

Can Software Robot Enhance Cognitive Functions of Senior People?: An Longitudinal Exploratory Field Study with Korean Older Adults

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Abstract

Background: The global prevalence of dementia is increasing at a substantial rate, underscoring the urgent need for effective treatment tools. As cognitive interventions become more accessible, non-pharmacological treatments such as digital cognitive training are gaining popularity. Past studies have predominantly focused on cognitive training applications, but their effectiveness can be limited by users' digital literacy. To address this challenge, we incorporate social interaction features, reward systems for app engagement, and AI conversational agents. In this study, we introduce a software robot called Saemi Talk, an AI conversational agent designed to facilitate cognitive training and engagement.

Objective: We developed a 12-week digital cognitive training program, Care & Cure, which incorporates a chatbot service, Saemi Talk, and a group chat service, Our Town. We conducted a field study to address two research questions. The primary objective aimed to determine whether the Care & Cure program enhances cognitive function in older adults. The secondary objective focused on assessing if Our Town improves social engagement by catalyzing Saemi Talk usage and fostering interaction between the AI agent, a software robot, and users.

Methods: A total of 133 participants were recruited for this study (age range: 51–83 years; mean age: 64.75 years). None of the participants were diagnosed with dementia. All participants underwent a three-month intervention using the Care & Cure program. The primary outcomes included changes in Korean-Mini Mental State Examination-Version 2 (K-MMSE-2) scores following three months of program participation. The secondary outcomes encompassed participant log data, degrees of social support (Medical Outcomes Study-Social Support Survey; MOS-SSS), depression scores (Short Form Geriatric Depression Scale-Korean Version; SGDS-K), and engagement scores (The Twente Engagement with eHealth Technologies Scale; TWEETS).

Results: The Care & Cure intervention substantially enhanced cognitive functioning, as evidenced by statistically significant increases in K-MMSE-2 (Hedges' $g = 0.35$, $p < .001$) scores. Active users showed statistically significant improvement in cognitive function compared to non-active users, particularly those with lower baseline K-MMSE-2 scores (Hedges' $g = 0.99$, $p < .001$). Emotional and informational social support showed statistically significant increases ($t = -6.509$, $p < .001$), alongside statistically significant increases in participants' willingness to engage with the program ($t = 2.008$, $p < .05$) and decreases in depression levels. Regression analyses demonstrated that engagement in group chat positively influenced cognitive training usage ($t = 12.395$, $p < .001$), which in turn improved social support scores ($t = 4.102$, $p < .001$) and cognitive function ($t = 2.467$, $p < .05$). However, using cognitive training programs alone did not result in a statistically significant improvement in cognitive

function. Adherence levels fell below expectations, with participants averaging 0.47 game sessions per day for Saemi Talk and 0.56 responses per day in the chat room for Our Town, indicating the need for strategies to enhance engagement and optimize intervention benefits.

Conclusions: The Care & Cure intervention effectively enhanced participants' cognitive function, social support, participation, and emotional well-being. Analysis revealed that strengthening social support was essential for achieving cognitive gains. Clinical Trial: N.A.

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Original Manuscript

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Abstract

Background: The global prevalence of dementia is increasing at a substantial rate, underscoring the urgent need for effective treatment tools. As cognitive interventions become more accessible, non-pharmacological treatments such as digital cognitive training are gaining popularity. Past studies have predominantly focused on cognitive training applications, but their effectiveness can be limited

by users' digital literacy. To address this challenge, we incorporate social interaction features, reward systems for app engagement, and AI conversational agents. In this study, we introduce a software robot called *Saemi Talk*, an AI conversational agent designed to facilitate cognitive training and engagement.

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Conclusions: The *Care & Cure* intervention effectively enhanced participants' cognitive function, social support, participation, and emotional well-being. Analysis revealed that strengthening social support was essential for achieving cognitive gains.

Keywords: cognitive impairment₁; mild cognitive impairment₂; chatbot₃; aging₄; mHealth₅

Introduction

The global prevalence of dementia is rising, with recent estimates indicating that approximately 50 million people currently live with dementia. It is estimated that the number will increase to 152 million by 2050 [1]. Dementia has a significant impact on personal, family, and economic levels, which costs the world about 1.3 trillion dollars [2]. Prevention is essential for dementia management. Among non-pharmaceutical interventions, digital cognitive training has become more popular because it has been shown to be effective [3-7]. In practice, traditional cognitive training programs are constrained by several limitations. These include (i) limited accessibility for older adults who have mobility issues, (ii) much depends on social workers, and (iii) substantial financial costs.

Many studies suggest that digital cognitive training programs with remote access can overcome these barriers [3-7]. These programs demonstrate greater scalability since they can reach a larger number of users simultaneously without requiring additional resources or staff. For example, while traditional cognitive training needs more therapists or social workers for each new group of users, digital cognitive training programs can be used by many more users with minimal additional cost. This efficiency in scaling makes them more cost-effective, which creates a more sustainable and widely accessible option [8-10].

However, current digital training programs have limited accessibility from home mainly because inadequate consideration of elderly users' digital literacy [11,12]. Low digital proficiency among older adults restricts their access to the digital training programs [13]. Even older users with the ability to use digital training programs at home equipped with all technological infrastructure often struggle with prolonged engagement [14]. Older adults face many challenges, including physical limitations, difficulty processing information, and digital service interfaces that are not easy to use [15]. These barriers worsen clinical results as the disease progresses, increased medical costs, and a greater patient burden [16].

Several solutions address these challenges, which include simplified user interfaces enough to reduce

cognitive load, gamification elements pursuing to promote user engagement, personalized digital literacy support, sending push notifications, using chatbots, and using tools to help people connect with others. These features enhance (i) usability, (ii) reduce cognitive demands and screen fatigue, and (iii) ultimately improve compliance and clinical outcomes [17]. Among these solutions, chatbots and group-based interventions have shown relatively strong potential for enhancing user engagement and effectiveness in digital cognitive training programs demonstrated by numerous studies [17-19].

Conversational agents, also known as chatbots, have the potential to resolve these barriers [20]. A substantial number of studies have shown that conversational agents used for healthcare interventions elicit moderate to high levels of participant satisfaction and acceptance, largely due to social support features [21-25]. These agents show promise to advance patient-centered care by supporting users in managing their own health [20,22]. Additionally, group-based interventions enhance program engagement by fostering interaction among members [23]. It is widely accepted that conversational agents provide effective social support when integrated with group interventions [24,25]. Two recent studies validate the effectiveness of a fully automated mobile conversational agent in providing social support [24,25]. In healthcare settings, the *Shared Medical Appointments (SMA)* model, which integrates group-based interventions, continues to gain wider acceptance as a way to improve patient engagement in treatment programs [26-29].

Under this circumstance, we propose *Care & Cure*, a chatbot-based service. The *Care & Cure* service offers 15 different cognitive training programs through *Saemi Talk*, along with a group chat feature called *Our Town*, where participants can interact with one another. This group interaction is intended to improve user engagement with *Saemi Talk*. At the core of this service is *Saemi*, a software robot that delivers personalized cognitive training and fosters social support through conversational interactions. By integrating these features, *Care & Cure* aims to meet both cognitive training and social needs of older adults.

Objectives

The primary objective of this study is to evaluate whether the *Care & Cure* program enhances cognitive function in older adults. The secondary objective is twofold: (i) assessing how social support impacts cognitive function and (ii) determining whether increased engagement with *Our Town* encourages greater usage of *Saemi Talk* and interaction with the AI agent. To achieve these objectives, we analyzed the utilization patterns of both *Our Town* and *Saemi Talk* to assess their

effects on cognitive function and social support.

Methods

Study Design

This was a single-arm, prospective, exploratory study. The protocol and all related materials were approved by the *Yonsei University Institutional Review Board* (IRB; 7001988-202401-HR-1397-06) prior to the study's initiation.

Study Recruitment

We recruited participants from *Suncheon*, a mid-sized city in *South Jeolla Province*, South Korea with a population of approximately 280,000. The city's elderly population reflects South Korea's aging demographics, with about 20% of residents aged 65 years or older [30]. *Suncheon* is well known for its robust infrastructure to support senior citizens through welfare centers, nursing homes, and silver towns that provide housing and healthcare services for older adults [31] (See [Multimedia Appendix 1](#), Section I for more details).

Suncheon Nonghyup, a key institution in the city, provides substantial support to the elderly community. Its well-established network facilitated the recruitment process (See [Multimedia Appendix 1](#), Section II for more details). The central office of the farmers' cooperatives distributed formal recruitment documents to local branches. Through this network, we recruited participants who met the inclusion criteria: individuals aged 55 and 75 who were proficient in using a smartphone. All participants provided written informed consent prior to participating in the study.

Inclusion and Exclusion Criteria

The inclusion criteria included adults (i) aged 55 to 75 years who were able to read and write Korean (for more rationale, see [Multimedia Appendix 1](#), Section III) and (ii) owned a smartphone with text typing proficiency. We excluded adults who (i) lacked formal education or were illiterate, (ii) had severe visual or auditory impairments, and (iii) experienced difficulty using a smartphone.

Prior to recruitment, we evaluated these criteria through a preliminary screening survey. Participants provided demographic information, including age, educational background, and literacy levels. They also demonstrated smartphone proficiency by performing basic tasks such as navigating the interface

and sending messages. Additionally, the survey assessed visual and auditory impairments. This screening process identified participants who met all study requirements.

