

# Crafting a Journey into the past with a Tangible Timeline Game: *Net Als Toen* as a Tool to Enhance Reminiscence in Elderly with Alzheimer's Disease

Renske Mulder<sup>1</sup>, Puck Kemper<sup>1</sup>, Hannah Ottenschot<sup>1</sup> and Anis Hasliza Abu Hashim<sup>1,2</sup> 

<sup>1</sup>Faculty of EEMCS, University of Twente, Drienerlolaan 5, Enschede, The Netherlands

<sup>2</sup>Research Group Human Media Interaction, University of Twente, The Netherlands

**Keywords:** Alzheimer's Disease, Reminiscence Therapy, Interactive Games.

**Abstract:** Alzheimer's Disease (AD) poses significant challenges for individuals and their caregivers due to its impact on memory, behavior, and cognitive abilities. With the projected increase in AD cases in the coming years, innovative technologies are needed to address the growing demand for elderly care and support for people with AD. Reminiscence therapy (RT) can have positive effects on the rate at which AD symptoms worsen. This paper presents an interactive game based on RT called *Net Als Toen*, which serves as a conversation starter. The ideation phase, lo-fi prototype development, and hi-fi prototype testing are discussed. Results from playtests show that the embedded reminiscence theory in *Net Als Toen* can help people with AD in talking about their memories. Additionally, results suggest that personalization options and improved user interface elements are important in making the application successful. Overall, this paper contributes to developing a social game based on RT, focusing on interpersonal reminiscence therapy, to foster interactive conversations and enhance the well-being of individuals with AD.


## 1 INTRODUCTION

Alzheimer's Disease (AD), a form of dementia, can have a significant impact on someone's life. It can cause problems with memory and behavior, and cognitive impairment. These symptoms can create challenges in caring for people who suffer from AD. More and more people are expected to suffer from AD in the upcoming years, with about 152 million people in 2050, compared to 58 million cases in 2019 (Nichols et al., 2022). In the earlier stages of AD, memory will often be affected most, making daily life more difficult. In the later stages of the disease, this impact can grow, which could also influence speech and movement. These symptoms often lead to anxiety, irritability, confusion, and frustration, which in turn can greatly impact someone's social life, isolating them from others and increasing feelings of loneliness (Balouch et al., 2019).

There is no cure yet to battle AD and its symptoms. However, the progression of AD can be slowed down (Wimo et al., 2015; Anand and Singh, 2013; Kaduszkiewicz et al., 2005) and some treatments are

already available. There are medicine-focused approaches and non-pharmacological methods available that include but are not limited to psycho-social therapies like art (Beard, 2011), music (McDermott et al., 2012; Wall and Duffy, 2010), and movement therapy (Karkou and Meekums, 2017), cognitive stimulation therapy (Carrion et al., 2018) like memory training (Woods et al., 2006) or 'Snoezelen' (Verkaik et al., 2005), and reminiscence therapy (Gräsel et al., 2003; Vernooij-Dassen et al., 2010). These forms of therapy are in most cases proven to improve quality of life (Woods et al., 2006) and mood (McDermott et al., 2012; Wall and Duffy, 2010), reduce aggression and levels of agitation, and alleviate feelings of loneliness (Filan and Llewellyn-Jones, 2006; Wall and Duffy, 2010) and depression (Verkaik et al., 2005; Vernooij-Dassen et al., 2010) in elderly with dementia.

This study highlights the application of reminiscence therapy (RT) theory in an interactive game. It is a non-pharmacological approach to slow down the progress of AD, or "a structured process of systematically reflecting on one's life". The main idea behind RT is to help the person with AD to remem-

 <https://orcid.org/0000-0002-3204-5719>

ber parts of their life, for example through stimulating conversation. This can reduce depression, help with calming behavior, and is used to treat psychological symptoms of AD (Lazar et al., 2014). RT can be very effective since it targets the remote memory of therapy participants (Cotelli et al., 2012). This means that participant would remember things from their earlier life but it is harder to remember events from the past years. This of course does vary per person and even per day (Cotelli et al., 2012).

