Validating a Novel Digital Face-Name Platform for Memory Enhancement in the Cognitively Healthy: A Baseline for Mild Cognitive Impairment Application

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Introduction

1.1 Rationale

Millions of people suffer from memory impairment worldwide, with an increasing amount of new cases per year. Mild Cognitive Impairment (MCI) is the transitional stage in cognitive decline, with observable memory and cognitive challenges that are worse than age-related deficits, however do not reach a level of severity that interferes with everyday functioning (Petersen et al., 2018). This condition affects around 10-20% of the elderly population, with a significant risk of progressing to more severe diseases such as Alzheimer's disease or Dementia (Golde, 2022). Notably, around 50% of individuals diagnosed with MCI have a high risk of transitioning to Alzheimer's within a five-year period, emphasizing the necessity for interventions (Petersen et al., 2018). There is no known cure for MCI or an effective large-scale measure to prevent its progression to dementia. Therefore, effectively addressing MCI is crucial not only to improve the quality of life among affected individuals, but also to prevent the large-scale impact of dementia. These impacts include the psychological and financial burdens on families, but also significant economic costs associated with long-term care and loss of productivity (Alzheimer's Disease International, 2019; Langa & Levine, 2014). Focusing on the treatment MCI offers the potential of delaying or even possibly preventing the advancement into Alzheimer's disease, alleviating the burden on healthcare systems. Therefore, it is important to invest in research and interventions targeting prevention of MCI. (Livingston et al., 2020; Reitz & Mayeux, 2014). This research study is aiming to develop and validate a novel cognitive training intervention, initially testing its effectiveness in cognitively healthy individuals. Establishing a baseline in this population is a first step toward applying the findings to MCI patients in future research. Understanding how this platform improves memory capabilities in cognitively healthy individuals will highlight its potential as a preventive measure and treatment for MCI.

1.2 Associative Memory

Associative memory is the ability of our brains to link various pieces of information together, such as recalling the face and name of a person or associating certain smells with particular events. Such memory depends on the activation and interaction of the hippocampus and other nearby regions of the brain, during both formation and retrieval of such relationships (Eichenbaum, 2017). These regions start to deteriorate over the course of MCI, particularly the hippocampus and associated cortical areas, which are essential for encoding and retrieving memories. As MCI progresses, the brain experiences a decline in neuroplasticity, the brain's ability to reorganize and form new neural connections. This is largely due to the accumulation of tau plaques and amyloid-beta proteins, which disrupt the typical neuronal function. Tau protein tangles inside neurons which inhibits their ability to communicate with one another, while amyloid-beta plaques build up between cells, causing inflammation and damaging synapses.

This combination of processes impairs the brain's ability to form new memories and retrieve existing ones, which is particularly evident in associative memory tasks (De Felice and Ferreira, 2014; Koch and Laskowski, 2017). Over time, these molecular and structural changes contribute to the cognitive deficits seen in MCI and Alzheimer's disease (Selkoe, 2012). For instance, research has demonstrated that as many as 50% of MCI patients have significant difficulty with associative memory tasks, such as recalling a person's name upon seeing their face (Sperling et al., 2014). Notably, 50% of those afflicted with MCI will eventually develop Alzheimer's disease, wherein the hippocampus is severely altered. (Petersen et al., 2018). By training associative memory to mitigate cognitive deficits in cognitively healthy individuals, this study aims to establish a baseline that can later be applied to MCI patients, who often face significant challenges in this area. In fact, associative memory decline has been demonstrated to be among the very first cognitive impairments to be observed in MCI across numerous studies, shown in around 30-40% of MCI patients (Monti et al., 2015). Therefore, associative memory needs much better understanding and addressing, since they impact everyday life interactions, hence calling for targeted treatments that help people with MCI cope with the condition even better.