Intervention

Our intervention delivered cognitive enhancement games specifically designed by neurologists, through two key components on the *KakaoTalk* platform: *Saemi Talk*, a conversational agent providing cognitive games, and *Our Town*, a group chat feature. We chose *KakaoTalk* because over 70% of South Korea's senior population uses it [32]. The *Care & Cure* program, designed to prevent dementia, integrates both components into this widely used messaging platform.

- A software robot, *Saemi*, functions as a conversational agent providing cognitive training through chatbot interactions. Conversational agents have been shown to facilitate effective remote treatment delivery [33]. These agents support users with communication difficulties through verbal or textual interactions [34,35], and are widely utilized for purposes such as memory enhancement [36] and CBT-based interactive tools for alleviating depression and anxiety [24]. For this reason, we developed *Saemi* as a conversational agent to offer 15 training games targeting six cognitive domains: calculation, language, attention, executive function, memory, and visuospatial processing [37-48] (Figure 1A; see [Multimedia Appendix 1](#), Section IV). The game difficulty adapts across five levels as users provide correct answers in *Saemi Talk*. Users receive four games for cognitive improvement at 8:00 a.m. A detailed description is available in [Multimedia Appendix 1](#), Section IV.
- *Our Town* provides a virtual space where participants interact through group chat, promoting regular engagement with other members. Each group includes more than five members, and they receive notifications and the members are expected to interact three times a day. An AI chatbot integrated into *Our Town* facilitates these interactions by moderating the group, encouraging users to engage in *Saemi Talk*, and inquiring about their daily gaming activities and general well-being. Participants receive feedback and rewards based on their daily, weekly, or monthly game completion rates (Figure 1B).

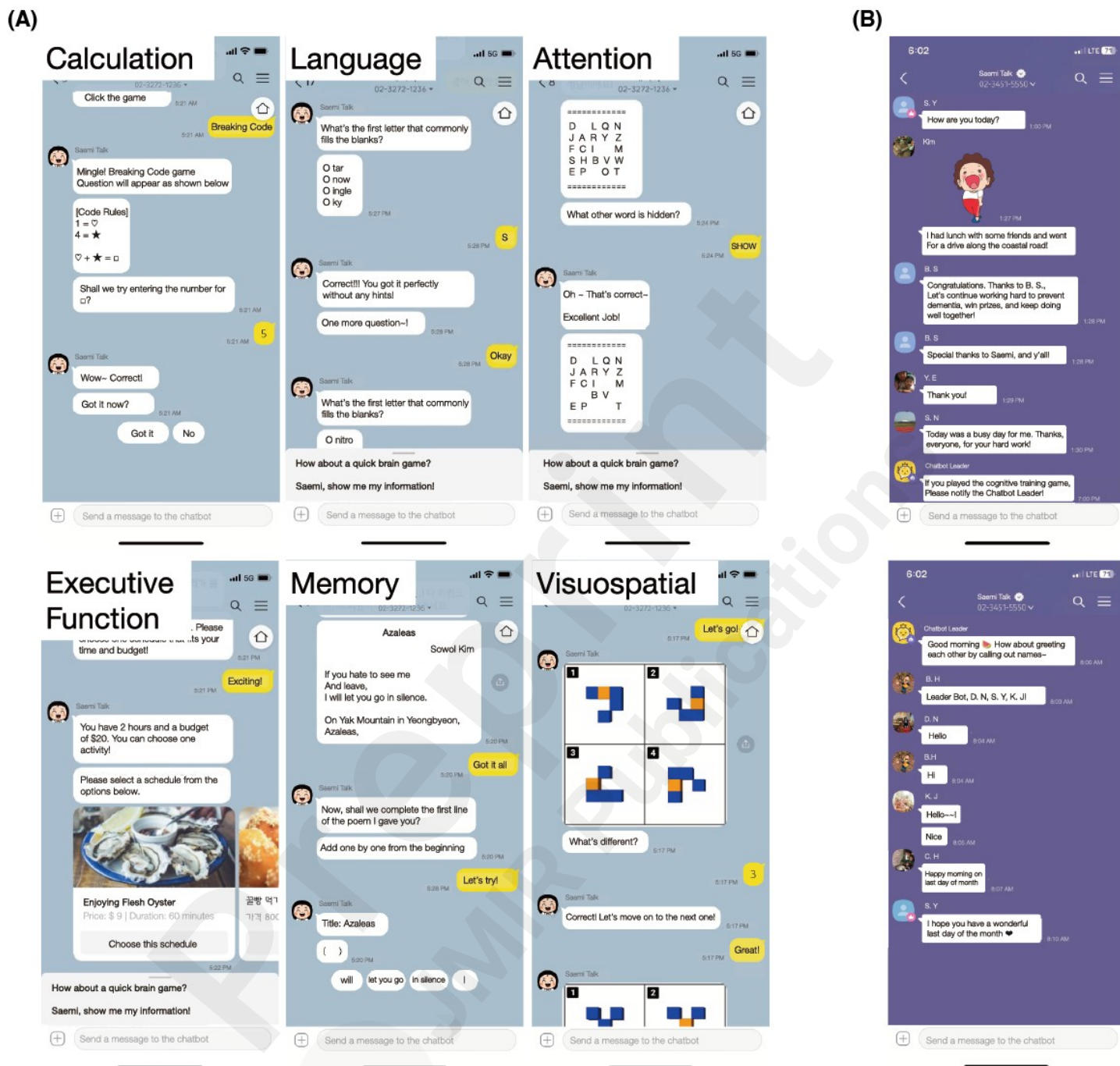


Figure 1. Overview on the proposed application. (A) Snapshots of *Saemi Talk* represent different cognitive domains in the following order: Calculation, Language, Attention, Executive Function, Memory, and Visuospatial function. **(B)** Snapshots of *Our Town*

The *Saemi Talk* chatbot functions as an autonomous digital facilitator, delivering morning greetings and encouraging cognitive training activities. The chatbot sends automated prompts three times a day (8:00 a.m., 1:00 p.m., and 7:00 p.m.) in *Our Town* to promote user engagement with digital cognitive

games and ensure task completion. To complement *Saemi Talk*'s limited autonomous functions, a human facilitator motivates less active members, monitors individual participation, and provides personalized feedback with external rewards. The facilitator tracks user messages in *Our Town* and monitors game performance through an administrative website.

For rewards, the group with the highest weekly participation rate receives \$5 gift cards for each participant and a group certificate. Additionally, when all group members complete their required four daily games, they receive restaurant gift cards for offline meetup. This integrated approach, combining an autonomous chatbot and human facilitation, fosters an environment that actively encourages engagement and consistent participation in cognitive training.

The interactions in *Our Town* exhibit straightforward structures with moderate turn-taking patterns. A daily interaction usually begins when the chatbot sends an automated morning greeting, which prompts individual responses from group members. These responses emerge sequentially, as members choose either personalised greetings or emoji-based communication. The exchanges primarily centre on three elements: mutual well-being enquiries, weather-related small talks and positive message sharing. The structural simplicity of these interactions, which consists of brief greetings and basic phrases, ensures comfortable participation. Members demonstrate varied communication preferences: some address each participant individually, whilst others prefer concise responses or emojis. Each interaction typically consists of five to ten turns, which reflects varying engagement levels. The uncomplicated, conversational nature of *Our Town* creates an accessible environment that accommodates diverse schedules and active communication styles.

A two-day educational session took place at the *Suncheon Nonghyup* Headquarters to establish baseline training. During this session, participants received an introduction to both the *Saemi Talk* programme and *Our Town* group chat, alongside a comprehensive guidebook. The research team provided telephone instructions for those unable to attend in person. Subsequently, all participants received a text message with the programme access link. The team installed *Saemi Talk* and *Our Town* directly onto the smartphones of session attendees.

Outcome assessment

The evaluation included four areas: cognitive function, emotional well-being, participant engagement and application usage. We employed two cognitive assessment scales: the Korean-Mini Mental State Examination-Version 2 (K-MMSE-2) [49] (see Supplementary Section V - Scales for more details).

These assessments took place at baseline and within seven days after the 12-week intervention. The K-MMSE-2 uses a 30-point scale, where scores of 24 or above refer to cognitively normal, 18-23 suggest mild cognitive impairment, and below 17 represent severe cognitive impairment. For emotional function assessment as a supplementary outcome, we used the Short Form Geriatric Depression Scale-Korean version (SGDS-K) [50] and the Medical Outcomes Study-Social Support Survey (MOS-SSS) [51] (see [Multimedia Appendix 1](#), Section V - Scales for more details). The SGDS-K employs a 15-point scale, where scores of 5 or below indicate no depression, 6-9 suggest moderate depression, and 10 or above signify depression. The MOS-SSS ranges from 19 to 95 points, with higher scores indicating stronger perceived social support. Changes in depression symptoms and social support served as secondary outcomes, with assessments occurring pre- and post-intervention.

In addition to these, we measured participation willingness using the Twente Engagement with eHealth Technologies Scale (TWEETS) [52] (see [Multimedia Appendix 1](#), Section V - Scales for more details), which uses a 9-point scale where higher scores indicate greater engagement willingness. The analysis on app engagement relied on log-data acquired from the administrative websites of both *Saemi Talk* and *Our Town* (see [Multimedia Appendix 1](#), Section V - Scales for more details). For *Saemi Talk*, engagement assessment included play frequency and duration across daily, weekly and monthly intervals. For *Our Town*, engagement metrics comprised the number of chat exchanges and user-agent interaction duration across identical time intervals. The overall usage metrics included total *Saemi Talk* hours and *Our Town* chat bubble quantities throughout the intervention period ([Table 1](#)).

