



# Proposal for a Parent-Child Mutual Dementia Prevention Brain Training Application Based on a Modified Double Diamond Process: Social and Psychological Theory and Reward Setting

Minchae Kim<sup>1</sup>, Sanghee Park<sup>2\*</sup>

<sup>1</sup>Department of Visual Design, Master, Kyung Hee University, Yongin, Korea

<sup>2</sup>Department of Visual Design, Professor, Kyung Hee University, Yongin, Korea

---

## Abstract

**Background** As societies enter a super-aged era, dementia has emerged as one of the most critical issues affecting the elderly population. While many existing solutions focus on cognitive training alone, this study offers a unique perspective by emphasizing the motivational role of parent-child interaction in promoting dementia prevention behavior. The primary objective of this research is to develop a brain training application that incorporates emotional support from adult children as a key driver for sustained engagement among elderly users.

**Methods** The study employed a modified Double Diamond process, with particular emphasis on the Discover and Define stages to ensure a deep understanding of the problem and user needs. Research methods included in-depth interviews with older adults and their children, field observations, focus group discussions (FGDs) with healthcare professionals, and expert consultations. These insights guided the application's design and development.

**Results** The outcome of the study is "Match," a brain training application that operates through linked versions for parents and adult children. The app's structure is built on the insight that emotional messages from children act as a significant source of motivation for elderly users. When adult children upload supportive messages, parents encounter them as rewards during their brain training sessions. This emotional feedback loop enhances user engagement and encourages continuous use of the application.

**Conclusions** The application's usability was validated through expert and user feedback, showing strong potential to support consistent brain training among the elderly. The study successfully demonstrates how the Double Diamond process can be adapted as an effective design methodology to address complex social problems, with the final contribution being the development of the "Match" application and —not the methodology itself.

**Keywords** Double-Diamond Process, Dementia Prevention Application, Social and Psychological Theories

---

\*Corresponding author: Sanghee Park (sh.park@khu.ac.kr)

*Citation*: Kim, M., & Park, S. (2025). Proposal for a Parent-Child Mutual Dementia Prevention Brain Training Application Based on a Modified Double Diamond Process: Social and Psychological Theory and Reward Setting. *Archives of Design Research*, 38(3), 77-105.

<http://dx.doi.org/10.15187/adr.2025.08.38.3.77>

**Received** : Dec. 26. 2024 ; **Reviewed** : May. 19. 2025 ; **Accepted** : May. 22. 2025

**pISSN** 1226-8046 **eISSN** 2288-2987

**Copyright** : This is an Open Access article distributed under the terms of the Creative Commons Attribution Non-Commercial License (<http://creativecommons.org/licenses/by-nc/3.0/>), which permits unrestricted educational and non-commercial use, provided the original work is properly cited.

---

## 1. Background and Research Methods

### 1. 1. Purpose of Study

As society enters an era of super-aging, the issue of dementia has emerged as a significant social concern. As of 2023, the number of dementia patients in South Korea has surpassed one million and is projected to reach 1.42 million by 2030. This trend underscores the importance of dementia prevention and the necessity for related research. Dementia extends beyond a mere health issue; it has evolved into a social problem, making dementia prevention a critical undertaking at a national level within an aging society (Jhu 2020). In line with this trend, studies related to social applications such as digital healthcare applications are being actively pursued.

However, current research in the design field regarding social design processes or service design aimed at dementia prevention is relatively scarce. Design serves as a powerful tool for problem-solving and can provide new approaches to social issues. This study aims to examine the issue of dementia from the perspective of design and planning, combining this social issue with design thinking to create design outcomes that embody social value. In this context, the application (hereinafter referred to as 'app') has been conceptualized as an output for problem-solving. Furthermore, at the process level, the 'Applied Double Diamond Process' undertaken to derive the project outcomes is proposed as a new social design process.

### 1. 2. Research Methodology

This study follows the Double Diamond process, a methodology in service design, but has been adapted by placing greater emphasis on the 'Discover-Define' phases. This approach aims to facilitate a comprehensive research stage that fosters a broad investigation of social issues that need resolution and a deep understanding of the users involved. It is characterized by the simultaneous exploration of social and psychological theoretical backgrounds before proceeding to the planning phase. In each stage, in-depth interviews and shadowing, among other research methodologies, were employed to derive a profound understanding, leading to ideation based on the insights gathered, which solidified the app's concept and functionality. By systematically implementing the initially planned adaptive Double Diamond process, we were able to develop an app that promotes sustainable usage for elderly users.

In the first diamond of the project, during the Discover phase, we extensively explored various issues related to dementia and conducted desk research and field research to investigate the surrounding environment and current conditions. During the desk research, we analyzed dementia-related problems and the role of brain training as a preventive measure, as well as reviewed case studies of similar applications. During the field research, we conducted in-depth interviews with senior users and their adult children as stakeholders and performed shadowing to understand the mobile device usage patterns of the senior generation. Next, in the Define phase, we defined the core of the problem based on the data collected during the Discover phase and articulated a direction for addressing it. A persona was established based on the research results to create a customer journey map and identify

pain points. Using techniques such as HMW (How Might We), we derived comprehensive insights based on the research findings and identified pain points. To realize social value through human-centered problem solving, we conducted a literature review in the fields of social and psychological studies related to problems, needs, and insights throughout the Discover and Define phases to seek sustainable solutions. Additionally, we aimed to delve deeper into the stages of the first diamond to establish a clear direction for problem solving. In the development phase of the second diamond, we established ideas and concretized them to solve the defined problem. During this phase, we explored various solutions based on the problem-solving direction set in the previous stage, and defined the app's core and detailed features. Subsequently, we designed wireframes for systematic app implementation and created a prototype. In the design process, we referenced preliminary materials such as UI design guidelines tailored for the senior generation to enhance visual quality and ensure usability. In the final delivery phase, we conducted usability and usefulness validation processes involving users and experts regarding the end product of the implemented app. Throughout the entire second diamond phase, we sought to enhance the completeness of the final output through iterative modifications and enhancements.

Phases	Discover	Define	Develop	Deliver
Objective	A Clear Understanding Of Dementia Issues And A Comprehensive Grasp Of Information On Senior Users	Establishment Of Insights Based On The Creation Of Senior User Personas And Customer Journey Mapping	Concept And Functionality Definition Of The Dementia Prevention Application	Validation Of Usability And Effectiveness, Followed By Final Refinement
Activities	<ul style="list-style-type: none"> <li>Current Status Analysis / Case Studies</li> <li>Review Of Literature On Social And Psychological Theories, Conceptual Exploration 1</li> <li>In-Depth Interviews (User Research 1)</li> <li>Shadowing (User Research 2)</li> </ul>	<ul style="list-style-type: none"> <li>Persona Creation</li> <li>Customer Journey Map Development</li> <li>Identification Of Pain Points / Insight Synthesis</li> <li>How Might We (HMW) Method</li> <li>Connection With Social And Psychological Concepts</li> </ul>	<ul style="list-style-type: none"> <li>Idea Generation</li> <li>Flow Chart Design</li> <li>Wireframe Establishment</li> <li>Visualization (UI Design)</li> </ul>	<ul style="list-style-type: none"> <li>Usability And Effectiveness Validation</li> <li>Expert Interviews (Focus Group Interview)</li> <li>Iterative Refinement</li> <li>Establishing Directions For Improvement And Enhancement</li> </ul>
Overview	Conducted <b>Desk Research</b> To Analyze The Status, Prevention Methods, And Examples Of Dementia-Related Applications. Complemented This With <b>Field Research</b> , Including In-Depth <b>Interviews</b> And <b>Shadowing</b> Of Senior Users And Their Children, To Gain A Deeper Understanding Of User Needs And The Perspectives Of Stakeholders.	The Core Problem Was Defined Using Data From The Discovery Phase, And A <b>Strategy For Resolution</b> Was Outlined. <b>Personas And A Customer Journey Map</b> Were Developed To Identify Key <b>Pain Points And Insights</b> . Additionally, Relevant <b>Social And Psychological Literature</b> Was Reviewed To Find Ways To Promote Sustainable User Engagement.	Ideas Were Developed To Solve The Defined Problem, Refining Them Into <b>Concrete Application Features</b> . This Included Wireframe Design And <b>UI Development</b> , Focusing On The Needs Of Senior Users.	The Final Application Underwent <b>User And Expert Testing For Usability And Effectiveness</b> . Based On This Feedback, Final Adjustments Were Made To Improve The Application's Functionality And Overall Design.
Problem-Solving Approach				
Design Resource	<Desk Research And Field Research> Basic Understanding Of The Problem Background / Concept And Situation Analysis / Analysis Of Similar Cases / In-Depth User Interviews / User Shadowing	<Insight Synthesis> Persona Creation And Customer Journey Map Development / Scenario Creation / Identification Of Pain Points / Insight Synthesis And Organization	<Idea Proposal> Concept Development / Prototyping / Visualization Iterative Feedback On Wireframes & Design / Implementing Improvements.	<Effectiveness Verification> User Testing / Expert Consultation / Iterative Improvement
	Researching Social-Psychological Theories / Linking Insights To Problems.			

Figure 1 Applied Double Diamond Process

The core characteristic of this Applied Double Diamond Process lies in its emphasis on integrating social and psychological theories with field research during the first diamond phase. This approach enables the generation of deeper insights and expands the weight of the Discover and Define stages to establish a solid and well-grounded planning foundation. The proposed process is expected to serve as a valuable framework for developing design

outcomes that realize social value and offer innovative solutions to complex societal challenges.