To cope with this increasing request for elderly care and care for people with AD, new and innovative technologies are necessary. Combining technology and RT could help support people with AD to enhance their memory and aid them in social communication. For this study, we have developed a prototype of an interactive tangible game called *Net Als Toen* that could assist people with AD and their relatives to improve their well-being.

## 2 BACKGROUND

### 2.1 Memory and Alzheimer's Disease

The effect of AD on memory mainly impacts explicit memory instead of implicit memory (Son et al., 2002). Explicit memory is the conscious remembering of past events, such as what you ate for breakfast yesterday. Implicit memory on the other hand is remembering past events or manners without intent. An example could be that someone might unconsciously remember how to use an old phone with a turning dial (Treadaway et al., 2019).

Another difference in effect on memory is the difference between short-term and long-term (remote) memory. The short-term memory of someone with AD can be heavily impacted. From someone not knowing where they put their keys, to not recognizing their family members. The symptoms can vary per person and the order and severity of the symptoms are different for everyone (MacDuffie et al., 2012).

### 2.2 Reminiscence Therapy

Reminiscence therapy can take many forms (Cotelli et al., 2012) and can be greatly influenced by the psychologist, researcher, or patient. Methods can be personalized, like a life story book where personal photographs or artifacts can be used (Lazar et al., 2014). There are also more general methods, where the topics are less personal. RT can be divided into two categories: intrapersonal and interpersonal. Intrapersonal is a form of individual and cognitive therapy, whereas

interpersonal is done in groups and takes more of a conversational form (Parsons, 1986). Researchers also see great opportunities for using multi-media solutions to spark conversations with other people. In conclusion, reminiscence therapy can be versatile and can take many different forms (Subramaniam and Woods, 2012). Since a social game based on RT is developed in this project, the focus lies on interpersonal reminiscence therapy. This means it is important for the players of the game to start reminiscing together, to talk about past life events, and to engage in an interactive conversation about these memories.

### 2.3 Reminiscence and Interactive Games

Reminiscence therapy has been integrated into interactive games in quite some instances already. Previous work, described in this section, on developing interactive games for people with AD has shown that personalization and familiarity are great tools to use during reminiscence therapy.

Nazareth et al. have created a board game, "Babbeldord", to stimulate narrative reminiscence. Babbeldord has used an interactive and personalized way to reach this goal. The game is a board game based on "Game of the Goose", which is a generally well-known game to Dutch elderly people. The game asks questions from a book called "Dierbare herinneringen" on topics like childhood and friendship (Nazareth et al., 2019). Reactions to the game have been positive overall. It is suggested for future research to refrain from including sensitive topics so uncomfortable interactions can be avoided and to formulate questions clearly and in an easy-to-understand way.

In another study, six different designs for toys were used for patients with AD. The toys were highly personalized and adapted to the user. The designers co-created the products with the families and caregivers of the patients. Within the design, they used events and artifacts from the participants' lives as a form of reminiscence therapy. Examples are a personalized music system and a fidget ring with seashells for someone who likes going to the beach. Most products had a great result, especially with one patient who started talking again after a long time of not communicating verbally (Treadaway et al., 2019).

Another example of reminiscence therapy is a study using food stamps in a game for people with AD. This game was focused on the use of food stamps and buying food with them. The researchers have found that this game helped the participants with memory and calculation (Chang et al., 2013).

Personalized photos can also be a great tool to use in reminiscence therapy. One study has used a library of old photos to spark a conversation between an older person with AD and a younger person, often a caregiver or visitor. This has helped initiate a conversation and therefore start reminiscing (Jiang et al., 2021).

King et al. exposed AD patients to personalized music and did a small training program. The researchers found that the favored music contributed to overall less anxiety, agitation, and behavioral issues (King et al., 2018).