Table 1. Measurement tool

Category	Measurement		Standard
Cognition	Cognitive Function	K-MMSE-2	30
Emotion	Depression	SGDS-K	15
	Social Support	MOS-SSS	19
Willingness to Participation	Participation	TWEETS	9
Log Data	User Engagement	Amount of Time of Cognitive Enhancement Game	Minute
		Number of Interaction in <i>Group chat</i>	Number

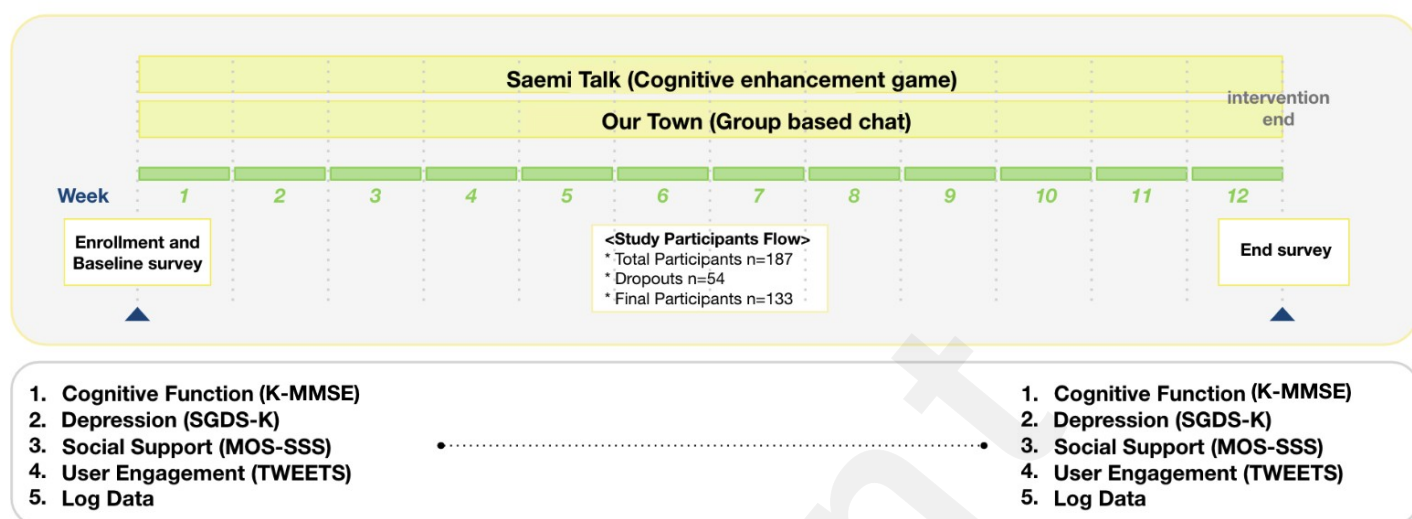
We arranged in-person meetings for pre- and post-surveys based on practical and methodological

considerations: participant age preferences, assessment administration requirements, facility availability, and geographical accessibility. The target population, aged 55-75, typically prefers face-to-face surveys over online formats. The *Suncheon Nonghyup* branch offered appropriate facilities, including halls and meeting rooms, for administering the Korean-Mini Mental State Examination-Version 2 (K-MMSE-2). These assessments required direct facilitator-participant interaction. The branch's proximity to participants' residences enhanced accessibility. Facilitators conducted pre-surveys during *Care & Cure* programme introduction sessions, whilst post-surveys coincided with reward collection visits, ensuring effective data gathering.

Study Procedures

We conducted the human subjects experiment for 12 weeks ([Figure 2A](#)). During this period, 133 participants (i) engaged in daily message exchanges through *Our Town* and (ii) completed four daily sessions of *Saemi Talk*. Each day at 8 A.M., participants received their daily activity instructions. Weekday activities consisted of four pre-selected games. During weekends and holidays, the system delivered dementia prevention information and notifications at 8 A.M. Participants maintained *Saemi Talk* engagement throughout the 12-week period. All participants completed these activities in their homes ([Figure 2B](#)).

(A)



(B)

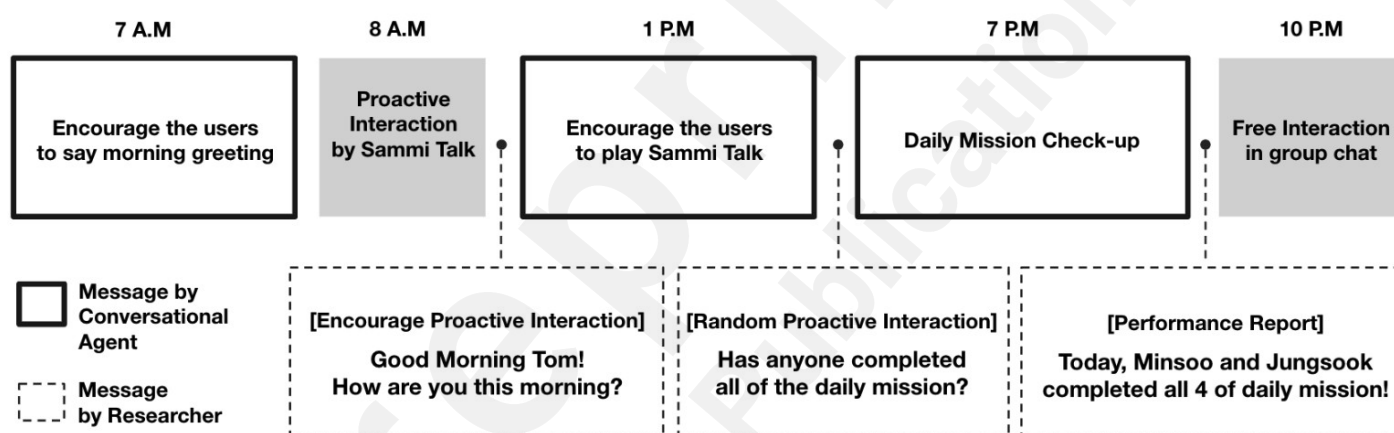


Figure 2. Overview on the study procedures. (A) Measurement tool according to the experimental procedure. **(B)** Facilitator interactions in *Our Town* (Group Chat).

Statistical Analysis

We analysed data from 133 participants using *SPSS version 28.0 (IBM SPSS Inc.)*. All participants completed the 12-week intervention, which included cognitive training games on *Saemi Talk* and the group chat platform *Our Town*. The study divided participants into two groups based on their engagement levels: active users ($n = 66$) and non-active users ($n = 67$). For comprehensive understanding on the impact of the training regarding the K-MMSE-2 scores, we additionally conducted a sensitivity analysis that categorised participants into lower ($n = 44$) and higher ($n = 88$) K-MMSE-2 groups, using baseline K-MMSE-2 median and standard deviation. Scores below one standard deviation indicated lower K-MMSE-2 status.

The analysis consisted of several components. Descriptive statistical analyses provided demographic information. Paired-sample *t*-tests identified significant differences in cognitive function, emotional relief and participation between pre- and post-intervention periods. Additional paired *t*-tests compared outcomes between lower- and higher K-MMSE-2 groups, and between high- and low engagement groups. Path analysis, through simple regression analyses, examined how group interventions affected *Saemi Talk* engagement, social support improvement and cognitive function. Repeated measures analysis of variance (ANOVA) assessed the mean and variability of daily *Saemi Talk* and *Our Town* usage across three months. Descriptive statistics supplemented this assessment for detailed data interpretation.

Results

Baseline Characteristics of the Participants

Initially, we recruited 187 participants for the study. Of these, 44 participants withdrew during the intervention period for primary measure due to survey incompleteness or personal circumstances, leaving 143 participants. After the 12-week intervention, 10 more participants withdrew for similar reasons before the second measure, resulting in 133 participants for final statistical analysis. These 133 participants ranged in age from 55 to 75 years (mean 64.76, SD 6.76). The demographic profile showed that 51.9% were female, 89.5% had been married, and 38.3% held elementary school diplomas. Most participants (68.4%) reported living with their spouse ([Table 2](#)).

Table 2. Demographic characteristics of the participants (n = 133).

Demographic characteristics	Value
Age (years)	
Mean (SD)	64.76 (6.76)
50-59, n (%)	32 (24.1)
60-69, n (%)	67 (50.4)
70-79, n (%)	34 (24.6)
Sex, n (%)	
Male	64 (48.1)
Female	69 (51.9)
Marital Status, n (%)	

	Married	119 (89.5)
	Unmarried	14 (10.5)
Education, n (%)		
	No Education	2 (1.5)
	Elementary School Diploma	51 (38.3)
	Middle School Diploma	33 (24.8)
	High School Diploma	30 (22.6)
	Community College Diploma	3 (2.3)
	College Diploma and Professional Degree	14 (13.4)
Cohabitation Type, n (%)		
	Living Alone	5 (3.8)
	Married Couple	91 (68.4)
	Married Couple with Children	31 (23.3)
	Etc	6 (4.5)

Primary Result

Overall Change in Cognitive Function

For all 133 participants, K-MMSE-2 scores showed significant improvement after *Care & Cure* programme usage ([Figure 3A](#); pre-trial: $M = 26.95$, $SD = 2.77$; post-trial: $M = 27.87$, $SD = 2.46$; $t = -4.106$, $p < .001$) with a weak effect size (Hedges' $g = 0.35$). The improvement was markedly greater in the cognitive impairment (CI) risk group compared to the healthy control (HC) group ([Figure 3B](#)). The CI group demonstrated a strong effect size (Hedges' $g = 0.724$), whilst the HC group showed a weak effect (Hedges' $g = 0.24$).