---

## 2. Theoretical Background

### 2. 1. Brain training and dementia prevention: necessity of motivation for dementia prevention

Dementia refers to a complex set of symptoms in which a normally developed brain is damaged or deteriorated due to external causes such as acquired trauma or illness, resulting in a general decline in cognitive functions such as intelligence, learning, and language, as well as higher-order mental functions. It primarily occurs in old age and is currently considered one of the four leading causes of death, following heart disease, cancer, and stroke, making it a critical neurological disorder (Korea Disease Control and Prevention Agency National Health Information Portal, <https://health.kdca.go.kr/>). The most traditional method of preventing dementia involves evenly training the six major cognitive domains to activate the entire brain. These six cognitive domains include attention, language ability, calculation ability, spatial-temporal ability, memory, and executive function. Language and calculation skills activate the left hemisphere of the brain; spatial-temporal ability stimulates the right and posterior parts of the brain; and executive function tasks stimulate the anterior region of the brain(Na, 2024).

While it is important to know the correct methods for preventing dementia, it is equally crucial to consistently and continuously implement dementia prevention behavioral guidelines. In 2014, a research team led by Professor Hong Chang-hyung of the Department of Psychiatry at Ajou University Hospital and Professor Lee Kang-soo of the Department of Psychiatry at Gangnam CHA Hospital conducted a dementia prevention program (commonly known as the 'Gold Medal Project') for 460 elderly individuals at the Suwon Mental Health Center. The program rewarded elderly participants who adhered well to dementia prevention lifestyle guidelines with gold medal stickers. The study revealed that cognitive decline was less prominent in the group incentivized with the gold medal symbol. This research project highlights the importance of 'motivation' in encouraging elderly individuals to consistently practice dementia prevention behavioral guidelines and participate voluntarily in activities(Park, 2014). Particularly, cognitive training and activities require repeated participation, and if there are no motivating factors, there is a significant likelihood that participation will cease. Therefore, it is essential to encourage elderly individuals to perceive dementia prevention activities as positive experiences that can lead to long-term behavioral changes.

### 2. 2. Mobile Applications as Tools for Dementia Prevention

Mobile applications (hereinafter referred to as mobile apps) are software programs that operate on mobile devices such as smartphones and tablets, contributing to users' convenient lifestyles through a variety of functions. Mobile apps are utilized across multiple fields, including information provision, social networking, entertainment, and healthcare, with

the advantages of accessibility and portability. In accordance with these benefits and characteristics, there are numerous apps developed specifically targeting elderly users. A typical example is digital healthcare apps that efficiently track physical activities, record heart rates or sleep patterns, and remind users of medication times. In other words, mobile apps can have a positive impact on enhancing the quality of life for elderly users in terms of healthcare management, fostering social connections, and increasing convenience.

The characteristics of mobile apps provide opportunities for solving issues related to dementia prevention. Currently, various government agencies, local governments, dementia-related centers, and senior community centers, including those in Seoul, are implementing programs aimed at dementia and elderly welfare initiatives for prevention; however, public awareness remains relatively low, and several challenges persist. One of the most frequently cited issues in senior leisure welfare facilities is the limited space and aging infrastructure (Song, Song, and Lee, 2021). In light of this, mobile apps that can be used anytime and anywhere without the constraints of time and place, as well as interference from others, can alleviate the inconvenience of seniors having to travel to specific locations at designated times, and may also reduce the burden on seniors who are reluctant to engage in social interactions and activities, thereby offering new possibilities for dementia prevention.

---

### **3. The First Diamond; Discover and Define**

In the initial stages of the Double Diamond process, specifically the ‘Discover’ and ‘Define’ phases, research plays a pivotal role in identifying the essence of the problem and understanding user needs. However, to effectively address social issues in a human-centered and user-centered manner, it is essential to move beyond superficial investigations of problem situations and behaviors to conduct multidisciplinary and comprehensive inquiries that encompass social, psychological, and humanities dimensions. Human behavior is shaped not merely by the fulfillment of needs but by a complex interplay of various factors including psychological motivations, social relationships, and cultural backgrounds. Therefore, an understanding of social and psychological theories can significantly enhance the ability to grasp and analyze user behavior. Additionally, an understanding of the underlying psychological mechanisms and social contexts of user behavior is crucial for fostering sustainable and meaningful user experiences. Consequently, this study aims to expand the emphasis on the Discover-Define stages during the execution of the Double Diamond process for solving social issues, while simultaneously incorporating an understanding of social and psychological concepts and theories.

#### **3. 1. Understanding the Problem: Desk Research on Dementia**

A comprehensive analysis of various research findings related to dementia and its prevention has laid the groundwork for problem-solving. The desk research conducted regarding the prevalence of dementia, the level of awareness about dementia, and guidelines for dementia prevention can be summarized as follows.

First, in terms of the current status of dementia incidence, according to the Future Population Projections by Statistics Korea, South Korea is expected to enter a super-aged society by 2025. The number of dementia patients is projected to increase from 833,000 in 2020 to 3.023 million by 2050. Dementia is rapidly increasing with the aging population and has established itself as one of the most prevalent age-related diseases (Statistics Korea, 2023). In other words, dementia should be addressed as a societal issue that requires solutions from multiple perspectives, and realizing social value through such efforts is crucial.

Second, in terms of public awareness of dementia, a survey by the Korean Society for the Prevention of Cardiovascular and Cerebrovascular Diseases found that dementia ranked highest (34.4%) among the illnesses most feared by the public. In addition, a dementia awareness survey conducted by the research team at Myongji Hospital revealed that there is significant fear surrounding dementia, indicating a strong need for campaigns and educational efforts to improve awareness and interest among younger generations (Myongji Medical Foundation, 2021). Therefore, it is necessary to develop strategies that alleviate public fear of dementia and increase awareness among younger age groups. Educational and promotional efforts related to dementia prevention should be strengthened particularly for younger people.

Lastly, since dementia is a complex disease related to the overall decline in cognitive function, with various causes and prevention methods, it is not sufficient to rely on conventional, one-size-fits-all solutions. To provide effective preventative strategies, research should be grounded in validated findings from the medical domains of neurobehavioral science, brain function, cognitive science, and psychology. The following sections summarize the literature reviewed based on this perspective.

First, from the perspective of brain nutrition management, one of the most significant causes of dementia is mitochondrial dysfunction. To reduce the oxidative stress that damages mitochondria, it is important to avoid alcohol, smoking, and stress. Dietary improvements, such as adopting a “brain-reset ketogenic diet,” are also essential (Hwang et al. 2020).

Second, from a medical and neuroprotection perspective, memory Third, in terms of temporal lobe activation—a brain region essential for memory, language, emotion, and perception—positive stimulation through meaningful experiences and recording memories via photos, videos, or journaling is recommended.

Fourth, to optimize brain function, one should think positively, spend time with uplifting individuals, and maintain regular contact with loved ones (Daniel G. Amen, 2000).

Fifth, from the perspective of managing neurobehavioral symptoms, non-pharmacological interventions such as praise, repetition, and encouraging participation in daily activities are effective in reinforcing appropriate behaviors (Korean Dementia Association, 2017).

Sixth, in addressing the root causes of cognitive decline, depression—identified as an independent risk factor for dementia—must be treated promptly (Sophia Wang et al., 2018; Byers & Yaffe, 2011).

Based on these findings, four key strategies for dementia prevention were identified: (1) promoting positive experiences and enhancing self-esteem, (2) implementing brain-training techniques to improve memory, (3) fostering ongoing social interaction and participation, and (4) managing stress, maintaining proper nutrition, and receiving psychological therapy.

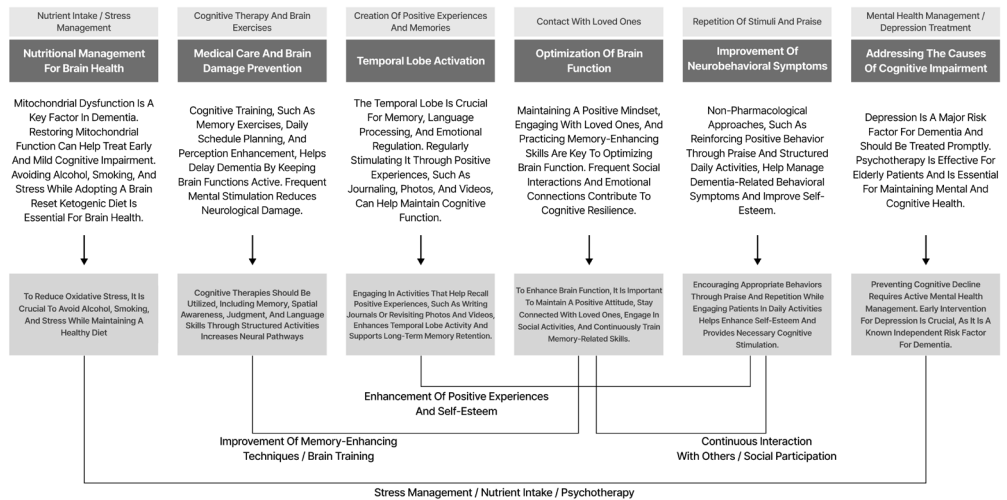


Figure 2 Desk Research about Dementia Prevention

### 3. 2. Understanding the Existing Market; Analysis of Dementia-Related Application Cases

The objective was to analyze the overview and user reviews of existing dementia prevention apps to identify the characteristics, advantages, and disadvantages of the dementia prevention applications currently available in the market. First, an analysis was conducted on three dementia prevention applications currently available in South Korea: Dementia Check, a comprehensive mobile portal for dementia screening; Descartes, which offers memory games and brain age tests; and Sylvia, an app that provides cognitive training and self-assessment tools for dementia patients. The findings from the analysis are outlined below, with references to the reviews on Google Play, the App Store, and One Store for the advantages and disadvantages.