## 2.4 Design Guidelines for People with AD

The main problems for designing for older people or Alzheimer's patients are memory, cognitive, visual, hearing, and mobility impairments; attention, concentration, personality changes; declining language and speech abilities, decent/no computer and literacy skills (Ghorbel et al., 2017).

A lot of studies have been done on how to design for people with AD. There is an abundance of papers about designing for dementia or Alzheimer's patients, all with their categorization of the problems and the proposed solutions/guidelines (Treadaway et al., 2019; Astell et al., 2018; Ghorbel et al., 2017; Satoshi Kawamoto et al., 2014; Carvalho and Ishitani, 2012; Sunwoo et al., 2010; Orpwood et al., 2005). There is a lot of overlap in the general rules and the reasoning behind those rules, so for this proposal the rules are generalized and put into the most common categories: cognitive, physical, and social. The guidelines are based on user experience, user interface, and system design for dementia or Alzheimer's patients.

In a 2018 paper, Astell et al. discuss the main difficulties people with AD can have (Astell et al., 2018). They have proposed fitting guidelines when designing to accommodate these problems. These guidelines present a well-substantiated list of rules to follow when designing for people with AD. This list, as seen in Table 1, presents the used guidelines.

## 3 METHODOLOGY

This section explains the design phases of the study. It consists of three phases: ideation, lo-fi prototyping, and hi-fi prototyping. During the ideation, brainstorming was done to develop the initial idea for the game. Further interviews led to specifying the concept idea. Later, a lo-fi prototype was designed to test the user experience, which included investigating the

Table 1: This table shows the guidelines from (Astell et al., 2018) on the left side and the method of implementation on the right side.

Guidelines	Implementation
Choose a goal or task that is clear, engaging and achievable	Focus on one goal (completing the timeline), there should always be a solution
Ensure that instructions are appropriate and understandable	Limited amount of text on an instruction slide, use simple rules
Ensure that prompts are effective and enabling	Focus on what the players can do instead of what they cannot do
Avoid timed responses and complex interactions	No time limits or timed interactions
Reduce or eliminate the possibility of failure	There is no way to fail at the game
Account for inaccurate or imprecise motor control	Use big pieces that do not require too precise movements
Create interfaces and interactions that are intuitive and realistic	Big buttons that clearly state what they do
Include visual and auditory accommodations	Use of a screen and an audio playback option
Tailor the activity to the person's interests	Possibility of a personalized version of the game
Design for an audience (group activity)	The game can be played with multiple people

appearance, interaction, and gameplay. The results from the lo-fi design round led to new design guidelines, in addition to the existing guidelines in Table 1, applied to the hi-fi prototype. During the hi-fi prototype test round, the technology and again the user experience were evaluated.

Because this study designs a game for people with AD, it is important to include the target group and stakeholders in every design phase as much as possible. By using a user-centered approach, you can continuously shape your project based on real user interactions and needs (Augusto Wrede et al., 2018). It makes sure the project remains closely aligned with the preferences of the target users.

### 3.1 Design Phases

This section explains the processes involved in this study.

#### 3.1.1 Ideation

The ideation phase was supported by the extensive literature review that was carried out beforehand. From the literature review, a set of guidelines was developed and followed with the brainstorming session. During the brainstorming session, the researchers sat together and used the Aoki method to come up with

ideas (Higgins, 1994). From these ideas, the concept was chosen. In this concept, players are presented with a physical board, event pieces, an info slot, and a screen. The players can use the screen to view and explore information about the events by putting a piece in the info slot. On the board, the players can move the event pieces from their starting position on the bottom to the timeline on the top side of the board. The board has some LEDs incorporated to indicate if the piece has been put in the right place. As soon as an event piece has been put in the right place, the screen displays conversation starter questions for the players to talk about. To illustrate the idea, a storyboard was created as in Figure 1.