Performance Changes in K-MMSE-2 subject to Baseline Cognitive Function

Similar patterns emerged between groups categorised by baseline K-MMSE-2 median scores. For sensitivity analysis, we divided participants into two groups based on their baseline K-MMSE-2 scores: the lower K-MMSE-2 group ($n = 66$) and the higher K-MMSE-2 group ($n = 67$). Participants whose K-MMSE-2 scores fell below the baseline median of K-MMSE-2 comprised the K-MMSE-2 lower group, with remaining participants assigned to the K-MMSE-2 higher group.

Independent samples *t*-tests examined cognitive improvement differences between groups. The analysis presented that the K-MMSE-2 lower group demonstrated significant score increases post-treatment, whilst the K-MMSE-2 higher group showed no statistically significant changes ([Figure 3D](#)). Effect size analysis showed substantial impact in the K-MMSE-2 lower group (Hedges' $g = 1.117$), whereas the higher group displayed an ignorable negative effect (Hedges' $g = -0.104$; [Figure 3E](#)).

Performance Changes in K-MMSE-2 based on the Application Usage Frequency

We once again categorised the participants into non-active ($n = 66$) and active user groups ($n = 67$) based on their engagement with *Our Town* and *Saemi Talk* over the 12-week period. The participants deliberately selected the "50% of the time" threshold (i.e., to ensure an equitable distribution between the two groups. This approach aligns with the methodologies employed by Horwitz et al., who categorized participants into top and bottom 50% engagement groups in digital mental health interventions [\[53\]](#), and Bucci et al., who found higher engagement correlated with improved clinical outcomes in the Actissist app [\[54\]](#). The findings support the efficacy of the classification method and highlight its significance in digital health research. To assess the statistical differences between the groups, independent samples *t*-tests were conducted. The result showed significant K-MMSE-2 score increases in the active user group post-treatment. Higher usage frequency (active group) corresponded with greater cognitive function enhancement ([Figure 3G](#)). The lower frequency group (non-active group) showed a weak effect (Hedges' $g = 0.151$), whilst the higher frequency group demonstrated a moderate effect (Hedges' $g = 0.523$; [Figure 3H](#)).

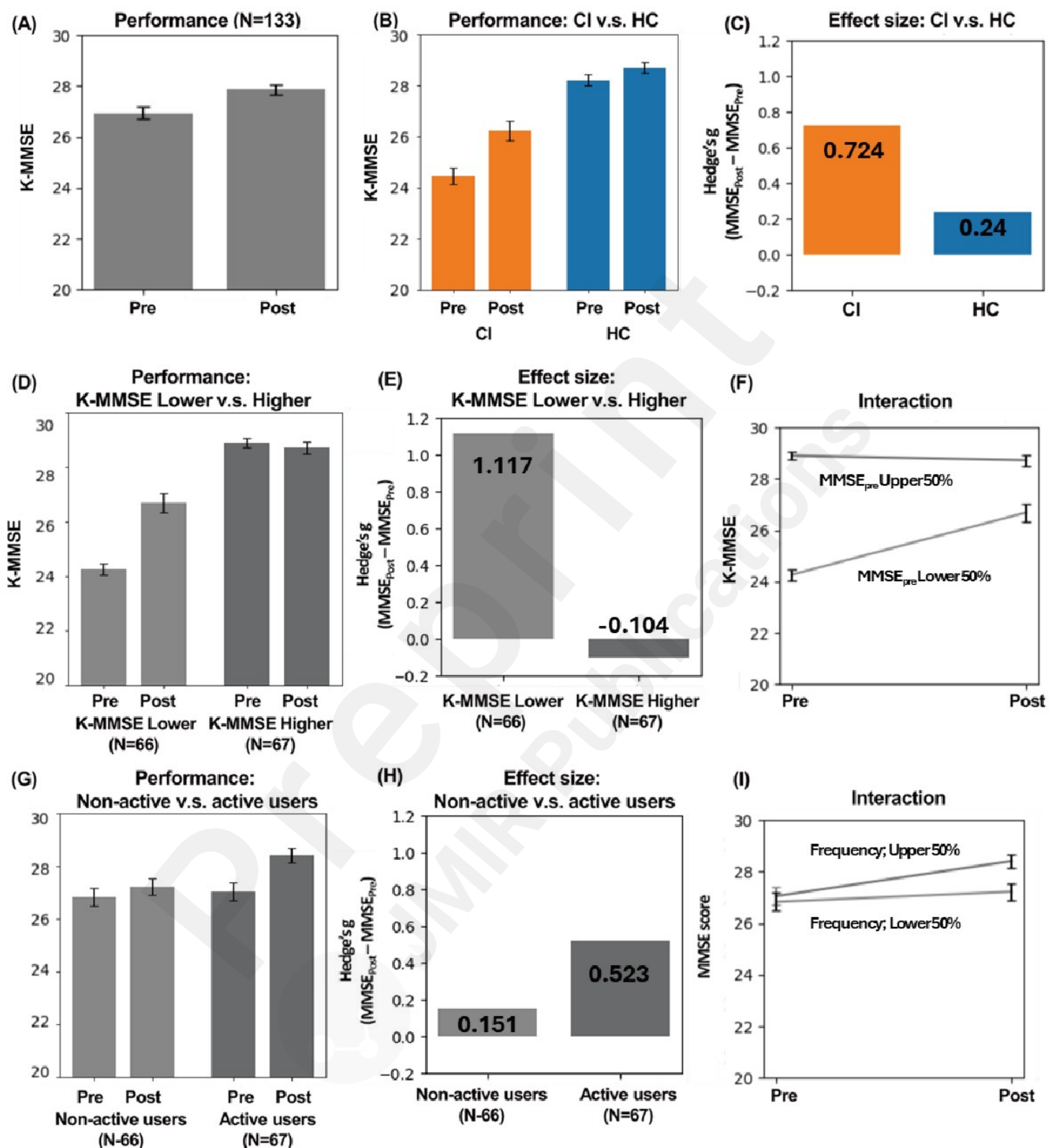


Figure 3. Overall Results. (A) Pre- and post-intervention comparison of cognitive function. (B) Performance enhancement comparing participants at risk of cognitive impairment (CI) versus healthy controls (HC). (C) Effect size. (D) Performance comparison between participants below and above baseline K-MMSE-2 median scores. (E) Effect size. (F) Interaction effect. (G) Performance

comparison between low (non-active) and high (active) app usage frequency groups (based on end-of-experiment user logs). **(H)** Effect size. **(I)** Interaction effect. We note that 'K-MMSE' in the plot refers to K-MMSE-2. (independent samples *t*-test; $p < .05$, $*p < .01$, $**p < .001$, $***p < .0001$; Note: K-MMSE-2 baseline adjusted from 0 to 23-26 range for enhanced readability; Error bars indicate Standard Error of the Mean [SEM]).

Performance Differences in K-MMSE-2 According to Age

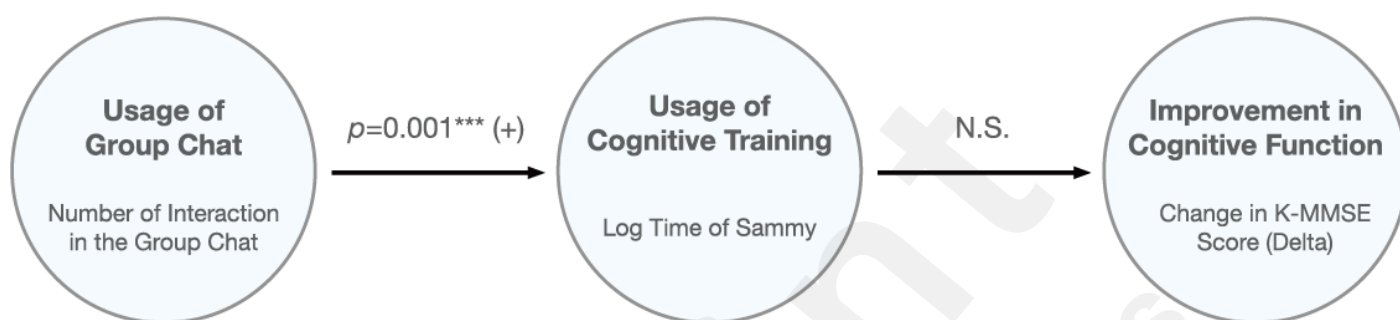
To investigate the influence of age, we again divided participants into two age groups based on the median age (66 years old): the lower age group (age ≤ 66 , $N = 70$) and the higher age group (age > 66 , $N = 63$). Independent samples *t*-tests examined cognitive improvement differences using K-MMSE-2 Delta scores. Both age groups showed increased K-MMSE-2 Delta scores, though these changes lacked statistical significance (lower age group: $M = 0.96$, $SD = 2.27$; higher age group: $M = 0.87$, $SD = 2.90$; $t = -0.187$, p -value not applicable). Effect size analysis revealed negligible differences between groups (Hedges' $g = 0.03$). See [Multimedia Appendix 1](#), Figure S2 for more details.