Table 1 Analysis of Dementia-Related Application Cases (1)

	Dementia Check'	Decartes'	Silvia'
Key Features	Developed by the Ministry of Health and Welfare and Central Dementia Center. Offers dementia risk check, brain health trainer, caregiver services, and a missing person guide.	Prevents dementia through memory games and brain age tests. Provides self-diagnosis, digital exercises like yoga and audiobooks, and brain training games.	Offers self-assessment, cognitive training games, medication management, expert consultations, and personalized programs for dementia prevention.
Pros	Provides useful information including brain training, caregiver support, and missing person guides.	Includes various physical exercises and medical knowledge. Enjoyable with multiple activities.	Features reminders for medication, enables training after assessments, and offers weekly expert consultations.
Cons	Does not display dementia check history or results. Lacks actual brain training via the health trainer.	Subscription model can be costly. Limited game variety and no free trial affects credibility.	Expert consultations require payment. UI may be hard to understand. Training games lack updates and are repetitive.

Next, for international examples of dementia prevention apps, we analyzed three applications: CogniFit, a leading U.S.-based brain training app that provides entertaining cognitive games; BrainHQ, developed by Posit Science to offer neuroscience-based brain

training; and a Dementia Prevention App developed as a supplementary service by Taiyo Life Insurance in Japan. The analysis is summarized below, with strengths and weaknesses assessed based on reviews from Google Play, the App Store, and related press materials.

Table 2 Analysis of Dementia-Related Application Cases (2)

	'Cognifit'	'BrainHQ'	'Taiyo Dementia Prevention App'
Key Features	Offers scientifically designed cognitive training games. Assesses brain function and provides personalized programs using neuroscience-based algorithms.	Provides neuroscience-based training by Posit Science. Enhances memory, speed, attention, and includes brain flexibility programs.	Supports dementia prevention as a supplemental service by a Japanese insurance company. Includes brain games, health advice, and lifestyle guidance.
Pros	Analyzes cognitive ability in detail and provides personalized training. Engaging games and credible research-backed content.	Based on brain plasticity. Offers clinically validated content with high scientific credibility.	Combines brain training with overall wellness support. Offers benefits to insurance members, boosting retention.
Cons	Game style may feel monotonous. Lacks long-term motivation. Limited features in free version.	Simple interface with repetitive patterns can be boring. Full access requires paid subscription and is relatively expensive.	Only available to insurance subscribers or has limited access. Lacks scientific validation and clinical proof.

An analysis of six dementia prevention applications—three domestic and three international—revealed that while these apps focus on enhancing cognitive functions and health management, they fall short in encouraging sustained user engagement. The Korean apps Dementia Check, Descartes, and Sylvia offer brain training and health features, but suffer from user attrition due to paywalls and repetitive content. Dementia Check, although free, is primarily diagnostic and lacks preventive or training functions. Meanwhile, international apps like CogniFit, BrainHQ, and the Taiyo Dementia Prevention App provide cognitive training based on scientific research but face limitations in motivation, interactivity, and accessibility. CogniFit and BrainHQ rely heavily on score-based feedback, which lacks long-term motivational impact, while the Taiyo app restricts access to insurance policyholders. Ultimately, these apps prioritize cognitive training, but their lack of emotionally driven motivational elements hampers sustained usage—emerging as a common limitation across the board.

### 3. 3. Understanding the Elderly Population: Research on Social and Psychological Aspects

Dementia, a chronic condition primarily affecting the elderly, progressively impairs brain function and diminishes cognitive abilities. To effectively grasp the multifaceted behaviors of the elderly, the core users, it necessitated an understanding of social and psychological theories. This aimed to provide a deeper insight into user behavior patterns and psychological mechanisms. The foundational theories related to the behavior and psychology of the elderly, along with the characteristics of the elderly as manifested in social and psychological contexts, can be summarized as follows.

Table 3 Content of research on social and psychological theory

Concept and Theory	Research Content
Theory of Heinz Kohut	<ul style="list-style-type: none"> <li>- Aging leads to narcissistic injuries due to various losses (biological, psychological, social)</li> <li>- Maintaining self-esteem becomes a key task for older adults.</li> <li>- Self-esteem is supported by economic stability, health, and strong social relationships.</li> <li>- From the perspective of social support, beneficial interpersonal relationships for the elderly are formed through personal and group networks, such as spouses, children, and siblings, which provide meaningful social connections(Dan Blazer, 1998).</li> </ul>
Socialization and Role Transition	<ul style="list-style-type: none"> <li>- In old age, learning opportunities decline, causing detachment and isolation.</li> <li>- Social losses increase: reduced income, morale, and increased dependency.</li> <li>- To prevent isolation, social relationships must be rebuilt.</li> <li>- Cassel (1976) argued that when older adults receive feedback, information, and guidance, they are better able to understand and adapt to continuously changing social networks.</li> </ul>
Activity Theory	<ul style="list-style-type: none"> <li>- Although lifespan limits remain stable, more people now live longer and healthier lives.</li> <li>- Staying active is essential for successful aging and life satisfaction.</li> <li>- Activities should go beyond routine maintenance and be meaningful.</li> <li>- This suggests that not only has lifespan increased, but individuals now generally experience later stages of life in better health(Fries, J. F., &amp; Crapo, L. M., 1981).</li> </ul>
Social Exchange	<ul style="list-style-type: none"> <li>- Older adults experience reduced social interaction due to both individual and societal factors.</li> <li>- Social exchange is maintained when perceived benefits exceed costs.</li> <li>- The social value of older adults depends on their societal contribution vs. support costs.</li> <li>- Such interactions are among the universal values of human society, shared by both human nature and the social order(Kim, 2019).</li> <li>- The primary factor determining the status of older adults is the balance between their contributions to society and the costs incurred to support those contributions(Kim, 1999).</li> </ul>

To ensure that the elderly consistently practice guidelines for dementia prevention and engage in ongoing cognitive training, effective methods to induce behavioral change are essential. Therefore, it is necessary to understand the psychological and social factors that sustain their participation in dementia prevention activities voluntarily. The social and psychological concepts and theories discussed below, including the concept of social support, incentive theory, self-determination theory, reinforcement theory, and socioemotional selectivity theory, explain the various motivations and mechanisms that drive human behavior.

Table 4 Contents of research on social and psychological theories related to motivation

Concept and Theory	Research Content
Social Support	<ul style="list-style-type: none"> <li>- Social support involves a network of relationships (family, friends, etc.) that provides emotional fulfillment and practical assistance.</li> <li>- Social Support refers to the intricate network of relationships with family, friends, and others that facilitates the exchange of information and assistance, thereby fulfilling emotional needs. (Zimet, Nancy, Sara and Gordon 1988).</li> <li>- Social support refers to meaningful, appropriate, and protective feedback received from one's environment, which helps individuals effectively cope with intermittent or ongoing stressors. (Blazer, 1982)</li> <li>- The effectiveness of support depends on whether it is perceived or actually utilized in times of stress.</li> </ul>
Incentive Theory	<ul style="list-style-type: none"> <li>- A behaviorist motivation theory where external rewards or punishments guide behavior.</li> <li>- Divided into positive incentives (approach motivation) and negative incentives (avoidance motivation).</li> <li>- Specific behaviors are prompted by external rewards (Korean Psychological Counseling Center, 2022).</li> </ul>
Self-Determination Theory, SDT	<ul style="list-style-type: none"> <li>- Explains motivation along a continuum from intrinsic to extrinsic regulation.</li> <li>- Self-determination Theory posits that an individual's behavior is regulated according to their level of autonomy or self-determination, and this regulation can be explained as a continuum of intrinsic and extrinsic motivation(Jeong &amp; Jang, 2015).</li> <li>- Older adults may become discouraged and experience reduced life satisfaction when they feel they are not in control (Rodin, 1986).</li> </ul>

Reinforcement Theory	<ul style="list-style-type: none"> <li>- Rooted in Skinner’s operant conditioning model.</li> <li>- Depending on the type of stimulus, reinforcement is categorized into reward and relief(Ma &amp; Baek, 2014).</li> <li>- ‘Reward’ involves providing a strengthening stimulus to enhance positive behavioral responses, while ‘Relief’ entails the alleviation of an aversive stimulus to boost positive behavioral responses</li> <li>- Common examples of social reinforcement include praise, smiles, reassurance, and physical expressions of affection. In this context, “deep understanding” is considered the greatest gift one person can offer another(Carl R. Rogers, 1955).</li> </ul>
Socioemotional Selectivity Theory	<ul style="list-style-type: none"> <li>- Posits that older adults prefer positive emotional content, aiding emotional regulation and well-being.</li> <li>- Emphasizes the role of future time perspective in shaping emotional goals.</li> <li>- As individuals enter old age, maintaining emotional satisfaction and well-being becomes a life goal, resulting in the normalization of emotional regulation to align with this objective(Nam, 2016).</li> </ul>

### 3. 4. Understanding the User: Field Research Targeting the Senior Generation and the Younger Generation

#### 3. 4. 1. In-depth interviews with senior users

In order to understand the perspectives of seniors on dementia, as well as their efforts and experiences related to dementia prevention and their awareness of dementia prevention applications, we conducted in-depth interviews targeting this age group, which is the stakeholder most likely to face dementia-related issues. We aimed to facilitate a natural communication process to elicit responses aligned with the project’s objectives from the senior population. The criteria for the survey subjects were limited to seniors aged 65 and older, a demographic known for its high incidence of dementia. From April 1 to April 5, 2024, the researcher personally conducted in-depth interviews with a total of 8 individuals at three senior centers.

The purpose of the interview was threefold: 1) to understand the perspectives of the elderly regarding dementia and dementia prevention, as well as their related experiences; 2) to ascertain whether they have experience with dementia prevention apps and to gather feedback on their usage; and 3) to gain in-depth insight into any discomforts and areas for improvement related to their various experiences with dementia prevention. Accordingly, the interview questions were formulated, and the key responses gathered after conducting the interviews have been summarized below.