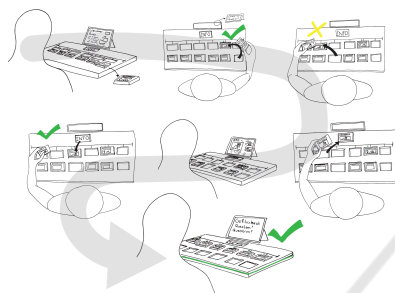


Figure 1: This storyboard shows seven steps of an example interaction with the game. 1) Take out a puzzle piece. 2) Place it on the timeline, the location is correct. 3) Place another piece on the timeline, the place is almost correct. 4) Place the piece in the info slot. 5) Receive information about this puzzle piece. 6) Place the piece on another spot in the timeline, this time the placement is correct. 7) Continue until the timeline is filled out completely.

To emphasize as much as possible with the target group, interviews were conducted. Due to ethical considerations, people with AD were not included in the interviews. Instead, 5 interviews took place which consisted of one expert and four caregivers. The expert interview questions were focused on getting tips on working with and designing for people with AD, reminiscence therapy, other forms of therapy, and the concept of the game. This expert is a senior lecturer at a university in Malaysia and specializes in psychology, aging and dementia studies, and mental health studies. The caregiver interviews gave insight into how to take care of someone with AD. Topics of the interviews included observations of and interactions with the person with AD, familiarity with technology, experience with therapy, and the concept of the game.

From the interviews, the participants agreed that the concept would be interesting to investigate and expected the game to be an effective and fun conversation starter. The following insights were gathered from the interviews.

- The game should be intuitive to play. Instructions should not be difficult to understand. It needs to be investigated whether having explanations for specific game elements would be beneficial.
- Personalization should be done via loved ones of the person with AD, not via nurses. The acquisition of personalized material should be looked into more clearly.
- The personal events can also include events that happened during the life of people who are close to the person with AD.
- The possibility of skipping conversation starter questions and/or receiving more questions should be investigated.
- It should be possible to quit the game at any point.

### 3.1.2 Lo-Fi Prototype

A lo-fi prototype was designed based on the ideas from the ideation phase and the interview results. From the interviews, it was concluded that the general idea for the appearance, interaction with the game, and ideas for gameplay are worth investigating.

The lo-fi prototype consisted of a physical prototype of the timeline board, without any technology in it yet, accompanied by a touchscreen with a working User Interface (UI). Figure 2 depicts the outline for the main slide that users were shown after putting an event on the info slot. Users were able to travel to several information slides from the main one. Figure 3 shows one of the three possible feedback slides ('correct', with the other possibilities being 'incorrect' and 'almost correct'). The example used in the figures shows one of the general events used in the game.



Figure 2: Main slide with information and buttons.



Figure 3: 'Correct' feedback slide.

For testing, the technology was mimicked by other means. For example, the LED lights were indicated with small pieces of paper in the color of the LED, and the screen and sound were controlled with a Wizard-of-Oz method instead of the prototype being automated. Figure 4 shows the lo-fi testing setup.



Figure 4: Lo-fi testing setup.

The user testing took place at the homes of the participants. These participants were not part of the target group for this research, but rather a proxy group. The participants were family members of the researchers who were all older than 50 years old. The user testing process consisted of two phases. The first phase consisted of four short scenarios which were done with the participants individually: reading the instructions, starting the game, evaluating the LED colors, and evaluating the sounds of the game. Additionally, the participants were asked what they think the goal of the game is. For the second phase, the participants were placed in pairs and they played the game without instructions from the researchers. The researchers observed the playtest. Once the participants completed the game, the researcher interviewed the participants to evaluate the playtest. The main goal of the lo-fi tests was to find out if the UI of the game is intuitive to use, if the instructions are clear if the sounds and LED colors are used logically, and if the game can effectively be used as a conversation starter.

The first phase was tested 6 times, which took approximately 15 minutes per participant. The second phase was tested 4 times, which approximately took 45 minutes per test session. Two lo-fi tests were held with 2 participants playing the game together, while the other 2 were held with only 1 participant playing. In these cases, the participant was asked to talk to the researcher during the game.