Secondary Result

Impact of Group Intervention on Engagement, Social Support, and Cognitive Function

To investigate the impact of group chat usage and cognitive training on cognitive function, simple regression analyses were conducted on two separate occasions. In the initial regression model, the usage of the *Our Town* (group chat), measured as the number of interactions, was found to statistically significantly influence the usage of cognitive training ($F = 153.646$, $p < .001$). The explanatory power of the regression model was approximately 54.0% ($R^2 = .540$). The Durbin-Watson statistic was 1.502, which is close to 2, indicating no significant concerns regarding the assumption of independence of residuals. Regarding the significance of the regression coefficients, engagement in *Our Town* (group chat) demonstrated a statistically significant positive effect on the usage of cognitive training ($\beta = .735$, $p < .001$). This finding suggests a positive and significant relationship between increased engagement in the group chat and greater usage of cognitive training tools. In the second regression model, the usage of the cognitive training tools, measured as total log time, did not statistically significantly influence the improvement of cognitive function, as assessed by the K-MMSE-2 Delta scores ($F = 0.158$, $p = 0.692$). The explanatory power of the second regression model was minimal, accounting for only 0.1% ($R^2 = .001$). The Durbin-Watson statistic was 2.050, which is close to 2, indicating no significant concerns regarding the assumption of

independence of residuals. Regarding the significance of the regression coefficients, cognitive training usage did not statistically significantly influence cognitive function improvement ($\beta = -0.035$, $p = 0.692$). This finding suggests that cognitive training usage did not contribute to cognitive function enhancement (Figure 4, Table 3).



* N.S. : Not Significant

Figure 4. Impact of group intervention on engagement and cognitive function.

Table 3. Summary of Regression Models Examining Group Chat Usage, Cognitive Training, and Cognitive Function

	Model	<i>B</i>	<i>S.E.</i>	β	<i>t</i>	<i>p</i>
1	Group Chat Usage → Cognitive Training Usage	1.138	0.092	.735	12.395***	<.001
	$F=153.646(p<.001)$, $R^2=.54$, <i>Durbin-Watson</i> =1.502, 95% <i>CI</i> =0.735					
2	Cognitive Training Usage → Cognitive Function Improvement	-0.001	0.003	-.035	-0.397	0.692
	$F=.158(p=.692)$, $R^2=.001$, <i>Durbin-Watson</i> =2.050, 95% <i>CI</i> =-0.035					

We conducted additional regression analyses to examine how social support mediated the relationships between group chat usage, cognitive training and improvement in cognitive function. In the initial regression model, the usage of the *Our Town* (group chat), measured as the number of interactions, was found to statistically significantly influence the usage of cognitive training ($F = 153.646$, $p < .001$). The explanatory power of the regression model was approximately 54.0% ($R^2 = .540$). The Durbin-Watson statistic was 1.502, which is close to 2, indicating no significant concerns regarding the assumption of independence of residuals. Regarding the significance of the

regression coefficients, engagement in *Our Town* (group chat) demonstrated a statistically significant positive effect on the usage of cognitive training ($\beta = .735$, $p < .001$). This finding suggests a positive and significant relationship between increased engagement in the group chat and greater usage of cognitive training tools. In the second regression model, frequent usage of cognitive training tools, defined as total interaction time with the conversational agent, was found to have a statistically significant influence on the enhancement of social support, as indicated by social support scores ($F = 16.830$, $p < .001$). The explanatory power of the second regression model was 11.4% ($R^2 = 0.114$). The Durbin-Watson statistic was 1.946, which is close to 2, indicating no significant concerns regarding the assumption of independence of residuals. Regarding the significance of the regression coefficients, frequent engagement with the conversational agent demonstrated a statistically significant positive effect on social support improvement ($\beta = .337$, $p < .001$). This finding suggests that more frequent interaction with the conversational agent enhances perceived social support. In the third regression model, improvements in social support had a statistically significant effect on cognitive function enhancement, as measured by the K-MMSE-2 Delta scores ($F = 6.830$, $p < .05$). The explanatory power of the regression model was 4.4% ($R^2 = 0.044$). The Durbin-Watson statistic was 2.084, which is close to 2, indicating no significant concerns regarding the assumption of independence of residuals. Regarding the significance of the regression coefficients, higher social support scores were associated with greater improvements in cognitive function ($\beta = .211$, $p < .05$). This finding suggests that individuals with greater social support experience significant improvements in cognitive function.

Conversely, cognitive training usage did not have a statistically significant impact cognitive function enhancement ($p = 0.692$). These findings suggest that cognitive function does not improve when individuals use cognitive games as standalone interventions. However, combining cognitive games with group interventions that boost social support and motivation to participate leads to cognitive function enhancement (Figure 5, Table 4).

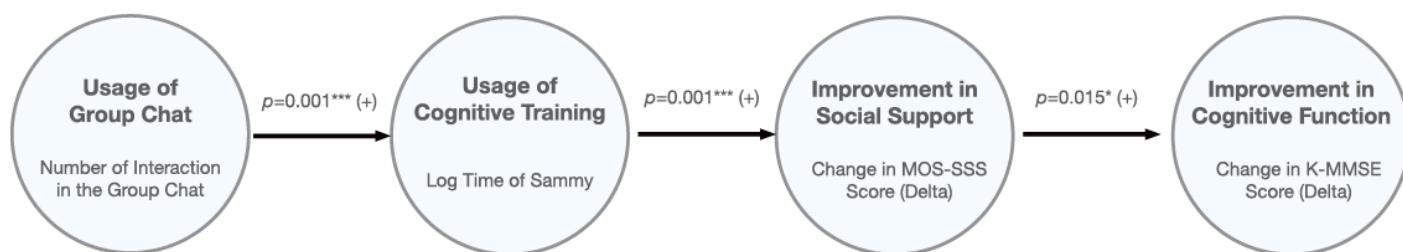


Figure 5. Impact of group intervention on engagement, social support, and cognitive function
(as a part of path analysis)

Table 4. Summary of Regression Analyses Examining the Mediating Role of Social Support

	Model	<i>B</i>	<i>S.E.</i>	β	<i>t</i>	<i>p</i>
1	Group Chat Usage → Cognitive Training Usage	1.138	0.092	0.735	12.395***	<.001
	<i>F</i> =153.646(<i>p</i> <.001), <i>R</i> ² =0.540, <i>Durbin-Watson</i> =1.502, 95% <i>CI</i> =0.735					
2	Cognitive Training Usage → Social Support Improvement	0.061	0.015	0.337	4.102***	<.001
	<i>F</i> =16.830(<i>p</i> <.001), <i>R</i> ² =0.114, <i>Durbin-Watson</i> =1.946, 95% <i>CI</i> =0.337					
3	Social Support Improvement → Cognitive Function Improvement	0.034	0.014	0.211	2.467*	<.05
	<i>F</i> =6.084(<i>p</i> <.05), <i>R</i> ² =0.044, <i>Durbin-Watson</i> =2.084, 95% <i>CI</i> =0.211					

Change in Social Support, Willingness to Participation, and Depression

Social support consists of four categories: (i) emotional/informational, (ii) material, (iii) affectional and (iv) positive social interaction support. Emotional/informational support showed the highest pre-post difference with statistical significance ($t = -6.509$, $p < .001$) and marginally strong effect size (Hedges' $g = 0.70$). Willingness to participate demonstrated significant differences in cognitive factors ($t = 2.159$, $p < .05$) with nearly moderate effect size (Hedges' $g = 0.43$). Within the subcategories of willingness to participate, affect showed significant pre-post differences ($t = 2.008$, $p < .05$) with moderate effect size (Hedges' $g = 0.51$), whilst behavioural measures showed no significant differences ($t = 0.244$, $p = 0.808$). Depression levels exhibited significant pre-post differences ($t = 3.093$, $p < .01$) with weak effect size (Hedges' $g = 0.21$). [Table 5](#) presents overall these results.

Table 5. Comparison of social support, emotional relief with program use before and after.

Parameters	Week 0, mean (SD) n = 133	Week 12, mean (SD) n = 133	Hedges' <i>g</i>	<i>t</i>	<i>p</i>
Social Support					
Emotional/Informational Support	30.19 (7.04)	34.10 (5.43)	0.70	-6.509***	<.001
material Support	15.18 (3.78)	16.25 (3.06)	0.37	-3.345**	<.01
Affectionate Support	10.81 (2.86)	11.87 (2.56)	0.29	-4.256***	<.001
Positive Social Interaction Support	15.23 (3.76)	16.43 (3.00)	0.37	-3.803***	<.001
Willingness to Participation					
behavior	10.45 (3.60)	10.35 (3.77)	0.47	0.244	.808
cognition	12.08 (3.34)	11.27 (3.58)	0.43	2.159*	<.05
affect	10.78 (3.90)	9.90 (4.02)	0.51	2.008*	<.05
Depression					
SGDS-K	2.77 (2.59)	2.23 (2.13)	0.21	3.093**	<.01

Engagement Analysis: Saemi Talk and Our Town

To examine the engagement frequency, we conducted a repeated measures analysis of variance (ANOVA) on the average daily usage frequency of *Saemi Talk* (conversation-based intervention) and *Our Town* (community-based intervention) over three months (Figure 6). The analysis showed significant differences in average daily usage frequency between *Saemi Talk* and *Our Town* in the third month ($p < .001$). Results indicated a significant main effect of usage duration ($F = 20.282$, $p < .001$) and a significant interaction between intervention types (e.g., *Saemi Talk*, *Our Town*) and usage duration ($F = 17.859$, $p < .001$). *Our Town* average daily usage frequency increased consistently, the highest in month three ($M = 0.90$, $SD = 0.11$), followed by month two ($M = 0.56$, $SD = 0.08$) and month one ($M = 0.24$, $SD = 0.05$). In contrast, *Saemi Talk* usage frequency varied, with highest engagement in month two ($M = 0.52$, $SD = 0.08$), followed by month three ($M = 0.47$, $SD = 0.11$) and month one ($M = 0.42$, $SD = 0.05$).