1.3 Current Methods for MCI Treatment

Most current treatments for MCI consist of pharmacological approaches and cognitive training therapies. However, such methods have significant issues. Pharmacological options, including cholinesterase inhibitors, have been adapted from treatments of Alzheimer's disease. Their efficacy for MCI, however, is very restricted. These medications have demonstrated the ability to provide only slight short-term gain in cognition; they are nevertheless ineffective at preventing Alzheimer's disease (Raina et al., 2008; Russ & Morling, 2012). A number of programs, such as puzzles, games, and exercise, have been developed as cognitive training interventions in an effort to enhance cognitive abilities. However, these programs often target the broader deficits associated with dementia rather than the more specific challenges of MCI. While these existing methods of cognitive training may offer minor improvements in cognitive performance, they often fail to address the underlying mechanisms of cognitive decline or prevent the progression to dementia (Sanjuán et al., 2020). This leaves a significant gap in effective, preventative treatments for individuals in the early stages of cognitive impairment, compared to those already experiencing the severe and irreversible decline associated with dementia. Therefore, current treatments may alleviate symptoms, but they do not provide a solution to prevent or reverse cognitive decline, highlighting the need for interventions that address the roots of MCI and better prevent its transition into Alzheimers's Disease. Although this study currently focuses on cognitively healthy individuals, the insights gained will contribute to the development of future interventions aimed at MCI patients(Livingston et al., 2020).

1.4 Face-Name Training

Face-name training is an understudied cognitive intervention that enhances associative memory through improving one's ability to link faces with names, a skill important not only for social interactions but also for everyday recognition. This kind of training, therefore, consists of repetitive exercises reinforcing these associations in order to improve recall accuracy. The face-name training is supported by research, both as a diagnostic and therapeutic tool. A previous study utilized face-name associative tasks to identify preclinical phases of Alzheimer's disease (Rentz et al., 2011). The findings indicated that inability to memorize face-name associations is an early indicator of cognitive decline. Additionally, this study noted that face-name memory tasks might be applied not only for diagnostic purposes, but also to track the course of preclinical Alzheimer's disease. Therapeutically, a previous study demonstrated that face-name pairs included in explicit memory training significantly enhanced performance on memory tasks in patients with MCI (Hampstead et al., 2008). This pilot study emphasized the efficiency of such training for improving cognitive function and gave further evidence that face-name training could be an important part of MCI management. However, in both studies, there is a primary reliance on short-term outcomes without extensive follow-ups. Building on previous research that demonstrates the efficiency and versatility of face-name training, this study will evaluate its effectiveness in cognitively healthy individuals, with the potential to inform future strategies for MCI treatment.

1.5 A Novel Digital Platform of Face-Name Training for MCI

A novel approach in treating MCI is based on a newly designed, easy-to-use, training paradigm that includes repeated exposure and retrieval of face-name associations. This innovative paradigm is specifically designed to apply the very principles of cognitive training that have shown great promise in improving memory retention and neural plasticity (Belleville, 2008; Rebok et al., 2014). By emphasizing repetitive training supported by digital technologies, this platform offers an alternative that ensures better efficiency compared to traditional cognitive therapies. While the initial focus of this study is on cognitively healthy individuals, the findings will establish a baseline for future applications of the platform in MCI treatment. Successfully demonstrating the platform's effectiveness in a healthy population can show insights into its potential as an accessible intervention for individuals with MCI, addressing the cognitive challenges they face.

1.6. Problem

Mild Cognitive Impairment affects memory and cognitive function, leading to difficulties in daily life and an increased risk of developing dementia. Traditional cognitive training methods--such as pharmacological interventions and traditional cognitive training--are often not sufficiently engaging or adaptive to individual needs, which can limit their effectiveness. Although Face-Name training has been shown to be effective as both a diagnostic and treatment tool, there has been minimal focus on its potential as a primary treatment, and even less attention given to transforming it into a user-friendly approach.

1.7. Goal

The goal is to develop and validate a novel digital platform that provides a user-friendly training environment for repetitive face-name pair recall, aimed at improving memory retention and cognitive function in cognitively healthy individuals, establishing a baseline that can inform future applications for individuals with MCI.. This goal aims to create a novel accessible digital platform that utilizes the effectiveness of Face-Name training, contributing to more effective interventions for cognitive decline.

1.8. Hypothesis

The use of a digital platform for repetitive face-name pair recall– FNAME-CogniFuse–will significantly improve memory retention in cognitively healthy individuals. These enhancements will persist over time, with notable refinements in 3 domains of memory; associative memory, free recall, and answer confidence. If successful, FNAME-CogniFuse could serve as an effective at-home treatment option, as well as a valuable tool in clinical settings, facilitating ongoing support and engagement for MCI patients in the future.

