extra burden of modifying technologies to improve their suitability in the context of daily life; when modification is not possible, these technologies are abandoned (Gibson et al., 2019). To solve these issues, technologies should be developed with PwD involvement to integrate their preferences and insights during every phase of the design process (De Vito Dabbs et al., 2009).

The primary objective of this thesis is to understand how PwD and their informal caregivers engage with daily activities. Secondly, these insights will be used to design a prototype based on the needs of PwD and their informal carers.

2. Literature Review

Personalization refers to the process of integrating the insights of a target user group into technology design; this procedure aims to present a technology's content and features in a way that the user group can understand and interact with (Lewis & Treviranus, 2013). Recent studies have shown that when personalized for PwD, technologies are more accessible and engaging (Meiland et al., 2017; Wood et al., 2023). For instance, when PwD had an opportunity to select images and personalize selected templates within a digital environment, they reported having a positive experience with the technology (Kelleher et al., 2021). However, this level of personalization remains insufficient as it still relies on pre-designed templates that offer a limited range of changes. This inadequacy is also the case for existing, "non-specific technologies" that are not expressly designed for PwD (Hirt et al., 2019). Frequently, caregivers must use "hacks" to improve these technologies' suitability for PwD. For example, caregivers may use tape to cover some numbers on a microwave trackpad so that PwD know what to press to warm up their food (Gibson et al., 2019). Currently, personalization measures remain limited since it tends to occur during post-design phases once many features are already fixed and cannot be easily changed. Instead, technology personalization should be taken into consideration throughout every phase of the design process to ensure that the needs of PwD and their informal caregivers are better addressed.

It is not enough to prioritize technology personalization; we must discuss ways to integrate the personalized ways in which people navigate their activities, or daily rituals. These personalized routines are guided by social, cultural, and interpersonal influences (Clymer, 2006; Knottnerus, 2012). Daily rituals provide structure to everyday life and can cultivate familiarity with daily tasks, routines, and objects; this structure can also facilitate interactions within PwDs' social environment (Briller & Sankar, 2011; Diks et al., 2021; Fiese et al., 2002; Giovagnoli, 2018; Goerlich, 2022). Daily rituals encompass four key components: habits, routines, tasks, and objects (Briller & Sankar, 2011). Habits are an individual's unconscious, repeated behaviours during daily activities (Giovagnoli, 2018). Habits are constructed from routines, which are the serialized paths used to conduct daily activities (Eyles, 1989; Gärling, 1992). In turn, these routines are conducted using individualized steps, known as tasks, and an individual's acquired objects (Löfgren, 2009). People will use these acquired objects and tools to make their everyday activities more efficient. If an object does not suit an individual's needs or preferences, it will be

modified (Brereton, 2013). Together, these four components work as a system that supports the performance of daily activities (Hancock, 2020).

When PwD are unable to continue their rituals independently or without disruptions they may experience increased agitation, poor self-image, and a decreased sense of autonomy (Johansson et al., 2011; Mahoney et al., 2015; Redfern et al., 2002; Rogers et al., 1999). PwD may determine technologies to be incompatible with their lifestyles when introduced to ill-suited designs that do not facilitate their daily activities (Thorpe et al., 2019). Alternatively, engagement with daily rituals maintains the continuity PwD have with activities pre- and post-onset of dementia. When habits, routines, and roles are supported in activities, it connects PwD to the rituals they engaged with pre-onset such as watching their favourite television programs, reading books, or meeting with old friends (Phinney et al., 2007). Integrating daily rituals into the design of technologies should be an important goal for technology developers as it can lead to improved adoption and acceptability of technology (Robillard et al., 2018).

Research on other populations has explored the process of integrating daily rituals into technology design (Kirk et al., 2016; Reyes Uribe, 2019). Seminal work around ritual machines show how family routines can continue when family members are separated due to work-related obligations (Kirk et al., 2016).Through a process of contextual inquiry, the researchers recreated a ritual of sharing a drink through the use of technology such as a smartphone and an Arduinos connected wine dispenser (Kirk et al., 2016). Contextual Inquiry is a qualitative methodology that focuses on gathering insights from a user's point-of-view during different activities (Raven & Flanders, 1996). Contextual Inquiry has also been used to understand how cultural rituals can be integrated into product design. Researchers mapped the experience of a Japanese tea making ceremony to create a product for organizing each step of the ritual and the specific objects it requires. This product aimed to assist those learning the tea-making ritual for the first time (Lévy, 2015).

Currently, there is only a small selection of studies that address how the daily rituals of community-dwelling PwD can be integrated into technology design. Preliminary work shows how technology can be modelled based on objects PwD have already integrated into their daily rituals, resulting in more positive experiences with the technology (Wallace et al., 2013). This result has also been observed with adults living with more severe cases of dementia; when technology was integrated into a blanket or pillow they liked to use, the participants found these

objects to be comforting and preferred to use them regularly (Kenning & Treadaway, 2018). Technologies which integrate the daily rituals of PwD and their caregivers also support engagement with activities that were previously abandoned due to cognitive impairment (Löbe & AboJabel, 2022). For example, participant interviews were used to re-imagine daily walking rituals into a bespoke virtual reality experience for PwD and their caregivers. This allowed them to visit places together after the onset of dementia and the increased burden on the caregiver had prevented excursions outside the home (Hodge et al., 2018). Additionally, when experiences associated with leisure activities (such as listening to music) were mapped into technologies by involving PwD and informal caregivers, PwD experienced lighthearted and playful interactions with the people in their home (Houben et al., 2022). Caregivers have voiced the importance of adapting technology to dementia prognosis and understanding how cognitive impairment changes overtime (Hirt et al., 2019). Therefore, technologies must integrate strategies from PwD and caregivers to navigate cognitive impairment rather than simply re-create experiences. As this is a new area of research, contributions that explore integrating rituals into technology design for PwD is important in the creation of future technologies that are well adopted and easy to use.

This thesis builds on these previous works to understand the daily rituals for community-dwelling PwD and integrate them into a prototype design. This research project seeks to answer the following question:

How can daily rituals be incorporated into the technology design to facilitate everyday activities for community-dwelling, older adults living with dementia?

This research question will be answered via the following three sub-questions:

1. How does the dementia-related cognitive impairment affect daily rituals?
2. What strategies do PwD use to navigate daily rituals post-onset of the disease?
3. How can we map these ritual-based strategies into the design of technologies that facilitate daily activities?

3. Methodology

To better understand PwD's daily rituals, this research project uses a *human-centered design* (or "HCD") framework. In practice, HCD centers the involvement of end-users throughout every stage of the research process (Boy, 2017; Interaction Design Foundation, 2019). HCD also involves rapid prototyping and partnering with communities of people to identify and overcome barriers (The Interaction Design Foundation, 2019). Throughout the project, an HCD framework was applied according to the "Double Diamond Paradigm" (see *Figure 1*) (Design Council, 2015). In the *Discovery phase*, 6 PwD and 8 informal caregivers were interviewed in dyad pairs and individually. Interviewees were asked to identify their daily rituals, including which involved frequent and independently performed activities. In the *Synthesis phase*, *AtlasTi* was used to analyze interview transcripts through the process of thematic analysis to identify four core themes. Finally, the (rapid) *Prototyping phase* served to create a series of iterative prototypes.

Design Research Paradigm
*(*adapted from the UK Council, 2015)*

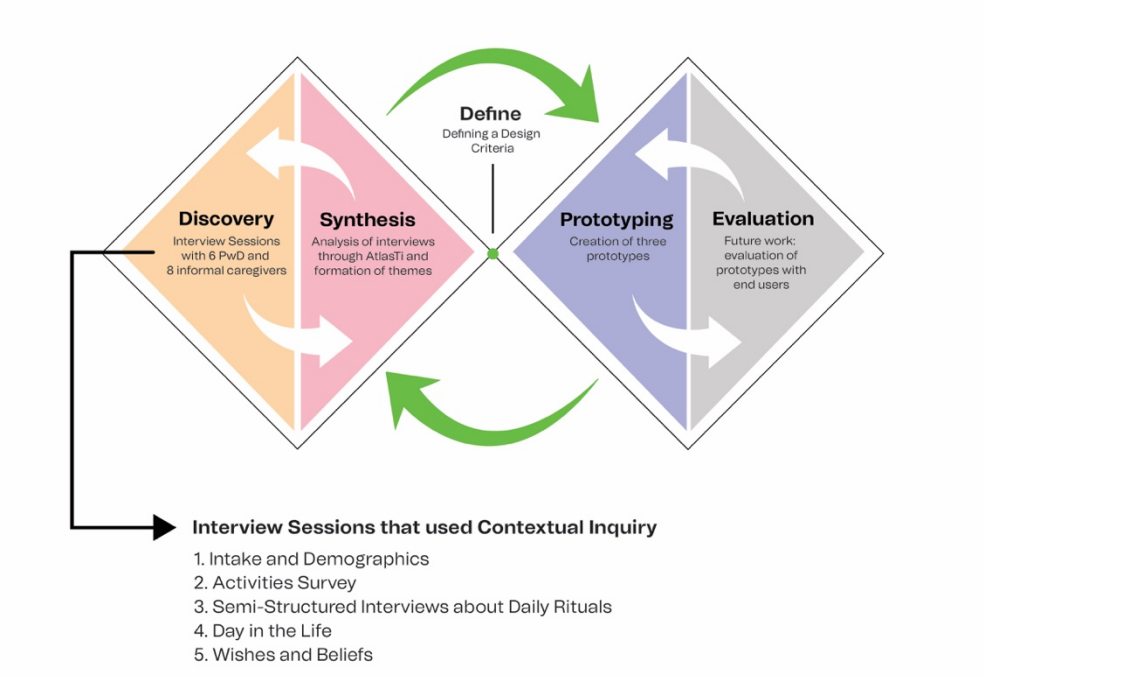

Figure 1. The Double Diamond Design Research Paradigm organizes each research phase within a HCD framework.

The interviews utilized contextual inquiry to understand daily activities from PwD and the caregivers' points of view. The interview session included the following components (as per *Figure 1)*:

1. **Intake:** During the intake session, the participants signed consent forms and filled out the demographic survey.
2. **Activities Survey:** Participants were given a list of activities and asked to rate which activities were most frequent and performed independently. Frequent and independent activities were classified as 'activities of interest.'
3. **Semi-structured Interviews about Daily Rituals:** Next, subjects participated in semi-structured interviews where they were asked to describe, step-by-step, (1) how they performed their activities of interest, (2) if they used any technology or tools, (3) how performing this activity has changed through the progression of dementia, and (4) whether they had any favoured strategies or ways they liked doing these activities.
4. **Day in the Life Worksheet:** Participants were then asked to place their described activities on a daily timeline. They were prompted to describe any tools or technologies they may use, how long they did these activities for, and whether they felt their daily rituals were interrupted during the day.
5. **Wishes and Beliefs:** Participants were asked open-ended questions about what they would change to navigate their experience of living with dementia/caring for someone with dementia, what technologies they wished they had access to, and if there were any additional insights they could share with the researcher.

To find relevant activities, data from a Statistics Canada survey called "2015 General Social Survey on Time Use" was used to find daily activities older Canadians engaged with most often. The 18 most popular daily activities amongst Canadians 65 and older were: Meal Prep, Making Tea or Coffee, Laundry, Grocery Shopping, Walking, Chores, Gardening, Knitting, Arts & Crafts, Watching TV, Reading for Leisure, Listening to Music, Volunteering, Sports, Cultural Activities, Shopping and Browsing for Other Items Besides Food, Playing Games on Devices, and Religious Activities (Government of Canada & Statistics Canada, 2015). A new survey was designed where these activities were placed on a four-point Likert scale (1-Never, 2-Rarely, 3-Sometimes, 4-Frequently) to indicate how often participants did this activity. Additionally, there

is a space to list the people involved if the activity was done with the support of someone else. There were also empty spaces provided so that participants could add in any frequent activities that were not on the list (see *Appendix A* for the configuration of this new survey tool).

Another tool that was used to prime responses from participants is "a day in the life timeline," adapted from the University of Pennsylvania Centre for Health Care Transformation & Information Design Thinking Toolkit (Center for Health Care Transformation and Innovation, 2020). Using this worksheet, participants could place their various daily activities from the "Activity Survey" on a time scale. Participants also described whether they used any technologies or tools to support their daily activities and how much of the day they spent doing certain activities (see *Appendix B* for this worksheet).