Findings from the lo-fi tests were used to improve the game. Below are some of the main findings that were gathered during the user test:

- The UI and corresponding LEDs should be improved for various reasons. Many participants

showed difficulties with finding, understanding, and paying attention to the instructions. Additionally, some participants showed difficulty understanding the LEDs.

- The game should include one or multiple personalization options. Many participants indicated that personal events would serve a more effective purpose as conversational starters than a limited amount of general events.
- The sounds do not have to be fine-tuned. When played in combination with showing the LED color, participants clearly understood the meaning of the sounds. More effort should be put into other aspects of the game due to time limitations.

### 3.1.3 Hi-Fi Prototype

The goal for the hi-fi prototype was to have a fully autonomous prototype, which would allow the researchers to test all functionalities of the concept. The results from the ideation phase and the lo-fi testing led to the final prototype design of the concept.

The few changes made entail the info slot being higher and a bit slanted towards the user. The reason behind these changes was that this design would better capture the user's attention towards the info slot. In addition to that, the board's reduced depth was intended to facilitate easier access to the top row of the slots. Lastly, the board was made to be a bit higher, to house all the technology in it. Figure 5 shows an improved version of one of the instruction slides.



Figure 5: One of the instruction slides.

Personalization is one of the elements that was highly suggested during the lo-fi session. However, due to time constraints, it was quite challenging to obtain the materials. Fortunately, it was possible to create a personalized version of the game with the help of family members. For the hi-fi test, two types of personalization were developed. The first one involved incorporating the user's actual personal events, while the other version allowed the caregiver to select from a variety of general events. For this session, the researchers recruited two types of user groups. The first group comprised proxy users, aged 50 and

above, who happened to be the family members of the researchers. The second group was the actual target group, consisting of one person with AD and their caregiver. Regarding personal events, the researchers gathered personal information and events from the proxy users. Only one game was available as it was created specifically for them. In contrast, the other version of the game contained 12 general events, and the caregiver was asked to select 6 events out of the given options.

The goal of these tests was to find out if the game could be a tool to initiate conversation between people with AD and their caregivers, if the users enjoy playing the game and to assess the game's performance, both in terms of technical aspects and user interaction.

This session consisted of a playtest and followed by an interview. During the session, two participants were present: a person with AD or a proxy user, and someone close to this person. Due to technical issues, the tests were conducted using the Wizard-of-Oz method, instead of a fully autonomous prototype.

For both the tests with target users as well as proxy users, the participants played the game together while being observed by researchers. After the playtest was over, both participants joined the interview to answer questions about their experience. The caregivers were contacted to get permission to include the person with AD in the interview. They were also asked to discuss the game's content and identify any topics that should be excluded from both the game and the interview. The Results section includes results from the hi-fi tests. An impression of the hi-fi playtest setup is seen in Figure 6.

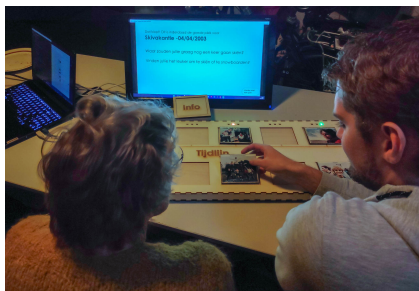


Figure 6: Hi-Fi testing setup.

### 3.2 Ethics

During all stages of this research, informed consent was gathered from the participants. For experts and proxy users, simple consent for participation and recording of data was acquired. When dealing with people within the target group, people with AD, the consent was also discussed with the caregiver. In all

cases, the person with early-stage AD was able to give consent.