Methodology

2.1 Overall Methodology Approach

The overall methodology approach focuses on novel testing of the FNAME-CogniFuse platform with cognitively healthy participants. Participants will complete a series of face-name pairing training sessions, and memory performance will be assessed through recall tasks at multiple stages of the experiment. Data analysis will involve statistical tests such as t-tests to evaluate improvements in memory performance and to identify any demographic influences on the effectiveness of the platform.

2.2 Student vs. Mentor

During this research, the student led all aspects related to experimental design, data collection, data analysis, development of the digital face-name training platform, and writing of the paper. The mentor provided guidance throughout the process.

2.3 Participants

The study involved 79 participants under the age of 18 who were recruited from my highschool science research program and completed the training sessions in a classroom setting. To comply with ethical guidelines, this research received Institutional Review Board (IRB) approval before the start of the study. Each participant signed consent forms, and parental assent was also collected. Demographic information, including age, race, and gender, was collected from the consent forms, and to maintain confidentiality, all data was de-identified. Each participant was assigned a unique "subject ID" number for reference during data analysis, ensuring that names were anonymized and only the research teacher had records of the participants' identities. This approach protected the participants' privacy and allowed for a comprehensive analysis of the data collected, facilitating insights into the efficacy of the digital face-name training platform.

2.4 Training Platform Development

The digital platform was created using Typeform to ensure user-friendliness and accessibility on digital devices via a link. Each step of the process includes clear directions to minimize user error. The study is divided into three phases, with the final phase (the test phase) further divided into three components to evaluate different memory domains: associative memory, free recall, and answer confidence.

Four different versions of the test were utilized, each featuring a unique set of AI-generated faces and names from generatedphotos.com. A total of 40 faces were sourced from generatedphotos.com, and 40 random first-last name pairs were generated from CHAT-GPT-4o. This was done in order to ensure a balanced and randomized set of face-name pairs, reducing the likelihood of bias.

In the Encoding phase, participants are presented with 10 faces and 10 names to learn. Following this Encoding phase, there is a 15-minute Delay to allow for memory processing. The Retrieval phase consists of three components. Retrieval A tests for associative memory, where participants view a face and must select the corresponding name from multiple-choice options, scoring from 1 to 10. Retrieval B assesses free recall memory, requiring participants to list all the names they can remember without stimulus, which is scored from 1 to 10. Lastly, Retrieval C evaluates answer confidence, where participants rate their confidence in their answers on a scale of 1 to 10. At the end of the test, participants receive a cumulative score ranging from 1 to 30, which is automatically recorded in Google Sheets for analysis.