Ethics for the interview protocol was granted by the York University Office of Research Ethics in May 2023. Following an ethics review, participants were recruited, and interview sessions were conducted in summer 2023 and fall 2023. Analysis of the interview sessions took place in fall 2023 and winter 2024. Final prototyping using insights generated occurred in fall and winter 2024. The following sections describe each research phase in detail.

4. Data Collection

Recruitment for the interview sessions took place between May 2023 and October 2023. Community organizations (such as the Ontario Caregivers Organization, the Alzheimer's Society of Peel, the Alzheimer's Society of York Region, and the Alzheimer's Society of Huron County) shared recruitment materials through their own communication channels (i.e., social media and websites). The study was also listed on the Alzheimer's Society of Ontario's database of research studies. Memory Lane Home Living, an organization focused on women living with dementia, allowed me to recruit at the World Alzheimer's Day event on September 21st, 2023, sharing recruitment materials through their website. Additionally, recruitment was done at the October 2023 AGEWELL Conference, an event focused on aging and technologies where preliminary results from the literature review were shared.

While the study was originally conceived for dyad pairs, some PwD did not have a caregiver and lived alone. Some caregivers also said they were uncomfortable including PwD in the study. This reticence was due to their care recipient's being in denial about their diagnosis or having recently transitioned to an assisted care facility. Additionally, some caregivers worried that their patients would find the study process agitating. Thus, participants were given the option to participate in the study independently. In total, 6 PwD (60≥year) and 8 informal caregivers participated in the study. There were 3 dyad pairs with one person living with dementia and one caregiver, 3 PwD who participated in the study on their own, and 5 caregivers who also participated in the study independently.

All five parts of the interview sessions were conducted together. On average, the interview sessions lasted one hour and thirty minutes. One caregiver chose to give insights on 2 PwD; they lived with one as a full-time informal caregiver and supported another patient occasionally. This was the longest session and spanned two hours. All participants were compensated with a $30 Amazon gift card as a token of appreciation.

4.1 Demographics

During the intake process, participants were given a demographics survey. In this survey, PwD responded to questions about their ethnicity and what stage of dementia they were in. Caregivers were asked about their patients' ethnicity, what stage of dementia they were in, and

how often they saw their care recipients. *Table 1* summarizes the demographic data given by PwD, and *Figure 5* summarizes the demographic data given by informal caregivers.

Demographic Data Provided by PwD

Ethnicity	Participation Format	Stage of Dementia	Type of Dementia
Chinese (Cantonese)	Dyad	Mid-Stage	Alzheimer's
Caucasian	Dyad	Early-Stage	Not reported
Indigenous	Dyad	Mid-Stage	Not reported
Caucasian	Individual	Early-Stage	Vascular Dementia
Biracial	Individual	Early-Stage	Not reported
Caucasian	Individual	Early-Stage	Vascular Dementia

Table 1. Demographic Data Provided by PwD Participants

Demographic Data Provided by Informal Caregivers

Ethnicity of PwD	Participation Format	Frequency of seeing PwD	Stage of Dementia for PwD cared for	Type of Dementia for PwD cared for
Chinese (Cantonese)	Dyad	Everyday, live together	Mid-Stage	Alzheimer's
Caucasian	Dyad	Everyday, live together	Early-Stage	Not reported
Indigenous	Dyad	Everyday, live together	Mid-Stage	Not reported
South Asian	Individual	Everyday, lived together before	Late-Stage	Not reported
Multiracial	Individual	Everyday, lived together before	Late-Stage	Alzheimer's
Caucasian*	Individual	Everyday, live together	Early-Stage	Alzheimer's
Caucasian*	Individual	Occasionally, once a week	Late-Stage	Alzheimer's
Caucasian	Individual	Everyday, lived together before	Late-Stage	Alzheimer's
Caucasian	Individual	Frequently, every couple of days	Early-Stage	Huntington's

* Data provided by one caregiver about two individual PwD

Table 2. Demographic Data Provided by Informal Caregivers

5. Results

This chapter describes results from the "Activity Survey" and interview sessions.

5.1 Activity Survey Results

Before sessions began, participants gave brief introductions, either about themselves or the PwD they were caring for. Next, PwD shared the following information: (1) the type of dementia with which they had been diagnosed, (2) the duration with which they had been living with dementia, and (3) their current stage of dementia. Meanwhile, caregivers shared which dementia type their care receiver had been diagnosed with and the disease's current stage. 83% of participants did not report which type of dementia they had. Of those who responded, 58% of PwD had been diagnosed with Alzheimer's Disease; 25% of participants had rarer forms of the disease, such as Huntington's disease-related dementia or vascular dementia. All PwD participants reported early to mid-stage dementia. Those in early-stage dementia participated either on their own or within dyad pairs. Meanwhile, all PwD living with moderate stages of dementia chose to participate in dyad pairs. Caregivers provided all data for any PwD with late-stage dementia. Next, participants were given a survey based on the Likert activity scale (see *Figure 2* for resuls*).* The y-axis on this rating scale displays participant codes, categorized by distinct ending letters: "C" represents caregivers, "F" represents PwD, and "D" represents PwD and their caregivers, grouped together in dyad pairs (e.g., ."P1DP5C"). Some PwD were paired with their caregivers since they performed activities together and, thus, reached joint consensus when responding to the survey.

Likert Ratings of Researcher-Prompted Activities

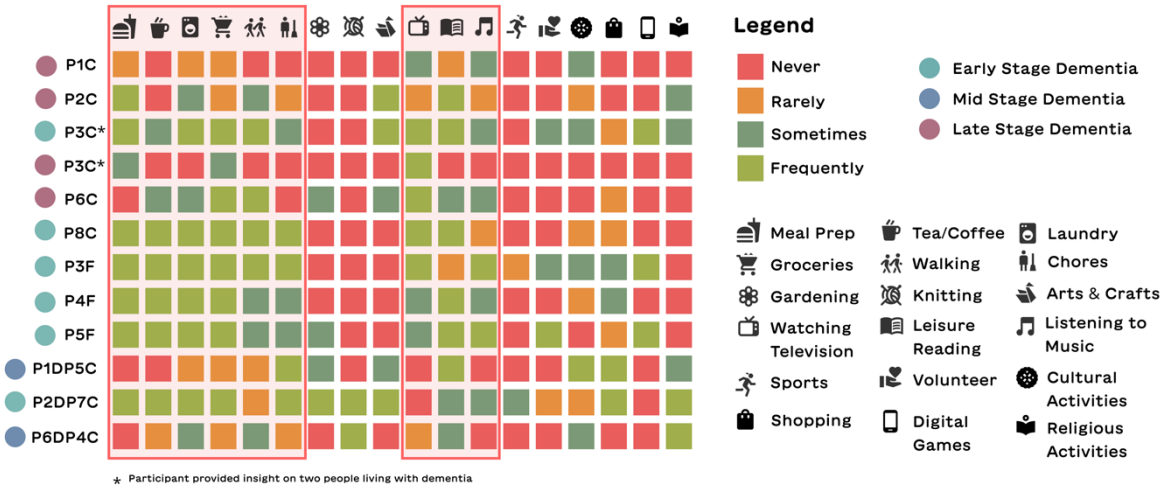

Figure 2. Likert Scale Ratings of 18 Different Activities Based on "General Social Survey on Time Use" (Statistics Canada, 2015). See Appendix A for Survey Format.

Figure 2 shows participants' reported activities, performed either occasionally or frequently. These activities included: meal preparation, tea or coffee making, laundry, grocery shopping, walking, chores, television watching, leisure reading, and music listening. Activities that a majority of participants reported performing "rarely" or "never" included: gardening, knitting, arts and crafts, organized sports, and religious activities. Regarding these less popular activities, participants stated that they were either "not interested," no longer had the physical capacity required (i.e., in the case of organized sports), or experienced difficulties accessing resources or the activity's required materials (i.e., in the case of gardening and volunteering). When providing responses for late-stage PwD, caregivers stated that their patients had previously performed activities such as: meal preparation, tea or coffee making, grocery shopping, leisure reading, and chores. Once they progressed into late-stage dementia, PwD lost the capacity to continue these previously-enjoyed activities and became largely sedentary.

Additionally, participants described whether or which activities (out of 18) were performed by PwD independently or with others (i.e., their caregivers (see *Figure 3).* Rare or never-performed activities were not characterized as independent and frequent, therefore, eliminated from this portion of the survey (and grayed-out in *Figure 3*).

Activities that are Individually Done vs. Done with Others

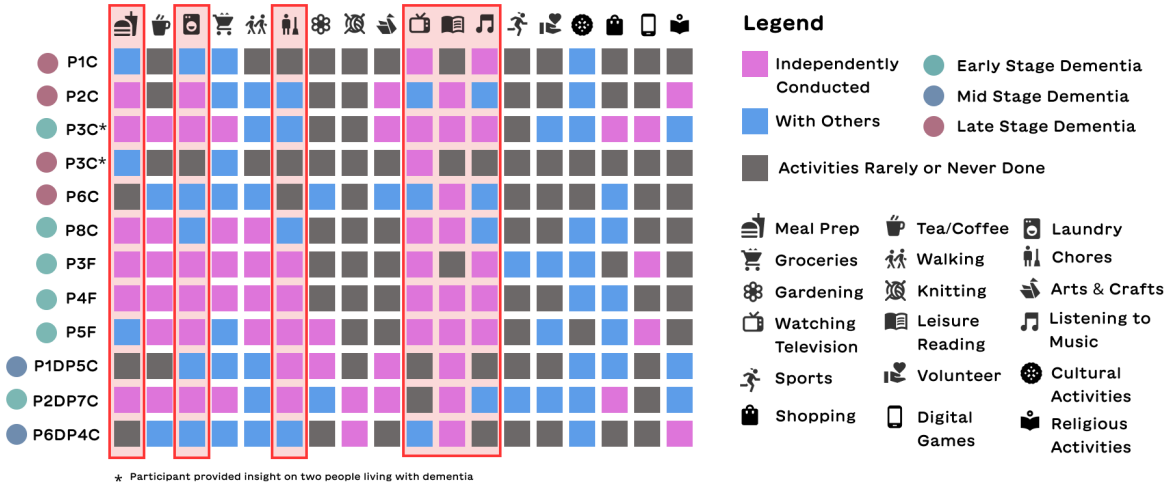

*Figure 3. 18 Participant Characterization of Independent or Frequent Activities. See Appendix A for the Survey Presented to Participants. *Items Based on the "General Social Survey on Time Use" (Statistics Canada, 2015).*

Participants also provided other activities in the empty spaces on the survey form (see *Appendix A).* These activities included tasks related to listed items, such as: meal planning, garbage disposal, and specific crafts like crocheting or painting. Additionally, participants added unrelated activities they liked to do, such as: news reading/watching, jigsaw puzzles, telephoning loved ones, attending community centre day programs, sewing/mending clothes, outdoor hobbies (i.e., camping or tobogganing), participating in cultural activities (i.e., celebrations like Diwali or caring for garments like sarees), photography, and learning computer-programming (i.e., with Arduino toy kits). Though participants initially reported rarely or never playing digital games, many went on to list mobile or desktop games (like Wordle, Sudoku, Solitaire, and Bridge) as additional activities.

Furthermore, participants indicated which activities they abandoned (i.e., volunteering and organized sports). Often, PwD abandoned these activities due to lack of opportunities in their communities. Participants also indicated abandoning activities that involved inaccessible systems and programming, which were designed for the general older adult population and ill-suited for PwD's particular needs. Finally, PwD abandoned some activities for reasons other than dementia. For instance, one participant had abandoned cultural rituals (like engaging in a tea-making ceremony and volunteering at her temple) after immigrating to Canada from Hong Kong. The

survey also demonstrated the huge role caregiver facilitation played in determining whether an activity would continue; when caregivers could no longer facilitate a previously independent activity, it was frequently abandoned.

Participants reported that reading often accompanied other activities, such as meal preparation (reading recipes), grocery shopping (consulting a list), visiting the library (for books/newspapers), playing the piano or singing (reading music or lyrics), gardening (journaling to keep track of what had been planted), religious practices (i.e., reading the Bible or Buddhist pedagogies), or games (i.e., reading crossword puzzles or Wordle).