Table 5 In-depth Interviews with Seniors

Questionnaire	Questionnaire	Summary of Key Responses
Understanding perspectives on dementia	What are your thoughts or opinion on dementia?	<ul style="list-style-type: none"> <li>- 'Ofcourse dementia is a terrible disease.'</li> <li>- 'I am not afraid of dementia itself. However, the thought of causing my adult children to suffer makes me believe I must not contract dementia.'</li> <li>- 'No one knows when or how dementia might suddenly come upon us, but if I were to be diagnosed with dementia, I would have to accept my fate.'</li> <li>- 'I must not get dementia.'</li> </ul>
Identifying efforts to prevent dementia	Have you had any specific experiences in making efforts to prevent dementia? If you do, what were those efforts?	<ul style="list-style-type: none"> <li>- 'I have looked up many methods for preventing dementia, but I end up only searching for information and not putting anything into practice. I did stop drinking alcohol, though.'</li> <li>- 'My son and daughter-in-law once got me a book about dementia prevention, but I am not sure if it was helpful. I try to engage in conversations as much as possible.'</li> <li>- 'Rather than focusing specifically on dementia prevention, I strive to maintain a generally healthy diet.'</li> <li>- 'I don't really live with an awareness of dementia.'</li> </ul>
Assessing awareness of existing dementia prevention programs	Are you aware of or have experienced participating in dementia prevention programs organized by the government or corporations?	<ul style="list-style-type: none"> <li>- 'I'm not particularly interested in this topic.'</li> <li>- 'I wouldn't be interested in going unless people say the programs work.'</li> <li>- 'It is a hassle to go so far.'</li> </ul>
Identifying experiences of using dementia prevention applications	Do you have any experience using a dementia prevention application?	<ul style="list-style-type: none"> <li>- 'I didn't even know such thing existed'</li> <li>- 'I only use my phone to text'</li> <li>- 'I have tried using it upon my daughter's recommendation'</li> <li>- 'I do not remember clearly, but I have tried using it once before.'</li> </ul>
Identifying additional need or requirements on dementia prevention applications	Will you share your feedback regarding dementia prevention apps, if you have tried it? (positive aspects, areas for improvement, etc.)	<ul style="list-style-type: none"> <li>- 'I had become quite accustomed to my mobile phone, so it was easy and enjoyable to use. However, after three consecutive days, it became bothersome, and I stopped. Once I ceased using it, I didn't feel a strong desire to pick it up again.'</li> <li>- 'I think apps that share recipes is more fun.'</li> </ul>

### 3. 4. 2. In-depth interviews with the adult children of the elderly

To explore the perceptions related to dementia and the experiences of adult children regarding their efforts to prevent dementia in their parents, we conducted in-depth interviews with three individuals from the 30s to 40s age group. The criteria for the subjects included being adult children of senior-generation parents who are at high risk for dementia, and their ages were restricted to between 30 and 55 years. From April 4 to April 7, 2024, the researcher engaged in one-on-one communication with a total of seven subjects. While we primarily aimed for face-to-face interviews, in cases where that was not feasible, we conducted the interviews using phone calls or KakaoTalk.

The aims of the interviews were: 1) to understand the perceptions of the 30s to 40s age group regarding dementia, 2) to gather experiences related to their efforts in preventing dementia for their parents, and 3) to ascertain the existence, opinions, and usage experiences of dementia prevention applications. Accordingly, we structured the interview questions and summarized the key responses gathered after the interviews as follows.

Table 6 In-depth Interviews with Children of the Elderly

Intent of Question	Questionnaire	Summary of Key Responses
Understanding perspectives on dementia	What are your thoughts or opinion on dementia?	<ul style="list-style-type: none"> <li>- 'Dementia is an illness that one should never contract.'</li> <li>- 'Dementia is more frightening and terrifying than cancer'</li> <li>- 'I can hardly bear to imagine my parents suffering from dementia to the point that they can no longer recognize the family members.'</li> </ul>
Identifying efforts to prevent dementia	Do you have any experience making special efforts to prevent your parents' dementia? If you have undertaken such efforts or are currently doing so, what measures did you take?	<ul style="list-style-type: none"> <li>- 'As people say, the source of all ailments is stress, so I strive to minimize any situations that may cause stress.'</li> <li>- 'I offered any guidelines for dementia prevention that I looked up.'</li> <li>- 'I often emphasize the importance of sufficient sleep and healthy eating habits, and urge my parents to put them into practice.'</li> </ul>
Assessing awareness of existing dementia prevention programs	Have you ever encouraged your parents to try a dementia prevention application? Additionally, what is your motivation or path that led you to encounter such applications?	<ul style="list-style-type: none"> <li>- 'I tried it on my mobile phone and thought it would be helpful as a preventive measure for my parents, so I installed it on my parents' phones as well. But I noticed they deleted it shortly thereafter.'</li> <li>- 'I was aware that there are brain training applications, but I haven't used them because I assumed they would only offer clichéd training exercises.'</li> <li>- 'I have recommended the use of these apps because I believe it is super helpful that the brain can be easily activated using a mobile phone app.'</li> </ul>
Identifying additional need or requirements on dementia prevention applications	If your parent(s) have experience on using these applications, I would appreciate any feedback on them. (positive aspects, areas for improvement, etc.)	<ul style="list-style-type: none"> <li>- 'I deleted it because the application installation and trial version of the brain training were the only free features.'</li> <li>- 'It seems that my parents did not consistently use it, indicating that the app does not guarantee interest or fun.'</li> <li>- 'The font size on the screen is smaller than expected, making it difficult for my parents to use, and they also mentioned that they found it challenging to understand what the buttons and icons represented.'</li> </ul>

### 3. 4. 3. Shadowing the Digital Device Usage Patterns of the Senior Generation

To assess the smartphone familiarity and usage attitudes of elderly individuals, a one-hour shadowing observation study was conducted with two seniors at a senior center, with their consent. The purpose of the shadowing was to 1) understand the usage attitudes and behavior patterns of the senior generation regarding digital devices, and 2) identify moments when seniors feel discomfort or enjoyment while using applications. The overview and results of the shadowing can be summarized as follows.

Table 7 Overview of the Senior Generation Shadowing

Shadowing Target	Location of Sessions	Session Date / duration	Purpose of Shadowing
7 Seniors (In-depth Interviewees + 3 people)	Senior Center in Suwon City	2024.4.1. / 2hrs	Understanding the senior generation's digital device usage attitudes and behaviors /Identifying moments when the senior generation experiences discomfort or joy while using applications.
6 Seniors (In-depth Interviewees + 4 people)	Senior Center in Daegu City	2024.4.3. / 1.5hrs	
Cons	Senior Center in an Apartment Complex Located in Daegu City	2024.4.5. / 1.5hrs	

Table 8 Result of Shadowing

Behavioral Patterns	Result of Shadowing
Usage Patterns of Mobile Applications	<ol style="list-style-type: none"> <li>1) When using a mobile phone, the individuals often talk to themselves and displays a certain lack of patience.</li> <li>2) The most frequently used applications are KakaoTalk, Photo Gallery, and YouTube. For communication, KakaoTalk is used more often than text message applications.</li> <li>3) When watching YouTube videos, the sound and screen brightness are set to the maximum level. The attention span of watching the videos is approximately 10 minutes, during which the individuals tend to keep the volume high while directing their gaze elsewhere.</li> <li>4) When using applications such as KakaoTalk and Naver, a magnifying glass is often used to read small texts.</li> <li>5) They tend to struggle to maintain focus on a bright screen for extended periods.</li> </ol>
Phone Calling Behavioral Patterns	<ol style="list-style-type: none"> <li>1) Seniors do not check their push notifications regularly.</li> <li>2) Among various notifications, the response speed to their children’s KakaoTalk replies was the quickest.</li> </ol>
Other general mobile phone usage patterns	<ol style="list-style-type: none"> <li>1) Seniors use mobile phones together when they meet up.</li> <li>2) The mobile phone battery is kept charged at all times.</li> </ol>

Additionally, brief interview was conducted regarding mobile phone usage following the shadowing session, where respondents were asked, “When do you find the most joy in using your phone?” The answer consistently reflected that the participants felt happiest during video calls with their adult children (or grandchildren) or when sending photos via KakaoTalk, which all other shadowing subjects agreed with. Through observing how elderly individuals interact with digital devices and applications, we gained insights that “while the senior generation faces limitations in maintaining prolonged focus on mobile phones as a digitally vulnerable population, they demonstrated quick response times and high engagement levels when receiving news from their adult children or viewing photos on their devices. Moreover, we gained further insight that there is a need for UI screen designs that consider the physical characteristics of the senior generation.

### 3. 4. 4. Summary of Field Research Findings

The results of the field research utilizing in-depth interviews and shadowing methodologies are summarized as follows. First, the elderly were making efforts to prevent dementia, primarily engaging in practices that were feasible within their daily lives. Additionally, dementia prevention apps were not considered familiar or approachable by the elderly, and users who had experience with these apps generally evaluated their sustainability negatively. Second, most adult children in their 30s and 40s had experiences of trying to aid their parents in dementia prevention, and given their relatively young demographic characteristics, they were aware of the existence of dementia prevention apps. They had experiences of encouraging their parents to use these apps due to the convenience of apps that are not constrained by time and space. However, they mentioned that drawbacks such as the paid subscription model, inconvenient usability, and the lack of motivation, led them to give low ratings to the effectiveness of dementia prevention apps. Finally, the elderly, as a demographic vulnerable to digital devices, had limitations in maintaining prolonged focus on their phones; nonetheless, they exhibited quick response times and high engagement levels while receiving news from their adult children or viewing photographs on their phones.



Figure 3 User Research & Shadowing

### 3. 5. Utilizing Methodology; Identifying Pain Points based on Customer Journey Mapping

To gain a more detailed and systematic understanding of the experiences that senior users may encounter, and to derive user-centric ideas, we created personas and ‘customer journey maps’. By analyzing various data collected through research, interview content, and shadowing results, we aimed to identify user needs, motivations, and behavioral patterns, while also discovering common patterns or characteristics. Subsequently, we developed a hypothetical persona that reflects the representative traits of each user segment, aiming for it to align closely with actual senior users, and then constructed the customer journey map as outlined below. Based on the goals, behavior patterns, and characteristics of the persona extracted from field research, we established the key stages of utilizing the dementia prevention app and mapped the actions, emotions, and thoughts of the persona at each stage. Throughout this process, we identified the touchpoints at which the persona interacts with the app and outlined the potential pain points that could arise at each touchpoint.