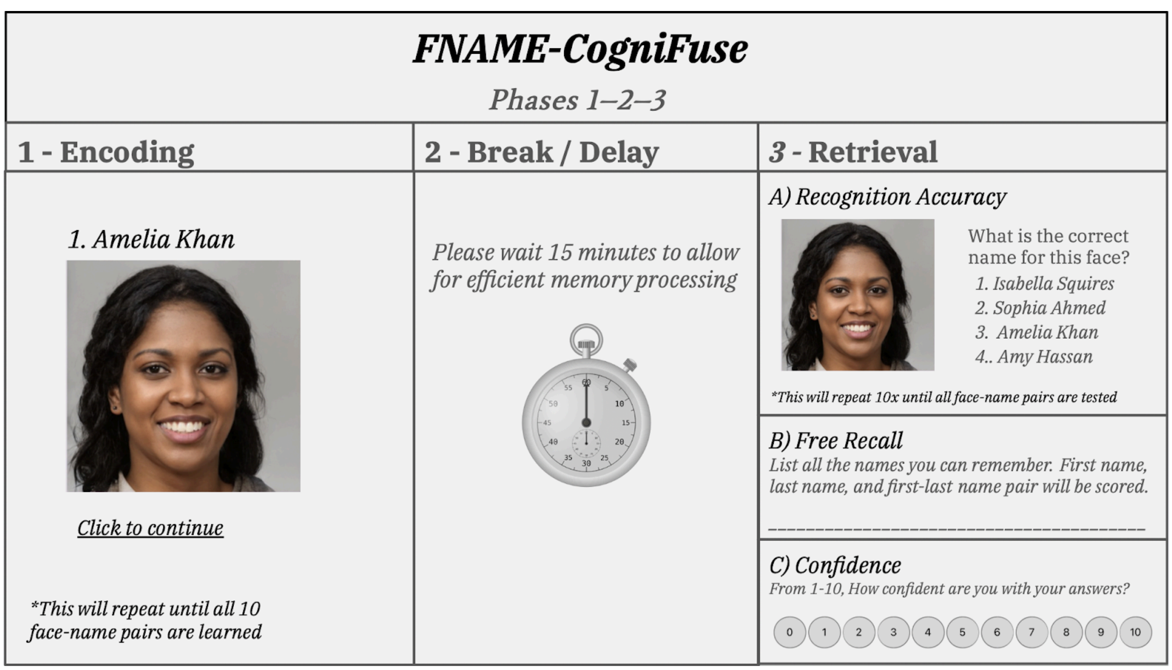

Figure 1: *illustrates the three stages of the FNAME-CogniFuse model: 1. Encoding, where participants learn 10 face-name pairs; 2. Break/Delay, a 15-minute pause for memory processing and consolidation; 3. Retrieval, divided*

into Retrieval A (recognition accuracy), B (free recall), and C (confidence). Each stage builds on the previous to enhance recall and cognitive engagement.

2.5 Experiment Timeline

The experiment timeline for participants is structured to optimize memory retention and performance by spacing training sessions. Each participant completes one version of the test every four days, resulting in around 18 days dedicated to the entire testing process. On Day 1, participants engage in Version 1 of the test. This repeats on Day 6 with Version 2, Day 11 with Version 3, and Day 18 with Version 4, each using a new set of face-name pairs. This structured timeline ensures that participants are not overwhelmed and can fully engage with each test version. The spacing of training sessions over five days was determined based on memory consolidation, the process by which newly acquired information is integrated into long-term memory (Nicholas J Cepeda, 2006). This typically occurs during successive periods of sleep and rest after learning. Research has shown that retention is improved with a break between learning since the brain can encode the material before further new information is offered. The introduction of a five-day interval in this regard enables participants to conduct the reconsolidation process, where existing memories are stabilized and often improved. This avoids the cognitive overload from frequent testing, leading to poorer recall from possible interference.

2.6 Experiment Data Evaluation

In the experiment data evaluation phase, participant data collected from the digital model is automatically transferred to Google Sheets for collection, and then moved to Microsoft Excel for easier analysis and figure generating. Since there are 4 different versions of the digital platform, 4 separate data sheets are created, with copies made for modification while the originals are secured away. From there, each participant's metrics will be calculated, including scores from associative memory, free recall, and answer confidence tasks. The data will then undergo statistical analysis to determine averages and overall trends in memory retention across the different test phases. Demographic information will also be considered.

The metrics for data analysis will be calculated on two different scales. The first is a score rating on a scale of 1 to 10, assessing performance on each individual recall task (1, 2, and 3). The second is a cumulative score of 1 to 30, which combines the ratings from all recall tasks. Both of these scales will be incorporated into the analysis to provide a comprehensive evaluation of participant performance.

After analyzing the four sets of data separately, a comparative analysis will be conducted to understand differences and variations between sessions 1-4. This will involve t-tests to assess the significance of the findings. Using a significance threshold of $p < 0.05$, the aim is to determine whether the improvements in memory retention achieved through the FNAME-CogniFuse platform are statistically significant, thereby providing strong evidence for its effectiveness in enhancing cognitive function in cognitively healthy individuals.

Results and Discussion

3.1 - Overall Memory Enhancement

The results of this study supported that there were significant improvements in memory performance across multiple domains, highlighting the effectiveness of the FNAME-CogniFuse platform in enhancing memory retention. Overall, participants demonstrated a significant increase in recall accuracy from the initial baseline assessment to the final training session, with an average improvement of 34% over the course of the study (Figure 1). The upward trend in performance across all sessions exemplifies the impact of the digital training approach. A p-value of .001675 was extracted from this data, highlighting its extreme significance. This result supports the hypothesis that FNAME-CogniFuse would enhance memory retention over time. The observed improvement aligns with findings in previous research which demonstrated that memory training interventions effectively enhance cognitive function and memory retention over time (Belleville., 2008).