5.2 Interview Results

When PwD or the caregivers indicated performing activities "sometimes "or "frequently," they received follow-up questions. These questions asked: how participants did the activity, what technologies or tools they used, and whether performing the activity had changed due to dementia. The activities most affected by dementia were meal preparation, excursion outside the home (i.e., going for walks, grocery shopping, and gardening), and reading. Some caregivers were reticent to facilitate activities within the kitchen due to safety concerns (i.e., proximity to potentially dangerous appliances). Caregivers also worried about activities outside the home; in the majority of cases, caregivers expressed concern that their care receivers might get agitated, confused, or lost. Often, caregivers reported facilitating reading by introducing PwD to short-form literature (i.e., comic books) or sharing digital literary content (ie., podcast links). However, beyond those tools, caregivers expressed not knowing how to facilitate reading in other ways. Some caregivers noted that PwD would attempt reading which appeared unsuccessful. Caregivers for late-stage PwD noted that they still valued literature, kept books on the bedside table, or frequently "scanned through" books or other coveted items like photo albums.

Daily rituals changed in response to dementia-related cognitive impairments and after new adaptive strategies were introduced to continue those previous rituals. One PwD described how kitchen-based rituals had changed from being unconsciously performed, to needing methodical pre-planning. For instance, before putting ingredients into a pot on a stove top, she would need to set every ingredient in one place. After placing an ingredient into the pot, she would have to put the item away. Otherwise, she would not remember which ingredients she had already used. Other participants also reported having similar rituals based on visual cues when

performing their activities. The most common visual cues were colour-coding calendars, writing notes or strategies when solving puzzles, and consistently keeping items in a specific location that PwD could remember.

Before the onset of dementia, daily rituals were mostly unstructured. However, after onset, PwD required more structured routines. One caregiver noted how their spouse living with dementia prepared the same meal every day for breakfast and insisted on taking meals at very specific times to manage memory loss. Caregivers were often assigned a role of "task master," assigning specific tasks within an activity. For example, one caregiver described how their care receiver could previously mend clothing on her own. However, as her disease progressed, she needed her caregiver to direct each stage of the mending task. When she needed to replace a button, her caregiver would select the button, thread the needle, and then point to the area of the shirt where it would be sewn. Once directed, the care receiver could independently sew the button. Other caregivers saw task managing as a group activity in which the person living with dementia would accomplish a small part of a larger activity. For example, when gardening, PwD were given tasks such as picking fruit, planting seeds, and watering plants. Meanwhile, caregivers would coordinate the activity by indicating where plants were, where seeds needed to go, and which plants needed watering. These structured and directed tasks became more common as PwD's cognitive impairments increased in severity.

Additionally, caregivers and PwD were asked whether they used any technologies during activities. Caregivers expressed negative attitudes towards digital devices, such as cellphones, and reported infrequent use by their care receiver. However, PwD reported using cellular devices to stay in touch with loved ones through texting, calling, and sending funny images (e.g., in family WhatsApp groups). They also used their phones for directions with navigation programs, such as Google Maps and local transit apps. One PwD noted that he particularly liked using Google Maps' "street view," since seeing pictures of unfamiliar places helped him plan his commutes without feeling overwhelmed. PwD also had affinity towards home appliances. When asked why they liked these appliances, PwD noted that they were "easy to use" and without too many steps. Caregivers echoed this insight, stating that care receivers would not use anything that was overly complex or difficult to "turn on."

Many participants talked about reading with great interest. However, some PwD expressed frustration with reading as they experienced challenges such as not being able to recall

what they had read, struggling to remember word meanings, having trouble focusing on pages, and feeling fatigued by large columns of text. As a solution, PwD would select shorter-form content, such as newspapers or magazines, to maintain their reading rituals.

PwD also selected books from familiar authors or based on recommendations from others (i.e., caregivers or people in their social environment). One PwD merged her journaling and reading rituals together, copying key phrases from readings into notebooks to support her memory (see *Figure 4).* The figure shows underlining, use of different pen inks to highlight key phrases, and the use of highlighting strategies. These are some ways PwD employed strategies to focus attention and remember important details in what they previously read.

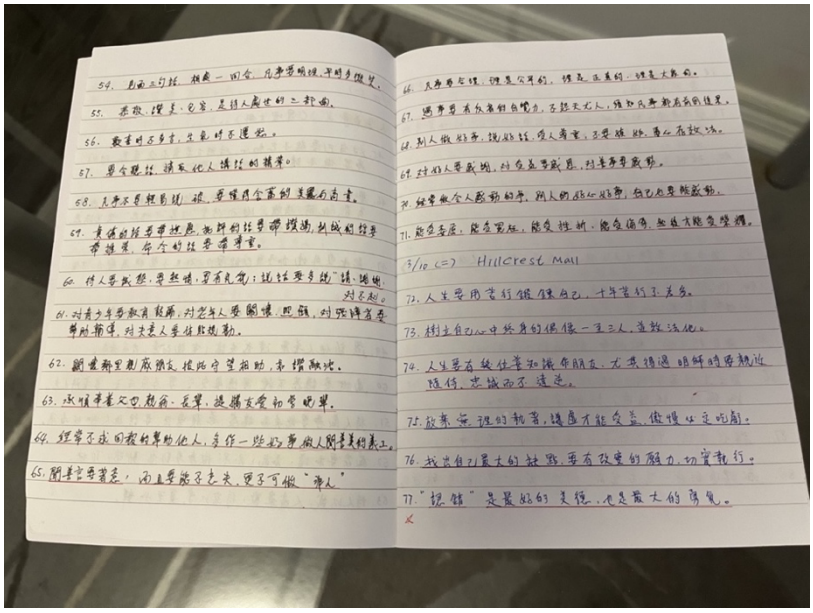

Figure 4. PwD's Notebook Demonstrates Annotation Strategies.

Table 3 shows a summary of select results from the semi-structured interviews. Only one activity was selected per participant/participant group for the sake of brevity. This figure demonstrates how these interviews revealed rituals within daily activities, how these changed after the onset of dementia, and what strategies were employed to navigate them. The PwD and caregivers are separated in this table since the strategies were sometimes reported by the caregiver and vice versa. After the onset of dementia, rituals were changed to involve new strategies that became part of the rituals. Before the onset of dementia, participants reported performing their rituals unconsciously or without thinking much about them. Due to this after the

onset of dementia, PwD experienced an increased cognitive load as they now had to make conscious efforts to engage in their rituals.

Impacts of Cognitive Impairment on Select Activities, Changes in Daily Rituals, and Strategies to Navigate Daily Rituals

Participant(s)	Activity described	Cognitive Impairments affecting activities	Daily ritual before the Onset of dementia	Daily ritual after the Onset of dementia	Strategies employed to navigate daily rituals
P1C	Laundry	Losing track of the tasks needed to complete the activity.	Could independently do the tasks without any help	Caregiver supervised however some individual rituals were not known	Prompting responses using familiar object related to the activity.
P2C	Sewing	Losing track of the tasks needed to complete the activity.	Could independently sew and mend clothes at will	Caregiver supervised directing using structured tasks	Using directed prompts to structure tasks
P3C1	Garbage Disposal	Trouble remembering schedule	Would remember garbage disposal occurs every two weeks	Marking the calendar with a blue dot to mark important dates	Colour coding and note taking
P3C2	Grocery Shopping	Trouble remembering items needed	Would purchase different items	Buys the frozen foods in bulk	Stocking up on familiar items
P6C	Gardening	Trouble organizing tasks	Could independently do all the tasks needed for gardening	Caregiver directs smaller tasks	Using directed prompts to structure tasks
P8C	Going to the Library	Reticent to participate in library programming due to communication difficulties	Could engage in community related programming	Goes to the library to acquire reading materials	Finding an alternate way to engage in an activity.
P1F	Going for Walks	Trouble navigating unfamiliar places	Could confidently navigate environments without confusion	Uses google maps street view to look at unfamiliar routes and neighbourhoods	Use of visual cues to navigate unfamiliar environments
P2F	Doing puzzles in the newspaper	Difficulty navigating task with high cognitive load	Could complete the puzzle in one sitting	Simplifies the puzzle by doing a little bit of it at a time	Reducing cognitive load by doing one chunk at a time
P3F	Reading	Trouble focusing attention while reading	Could read anything no matter the format	Prints out digital content in order to annotate and mark up key phrases	Highlighting, underlining, and colour coding important phrases.
P1D (PwD in Dyad Pair)	Reading	Trouble Remembering previously read information	Reading and occasionally reflecting on what was read in a journal	Reading and writing down key passages in a journal.	Writing Notes, Highlighting, underlining, and colour coding
P5C (Caregiver in Dyad Pair)	Reading	Trouble Remembering previously read information	Reading and occasionally reflecting on what was read in a journal	Reading and writing down key passages in a journal.	Buying notebooks to support these rituals
P2D (PwD in Dyad Pair)	Meal Preparation	Trouble remembering recipes and which ingredients were added to the cooking vessel	There was no need to use recipes in the kitchen and cooking was more instinctual	Cooking is a highly structured activity. Recipes are preselected and followed. Ingredients are visually grouped into categories of what has been used and what hasn't been used yet.	Visually grouping ingredients and following recipes
Participant(s)	Activity described	Cognitive Impairments affecting activities	Daily ritual before the Onset of dementia	Daily ritual after the Onset of dementia	Strategies employed to navigate daily rituals
P7C (Caregiver in Dyad Pair)	Meal Preparation	Trouble remembering which items are included in a recipe	There was no need to use recipes in the kitchen and cooking was more instinctual	Selecting recipes together with PwD	Taking on some tasks like preparing meat however it was noted by the caregiver that they did this pre-onset as well.
P6D (PwD in Dyad Pair)	Reading	Trouble remembering previously read information	Reading any content without difficulty.	Reading comic books with short narrative segments	Switching to short form content in order to better navigate reading
P4C (Caregiver in Dyad Pair)	Reading	Trouble remembering previously read information	Reading any content without difficulty.	Reading comic books with short narrative segments	Curating digital comic books with PwD

Table 3. Summary Table of Selected Activities Demonstrating the Impact of Cognitive Impairments on Daily Rituals and the Strategies Used to Continue Activity-Related Rituals.

Each participant or dyad pair filled out a "day in the life" worksheet (see *Appendix B).* These findings revealed the challenges participants faced when navigating daily rituals. The participants also expressed facing challenges when strategy-focused daily rituals were disrupted. These disruptions caused agitation, recurrence of more severe memory-related issues, and abrupt mood changes. One caregiver shared that any interruption of PwD's rituals would negatively impact the rest of the day while PwD tried their best to recuperate from the extreme changes in mood. Nevertheless, PwD found immense joy when they were able to continue their daily rituals or when their caregivers could facilitate them. In contrast, PwD expressed sorrow when speaking about activities that were being impacted by dementia, especially due to a lack of strategies to support the transition. For example, one PwD was both sad and frustrated that she couldn't finish a book, since reading had been an activity she had always enjoyed.

In the "wishes and beliefs" portion of the interview, participants were asked what they wished they had to better manage their dementia and if they wished to provide any additional and final insights. Some participants stated having nothing they would change, and that they were happy or satisfied with their present situations. Others gave detailed descriptions of things they would like to change and ways technology could address those wishes. *Table 4* provides a summary of the wishes and beliefs participants expressed about tools, technology, or structural changes that could support their condition. The table separates dyad pairs as each individual may have expressed different wishes and beliefs from their partners.

Participant Wishes and Beliefs/Final Insights

Participant(s)	Wishes/Beliefs	Beliefs/Final Insights
P1C	Technology that can take complex mechanisms in appliances and do those with less steps.	It is very important for PwD to continue their rituals and technology should support caregivers in facilitating those daily rituals.
P2C	Access to technology is difficult due to financial constraints, and there should be government funding available to access technologies	Technology should accommodate caregiver customization and curation.
P3C	No wishes or beliefs.	No final insight/belief.
P6C	Technology that can curate activities that are appropriate for PwD to engage with.	It is difficult for a caregiver to witness PwD lose their engagement with daily rituals.
P8C	Technology that can help with meal planning and organize items into groups, technology that can help provide reminders when tasks are forgotten in activities, technology to manage caregiver activities, and access to resources for activity curation.	No final insight/belief.
P1F	No wishes or beliefs.	While its difficult, one should try to come to terms with their onset earlier so they can start to make accommodations that will help them in

		the future. Technology can be part of those accommodations.
P2F	Store physical books in a compact manner.	Loves to share his love of reading with his grandchildren.
P3F	No wishes or beliefs.	No final insight/belief.
P1D (PwD in dyad pair)	No wishes or beliefs.	No final insight/belief.
P5C (caregiver in dyad pair)	Technology that can magnify text to make reading easier and technology that can translate physical photo albums into storable digital files. Technology can be easy to work with and as intuitive as "flipping" a page.	No final insight/belief.
P2D (PwD in dyad pair)	Technologies in general are difficult to access due to lack of reliable Wi-Fi in rural areas.	Lack of access makes it difficult to feel as though you are a part of a community.
P7C (caregiver in dyad pair)	No wishes or beliefs.	No wishes or beliefs.
P6D (PwD in dyad pair)	No wishes or beliefs.	No wishes or beliefs.
P4C (caregiver in dyad pair)	AT that can help monitor the PwD's progress when the caregiver is not home.	Caregiver burden is difficult to manage as a full-time caregiver.