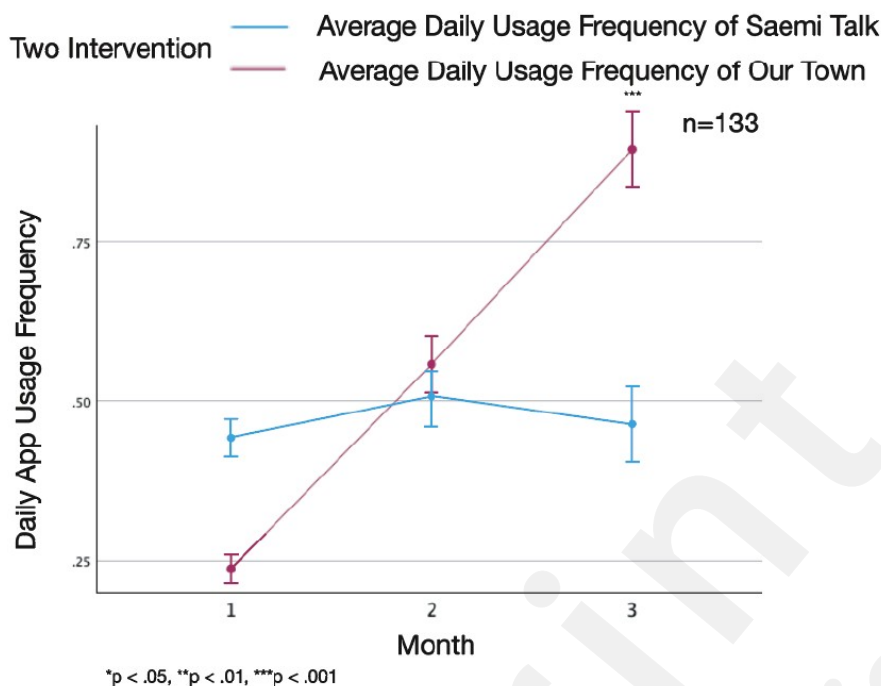


Figure 6. Changes in Participant *Saemi Talk* and *Our Town* Usage Frequency Following Intervention Implementation

Discussion

Principal Findings

The *Care & Cure* programme demonstrated effectiveness in improving cognitive function across all 133 participants, with particularly strong enhancement among individuals with lower K-MMSE-2 scores. This aligns with the programme's evidence-based development, which incorporated clinical expertise from neurologists at *Mokdong Ewha Womans University Hospital*.

The *Saemi Talk* content followed validated clinical frameworks across multiple cognitive domains. The calculation games are shaped from the *WRAT-3 Arithmetic subset* and *Digit Symbol Substitution Test (DST)* [37,38]. Visuospatial tasks incorporated the *Mental Rotation Test (MRT)* [39], whilst attention-focused games utilised crossword puzzles and the *MoCA letter-a tapping test* [40,41]. Executive function games employed the *UCSD Performance-Based Skills Assessment (UPSA-3)* and *Trail Making Test* [42,43]. Memory tasks integrated the *Korean Naming Test (KNT)*, *Chinese idioms*, and *Rey-Osterrieth Complex Figure Test* [44-47]. Language games incorporated the *Montreal Cognitive Assessment (MoCA)* initial letter fluency test and *Scrambled Sentences Test (SST)* [40,48].

However, the specific cognitive impact of individual game components requires further investigation.

Higher usage frequency of *Care & Cure* corresponded with enhanced cognitive function. *Our Town* appeared to moderate this effect by increasing *Saemi Talk* engagement. Participants who showed higher *Our Town* engagement dedicated more time to *Saemi Talk* and achieved superior cognitive function scores. The group chat format likely enhanced engagement through shared performance goals, achievement reports and peer encouragement. These findings align with previous research on group chat-based cognitive enhancement programmes [27,28].

Nonetheless, *Our Town* did not directly enhance cognitive function; rather, its impact emerged through social support mechanisms. The integration of *Our Town* and *Saemi Talk* (a software robot) in the *Care & Cure* programme enhanced social support, which in turn improved cognitive function. Whilst *Our Town* lacked direct cognitive benefits, it appeared to function as an indirect motivational tool. Users who engaged with *Our Town* demonstrated improved social support scores, likely stemming from affective support and positive interactions with an AI chatbot-based software robot. This aligns with previous research suggesting that AI chatbots can provide social support and reduce depressive symptoms among older adults [55,56].

On a secondary issue, the *Care & Cure* programme effectively reduced emotional distress, with participants experiencing emotional changes through enhanced social support. Programme engagement, measured through *Our Town* chat interactions, showed increasing participant responses to the chatbot-based software agent, reaching 3.8 times the initial level by month 3 (Figure 6). This increased engagement suggested more frequent conversations with both the software agent and other participants, potentially facilitating positive social exchanges and providing emotional, affectionate and informational support. However, chat interaction frequency alone provides limited insight into intervention adherence. Future research should examine more precise adherence measurements. The study suggests that increased social support influenced participants' depressive symptoms [57-60].

Limitations

Initial expectations anticipated high levels of user-software robot interaction in *Our Town*. However, the data indicated lower interaction levels than that we expected, with *Our Town*'s primary impact emerging through its influence on *Saemi Talk* usage patterns.

Conclusions and Future Research Direction

The *Care & Cure* programme demonstrated effectiveness for cognitive enhancement, with more frequent participation corresponding to greater improvement. The programme showed particular efficacy among cognitively impaired participants. Additional benefits included reduced depressive symptoms, enhanced social support and increased participation willingness.

Our hypothesis proposed that increased *Our Town* usage would enhance *Saemi Talk* engagement, subsequently improving cognitive function. The data confirmed that higher *Our Town* usage directly increased *Saemi Talk* participation. However, increased *Saemi Talk* usage alone did not yield statistically significant cognitive improvements. When examining social support as a mediator between *Saemi Talk* usage and cognitive enhancement, results indicated that social support directly influenced cognitive improvement. This relationship requires further investigation to understand underlying mechanisms.

Whilst the top 50% of programme users showed greater K-MMSE-2 improvements, the causal relationship between *Saemi Talk* usage and cognitive enhancement lacked statistical significance. Future research should examine the relationship between *Our Town* and *Saemi Talk* usage patterns to better understand these outcomes.

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The manuscript was edited for the English language by *Editage*, and corrected grammar and typographical errors using *DeepL* and *ChatGPT 4o*.

Conflicts of Interest

Jinwoo Kim holds the intellectual property rights for the applications used in this study. Additionally, he has a direct financial interest in *HAI Inc*, where he serves as CEO and shareholder. He has also been a participant in the *Suncheon Care & Cure project* outside of grant support. The financial relationship between Jinwoo Kim and HAI Inc was reviewed by *Yonsei University*, and his involvement in this research project has been approved in accordance with its conflict-of-interest policies. Authors B. H. Yun, H. J. Ko, W. Kim, and S. Y. Park are employed by *HAI Inc*. Author Bohee Kim is employed by *LG Electronics*. All authors declare no other competing interests.

Abbreviations

mHealth:				Mobile		Health
MCI:		Mild		Cognitive		Impairment
K-MMSE-2	:	Korean-Mini	Mental	State	Examination-Version	2
MOS-SSS:		Medical	Outcomes	Study-Social	Support	Survey
SGDS-K:	Short	Form	Geriatric	Depression	Scale-Korean	Version
TWEETS:	Twente	Engagement	with	eHealth	Technologies	Scale

Multimedia

Appendix

1.

The evidence-based clinical examination of *Saemi Talk* contents
[\[PDF File \(Adobe PDF File\), 000 KB-Multimedia Appendix 1\]](#)