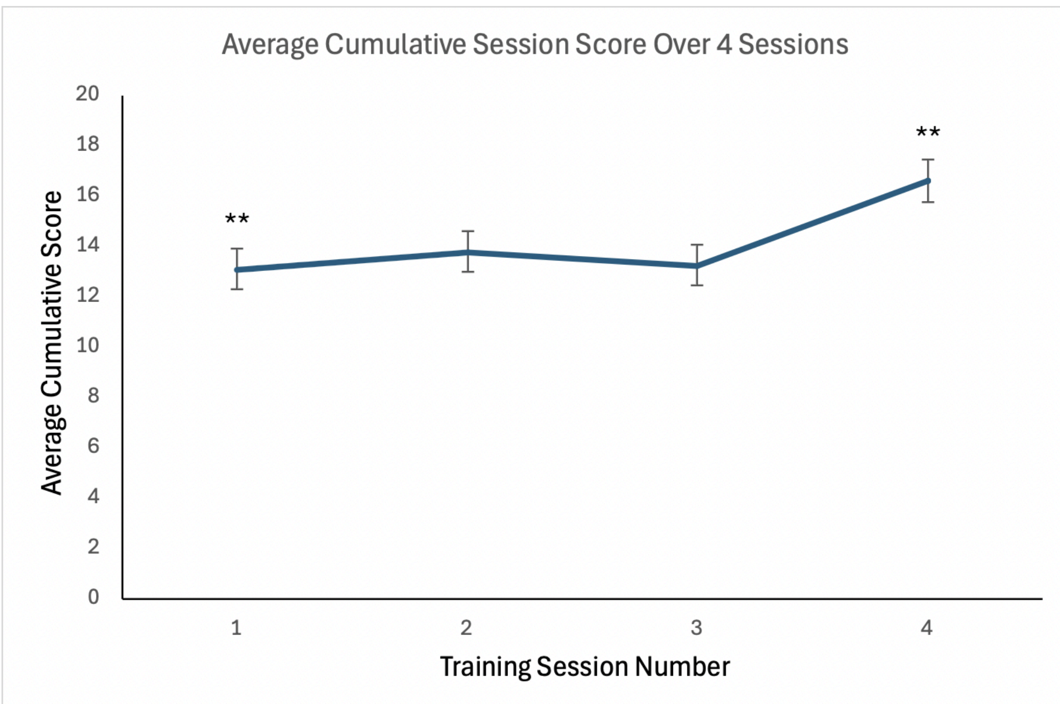

Figure 2 (Cumulative Session Score Over 4 Sessions): *This depicts the cumulative score (min possible score: 0, max possible score: 30) of participants across the 4 training sessions. This graph shows a 34% average increase in recall accuracy from baseline to the final training session, with a p-value of 0.0017 derived from t-tests indicates statistical significance when comparing distribution of scores between session 4 and session 1. ** **Indicates significance (p-value < .01)***

3.2 - Associative Memory (Retrieval A) Performance

In the domain of associative memory (Retrieval A), recall performance showed significant improvement, particularly after the midpoint of the training program. The accuracy of face-name pair recall increased by 36%, with the most noticeable gains occurring in the later sessions (Figure 2). The p-value for Retrieval A was 0.001437, indicating a statistically significant improvement in associative memory performance. This result supports the hypothesis that repetitive face-name pair exercises contribute to enhanced associative memory. This data will be used as a benchmark to demonstrate the effectiveness of the FNAME-CogniFuse platform and will also support the potential of future applications in clinical settings. Similar results were noted in previous research, where face-name associative memory training significantly improved memory function, particularly with repeated practice (Hampstead et al., 2008).