Subsequently, a virtual persona was created to reflect the key characteristics of each user segment that is closely aligned with actual senior users. Based on this persona, a customer journey map was developed as outlined below. The major stages involved in using the dementia prevention app was established by utilizing the goals, behavioral patterns, and traits derived from field research, which creates a mapping of the actions, emotions, and thoughts of the persona at each stage. During this process, interaction points between the persona and the application were identified, along with potential issues at each point.

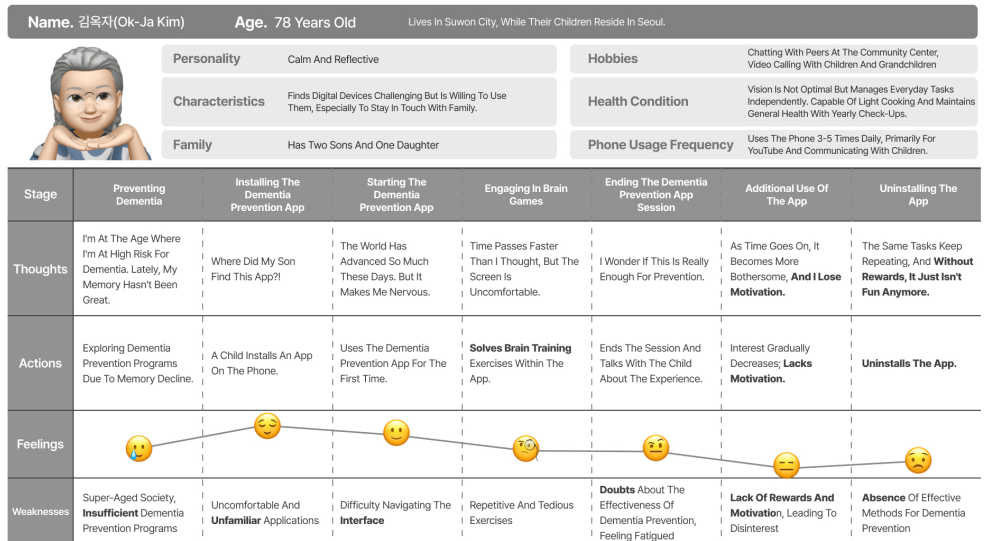


Figure 4 Persona & Journey Map

The results of the customer journey mapping revealed two key pain points. First, the currently available dementia prevention apps result in dissatisfaction among users from the senior demographic in terms of UX/UI. While the app has the advantage of providing convenient brain training, older users experience discomfort due to the cumbersome UI and repetitive, uniform training methods. Secondly, the existing dementia prevention apps lack a reward system and motivational elements that encourage sustained use. This deficiency makes it challenging to maintain continued engagement, leading to disillusionment with the dementia prevention experience. Therefore, it is essential to develop dementia prevention apps that address these pain points.

### 3. 6. Establishing Insights and Problem-solving Direction: ‘Support from Adult Children’ as a Reward

This study employed the HMW (How Might We) method based on field research and customer journey map pain point analysis to derive a creative problem-solving direction. As a result, the key challenge was defined as motivating elderly users to continue using dementia prevention applications consistently. Most existing dementia prevention apps adopt a score-based feedback system aimed at enhancing cognitive abilities. However, this approach provides only a sense of accomplishment and lacks the depth required to serve as a long-term motivational factor. This limitation is particularly evident among older adults who are less familiar with digital technology—score increments alone are often insufficient to sustain engagement. Thus, a stronger motivational mechanism was necessary. To address this, the researcher analyzed the moments when seniors most actively engage with smartphones. Previous findings indicated that the moment when older users most actively use their smartphones is when communicating with their adult children. This suggests that the elderly are more engaged not merely during cognitive training tasks, but when they receive emotional satisfaction through encouragement and support from their adult children. Based on this insight, this study proposed a core solution that offers communication with adult children as a form of reward within the brain training process. By introducing the

concept of emotional motivation—an element absent from existing dementia prevention apps—the goal was to move beyond basic score feedback and instead utilize emotional bonding as a means of fostering sustained engagement.

To validate the effectiveness of this concept, several social-psychological theories related to elderly motivation were applied. First, according to Social Support Theory, emotional support provided by adult children positively influences the psychological well-being of their parents, thereby helping them sustain consistent behaviors. In addition, both Incentive Theory and Socioemotional Selectivity Theory suggest that receiving messages or support from one’s adult children can act as an extrinsic reward that enhances emotional satisfaction and, in turn, fosters motivation. Furthermore, through the application of Self-Determination Theory and Reinforcement Theory, emotional exchanges with adult children serve as ongoing motivational stimuli for elderly users, reinforcing positive perceptions of brain training and increasing the likelihood of sustained participation.

In conclusion, the application was designed not simply around a score feedback system, but rather on a novel approach that utilizes “emotional connection with one’s child” as the core motivational factor. Unlike existing dementia prevention apps that focus solely on cognitive training, this approach incorporates emotional family interactions, thus functioning as a practical and emotionally engaging solution that can effectively trigger user behavior.

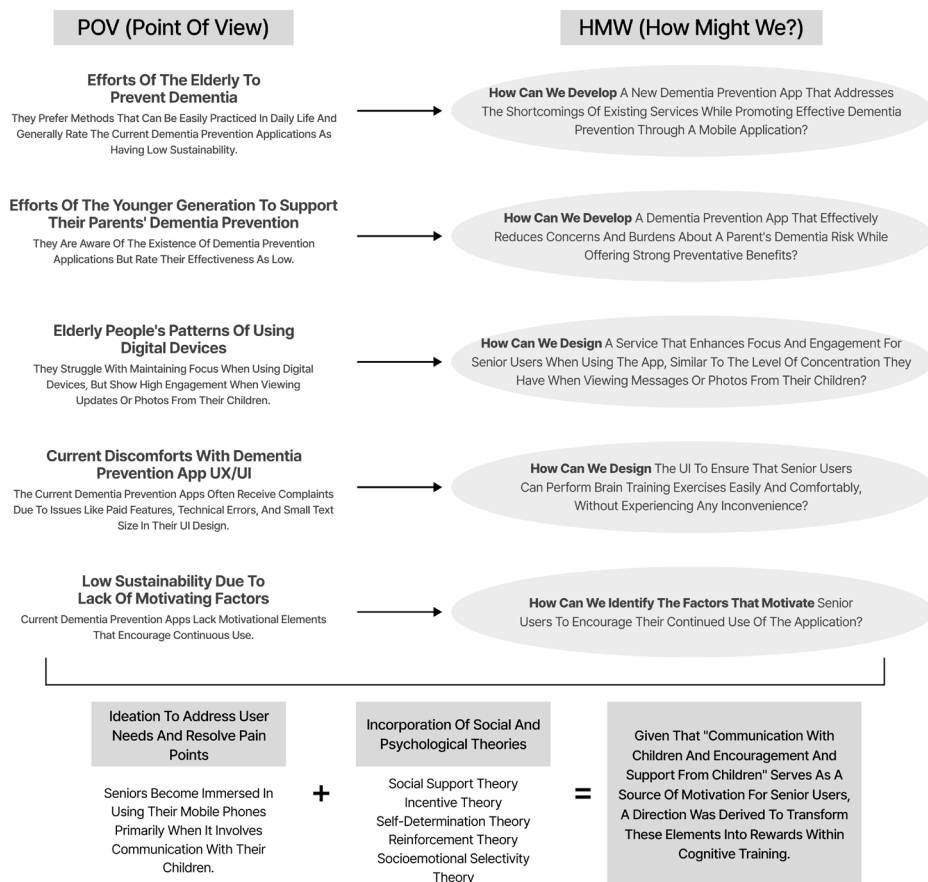


Figure 5 Insight

---

## 4. The Second Diamond: Develop and Deliver

### 4. 1. Establishment of the application concept and features

In accordance with the sequential process outlined above, it is noted that communication with adult children, along with their encouragement and support, can serve as significant rewards for enhancing the happiness of the senior generation. Accordingly, a reward system was developed in the app to display adult children's and grandchildren's faces. As a result, a system of two interconnected apps was devised: one for parents and one for adult children. When adult children leave encouraging messages, audio, photos, or videos in their version of the app, parents are presented with these reward elements each time they engage in brain training through the parents' version of the app, thus providing sustained motivation for their training efforts. The reward system offered by the app can provide psychological satisfaction to senior users by enabling them to experience emotional connections with their adult children, extending beyond mere cognitive training.

After defining the app's core concept and functionalities, each feature was planned, and an app name and slogan were created to convey the service's value clearly. Under the fundamental feature of "providing motivation through mutual interconnection of the two apps," the parents' version includes detailed functions such as "adjusting brain training difficulty," "viewing encouragement messages," and "checking adult children information," while the adult children's version includes "leaving encouragement messages," "viewing parents' training results," and "checking parent information." In terms of naming and slogan, we finalized the app name as 'Match' which reflects a playful linguistic twist on the word 'dementia' (when read in reverse in Korean) while embodying the value of connection between parents and adult children. Consequently, the slogan was finalized as 'Overturning Dementia and Realizing the Value of Connection, Match.'

### 4. 2. Application Designing: Wireframe

In the app design process, creating a flowchart followed by wireframes is essential to systematically structure the user experience. First, a flowchart was created to visually map out the transitions between features and screens within the app, allowing for a clear and comprehensive planning of the overall user flow. This helped anticipate the sequence and manner in which key features would be implemented and enabled the logical design of user interactions. To ensure ease of use for the senior generation, unnecessary complexity was minimized and core functionalities were clearly communicated. Based on this structured flowchart, the parent version of the app was designed with a simplified and intuitive interface to deliver brain training and support messages from children, while the child version was designed to allow users to easily view their parent's training results and send supportive messages in various formats.