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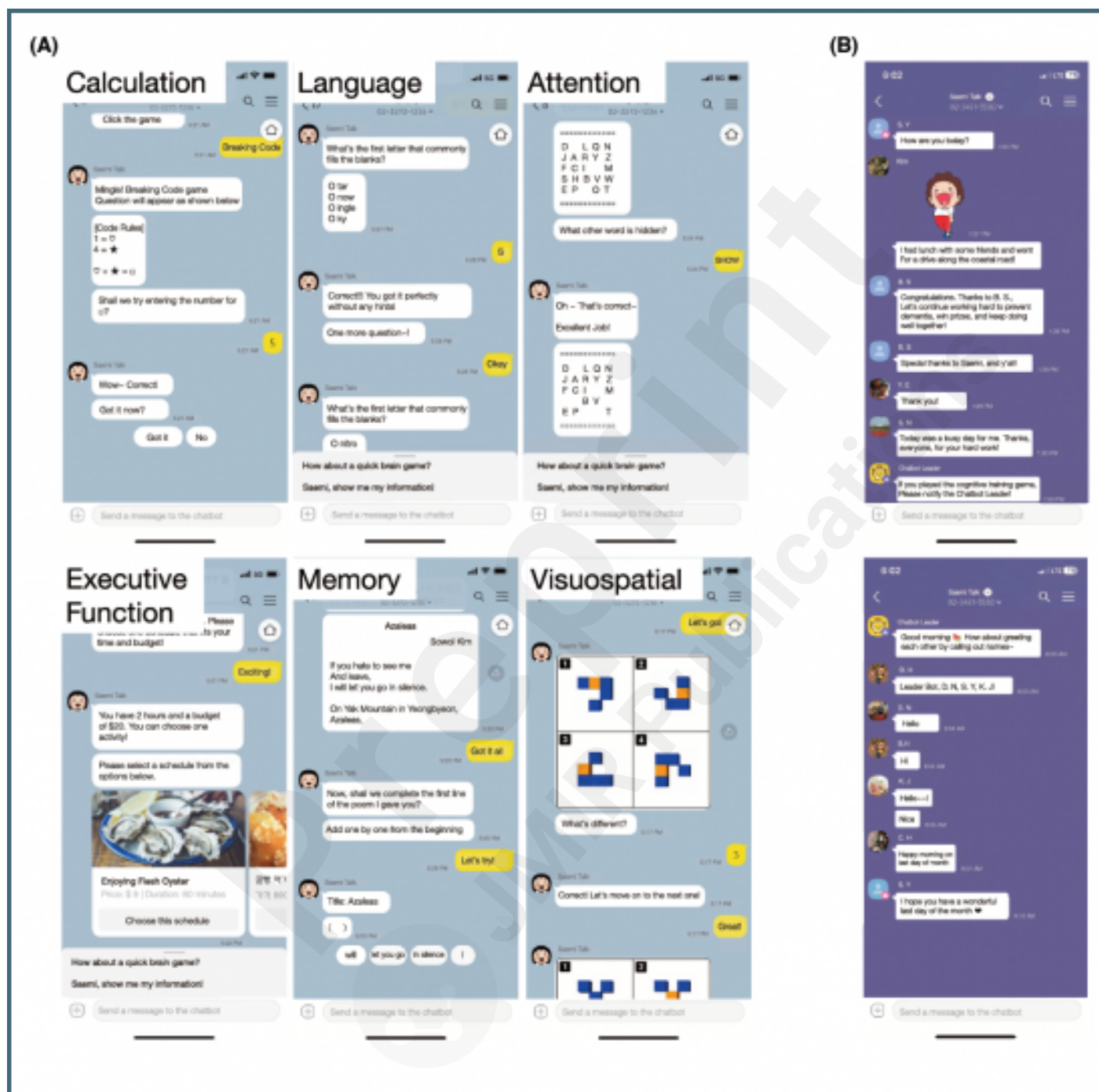
Supplementary Files

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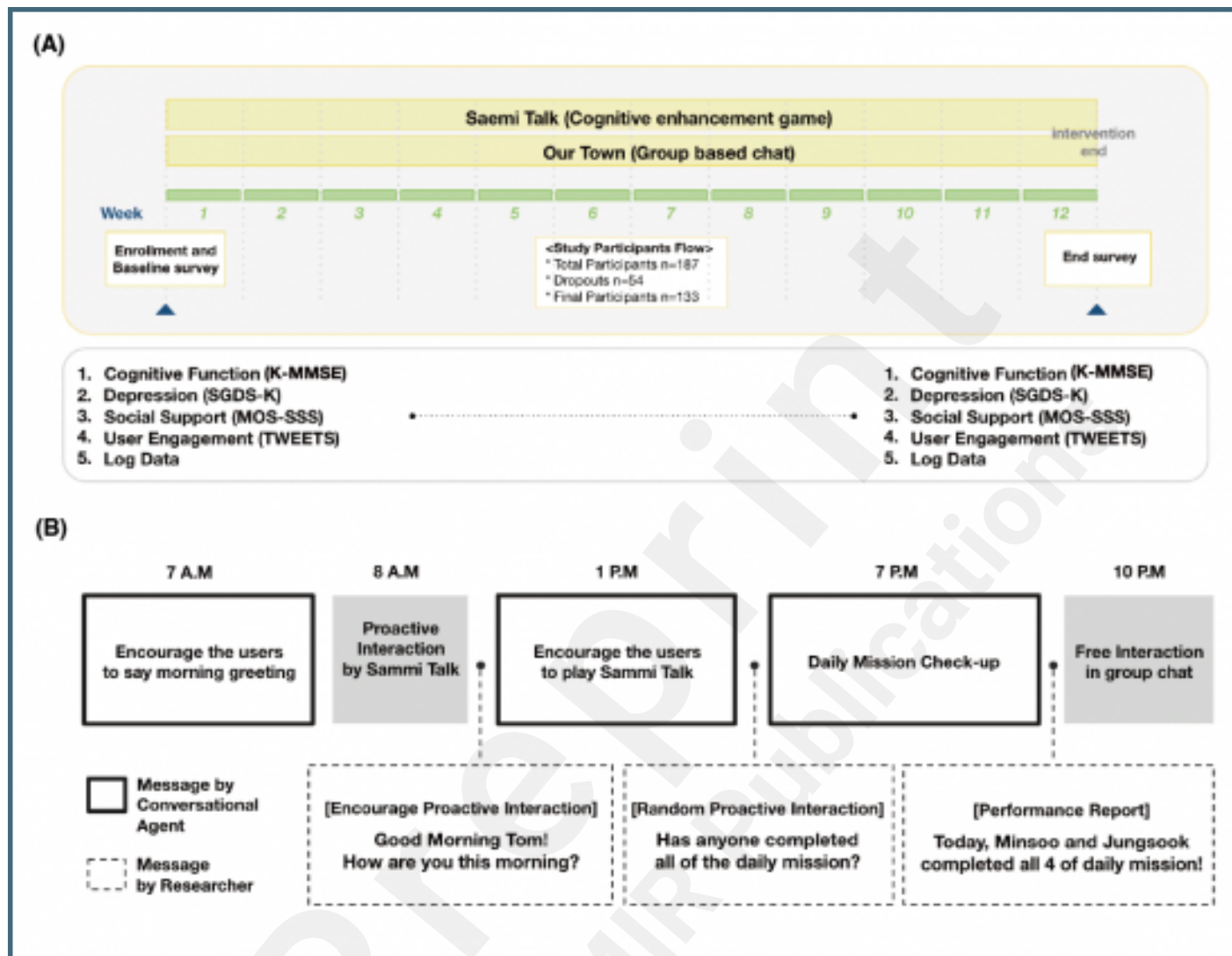
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Figures

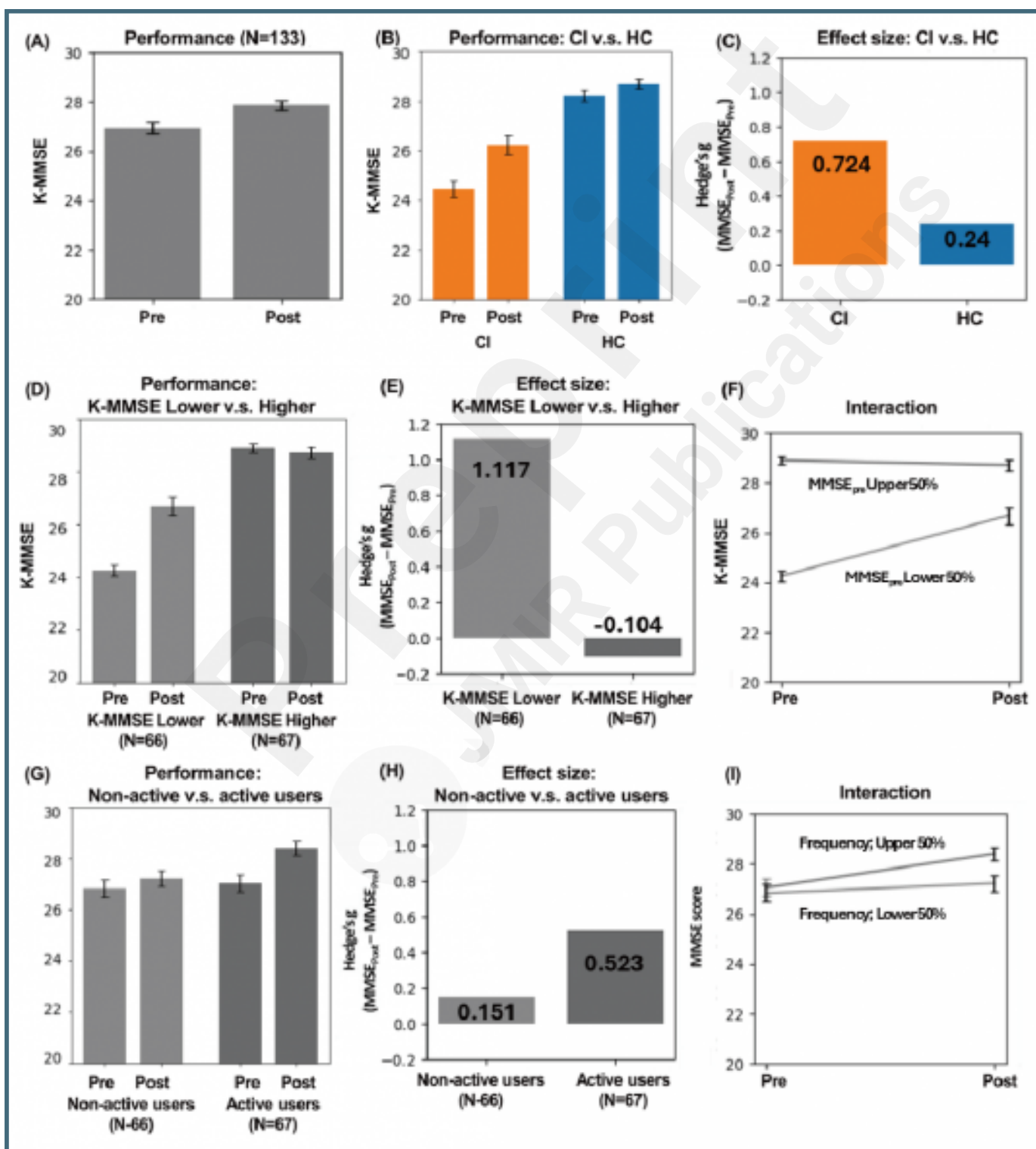
Overview on the proposed application. (A) Snapshots of Saemi Talk represent different cognitive domains in the following order: Calculation, Language, Attention, Executive Function, Memory, and Visuospatial function. (B) Snapshots of Our Town.