Transparency has been a crucially important topic regarding ethics. All participants were aware of the exact test layout and what was expected of them. They were told they would be playing a game together, focusing on creating a timeline of events. The participants were told the prototype was not functioning on its own, so a person puppeteering the game was sat next to the setup. At the beginning of the test, it was explained to the participants that they could ask questions to the observers only if they were unable to progress using the instructions provided or if anything besides the game was unclear. Next to that, it was made clear that the researchers would take place at some distance to observe and take notes.

After the Hi-Fi test, the participants could ask any last questions or give any comments. They were also reminded of their right to withdraw from the study at any time and were thanked for their participation.

The ethical application was approved by the ethical committee of EEMCS at the University of Twente.

## 4 RESULTS & DISCUSSION

This section describes the results of the playtests, divided into subsections according to the topics of the interviews that were held after the playtests.

### 4.1 Results

In total, four playtests were carried out with participant pairs. Two pairs consisted of one person from the target group and one caregiver, while the other two served as proxy pairs.

When observing the participants it became clear that none of the participants completed the instructions before trying out the game. As a result of this, the conversation starter questions were often not seen or quickly disregarded. Additionally, this caused some groups to be left without understanding what the info slot was meant for, resulting in the info slot not being used as often as anticipated. Despite this, all pairs were able to play the game and talk about their past and/or the presented general events.

Three out of four pairs were enthusiastic about the game. Their feedback included, among other things, that the puzzling aspect was a positive feature. The fourth pair noted they were not interested in the topics of the general events, which had a negative effect on their enjoyment.

All pairs were able to interact with the game without help until completion and noted that the lights and

sounds used gave clear feedback about the status of a placed piece. However, the visual feedback on the screen was often not noticed or quickly disregarded.

Pairs who had not read the instructions during the game were led through them afterward. Participants mentioned the instructions were not too complex and did not contain too much information. However, future versions of the game would need a better way to keep the attention of users.

The duration of the game was highly dependent on how much the participants talked with each other. Those who did not talk a lot noted that the game seemed brief. Most participants found the replayability of the game high, with the side note that the event pieces would need to be different. One pair noted that the number of pieces could be overwhelming, but others found 6 to be a suitable number of pieces.

The participant pairs with one person from the target group played the game with general event pieces. Beforehand, a poule of 12 event pieces was prepared by the researchers. Together with the caregiver, 6 out of these 12 event pieces were chosen before the start of the playtest based on the assumed preferences of the participant from the target group. Some events were found to be more enjoyable than others, depending on whether the participants knew much about the event. It was also mentioned that the music events were too modern. One participant pair noted they would have liked to play the game with event pieces from their personal life.

Proxy users played the game with personalized event pieces. Both pairs were enthusiastic about the events and the game in general. Even though the events were familiar to the players, it did not take away the puzzling aspect. There were mixed opinions about the difficulty of the game, with one pair suggesting options to make the game easier and the other to make the game more difficult. It was also noted that it is not possible to control which memories, good or bad, an event piece can bring up. This should be kept in mind when picking event pieces, and it is good to have someone present when playing the game who can comfort the users.

## 4.2 Limitations

Limitations related to testing and project setup should be taken into consideration. In general, the number of people who participated in interviews and user testing was low and did not include many people from the target group. It should also be considered that all participants were Dutch, leaving no room for investigating cultural differences. User testing was also done with self-made lists of questions instead of scientific

ally grounded existing questionnaires. Additionally, due to unforeseen technical issues, the final prototype did not function autonomously and it was not possible to play audio and video directly.

## 4.3 Conclusion

*Net Als Toen* was able to provide an enjoyable experience for most participants of the study. The personalized version of the game, which includes events from the users' personal lives, proves to be a highly effective conversation starter. However, it is important to note that this study was conducted with a small group of people. Although lo-fi user tests were performed, any future prototype will require more usability testing. Most guidelines from Table 1 are met during the hi-fi tests, except the unclear instructions. Thus, important aspects, such as users omitting the instruction slides or not utilizing the info slot, should be thoroughly considered before future user tests. An established questionnaire should be used to gather user feedback.