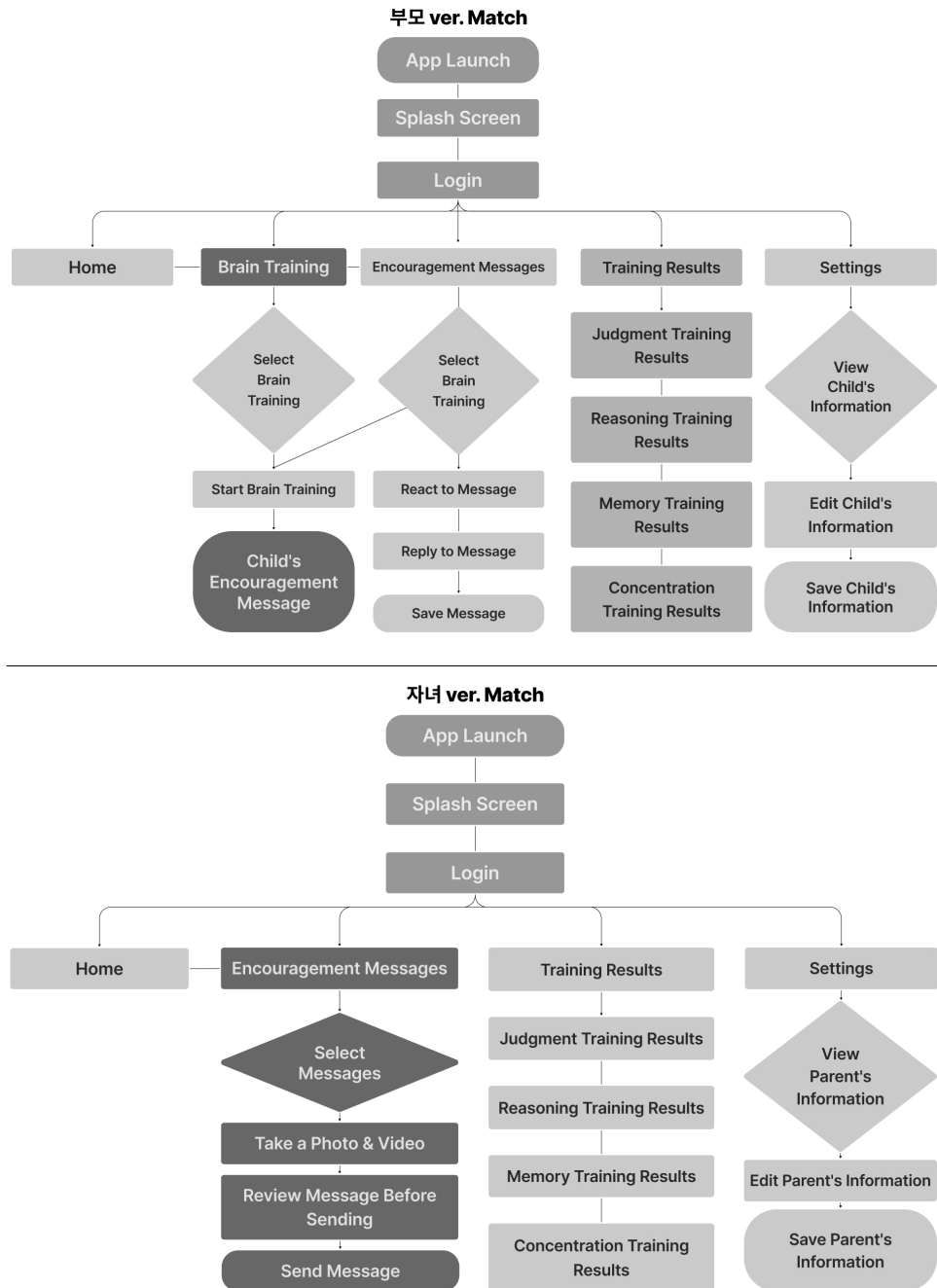


Figure 6 Match Wireframe

### 4. 3. Application Implementation; UI design by functionality

#### (1) Parent Version of the Application

The main interface of the Match parent version can be divided into three screens: 'Home screen', 'Brain Training', and 'View and Display Child Encouragement'. Firstly, the primary functions of Brain Training, View Child Encouragement, and View Training Results are easily accessible on the Home screen. Furthermore, users can intuitively check the brain training history and scores of the day, enabling them to gauge their progress in the activities.

Secondly, the proposed application is fundamentally a brain training application. According to research findings, frequent use of the brain in daily life can reduce neurological damage, indicating that increased cognitive activity helps prevent dementia. Through consistent brain training, it is possible to delay the onset of dementia by increasing the number of neural transmission pathways. In particular, activities such as memory exercises, orientation, perception, concentration, judgment, spatial awareness, numerical reasoning, language tasks, and journaling are known to be effective in this regard (Jung., et al., 2018). In the case of Brain Training, users can select from one of four training options that aid in brain activation (cognitive ability, judgment, concentration, memory). For each training session, a time limit is established to enhance concentration, and a variety of problems is presented to minimize boredom.

Lastly, when users correctly answer questions or achieve high scores during Brain Training, a motivational video (or image) featuring their child is displayed randomly. This feature serves as a key differentiator of the application, as it has the potential to motivate users to solve problems or to maintain engagement in brain training activities. The non-dominant hemisphere of the brain—responsible for functions not typically carried out by the dominant hemisphere—plays a role in recognizing facial expressions and processing vocal tones or intonations from others (Daniel G. Amen et al., 2000). This contributes to emotional stability and influences the temporal lobe of the non-dominant hemisphere. The encouragement content can be reviewed after the training is over, but with restricted access to only contents that was viewed during the training of that particular day, thereby promoting consistent engagement in brain training. As an additional feature, the application prompts users—before exiting the app—to recall the most memorable message received from their child during the day’s training session and write down why it was particularly meaningful. This encourages memory-based activation of the temporal lobe and provides a thoughtful conclusion to the training session.

In terms of UI design, accessibility was prioritized, reflecting the characteristics of the elderly demographic. A relatively eye-comforting green color was employed, alongside a sans-serif typeface to enhance readability. Considering the visual capabilities of the senior generation, adjustments were made to the font size of the main text and titles, positioning essential information in the center for ease of recognition. Graphic elements were designed with large buttons and intuitive icons to facilitate accurate touch interactions and to further enhance accessibility.



Figure 7 Application “Match” (1)

## (2) Adult Child Version of the Application

The main screen of the Match child version can be divided into two sections: 'Home' and 'Leave a Support Message.' Firstly, on the Home screen, children can view the real-time results of their parent's brain training activities at a glance, and by clicking on the activity history button, they can access detailed records of the brain training activities, scores, and levels of dementia prevention, among other information. A large button is prominently placed to facilitate easy and convenient access to this primary function. Next, the 'Leave a Support Message' feature, which is the most crucial function, allows the adult children to leave encouraging messages in the form of images or videos, and when opting for video messages, a suggestion feature for commentary is provided to enable users to easily create a variety of support messages. This functionality is designed to encourage ongoing support and encouragement to parents without burden, thereby enhancing the interactivity between the two applications.

In terms of UI design, the application reflects the digital affinity and aesthetic preferences of the 30-40 age group. While maintaining an overall consistency with the parent version, the same color scheme is utilized as the main color to strengthen the brand identity. A sans-serif typeface is employed, with the body text set at 14-16 points and titles at 20-28 points to improve readability. As for the layout, it is structured simply and intuitively to enhance the efficiency of information navigation, with critical information positioned at the top of the screen to capture the user's attention. For graphic elements, a minimalistic and intuitive approach is taken, providing appropriately sized buttons and touch areas.



Figure 8 Application “Match” (2)

### (3) Interaction Between the Parent and Child Versions of the Application

Match is a parent–child interactive dementia prevention application developed based on insights obtained through Double Diamond process-driven research, and is guided by the core solution of “connection with one’s child” as a form of motivational reward. The interaction between the parent version and the child version of the application unfolds as follows.

First, the child user utilizes the “Send a Support Message” feature to upload photos, videos, or voice messages intended for their parent. Once uploaded, these messages are automatically updated and linked to the parent’s version of the application. During brain training sessions, the parent version is designed to display the child’s support messages at key moments—either upon solving a set number of problems or when the difficulty level increases. For example, while the parent is engaged in concentration training, a randomly selected message from the child may appear after the parent answers a specific number of questions correctly. These emotionally resonant messages are intended to inspire and motivate the parent through positive reinforcement.

Importantly, the messages are not accessible on demand; they can only be viewed in the midst of brain training sessions. This ensures that emotional feedback is directly tied to the user’s engagement in cognitive activity, encouraging continuous participation. Once all available support messages have been delivered and viewed by the parent, the child receives a push notification prompting them to upload new support messages via the child version of the app.

This mode of interaction functions as a meaningful reward mechanism for the parent, offering emotional motivation that is absent in existing dementia prevention applications. The system is specifically designed to activate motivation by enhancing emotional bonds and communication between senior users and their adult children. By satisfying the needs of both the primary user group (the elderly) and their indirect stakeholders (adult children), this solution addresses previously identified pain points and demonstrates the potential to deliver tangible social value through a human-centered digital service.