Table 4. Summary of Participant Wishes and Beliefs.

Though participants; wishes varied according to their situations, they all provided meaningful insights about their needs and values. However, some of these wishes and beliefs/final insights exceeded this study's scope, for example, one participant's wishes for better Wi-Fi access and funding for acquiring technologies. More relevant insights included wishes for technologies programmed with assistive features. For example, the dyad pair P1DP5C wished for a feature which could trigger with the "turn of a page." Additionally, P1C wished for technology with streamlined task flows and minimal steps.

6. Analysis

In this section, results from the survey and interviews will be analyzed for meaningful insights. These findings will serve as the basis for creating a prototype that integrates daily rituals.

6.1 Identifying an Activity of Interest

Within the context of this study, an "activity of interest" (AoI) refers to PwD's frequent and independently performed tasks. First, partcipants' AoI will guide the analysis of interviews. Subsequently, partcipants' AoI will serve as the basis for an assistive technology design prototype. The survey results were cross referenced (as per *Figure 5)* to identify these AoIs. The following six activities were common among all participants: meal preparation, laundry, chores, watching television, reading, and listening to music.

Since 75% (9/12) of PwD indicated that reading was an occasional or frequent activity performed individually, it was identified as a significant AoI. Of the three people who did neither read occasionally nor frequently, two mentioned having stopped reading due to dementia-related impairments. Furthermore, 58% (7/12) of PwD reported using reading during activities such as grocery shopping (reading a list), cooking (following a recipe), engaging in religious rituals, or gardening (keeping a written catalogue of plants in their garden). Additionally, 50% (6/12) of PwD read the newspaper as a daily ritual.

Cross Referencing Likert Ratings and Activities Done Frequently and Independently to Find AoI

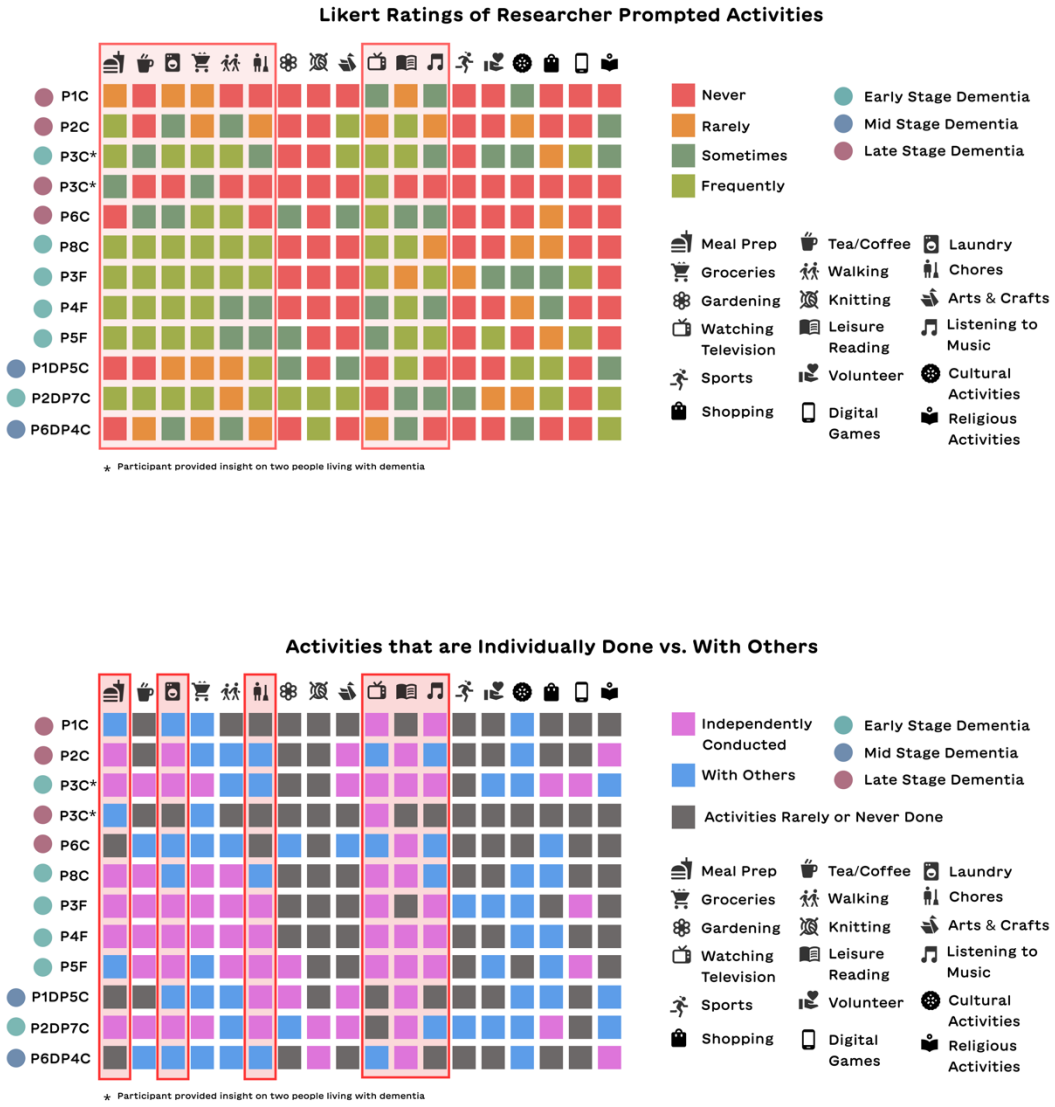

Figure 5. Cross Reference of Frequent or Occasional Activities and Independent/Coactive Activities.

Due to the high prevalence of reading as an activity among this participant group, it was chosen to guide the coding process (see section 6.2). Additionally, reading is the AoI that the prototype designed in this thesis will support with the integration of reading rituals.

6.2 Thematic Analysis of the Interviews

Braun and Clarke's (2012) method of thematic analysis was used to identify themes from the interviews and guide the later stages of this research project. As noted in the previous section, reading was selected as the AoI. *ATLASTi* was used as the software to find codes or patterns within the data, and then to organize these codes into five groups. These coding groups were: (1) cognitive impairments related to reading (2) cognitive impairments related to other activities (3) preferences (4) strategies related to rituals from other activities (5) reading-based rituals and strategies. It was important to consider code groups 2 and 4 which explore cognitive impairments and strategies based on other activities, since these elements could apply to reading. Code group 3 based on preferences was also added to capture some of the insights from the "wishes and beliefs" portion of the interview sessions (see *Table 4*), relevant insights from the "day in the life" worksheet, and the other portions of the interview. *Table 5* presents a summary of the coding groups and the individual codes within each group.

Coding Groups Used in the Thematic Analysis of Interviews

Coding Group	Individuals Codes
Cognitive Impairments Related to Reading	Can't recall previously read content, Difficulty Comprehending the Meaning of Words, Loss of Reminiscence, Hard to Move from Word to Word, and Trouble Focusing Attention
Cognitive Impairments Related to Other Activities	Hyper fixations, Illogical Actions or Thoughts, Impairment in Planning Skills, Lack of Flexibility, Loss of Reminiscence, Trouble Sequencing Steps, Trouble with Organization
Preferences	Ability to Annotate and Write, Access to a Library, Access to Pre-Curated Content, Adapts to the Progression of Dementia, Caregiver Curation, Intuitive, Social Engagement, Supports Independence, Supports Previously Owned Reading Material
Rituals Related to Other Activities	Supplemental activities that Are Related to Supporting Cognition, Affinity for Familiar Items, Chunking into Categories, Direct Prompts, Following Instructions, Labelling, Making a List, Using Objects as Memory Primers, Simplifying Tasks, Structured Tasks, Thinking Out Loud, Using Pre-Curated Content, Visual Completion
Reading Rituals and Strategies Related to Reading	Bookmarking, Books as important objects, Changing Reading Environments, Changing Modes: Text to Image, Colour coding, Changing to Common Language, Receiving Book Recommendations, Going Back to the Same Books, Highlighting Key Phrases, Notetaking, Sequencing through Numbering, Switching to Short Form Content

Table 5 Coding Groups and Individual Codes within Each Category.

Subsequently, a code-document analysis was performed using *AtlasTi.* This analysis highlighted the most frequent codes for each group (individual caregivers individual PwD, and dyad pairs). These codes are reflected in *Figure 6.* Less frequent codes were automatically eliminated by the software. The dyad pair was treated as one analytical unit since it only generated one interview transcript.

	Caregivers Solo 5 180	Dyads 3 63	PwD Solo 3 59	Totals
Ability to Annotate and... 11	1	8	2	11
Access to Library 5	4		1	5
Access to Pre-Curated... 9	2		7	9
Activities that Train the... 8	3		5	8
Adapts to progression... 13	13			13
Affinity for Familiar Dat... 35	27	1	7	35
Caregiver Curation 31	24	7		31
Direct Prompts 30	26	4		30
Division of Labour 19	12	3	4	19
Impairment in Planning... 6	5	1		6
Intuitive 11	6	3	2	11
Loss of Reminiscence 36	18	13	5	36
Notetaking 10	4	3	3	10
Objects as Memory Pri... 7	7			7
Simplifying Tasks 21	21			21
Social Engagement 20	13	6	1	20
Structured Tasks 20	14	4	2	20
Supports Previous Own... 8	4	1	3	8
Trouble Sequencing St... 14	9	2	3	14
Trouble with Organizati... 6	5		1	6
Using Pre-Curated Con... 7	2		5	7
Visual Completion 11	2	6	3	11
Totals	**222**	**62**	**54**	**338**

Figure 6. Code Document Analysis of Document Groups in AtlasTi Illustrating Code Frequencies.

The most significant codes (out of 22, see *Figure 6)* were: affinity for familiar items, caregiver curation, directed prompts, simplifying tasks, social engagement, and structured tasks. From here, a code co-occurrence analysis using *AtlasTi* was performed between all 22 codes.

Grounded coefficients (GR) produced by *AtlasTi* represent the linkage strengths between data points; the higher the number, the stronger the connection (Gaisbauer et al., 2023). *Figure 7* illustrates these linkages along with a graphical representation in a force-direction co-occurrence map. Codes with low GR were grouped with related, higher GR codes. For instance, "access to pre-curated materials" (GR=9) and "using pre-curated content" (GR=7) were grouped with "caregiver curation" (GR=31).

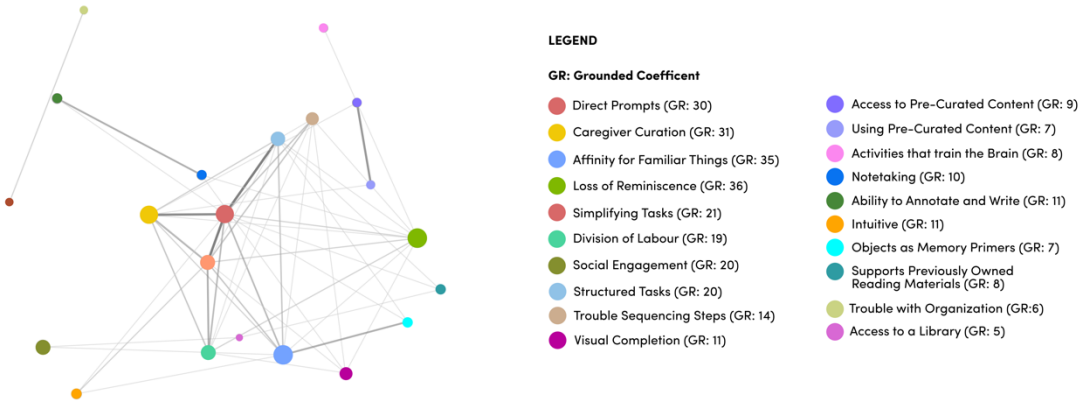

Figure 7. Force-Direction Co-Occurrence Map Generated by AtlasTi with Grounded Coefficients.