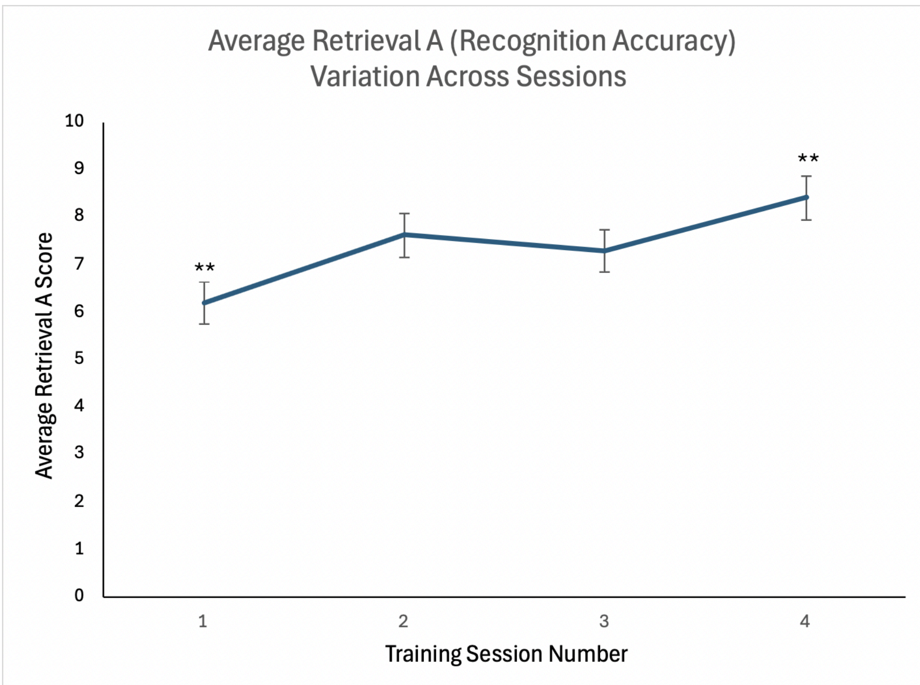

Figure 3 (Retrieval A--Recognition Accuracy--Variation Across Sessions): *This graph depicts the variation in retrieval A scores (min possible score: 0, max possible score: 10) across all four training sessions. Error bars represent the range in which patients recorded a recognition accuracy. As demonstrated, there was a 36% increase in face-name pair recall accuracy, with the most significant improvements occurring in later training sessions. A p-value of 0.0014 derived from t-tests confirms the statistical significance of the improvement in associative memory.* ***** Indicates significance (p-value < .01)***

3.3 - Free Recall (Retrieval B) Performance

In the domain of free recall (Retrieval B), participants showed a decrease in memory performance over the course of the training, with a 11% decline in recall accuracy from the first to the last session (Figure 3). However, the line graph reveals that while participants' performance declined in the middle of the training sessions, there was a slight improvement toward the end. Despite the overall decline, the improvement in the final sessions is notable, considering the increasing difficulty of the task as the training progressed. The p-value for Retrieval B was 0.225956, which is not statistically significant, suggesting that the overall trend of performance decline was not strong enough to suggest the training led to sustained declines in free recall. These results indicate that free recall might be more resistant to improvement under the conditions of this experiment. This finding suggests that future modifications to the training structure, particularly this section, may be necessary to reduce the impact of task difficulty and achieve greater improvements in free recall performance. These findings align with previous research that suggests task difficulty and reliance on internal memory cues--without external stimuli like a face being shown--can make recall more challenging. This is especially true for tasks that require more complex cognitive processing (Craik and Lockhart, 1972).