#### 4. 4. Evaluation for Users and Experts

To validate the effectiveness of the application and ensure user satisfaction, it is essential to conduct user testing along with expert consultation/validation. During this user testing, elderly participants engage with the application, allowing for the identification and rectification of potential issues and areas for improvement beforehand. Additionally, expert validation from related fields enhances the application’s reliability and assesses its market potential. Accordingly, testing was conducted on the final outcome of planning and UI design process, involving three senior users, three users from the younger generation, and five experts in UXUI and service development. Referencing prior research (Yoo et al., 2024) and analyzing the evaluation criteria from the Smart App Awards, UX evaluation factors were collected and compiled to construct a total of ten questions across three categories: utility, usability, and aesthetics, as outlined below. The evaluation utilized a Likert scale (ordinal scale), ranging from ‘Strongly Disagree (1 point)’ to ‘Strongly Agree (5 points)’.

Table 9 Focus Group Interview Question

Category	Questions
Usefulness of Planning (whether this application provide practical assistance in preventing dementia)	1-1. (both versions) Can brain training through applications provide tangible assistance in addressing dementia issues? 1-2. (parent version) Is the application structured appropriately to enable senior users to use it periodically in order to prevent dementia? 1-3. (parent version) Does it provide motivation for senior users to actively engage in brain training? 1-4. (child version) Does the application provide reasons for child users who are worried about their parents’ risk of dementia to continue using it?
Usability of Functions (whether users can continuously and effectively use the application)	2-1. (both versions) Do the application’s features align with its purpose while providing services intuitively? 2-2. (parent version) Can senior users navigate the application easily without getting lost? 2-3. (parent version) Is the process of brain training for senior users systematically organized in a manner that facilitates convenience? 2-4. (child version) Is it possible for child users to utilize the application easily and conveniently?.
The Aesthetics of the User Interface (whether it provides an application design that is intuitive and considers user convenience)	3-1. (both versions) Is the application’s menu and navigation designed to be intuitive and considerate of user convenience? 3-2. (both versions) Is the classification and structure of the information logical, and is the labeling easy to understand and appropriately organized?

The testing was conducted by presenting the application screen to both the user and expert groups and evaluating the metrics accordingly. The results of the test yielded an average score of 3.9 from user participants, while child participants gave a score of 4.7. Expert users gave a score of average 4.1. Additionally, an unstructured interview was conducted with the expert group following the test. Four experts, actively engaged in the fields of UX/UI, service design, and product development and planning, provided in-depth evaluations from technical, design, and user experience perspectives, highlighting detailed aspects that could be overlooked during the development process, thus contributing to the delivery of a higher quality service to actual users. The expert validation results is summarized as follows.

Table 10 Verification and Feedback Content

Expert	Verification and Feedback Content
Expert A (UXUI Designer)	<ul style="list-style-type: none"> <li>- It is intriguing to interpret dementia prevention as a form of reciprocity within the parent-child relationship, and the process of deriving conclusions through research and interviews appears to be well-structured.</li> <li>- The impression is strongly conveyed that parents are solving problems while adult children provide rewards, which does not foster a sense of two-way communication. It may be beneficial to incorporate features or elements that actively engage adult children in the process.</li> <li>- Furthermore, if the project is planned as a free service, there is a need for establishment of a business model (BM) for when it eventually becomes commercially viable.</li> <li>- Regarding the interface, the UI section features components that are composed of similar colors, which does not effectively deliver clear groupings. This aspect warrants improvement.</li> </ul>
Expert B (UXUI Design Researcher)	<ul style="list-style-type: none"> <li>- From a planning perspective, the thorough research on direct and indirect stakeholders, along with various human-centered studies, derived vivid insights and led to the pursuit of ideation that meets their needs.</li> <li>- In terms of UI screen design, it is recommended to explore resources related to accessibility for the senior generation. There is a guideline that suggests "the contrast ratio between the text content and background should be at least 4.5:1" for general texts. When applying the color codes for the Match screen, the contrast ratio turns out to be approximately 2.573:1.</li> <li>- It is assessed that the text sizes in the parent and child versions differ, and the navigation tab bar at the bottom of the parent version screen is well-designed, in a way that specifically target older users by providing text options.</li> </ul>
Expert C (Professor of UXUI field)	<ul style="list-style-type: none"> <li>- It appears beneficial to present the desire to see one's adult children as a form of compensation in terms of the design aspect related to rewards. However, in order to advance the product, there is a need for specific strategies and depth in design. From the parents' standpoint, the aspect they are likely to encounter frequently is the messaging from their adult children, but there is a concern that this may become rapidly monotonous if repeated too often.</li> <li>- There is a necessity for establishing mechanisms to obtain diverse input data from the adult children's version of the application. For instance, it would be advantageous to derive reactions through various missions, think about the formulating contextually relevant messages, or incorporate real-time responses taking time-sensitivity into consideration, exploring various other approaches.</li> </ul>
Expert D (Professor of Service Design field)	<ul style="list-style-type: none"> <li>- In terms of planning new services for the rapidly growing elderly population, 'Match' could potentially serve as a means of revitalization for seniors.</li> <li>- It appears that the research, from literature review to field research, has been carried out very thoroughly from a service planning perspective. From a practical standpoint, it seems necessary to make a business model or revenue structure for marketing management when operating this service. Regardless of the type of service (unless it is planned with a public benefit aspect), a clear return on investment (ROI) is essential for ongoing maintenance and operation.</li> <li>- In the case of the elderly, there is a remarkable propensity to respond fervently to community-based gatherings. Reflecting this aspect, I hope that the service called 'Match' can serve not only as a connection between the elderly and their adult children, but also provide opportunities for local seniors to meet and connect with one another.</li> </ul>

In addition, the usability of the application developed in this study was reviewed not only by UX experts but also by medical professionals specializing in geriatric care. A supplementary focus group interview (FGI) was conducted with three healthcare professionals—a physician from a long-term care hospital in Gangwon Province, a former practitioner at a geriatric hospital, and an internist specializing in elderly care—to assess and anticipate the actual

effectiveness and contribution of the application to dementia prevention. The expert review results suggested that, compared to existing dementia prevention applications, this application may offer a more effective motivational mechanism to encourage continued use among elderly users. In particular, the medical professionals involved in the FGI commonly noted that the parent–child interaction model proposed by the app could serve as a meaningful form of emotional reinforcement for older adults, and they expressed a generally positive outlook on the app’s usability. However, several participants also emphasized the need for further experimental research. Specifically, while the expert evaluations offer encouraging insights, they alone are insufficient to fully validate the app’s effectiveness in the absence of clinical trials. As such, the experts recommended developing a Minimum Viable Product (MVP) and conducting real-world user testing to empirically verify whether the proposed solution can produce a significant impact on dementia prevention.

Table 11 Verification and Feedback Content

Expert	Verification and Feedback Content
Expert A (Medical staff of the Thoracic Department of Aged Care Hospital)	<ul style="list-style-type: none"> <li>- If hospitalized patients in long-term care facilities are able to consistently engage in brain training and communicate with their adult children and family members through the application, it may prove effective in both preventing dementia and alleviating its symptoms.</li> <li>- The rewards offered through the application could serve as meaningful motivation for patients, particularly those who have limited daily activities, encouraging them to actively participate in cognitive training.</li> <li>- When generating brain training exercises, if the content could be categorized to reflect domains frequently assessed in neuropsychological evaluations such as the Seoul Neuropsychological Screening Battery (SNSB)—including attention, memory, language, judgment, visuospatial perception, frontal lobe function, and emotional regulation—it could provide clinically valuable data for healthcare professionals in diagnosing and evaluating the progression of various types of dementia.</li> </ul>
Expert B (Medical staff of the Anesthesiology Pain Department at Aged Care Hospital)	<ul style="list-style-type: none"> <li>- The positive emotional responses often exhibited by elderly users upon receiving messages from their adult children are frequently observed in long-term care settings as well. This indicates that such a design could meaningfully contribute to continued engagement with the application.</li> <li>- The application’s interface is simplified in alignment with the cognitive characteristics of elderly users, and the inclusion of support messages during training sessions effectively provides emotional stability—an aspect perceived as particularly impactful.</li> <li>- While emotional connection with adult children or family members is a crucial factor for real patients, which makes the concept a promising one, its sustainability may be limited if busy adult children are unable to consistently upload messages. To enhance long-term engagement, it would be beneficial to incorporate additional motivational elements for adult children. Specifically, allowing multiple family members (e.g., siblings, cousins) to participate in sending reward messages via the child version of the application could help establish a more robust and sustainable reward system.</li> </ul>
Expert C (Oriental doctor)	<ul style="list-style-type: none"> <li>- Most dementia prevention applications primarily focus on functional cognitive training, which often limits their ability to encourage repeated use by users. However, this application stands out for its incorporation of emotional motivation by positioning the child’s support as a reward, providing a naturally integrated incentive mechanism.</li> <li>- Considering the primary user age groups, it is expected that patients will typically fall within the 70–90 age range, while their adult children will be between 45–65 years old. For patients in the older age bracket, using a smartphone independently may be challenging; therefore, developing a companion application optimized for tablet devices could enhance usability and accessibility.</li> </ul>

---

## 5. Conclusion

### 5. 1. Summary and Significance of the Research

This study aimed to propose a brain training application for dementia prevention and achieved meaningful outcomes from both procedural and result-oriented perspectives. From a procedural standpoint, the study employed an Applied Double Diamond Process as a systematic approach to solving a pressing social issue. In contrast to the conventional Double Diamond process, this adapted version placed a greater emphasis on the Discover and Define stages, strengthening in-depth research and multifaceted analysis. Through a combination of literature reviews, field research, user interviews, and customer journey map analyses, the study systematically identified the genuine needs of senior users and the key motivational factors necessary for effective dementia prevention. This comprehensive approach enabled the development of a creative and targeted direction to address the shortcomings of existing dementia prevention applications.

From a result-oriented perspective, the study proposed a motivational strategy centered around emotional interaction between parents and adult children, moving beyond the conventional focus on cognitive training alone. While existing applications primarily aim to enhance cognitive functions, they often fall short in sustaining long-term user engagement. The solution proposed in this study introduces “encouragement from adult children” as a form of emotional reward to promote continued brain training. This approach is rooted in insights drawn from dementia prevention research, social-psychological theories, and observational methods, and it reflects a significant differentiation from existing dementia prevention applications.