The following themes were derived based on the grouping process:

1. **Curation of reading content by caregivers, PwD's social circles, and trusted sources** was identified as an important strategy for adapting to dementia progression. Caregivers often recommended and shared relevant books, activities, and links with PwD. When PwD searched for content themselves, they preferred pre-curated content to manage cognitive overload (e.g., the sense of overwhelm that came from searching the web). PwD also preferred seeking out familiar content that came from trusted sources, such as newspapers that they liked to read or recommendations from friends.
2. **Affinity for familiar content** overlapped with theme 1 ("curation") as PwD once again reported using familiar, trusted sources to acquire reading materials. PwD also expressed a

reluctance to seek out new authors or written content. Most participants preferred the tactile experience of physical books, newspapers, and magazines. They also had active subscriptions with print newspapers, such as *the Globe and Mail, the Atlantic, or MacLean's*. Others had carefully curated bookshelves that they coveted and were, thus, reluctant to adopt technology like eBooks or audiobooks. They also enjoyed doing activities such as doing crosswords, colouring pages, puzzles, or sudoku while performing their newspaper reading rituals. Additionally, some participants reported having done their described activities for years.

3. **Supporting reminiscence through structured prompts and directed tasks** was a key concern for participants since it was the most common cognitive impairment, and PwD often forgot what they had previously read. The most common strategies to support reminiscence were the use of direct prompts, structured and simplified tasks, caregiver facilitation (to make tasks less complex), and categories to organize content (into distinct groups). PwD considered tools or appliances to be "intuitive" when they involved fewer steps to set up.
4. **Annotation and notetaking strategies** reading rituals changed due to dementia and incorporated with strategies such as notetaking, key phrase highlighting, underlining, and colour coding. Notetaking and highlighting strategies were cited most frequently. PwD expressed wanting to annotate texts (by writing their own notes in a printed text). This visual strategy served to mark activity progress and could be transferrable to other reading rituals. For example, visual cues such as bookmarks, notes, underlines, and highlights can help structure reading activities.

These four, integral themes will serve to inform the design criteria and its subsequent mapping into AT features. In the next chapter, the results and analysis will be explored in relation to existing literature on Caregiver Facilitation and Reading for People with Dementia.

7. Discussion

As previously mentioned, this research project strove toward two goals. First, this study aimed to understand community-dwelling PwD's daily rituals during routine activities or tasks. This was done by engaging in interview sessions with PwD and/or their informal caregivers. Secondly, this study conducted interview sessions about daily rituals to design an early-stage prototype.

The interview process revealed that the current definition of rituals as "individualized ways of doing activities" is too simplistic (Clymer, 2006; Knottnerus, 2012). As indicated in these interviews, there are many different types of rituals. For example, PwD can perform individual rituals independently and, sometimes, without the caregiver's knowledge. In contrast, there are also social and familial rituals that the caregiver knows very well and, therefore, can facilitate well. An activity (like reading the newspaper) can also be a ritual. However, rituals can also involve micro-rituals (e.g., using a favourite highlighter colour to highlight key phrases). For the purposes of the design process, the prototype will focus on individual and micro-rituals and aim to facilitate each daily ritual.

One of the key findings of the study is that cognitive impairment drastically impacts daily rituals for PwD. As the cognitive impairment worsens; rituals are either abandoned, require extensive caregiver facilitation, or require PwD to find strategies in order to continue the ritual. Existing literature on facilitation, has noted that caregiver facilitation is impacted by access to educational resources on facilitating activities, poor quality and mistrust of services, and caregiver beliefs and attitudes (Macleod et al., 2017). This was consistent with this study's findings; caregivers also reported feeling burned out while trying to find ways to accommodate daily rituals, since disruption of daily rituals caused agitation, sorrow, and withdrawal for PwD.

In this study, caregivers often described how they managed task complexity to facilitate activities for PwD. When caregivers were aware of rituals, they could simplify tasks to help PwD navigate them. These simplification measures included the division of labour (i.e., taking on some of an activity's more complex tasks so that PwD have smaller tasks with less steps) and the use of directed prompts (guiding each step within a task flow). This finding aligns with previous studies exploring how caregiver prompts (to direct tasks) can be mirrored within the design of prompting technologies (Seelye et al., 2012). However, caregivers were less successful in facilitating activities such as reading and any other AoIs. Participants were unable to state how

rituals were integrated into specific activities, and one caregiver even described individual rituals as “trade secrets.” Since caregiver facilitation with activities like reading are typically difficult, this is one place that technology can intervene.

The four themes found through thematic analysis of the interview sessions describe some of the predominant strategies used by PwD to navigate daily activities like reading. Theme one discusses “caregiver curation of reading content.” Curation is a type of a facilitation in which a caregiver selects materials they know PwD will engage with. While reading is an individual activity, social reading (between PwD and those in their social environment) presents a meaningful opportunity for social connection and engagement through discussions about literature (DeVries et al., 2019). Curation is not specific to reading; caregivers will often curate activities for PwD which lead to better continuity and cognitive functioning. Activities that cannot be successfully curated often result in discontinuation, increased caregiver burden, and negative experiences for PwD (Allison et al., 2022).

Theme two, “affinity for familiar content,” is a strategy used by PwD to continue daily rituals. PwD had an affinity for familiar objects, schedules, authors, and books. One study found that the degree to which readings were understood by PwD depended upon the experiences they had with reading before the onset of dementia (Claridge & Rimkeit, 2018). It is possible that PwD will seek out familiar content because they know they had a positive experience previously or they feel comforted by a sense of familiarity. Previous studies also found that people changed objects to make them fit their new daily rituals (Brereton, 2013; Gibson et al., 2019). However, the participants in this study did not make changes to any objects related to their rituals; instead they had attachments to objects such as books (which they refused to part with) and often kept these items close, even after they stopped partaking in their associated rituals. Since PwD often wish to maintain their previous reading habits (cultivated before the onset of dementia), future technologies will need to support these activities.

Theme three described how modifying tasks (for more structure, direction, and simplicity) could improve reminiscence. Another strategy is the division of labour during activities to provide PwD with simpler tasks within a larger activity. For instance, if PwD had been washing dishes as an activity before, they would only be drying the dishes and handing them to a caregiver to be placed back in the kitchen post-onset of dementia. However, this strategy was not always successful. Many PwD did not welcome caregiver facilitation of their

daily ritual; instead, they preferred the ritual be abandoned over caregiver interference. Furthermore, the onset of dementia greatly changed the dynamic of the family as PwD became dependent on their caregivers (Egdell, 2013). It is important to preserve the autonomy within independent rituals as it can improve PwD's engagement in daily life, increase confidence, and foster empowerment (Phinney et al., 2007). Technologies may be able to facilitate activities when caregiver facilitation is not welcome or difficult to achieve.

Theme four identifies rituals and strategies applicable to reading. Once worsening cognitive impairments made reading more difficult, PwD incorporated new strategies into their reading rituals. These strategies included notetaking, highlighting, underlining, and colour coding to keep track of reading content or to remember reading content better. Since these "study strategies" are common among the general population, PwD could have adapted these habits from their time in school (Wade et al., 1990). Note-taking is a knowledge construction tool which allows the note-taker to organize content in a way they can understand (Castelló & Monereo, 2005). Technologies provide PwD with powerful annotation tools which can facilitate knowledge construction and allow them to more easily decipher existing reading materials.

These four themes demonstrate how strategies became an intrinsic part of daily rituals post-onset. PwD describe them as "hacks" or "shortcuts" that help them continue to do these activities. However, PwD often stumble on these strategies through trial and error. Some are unable to find strategies and instead abandon the activity. This was true for participants who abandoned reading altogether because it was becoming too frustrating. Reading as an activity for people with dementia is said to offer some restorative effects to memory, improve mood, and boost cognitive functioning (Clark et al., 2019; Longden et al., 2016). Other studies focus on the impairments related to reading (Claridge & Rimkeit, 2018; Storandt et al., 1995) for people in early-stages of dementia. However, there has not been much research on reading for people with dementia or specific reading rituals as investigated in this study. Reading is a complex activity that calls for further investigation beyond the scope of this study.

Additionally, existing technologies for reading are not specific to the needs of PwD. These technologies have been largely designed for children with reading disabilities or young children who are learning to read (Gasparini & Culén, 2012; Svensson et al., 2021). The technologies generally fall into three categories. These are digital books or e-books that have text to speech capabilities (Cavanaugh, 2002), optical character recognition devices (OCR) that help

scan handwritten text, images, and other content into a digital interface, and optical magnifiers which are assistive devices that help with low vision by magnifying text content (Bowers et al., 2007). These technologies are not equipped to support reading rituals PwD have with notetaking, highlighting, colour coding, and underlining. They also do not have ways to facilitate social engagement between PwD, caregivers, and people in their social environment. Therefore, they currently do not meet the needs of PwD.

This section has answered the first two sub questions of the thesis. Cognitive impairments drastically impact daily rituals to the point where they are abandoned if there is not sufficient caregiver facilitation to help PwD continue that ritual. However, activities which are done frequently and independently are more difficult for caregivers to facilitate. Additionally, strategies related to continuing doing rituals were identified through the four themes pinpointed in the thematic analysis. The next section seeks to answer the third and final sub question: How can we map these ritual-based strategies into the design of technologies that facilitate daily activities?

7.1 Design Implications

Before design implications can be considered, it is important to make note that caregivers had negative attitudes about technology and felt PwD would not be able to use them. In contrast, PwD reported using smartphones, tablets, and computers in their day-to-day life without many barriers; however, they did report finding the digital environment fatiguing. The majority of PwD participants preferred print books, magazines, and other reading ephemera, especially materials that were familiar to them. Reading was performed with other rituals, such as meal preparation, grocery shopping, and religious activities. Therefore, it was important to find a solution able to suit any available reading material.

Ideation began through sketching using the "10x10 sketch method," which allows the exploration of various concepts using a 10x10 grid (Weprin, 2020). Initial rough sketches were mostly focused on finding a format (see *Figure 8)*. Existing technology, such as OCR in conjunction to audio prompts was considered. Housing technology within objects (i.e., bookmarks or watches) was considered. These ideas were not pursued further since this level of product development reached beyond this project's scope. This study also considered creating a library using virtual reality (VR) – a fully-immersive and interactive digital environment (Latta

& Oberg, 1994). However, this idea was dropped since fully digital environments can be disorientating for PwD; instead it is recommended that semi immersive digital environments like Augmented Reality be used for PwD (Kim et al., 2019).