In conclusion, our prototype requires further testing. Future testing should include a fully working prototype, subjected to a more extensive, broader, and more diverse participant pool, particularly including individuals with AD. The integration of personalized events is recommended to enhance enjoyment and encourage the participants to share their memories.

## REFERENCES

- Anand, P. and Singh, B. (2013). A review on cholinesterase inhibitors for alzheimer's disease. *Archives of Pharmacal Research*, 36(4):375–399.
- Astell, A. J., Czarnuch, S., and Dove, E. (2018). System development guidelines from a review of motion-based technology for people with dementia or mci. *Frontiers in Psychiatry*, 9:3–7.
- Augusto Wrede, J., Kramer, D., Alegre, U., Covaci, A., and Santokhee, A. (2018). The user-centred intelligent environments development process as a guide to co-create smart technology for people with special needs. *Universal Access in the Information Society*, 17:117.
- Balouch, S., Rifaat, E., Chen, H. L., and Tabet, N. (2019). Social networks and loneliness in people with alzheimer's dementia. *International Journal of Geriatric Psychiatry*, 34(5):666–673.
- Beard, R. L. (2011). Art therapies and dementia care: A systematic review. *Dementia*, 11(5):633–656.
- Carrion, C., Folkvord, F., Anastasiadou, D., and Aymerich, M. (2018). Cognitive therapy for dementia patients: A systematic review. *Dementia and Geriatric Cognitive Disorders*, 46(1-2):1–26.