More importantly, the solution proposed in this study goes beyond mere functional improvements; it presents a new direction for dementia prevention applications by incorporating practical motivational factors tailored to senior users. By encouraging consistent brain training through emotional reinforcement, this approach is expected to enhance the effectiveness of dementia prevention efforts and improve the overall quality of life for elderly individuals.

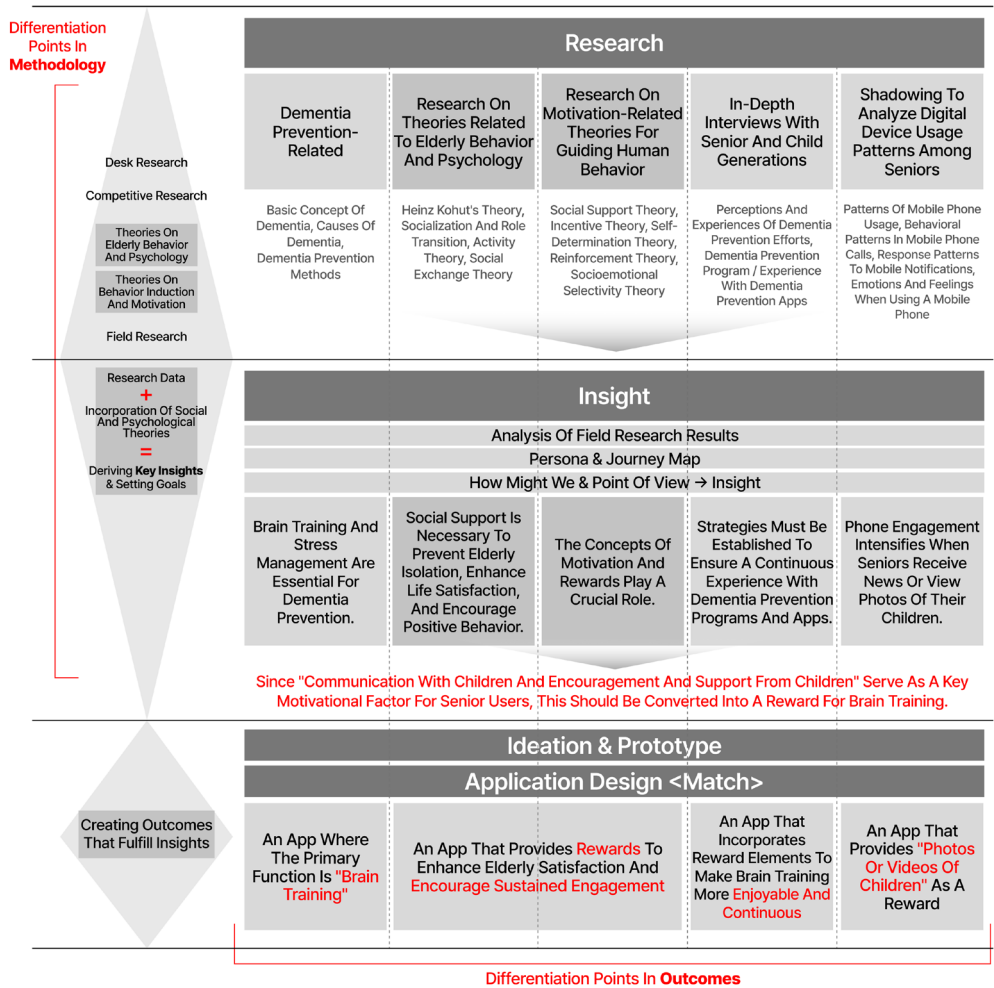


Figure 9 Differentiation in Research Methodology and Outcomes

## 5. 2. Limitations and Suggestions for Future Research

This study proposed a dementia prevention application that encourages sustained brain training in senior users by leveraging emotional interactions with their adult children as a motivational strategy. Through this approach, the study aimed to address the limitations of existing dementia prevention applications and contribute to the development of more effective cognitive training solutions. However, to enhance the academic and practical impact of this research, further empirical verification and supplementary studies are necessary.

First, there is a need for more quantitative validation of the actual impact of parent-child interaction on app usage. While this study identified parent-child interaction as a motivational factor for seniors based on social-psychological theories and user interviews, empirical validation was limited. Future research should incorporate experimental designs and detailed survey items that can specifically measure the influence of adult children's encouragement on the continuity of brain training in parents. For instance, adding evaluation questions such as, "Did receiving a support message from your child increase your motivation to continue brain training?"—along with general UI/UX questions—would allow researchers

to obtain more objective data on the effectiveness of the proposed motivational approach. Second, in line with the above, longitudinal usability research based on actual user testing is required. Although this study built a prototype and conducted expert evaluations with UX/UI specialists and healthcare professionals, the application was not officially launched. Thus, follow-up research should focus on deploying the application in a real-world context, collecting long-term user data, and analyzing patterns of engagement and sustained use. Such a study would allow for empirical assessment of whether emotional interactions between parents and adult children function as a meaningful motivational reward over time, and whether this interaction has only a short-term effect or also contributes to long-term app engagement and training adherence.

In conclusion, this study holds significance in that it proposed a novel approach to sustaining user engagement in dementia prevention applications. However, future research should quantitatively verify the motivational effect of parent-child interaction, evaluate long-term usability and dementia prevention outcomes based on real user data, and explore broader applications across diverse user groups. These efforts would further strengthen the academic and industrial contributions of this research.

## References

1. Amen, D. G. (2000). *Change Your Brain, Change Your Life*. Hanmunhwa.
2. Blazer, D. G. (1982). *Depression in Later Life*. St. Louis: C.V. Mosby.
3. Blazer, D. G. (2007). 노년기 정신건강 [Mental Health in Later Life]. HAKJISA.
4. Cassel, J. (1976). The Contribution of the Social Environment to Host Resistance. *American Journal of Epidemiology*, 104, 107.
5. Fries, J. F., & Crapo, L. M. (1981). *Vitality and Aging: Implications of the Rectangular Curve*. San Francisco: W. H. Freeman and Co.
6. Hwang, S. H., & Lee, Y. H. (2020). *잠든 당신의 뇌를 깨워라 [Awaken Your Sleeping Brain]*. Book&Edu.
7. Jhu, Y. (2020, October). The Seoul Asan Medical Center research team validates the effectiveness of the 'Smartphone App' for cancer patients. *Medical Observer*. Retrieved from <http://www.monews.co.kr/news/articleView.html?idxno=214345>
8. Jung, J. H., Hong, M. H., Kim, H. J., & Koo, D. H. (2018). 치매가족을 위한 치매관리 프로그램 [Dementia Management Program for Families]. Elman, p.161.
9. Jung, S. H., & Jang, Y. S. (2015). 자기결정성이론의 HRD 적용에 대한 논의 [Discussion on Applying Self-Determination Theory in HRD]. *HRD Research*, 17(3), 101.
10. Kim, M. A., Kim, T. J., Moon, M. Y., & Kim, T. H. (1999). 사회적 노화이론에 대한 고찰 [Review of Social Aging Theory]. *Journal of Korean Gerontological Nursing*, 85-96.
11. Kim, Y. M. (2024). *Cogging Brain Exercise Workbook*. Seoul: Keungeulja Publishing.
12. Korea Psychological Counseling Center. (2022, June 27). Motivation: What is it? Retrieved from <https://www.mypkcc.com/43/?q=YToyOntzOjEyOjRZl3b3JkX3R5cGUiO3M6MzoiYWxsljtzOjQ6InBhZ2UiO2k6MTM7fQ%3D%3D&bmode=view&idx=11962424&t=board>
13. Korean Dementia Association Neurobehavioral Research Group. (2017). 치매의 신경행동증상 [Neurobehavioral Symptoms of Dementia]. The Korean Medical Publishing, pp. 48-52.
14. Ma, S. E., & Baek, C. H. (2014, May). 유아용 사운드 인터랙티브 식탁도구 "베베포크" 강화이론 기반 연구 [Study on Sound-Interactive Tableware "Bebe Fork" for Infants Based on Reinforcement Theory]. *Proceedings of the Korean Society of Design Science*, 142.
15. Myongji Hospital Dementia Research Institute. (2021, December). Evaluation tool for dementia awareness and survey. Myongji Medical Foundation.

16. Nam, M. K. (n.d.). *Validation of Socioemotional Selectivity Theory* (Doctoral dissertation, Ewha Womans University). Seoul, Korea: Ewha Womans University.
17. Na, D. R. (2024). *90% Chance of Dementia Prevention*. Seoul: Neumin.
18. Park, H. J. (2014). Preventing dementia while trying to win a 'Gold Medal'. *Modern Health News*. Retrieved from <http://hnews.kr/news/view.php?no=23594>
19. Rodin, J. (1986). Control and Well-being in the Elderly. *Sciences*, 233, 1271.
20. Sophia, W., & Nussbaum, A. M. (2018). *Pocket Guide for Elder Mental Health*. HAKJISA.
21. Song, M. J., Song, J. S., & Lee, H. W. (2021, April). 경로당의 시설규모와 치매 예방 프로그램 운영 [Research on the Facility Size of Senior Centers for Dementia Prevention Programs]. *Journal of the Architectural Institute of Korea*, 41(1), 579.
22. Statistics Korea. (2023, September 26). 2023 Statistics on the Elderly. Retrieved from [https://kostat.go.kr/board.es?mid=a10301010000&bid=10820&act=view&list\\_no=427252](https://kostat.go.kr/board.es?mid=a10301010000&bid=10820&act=view&list_no=427252)
23. Zimet, G. D., Dahlem, N. W., Zimet, S. G., & Farley, G. K. (1988). The Multidimensional Scale of Perceived Social Support. *Journal of Personality Assessment*, 52(1), 30-41.