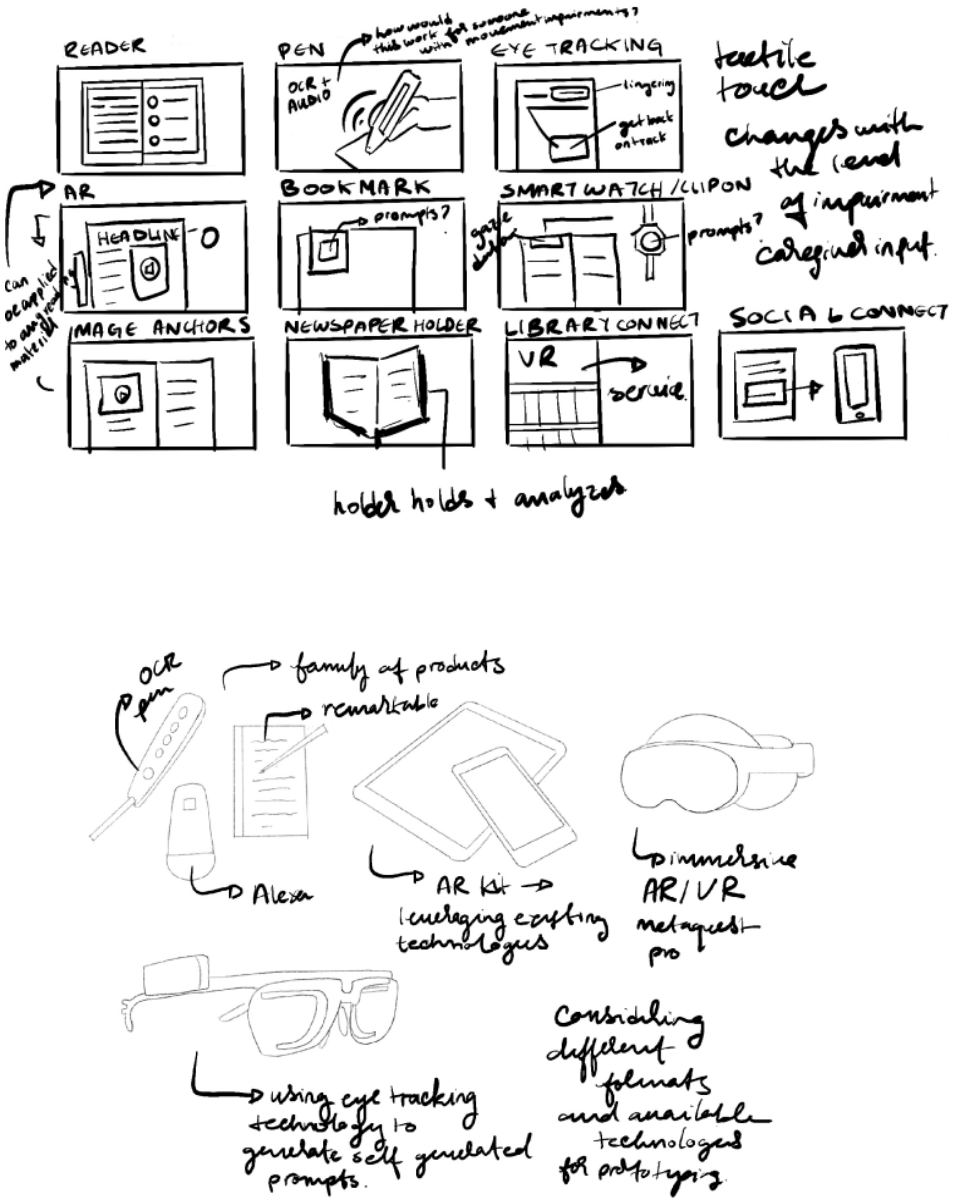

Figure 8. Early Sketches for an AT Integrating Daily Rituals.

Nevertheless, one of the formats explored through preliminary sketches involved augmented reality (AR), which is an emerging interface experience where digital objects both tangible (like 3D models) or intangible (like audio prompts) can be layered onto of a real-time video feed using cameras and eye-tracking technology (Carmigniani & Furht, 2011). AR has

shown promise as being a highly flexible and adaptable emerging technology that can serve as assistive technology for people with dementia (Desai et al., 2018; Ghorbani et al., 2019; Hayhurst, 2018). PwD also deem a technology to be better integrated into their daily life if they are discreet and built into already owned technologies (Robinson et al., 2009). Apple's ARKit framework can be used to create AR apps for the iPad and iPhone, devices PwD might already own (Ingebrand et al., 2022; Joddrell et al., 2016; Oufqir et al., 2020).

8. Prototyping

A design criteria comprises a design project's goals, which must be achieved through feature creation, be specific, and explicit (Perelman et al., 1997). Prototyping for this study began by formulating a design criterion using the themes identified in Section 6.2 for the thematic analysis of interviews. *Table 6* shows this design criteria in relation to the four themes.

Design Criteria Formed from PwD and Caregiver Interviews

Primary Design Requirement	Connection to Theme from Thematic Analysis
The prototype must work with any reading material that the PwD owns, such as books, magazines, newspapers, and comic books.	Related to **Theme Two: Affinity for Familiar Content**
Support caregiver curation and foster social engagement between PwD and people in their social circle.	Related to **Theme One: Curation of Reading Content by Caregivers, PwD's Social Circle, and Trusted Sources**
Must offer annotation tools that help PwD take notes, highlight, bookmark, and colour code reading material.	Related to **Theme Four: Annotation and Notetaking Strategies**
Should have the option to share annotations with PwD's social circle.	Related to **Theme One: Curation of Reading Content by Caregivers, PwD's Social Circle, and Trusted Sources**
Must recap previously read content through with different formats.	Related to **Theme Three: Supporting Reminiscence through Structured Tasks and Directed Prompts**
Prompt the user with simple instructions and design tasks within the interface that have fewer steps and are structured	Related to **Theme Three: Supporting Reminiscence through Structured Tasks and Directed Prompts**
Support activities related to reading that are a part of PwD's daily rituals, such as doing crossword puzzles, doing Sudoku, or colouring.	Related to **Theme Two: Affinity for Familiar Content**

Table 6. Design Criteria Formed from the Themes Identified in the Thematic Analysis of Interviews.

Each design criterion was formulated by looking at each theme, deciphering their main ideas, and by looking at different codes that formed each theme. For example, theme three had a collection of strategies related to supporting reminiscence. These strategies all involved simplifying task complexity, adding structure, and prompting/directing steps. Caregivers' strategies were then mapped into a requirement for prompting users with simple, structured instructions and design tasks within the interface. Criteria also addressed opportunities where technology could intervene if strategies did not exist. Again, one of the trends found in theme three was that PwD did not remember previously read reading material. Since technology could support reminiscence by recapping previously read information in different formats, this assistive feature became a design requirement. By identifying the trends within each theme, seven more primary design requirements added (see *Table 6).*

These design requirements were then used to brainstorm, or mind map, potential features. This method of mindmapping was chosen since, by visually organizing notes around one central theme or idea, mind mapping promotes the generation of new ideas (Zahedi et al., 2016). *Figure 9* is an example of a mind map for the design requirement, "must offer tools that help PwD take notes, highlight, bookmark, and colour code reading materials".

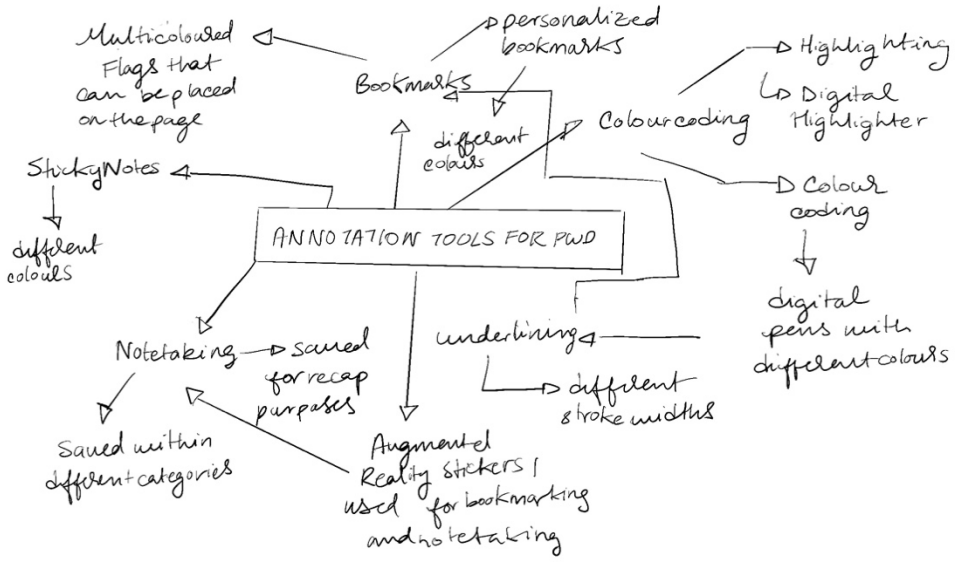

Figure 9. Sample Mind Map Used to Ideate Features related to the AT Design Requirement of Having Annotation Tools.

This mind map explores various ways an AT feature might provide different annotation tools. Some of these digital tools are AR sticky notes, customized bookmarks, highlighters, pens, and AR stickers. These tools are designed to help PwD make notes while reading material such as magazines, books, or comics. This process translates each requirement into features which address its corresponding requirement. *Table 7* shows a summary of the features derived from the design criteria.

Features Related to Each Criterion Based Design Requirement

Primary Design Requirement	Feature(s) that Address the Criterion
The prototype must work with any reading material that the PwD owns, such as books, magazines, newspapers, and comic books.	Layering of augmented reality elements on existing reading materials allows people to use any reading material they own.
Support caregiver curation and foster social engagement between PwD and those in their social circle.	Caregivers can send their recommendations to PwD within the prototype. For example, if a PwD is done reading a similar book, these recommendations are sent as well as recommendations available in their local library.
Must offer annotation tools that help PwD take notes, highlight, bookmark, and colour code reading material.	Digital tools are available within the prototype that allow the PwD to write notes, create bookmarks, highlight with different colours, underline with different pens.
Should have the option to share annotations with PwD's social circle.	PwD and caregiver can annotate a document together and PwD can send the annotations to their caregiver.
Must recap previously read content through with different formats.	Prototype recaps content in different formats that PwD can choose. The different formats are through an audio recap, a video recap, a slideshow of images with an audio description, or a comic book style recap
Prompt the user with simple instructions and design tasks within the interface that have fewer steps and are structured.	Prototype produces a series of prompts that helps PwD find the tools they need to complete their reading rituals.
Support activities related to reading that are a part of PwD's daily rituals, such as doing crossword puzzles or doing Sudoku or doing a colouring page.	Transforms written content on a page into short form content related to the activities people like, such as crossword puzzles or colouring pages. Also helps support activities such a crossword puzzle.

Table 7. Primary Design Requirements Associated to AT Features.

In addition to these primary design features (see *Table 7*), two secondary design features for the prototype were considered. The first one would provide PwD with the option to magnify text, a design wish expressed by participant P5C (see *Table 4).* Larger font-sizes are also perceived better within AR environments, making it easier for PwD to perceive and interact with digital text (Cardenas et al., 2021). The next secondary design requirement would automatically prompt responses by leveraging eye tracking capabilities within the prototype. For example, if a PwD was reading and unsure of a word's meaning, their gaze would fixate on the word. If this happened for a long period of time, the prototype would generate a prompt asking the user if they wanted a definition; this feature is known as gaze-cueing (Pfeiffer et al., 2013). For this prototype, text magnification and gaze cueing were not primary design features since they are not ritual-based. However, these features were secondary requirements since they address other needs PwD may have and could make the prototype easier to use. Though features will evolve over the course of the design process and future user testing, these initial primary and secondary features make a good starting point to start designing a prototype.

User flow diagrams were used to plan the ways in which PwD would interact with the prototype. Also, they could use the different tools housed within the prototype and benefit from the features available. These user flow diagrams enable sequential visual mapping process and

are a tool used by designers to plan all the different interactions a user may need to navigate digital experiences (Hartson & Pyla, 2018). Each design feature (see *Table 7)* was broken down into different user flows. Then, some features were broken down into base elements. For instance, one of the design features aimed to give PwD a set of annotation tools (i.e., for highlighting, notetaking, underlining, and colour coding). Instead of trying to create a task flow for all of these tools together, a task flow for each of these tools was made. *Figure 10* shows a sample user flow for the highlighting tool that PwD can use to highlight key phrases in the text and save them as bookmarks. The prototype experience was created based on the interplay of user inputs; these are shown on the diagram as a diamond shape and triggered actions illustrated as a rounded rectangle. The prototype generates prompts to give the user instructions on how to use the tools within the AR environment. Success sounds were used as prompts to signal task completion to the user, allowing them to transition to another task or go back to reading.

To enable seamless navigation through the task flow, a personality for the prototype was conceived. Previous work on an empathetic digital companion, known as "Shima," shows that when technology acts as a companion, it can evoke an empathetic response from the user, allowing them to "bond" with the technology and improve their overall experience with it (Prendinger & Ishizuka, 2005). Studies on conversational digital interfaces for PwD has demonstrated improved engagement with technologies featuring conversational mechanisms (Stara et al., 2021). The SaTs Lab has also explored how PwD experiences with conversational interfaces compare to instructional interfaces (Mutsuddi et al., 2023). As per the design features, it was important to provide simple instructions as per the design features. It was also worth considering using conversational prompts to increase user engagement with the prototype. For this reason, the prototype was named "Whitty" and would be the prototype's "character" for engaging with PwD users. For example, when PwD use the recap feature, Whitty might ask how a user would prefer to have the information recapped to them and present the options (instead of having options just appear on the screen). This prototype name was chosen based on a play-on words, since "witty" denotes cleverness and connotationally relates to reading activities.