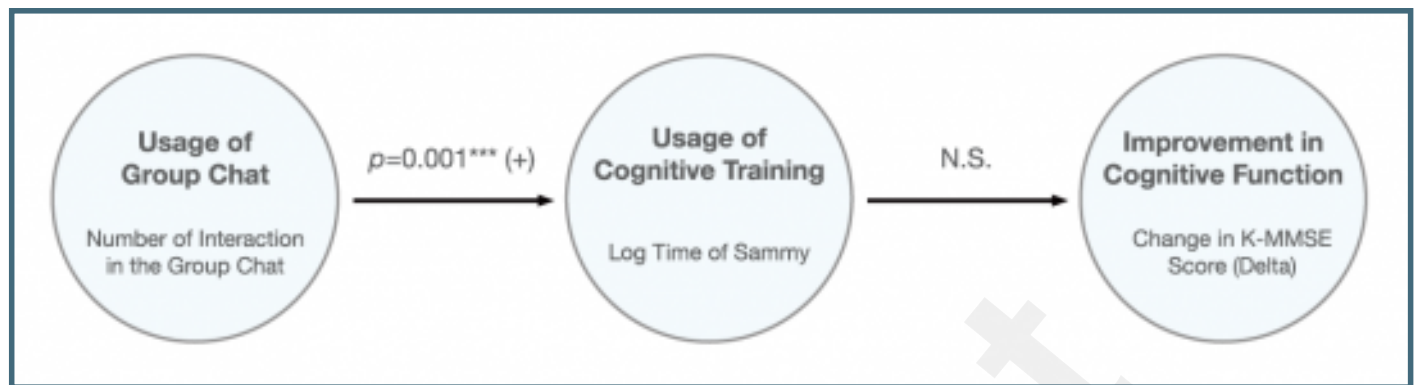
Overview on the study procedures. (A) Measurement tool according to the experimental procedure. (B) Facilitator interactions in Our Town (Group Chat).



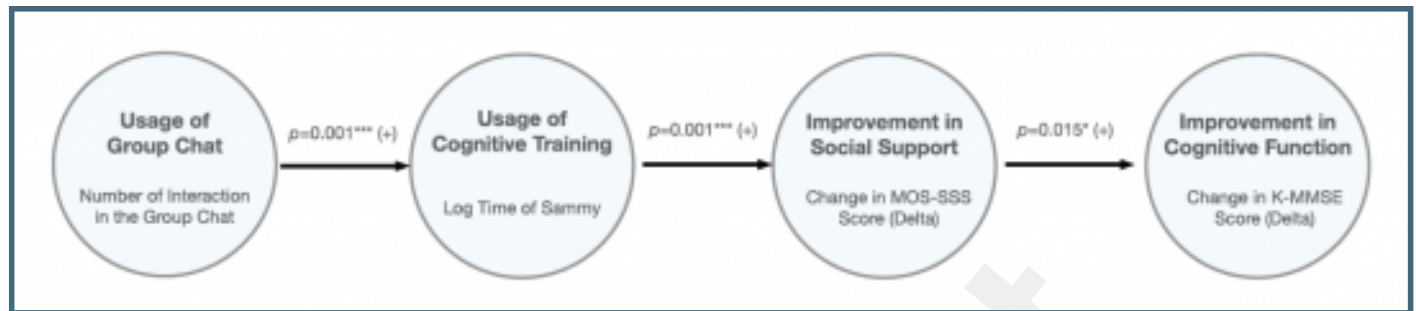
Overall Results. (A) Pre- and post-intervention comparison of cognitive function. (B) Performance enhancement comparing participants at risk of cognitive impairment (CI) versus healthy controls (HC). (C) Effect size. (D) Performance comparison between participants below and above baseline K-MMSE-2 median scores. (E) Effect size. (F) Interaction effect. (G) Performance comparison between low (non-active) and high (active) app usage frequency groups (based on end-of-experiment user logs). (H) Effect size. (I) Interaction effect. We note that 'K-MMSE' in the plot refers to K-MMSE-2. (independent samples t-test; $p < .05$, $*p < .01$, $**p < .001$, $***p < .0001$; Note: K-MMSE-2 baseline adjusted from 0 to 23-26 range for enhanced readability; Error bars indicate Standard Error of the Mean [SEM]).



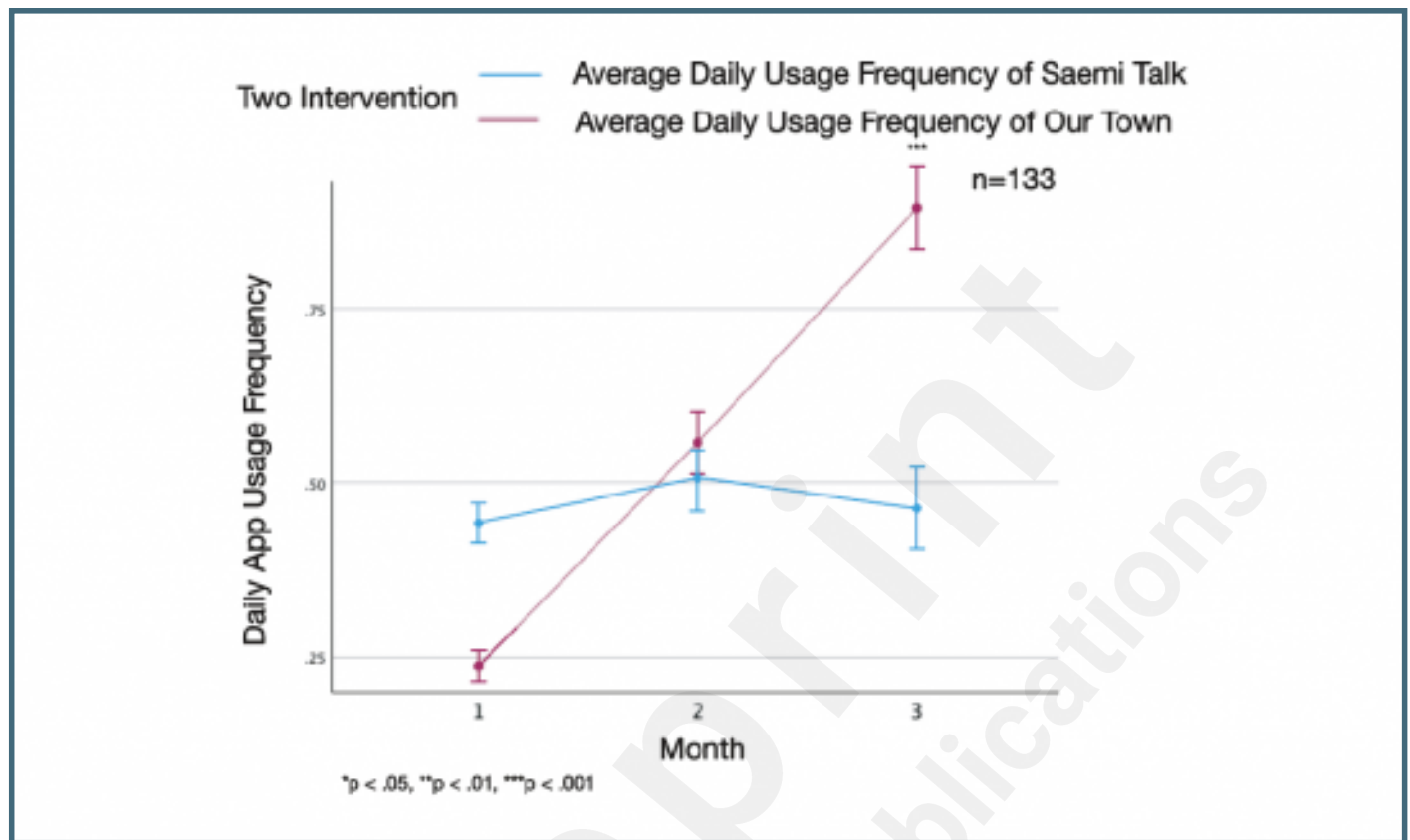
Impact of group intervention on engagement and cognitive function.



Impact of group intervention on engagement, social support, and cognitive function (as a part of path analysis).



Changes in Participant Saemi Talk and Our Town Usage Frequency Following Intervention Implementation.



Multimedia Appendixes

Supplementary Material Cognitive Functions Software Robot Sutdy.

URL: <http://asset.jmir.pub/assets/83c4891c4b71ca3acf5bc7f345f5453b.docx>



Related publication(s) - for reviewers eyes onlies

This manuscript was previously submitted to the Journal of Medical Internet Research and underwent Round 2 peer review before being ultimately rejected. We have revised the manuscript based on the feedback received from the JMIR reviewers. This submission reflects those revisions, and we believe that the manuscript is now a better fit for JMIR mHealth and uHealth given its focus on mobile digital interventions for cognitive health in older adults.

URL: <http://asset.jmir.pub/assets/2b26a3b67eb24aa615c9a0b73d5da430.pdf>

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URL: <http://asset.jmir.pub/assets/6714e44fd944c5cbea089eb3efa906a8.pdf>

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URL: <http://asset.jmir.pub/assets/b056ec435d635c81996f7091163b698f.pdf>

TOC/Feature image for homepages

A participant from the program using a cognitive training game app.