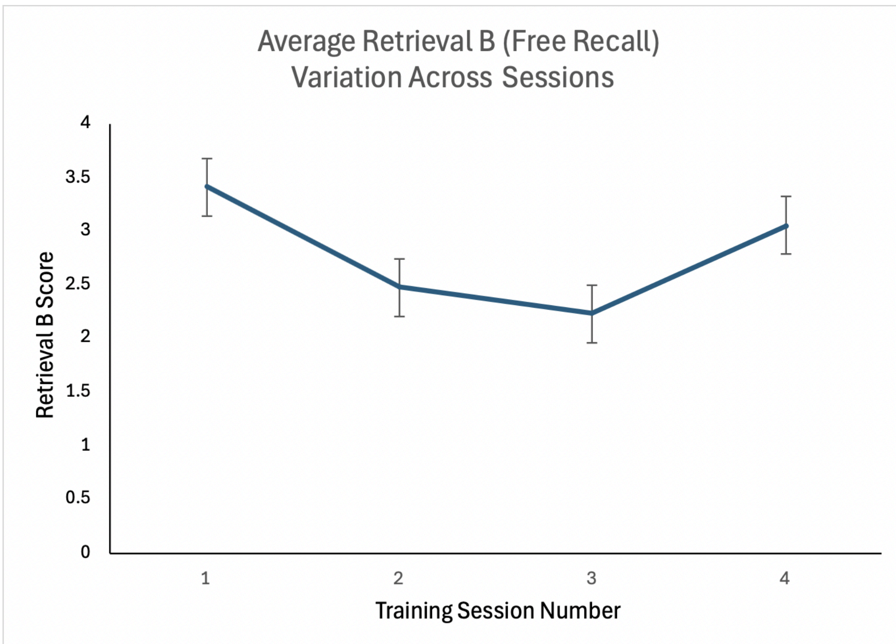

Figure 4 (Retrieval B--Free Recall--Variation Across Sessions): *This depicts the average Retrieval B score (min possible score: 0, max possible score: 10) across the 4 training sessions. This graph shows an 11% decline in recall accuracy, with a slight improvement in the later sessions. A p-value of 0.225956 derived from t-tests indicates that the decline in performance was not statistically significant, suggesting that the task difficulty may have impacted free recall performance.*

3.4 - Answer Confidence (Retrieval C) Performance

In the domain of answer confidence (Retrieval C), recall performance showed significant improvement, with participants reporting an increase in confidence ratings by 48% on a Likert scale of 1 to 10 (Figure 4). The p-value for Retrieval C was 0.002511, indicating a statistically significant increase in confidence throughout the training. This improvement suggests that as participants became more skilled at the task, their self-assessed confidence grew, reflecting enhanced engagement and cognitive self-efficacy. These results support our hypothesis, indicating that confidence-building exercises can enhance the effectiveness of the training. These results demonstrate the key role of confidence in memory enhancement and providing a point of comparison for future studies. The increase in confidence ratings is consistent with the framework proposed in previous research that links successful memory retrieval to enhanced metacognitive confidence and cognitive self-efficacy (Ranganath and Ritchey, 2012).

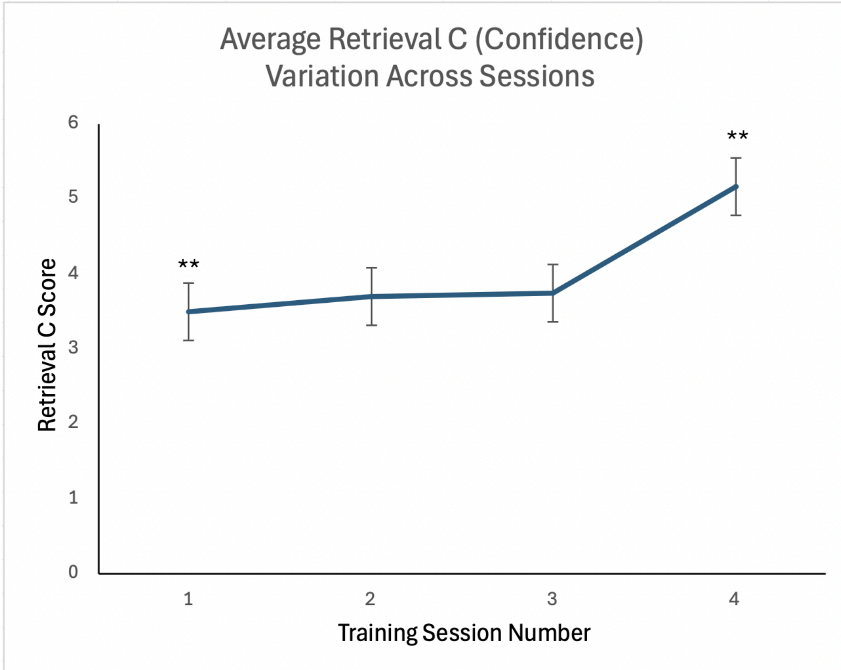

Figure 5 (Retrieval C--Confidence--Variation Across Sessions): *This depicts the average Retrieval C score (min possible score: 0, max possible score: 10) across the 4 training sessions. This graph shows a 48% increase in confidence ratings on a Likert scale, indicating significant growth in participants' self-assessed confidence. A p-value of 0.002511 derived from t-tests confirms the statistical significance of this improvement. ** **Indicates significance (p-value < .01)***

3.5 - Performance Progression of Top Performers Across Training Sessions

An in-depth analysis of the progression of the top four performers demonstrated consistent improvements across all training sessions. These top 4 participants achieved an average increase of 113% in cumulative recall accuracy from the first to the final session, highlighting the potential of the platform for sustained cognitive enhancement (Figure 5). The line graph depicting session progression for these top performers shows a linear trend, highlighting the effectiveness of the training in producing memory improvements. This finding further supports the hypothesis and emphasizes the platform's capability to deliver significant memory benefits. The linear improvements observed in the top performers mirror findings in previous research that demonstrated significant and sustained cognitive gains in motivated individuals engaged in memory training programs (Jaeggi et al., 2008).