Example of a User Flow Diagram focused on Annotation

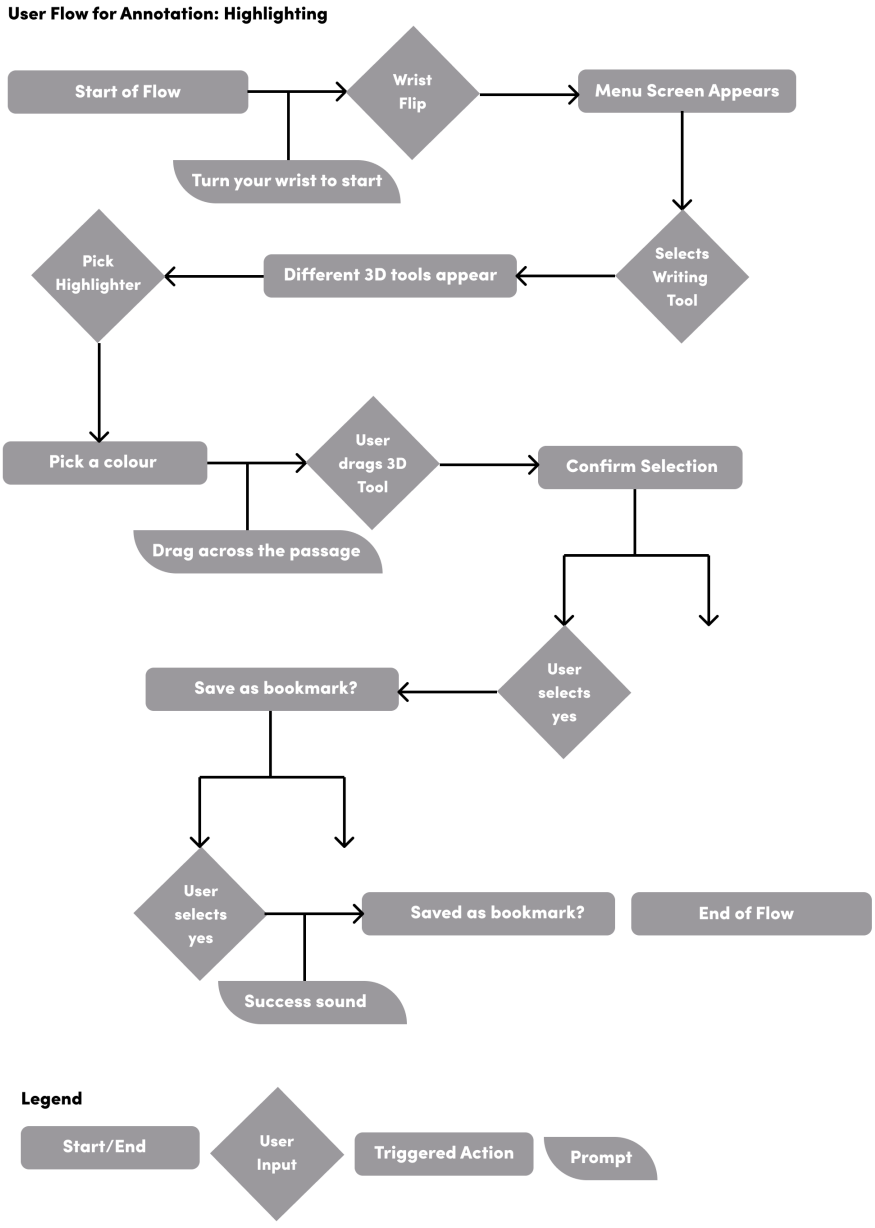

Figure 10. Sample User Flow Diagram Illustrating Potential User Interactions with the Annotation Tool for Highlighting Key Phrases.

Based on the user flow requirements, storyboards were then created to visually conceive how AR elements and experiences would be layered atop existing books and magazines. These storyboards were used to visualize post-interaction scene-to-scene changes within a technology (Nielsen Norman Group, 2018). *Figure 11* shows a sample storyboard for the "recap" feature in

which a PwD user chooses to recap previously read content with a video, then sends that video to a caregiver.

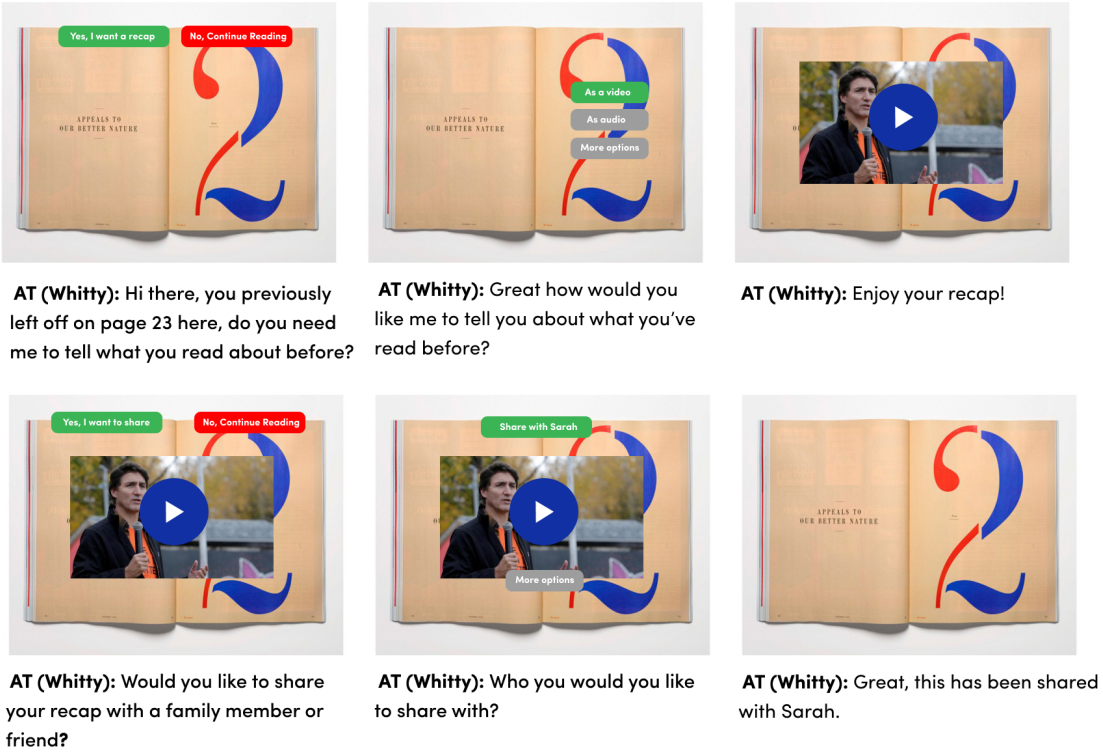

Figure 11. Sample Storyboard showing the recap feature and the audio narration of the AT alongside the visual layout of AR elements.

The storyboard in *Figure 11* shows how the content can be overlayed overtop existing reading materials and transformed based on user inputs. Additional modalities, such as video and audio, can be used to supplement what was previously a text-based experience. The storyboards were essential in planning where the different buttons would sit on the page and what areas of the page could be obscured temporarily (for example, the video blocking the text to show the recap).

Following storyboarding, the first prototype was a concept video exploring the gaze-cueing feature. Here, the PwD's gaze would be tracked using eye-tracking software, and the prototype would track how long the gaze lingered on different words. As shown in *Figure 12,* if the PwD's gaze lingered on a word for too long, the prototype would generate a prompt to ask whether the user wanted to know the word's meaning. Likewise, if the user focused on the name of a location, the prototype would ask whether they wanted to see it on a map. Then, the user could select the "see on a map" prompt to generate the visual of a map.

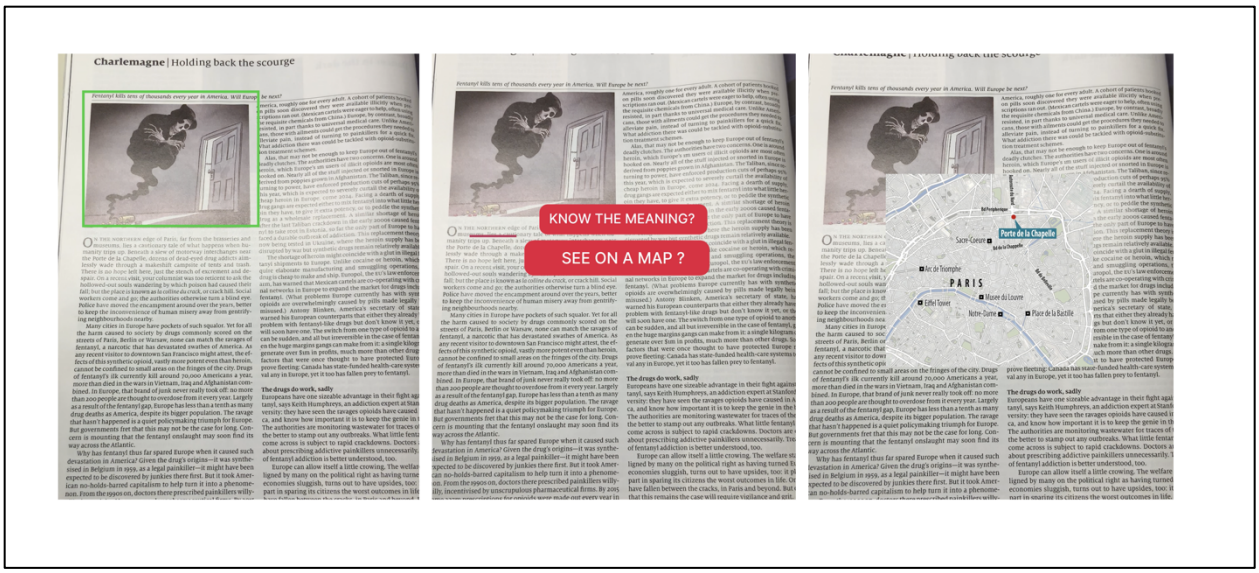

Figure 12. Conceptual Prototype That Explores How Eye Tracking and Gaze-cueing Can Be Used to Generate Prompts within the Prototype.

Feedback from the general community and researchers in the field of aging, gerontology, and vision science was sought out at "The New VISTAs in Vision Research Conference" in December 2023. The feedback suggests that, while this prototype shows promise, eye tracking technology is still in its infancy and is not advanced enough to track gaze towards specific words on a page to trigger prompts from the prototype. Additionally, eye tracking technology is not inclusive; accuracy of eye tracking is affected by different eye colours and head positioning (Hessels et al., 2015). Due to the limitations of eye tracking, gaze-cueing to generate prompts within the prototype was not a feature that could be integrated in the final prototype.

The second prototype was designed in the ARKit platform's "Reality Composer." A sample spread from the magazine *The Economist* was used as the reading material the prototype would support. The content of the spread were movie reviews that were written in text-heavy paragraphs. A scanned image of the magazine page was used as an Image Anchor. In order for an AR experience to trigger, the objects need to find a real world "anchor point;" an "image anchor" is any visual that can serve as this "anchor point" (Di et al., 2021). Then, the prototype would respond anytime the user flips to the page making it as intuitive as "flipping open a book."

The dense paragraphs of text can then be transformed into images (movie posters that represent each review). An audio prompt from the prototype tells the user to tap on any of the posters on the touch screen to see more. When a poster is selected, it opens a menu while the written review is narrated to the user. Key figures mentioned in the review are shown along with

the movie poster with the option to save the movie in a virtual movie journal. If the user does not know who the key figure is, they can tap on the portrait to learn more. This prototype experience is shown In *Figure 13.* Assets such as buttons and menu screens were designed in Figma while the images are sourced from the International Movie Database (IMDb). The behaviors, interactions, and scene changes were all accomplished and designed using the mechanisms within Reality Composer and Reality Kit.