- Carvalho, R. and Ishitani, L. (2012). Motivational factors for mobile serious games for elderly users. *Simpósio Brasileiro de Games e Entretenimento Digital (SBGames)*, pages 26,27.
- Chang, K., An, N., Qi, J., Li, R., Levkoff, S., Chen, H., and Li, P. (2013). Food stamps: A reminiscence therapy tablet game for chinese seniors. *2013 ICME International Conference on Complex Medical Engineering*.
- Cotelli, M., Manenti, R., and Zanetti, O. (2012). Reminiscence therapy in dementia: A review. *Maturitas*, 72(3):203–205.
- Filan, S. L. and Llewellyn-Jones, R. H. (2006). Animal-assisted therapy for dementia: A review of the literature. *International Psychogeriatrics*, 18(4):597–611.
- Ghorbel, F., Métails, E., Ellouze, N., Hamdi, F., and Gargouri, F. (2017). Towards accessibility guidelines of interaction and user interface design for alzheimer's disease patients. In *Advances in Computer-Human Interactions (ACHI) 2017*.
- Gräsel, E., Wiltfang, J., and Kornhuber, J. (2003). Non-drug therapies for dementia: An overview of the current situation with regard to proof of effectiveness. *Dementia and Geriatric Cognitive Disorders*, 15(3):115–125.
- Higgins, J. M. (1994). *101 creative problem solving techniques : the handbook of new ideas for business*. New Management Pub. Co.
- Jiang, L., Siriaraya, P., Choi, D., and Kuwahara, N. (2021). A library of old photos supporting conversation of two generations serving reminiscence therapy. *Frontiers in Psychology*, 12:10.
- Kaduszkiewicz, H., Zimmermann, T., Beck-Bornholdt, H.-P., and van den Bussche, H. (2005). Cholinesterase inhibitors for patients with alzheimer's disease: Systematic review of randomised clinical trials. *BMJ*, 331(7512):321–327.
- Karkou, V. and Meekums, B. (2017). Dance movement therapy for dementia. *Cochrane Database of Systematic Reviews*, 2017(2):3,4.
- King, J., Jones, K., Goldberg, E., Rollins, M., MacNamee, K., Moffit, C., Naidu, S., Ferguson, M., Garcia-Leavitt, E., Amaro, J., and et al. (2018). Increased functional connectivity after listening to favored music in adults with alzheimer dementia. *The Journal Of Prevention of Alzheimer's Disease*, 6(1):1–7.
- Lazar, A., Thompson, H., and Demiris, G. (2014). A systematic review of the use of technology for reminiscence therapy. *Health Education & Behavior*, 41(1):51S, 52S.
- MacDuffie, K. E., Atkins, A. S., Flegal, K. E., Clark, C. M., and Reuter-Lorenz, P. A. (2012). Memory distortion in alzheimer's disease: Deficient monitoring of short- and long-term memory. *Neuropsychology*, 26(4):509–516.
- McDermott, O., Crellin, N., Ridder, H. M., and Orrell, M. (2012). Music therapy in dementia: A narrative synthesis systematic review. *International Journal of Geriatric Psychiatry*, 28(8):781–794.
- Nazareth, D. S., Burghardt, C., Capra, A., Cristoforetti, P., Lam, W., van Waterschoot, J. B., Westerhof, G. J., and Truong, K. P. (2019). Babelbord: A personalized conversational game for people with dementia. *Communications in Computer and Information Science*, page 169–173.
- Nichols, E., Steinmetz, J. D., Vollset, S. E., Fukutaki, K., Chalek, J., Abd-Allah, F., Abdoli, A., Abualhasan, A., Abu-Gharbieh, E., Akram, T. T., and et al. (2022). Estimation of the global prevalence of dementia in 2019 and forecasted prevalence in 2050: An analysis for the global burden of disease study 2019. *The Lancet Public Health*, 7(2):e106.
- Orpwood, R., Gibbs, C., Adlam, T., Faulkner, R., and Meegahawatte, D. (2005). The design of smart homes for people with dementia—user-interface aspects. *Universal Access in the Information Society*, 4(2):156–164.
- Parsons, C. L. (1986). Group reminiscence therapy and levels of depression in the elderly. *The Nurse Practitioner*, 11(3):75,76.
- Satoshi Kawamoto, A. L., Martins, V. F., and Soares Correa da Silva, F. (2014). Converging natural user interfaces guidelines and the design of applications for older adults. *2014 IEEE International Conference on Systems, Man, and Cybernetics (SMC)*.
- Son, G.-R., Therrien, B., and Whall, A. (2002). Implicit memory and familiarity among elders with dementia. *Journal of Nursing Scholarship*, 34(3):263–267.
- Subramaniam, P. and Woods, B. (2012). The impact of individual reminiscence therapy for people with dementia: Systematic review. *Expert Review of Neurotherapeutics*, 12(5):545–555.
- Sunwoo, J., Yuen, W., Lutteroth, C., and Wünsche, B. (2010). Mobile games for elderly healthcare. *Proceedings of the 11th International Conference of the NZ Chapter of the ACM Special Interest Group on Human-Computer Interaction on ZZZ - CHINZ '10*.
- Treadaway, C., Fennell, J., Taylor, A., and Kenning, G. (2019). Designing for playfulness through compassion: Design for advanced dementia. *Design for Health*, 3(1):27–47.
- Verkaik, R., van Weert, J. C., and Francke, A. L. (2005). The effects of psychosocial methods on depressed, aggressive and apathetic behaviors of people with dementia: A systematic review. *International Journal of Geriatric Psychiatry*, 20(4):301–314.
- Vernooij-Dassen, M., Vasse, E., Zuidema, S., Cohen-Mansfield, J., and Moyle, W. (2010). Psychosocial interventions for dementia patients in long-term care. *International Psychogeriatrics*, 22(7):1121–1128.
- Wall, M. and Duffy, A. (2010). The effects of music therapy for older people with dementia. *British Journal of Nursing*, 19(2):108–113.
- Wimo, A., Ali, G.-C., Guerchet, M., Prince, M., Prina, M., and Wu, Y.-T. (2015). *Adi - world alzheimer report 2015*.
- Woods, B., Thorgrimsen, L., Spector, A., Royan, L., and Orrell, M. (2006). Improved quality of life and cognitive stimulation therapy in dementia. *Aging & Mental Health*, 10(3):219–226.