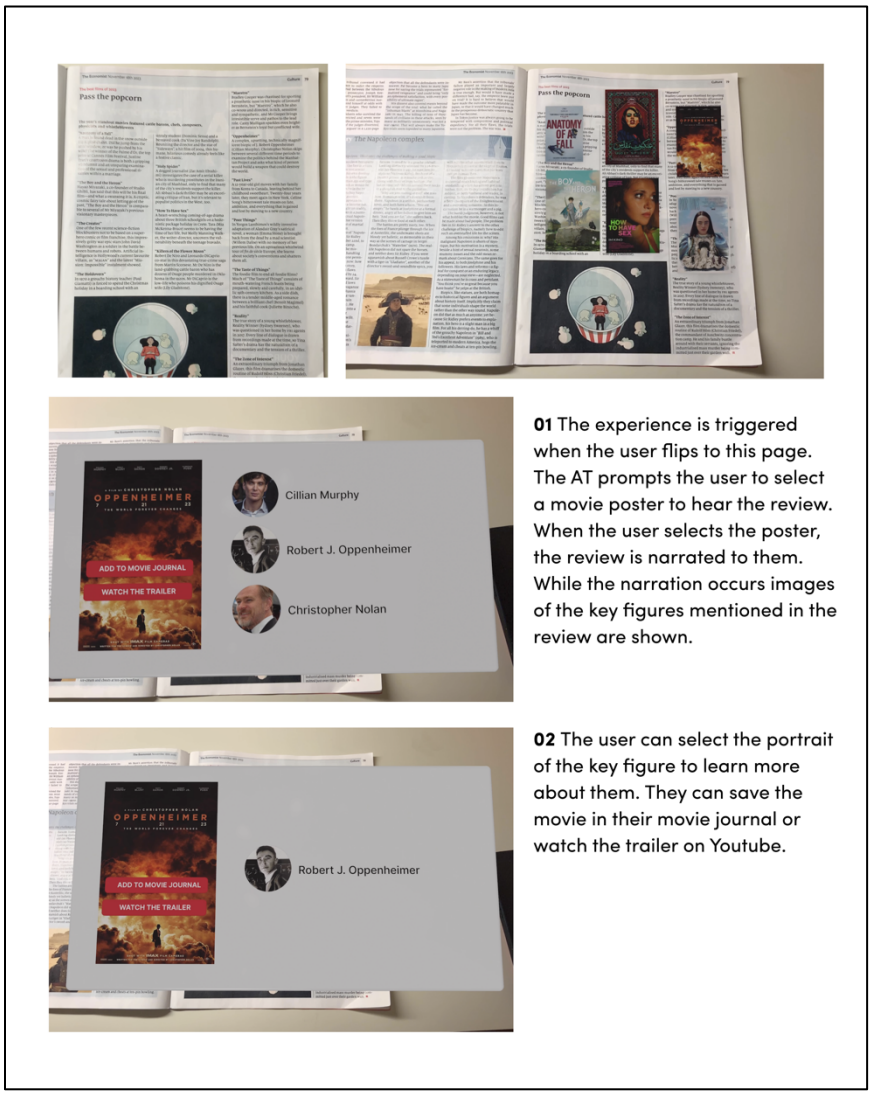

Figure 13. Prototype #2 Which Transforms Content on a Text-Heavy Page into Short-form Content with Images and Minimal Text.

In December 2023, this prototype was demonstrated at "The New VISTAs in Vision Research Conference," an event held for the public, technology developers, and researchers in the field of vision science. The feedback from the session suggests that the prototype could reduce cognitive load by changing longform content like large paragraphs of text into images and

reduces reader fatigue. Cognitive load theory refers to the mental effort needed to navigate or scan new materials in order to pick up key details (Plass et al., 2010). Cognitive load can be mitigated using images because there are less elements on the page the user has to focus on (Nielsen Norman Group, 2013). It was also noted that the menu obscured too much of the screen real estate. There were also some usability issues with the prototype. The prototype would not respond in low light conditions. It was also difficult to hold the tablet in one hand and the magazine page in the other. The potential to explore wearable prototype in the future is possible, since the ARKit platform can be used to create experiences for VisionOS, Apple's new headset solution. However, it was not feasible to develop this solution within the scope of this study.

The final prototype was created in the ARKit platform for the Apple iPad. To demonstrate every feature, four spreads from *Maclean's* magazine were chosen along with three pages from the Ontario version of the newspaper *Globe and Mail.* One of these pages included a crossword and book reviews which PwD use to find books as a trusted and familiar source. Scanning these spreads in high definition at 600 pixels per inch resolved the usability issue of the experience not responding in low light conditions, and the prototype responded in many different lighting conditions. Assets for the prototype were made in Figma (buttons), Adobe Photoshop (puzzle items), Procreate (colouring page), Nomad Sculpt (3D models), and Voice Booking (voice prompts). The success sound effects to indicate the completion of a task flow were sourced from the open-source site Pixabay. All the interactions were designed in the ARKit platform's "Reality Composer." *Figure 14* shows the final prototype and some of its features in use on a magazine page.

The size of the user interface elements, such as the buttons, were sized down according to feedback and anchored to the side of the page (with the option for the user to close the larger menu if they find it obtrusive). The magnify button (to make text bigger) is anchored to the top of the page. As a result, the option to magnify text will remain on the page even when the other menu is closed. All the features of the final prototype are summarized in *Table 8.*

Figure 14. The final prototype designed using the ARKit Platform for the iPad Pro used in conjunction with a magazine page.

Design Requirement	Feature(s) that address the criteria in the final prototype
The prototype must work with any reading material that the PwD owns such as books, magazines, newspapers, and comic books.	ARKit (Reality Kit and Reality Composer) was used to layer AR elements on top of existing reading materials.
Support caregiver curation and foster social engagement between PwD and those in their social circle.	PwD have the ability to share annotations, receive recommendations, and send recommendations to their caregiver. Recommended reading materials if they are available at the local library are tagged as such.
Must offer annotation tools that help PwD take notes, highlight, bookmark, and colour code reading material.	PwD can bookmark items with custom bookmarks, highlight, circle and underline key phrases in the text. They can also choose different colours for their annotations.
Should have the option to share annotations with PwD's social circle.	PwD can share their annotations with caregivers, and they can mutually annotate together.
Must recap previously read content through with different formats.	Recaps are offered as video, audio, as a slideshow, and through an interactive comic book type experience
Prompt the user with simple instructions and design tasks within the interface that have fewer steps and are structured.	Whitty an AR reading companion leads PwD through the prototype experience through voice prompts. It also provides reminders to PwD to help them focus on reading.
Support activities related to reading that are a part of PwD's daily rituals such as doing crossword puzzles or doing Sudoku or doing a colouring page.	Written content can be transformed into a crossword, a jigsaw puzzle, or a colouring page. The prototype can also support PwD doing the crossword or filling out a Sudoku.
PwD must have the ability to make text larger to make it easier to read.	The Make Text Bigger button can be used to magnify the text on the page to make it easier to read.

Table 8. A summary of all the features that were integrated into the design of the final prototype with the design criteria.

The final prototype uses augmented reality to create a technology that could work with any reading material PwD own. Because this is an early-stage prototype, the software needs to be told what to anchor onto using image anchors. Since most books and magazines are designed with common page conventions (Samara, 2023), the design could be transferrable to other materials. The designed technology also gives PwD ways to continue rituals related to reading, such as annotating (highlighting, underlining, and colour coding), doing crosswords, and doing puzzles. It fosters social engagement between PwD and those in their social circle by giving PwD the ability to share annotations, give recommendations, and receive recommendations. The prototype supports reminiscence by recapping previously read reading content in different formats, providing various ways to take notes, and providing reminders to PwD to stay on track while they are just reading. These features are derived from the insights given by PwD and their caregivers which were then used to create the design criteria which served as a guide in the design process. This shows how some of the strategies used by PwD were mapped into technology design.

9 Limitations and Future Implications

9.1 Limitations

While this study does take the approach of HCD (see *Figure 1),* it is not a true HCD process the formation of the research question for instance should arise from the discovery and synthesis phases. Instead, this study adapted the HCD model to form the design criteria through the synthesis of results. Additionally, during the prototype stage, PwD and informal caregivers should be included so they can provide feedback on the prototype in early stages. Though, this study could only receive informal feedback on the early-stage prototype at the VISTA conference (2023) based on time constraints. However, future work will focus on evaluating the prototype and prototyping phase may occur again as it is an iterative process which is cyclical rather than linear.

The activities survey used to prompt PwD and caregivers about their daily activities (*Figure 2)* is limited because the activities are represented as static entities. Participants noted that many activities changed frequencies due to impairments in dementia or life changes, such as immigration. Therefore, it did not help participants express the dynamism of the activities.

The method of forming themes through co-occurrence analysis has some limitations. For instance, in the initial code-document analysis, any code that occurred less frequently among the document groups was removed. These less frequent codes may have important strategies that were removed. Due to the fact that there were more caregiver participants in the participant group, there were more codes in the data from caregiver's perspectives rather than PwD's.

PwD were also reticent to share specific impairments related to reading so the study may not have captured all the possible impairments that make the ritual of reading difficult. The PwD participants were all well versed with technology as well, so this study is not representative of PwD who are not comfortable with technology.

9.2 Future Implications

The prototype now needs to be tested with PwD and caregivers that participated in the interview sessions to get feedback on the features that were chosen to represent their rituals within the technology design. This will lead to another phase of refinement and iterating, as well as any insights that might drive new avenues of research.

Additionally, the field of interaction design, specifically augmented reality, is still emerging and developing. There are many technological advances that can be integrated in

design with a multidisciplinary focus. For example, advances in eye tracking technology from the field of vision science can make it possible to generate self-cues and prompts (Sibert et al., 2000). Artificial intelligent systems can be used to generate new prompts (Hoey et al., 2011), to create image assets to transform text-based content (Boden, 1998), and make it possible to make technological companions that are more flexible to changing conditions for PwD (Spitale & Garzotto, 2020).

The study should also be done with a diverse group of participants, since rituals are not just lost to dementia but to major life changes like immigration. Technologies that support cultural rituals or religious rituals would be important to make sure engagement with those types of rituals is preserved. It would also be interesting to do the study with PwD who are not as conversant with technologies or have poor access to technologies due to where they are located.

Further study around the activity of reading is needed. An observational study would help clarify gaps in understanding about what PwD do while they are reading. Another potential study could also look at how reading intersects with other activities such as playing the piano/singing, cooking, grocery shopping, and religious activities. The social aspects of reading, such as sharing recommendations, discussing books, and using the discussion to foster social connection with other people (Longden et al., 2016), need to be better understood as the need to foster meaningful social connections is an important concern for PwD and their caregivers (DeVries et al., 2019).

This study involved PwD and their caregivers to understand how dementia-related cognitive impairments impact daily rituals and the strategies they use to navigate these daily rituals. These insights enabled the creation of design criteria which inspired the prototype design features presented in this thesis. This work aims to fill the need for dementia-specific technology to facilitate reading rituals, since no current tools exist. In addition, research around integrating rituals into the technology design is part of an emerging field, and very few technologies which consider daily rituals are presently available. Integrating daily rituals into technology design can lead to the creation of new technologies, able to better facilitate everyday activities (Czarnuch et al., 2016; Wood et al., 2023) and be more easily adopted by users (Boyle et al., 2022; Robillard et al., 2018). Support from technologies can offer a way to help community-dwelling PwD stay in their homes with their families longer; this is hugely important since having the opportunity to age in these familiar places improves PwD's overall quality of life.

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Appendices

Appendix A: Activities Survey Worksheet

Activity Survey for Persons Living with Dementia

For each activity listed please mark with a checkmark how often you are doing this activity (1- Never to 5- Daily) and the people involved with these activities. At the end of this chart there are blank spaces provided for you to fill in other activities.

Everyday Activities	1 Never	2 Rarely	3 Sometimes	4 Frequently	People Involved
Preparing Meals					
Making Tea/Coffee					
Doing Laundry					
Grocery Shopping					
Going for a walk or run					
Doing chores around the house					
Gardening					
Knitting/ Crocheting					
Doing a craft					
Watching TV or movies					
Reading					
Listening to music					

Everyday Activities	1 Never	2 Rarely	3 Sometimes	4 Frequently	People Involved
Volunteer					
Participate in Organized sports					
Engaging in cultural activities					
Shopping					
Playing games on digital devices					
Religious or Spiritual activities					
Listening to the radio					
Reviewing photography					

Appendix B: Day-in-the Life Worksheet

A Day In the Life

For this activity, you will be prompted by the interviewer to describe a day in your life. Write down the activity and the objects and/or technologies you use for different activities. Describe out loud how you do that activity and you will be prompted to answer some questions.