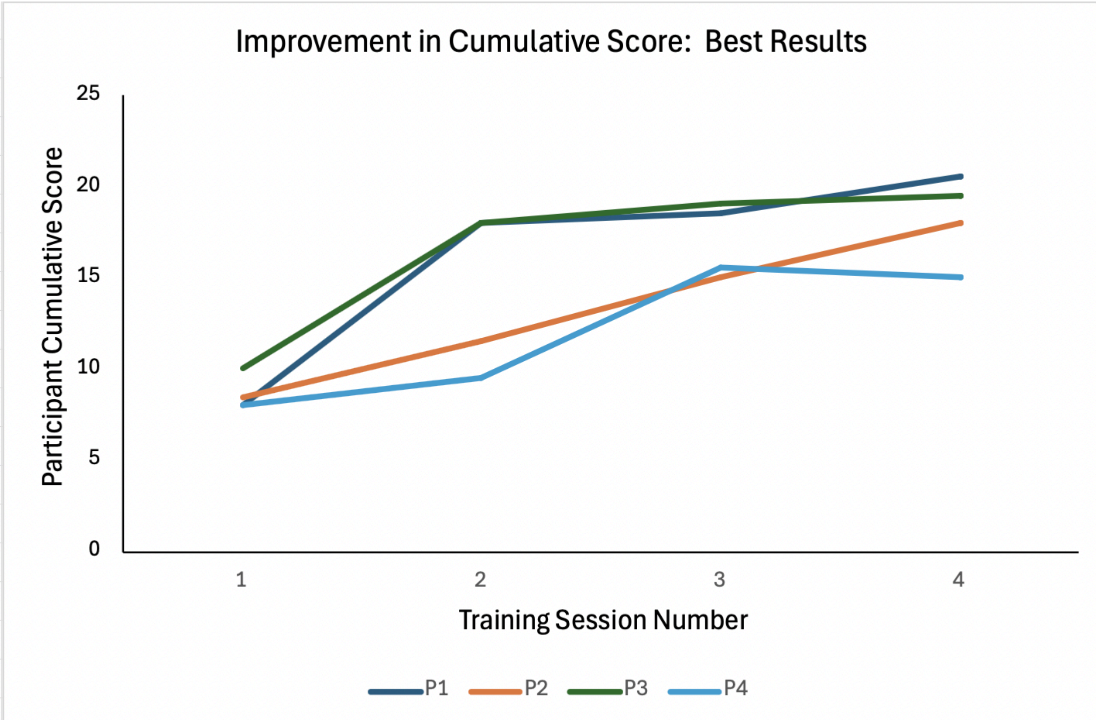

Figure 6 (Improvement in Cumulative Score: Best Results): *This graph represents the 4 participants with the best overall cumulative scores (min possible score: 0, max possible score: 30) on the recall accuracy tests across four training sessions. As demonstrated, there was a 113% average increase in recall accuracy for the top 4 performers, illustrating consistent improvement across all training sessions, with a linear trend indicating sustained cognitive enhancement.*

3.6 - Demographic Influence on Training Outcomes

Analysis of the impact of ethnicity on training outcomes revealed varied improvements across different demographic groups. Some ethnic groups exhibited a higher average percent change in recall accuracy. Notably, White participants had an average percent change of 59.63%, while Asian participants had an average percent change of 23.79% (Figure 6). Additionally, the only participants who had negative percent change scores--meaning their recall diminished over the training sessions--were from the Asian participant group. A possible explanation for this is because of name familiarity, as participants may have found it easier to recall names that were culturally or ethnically familiar to them. For instance, Asian participants might recognize certain Asian names more easily, while White participants may be familiar with Western names. Additionally, since names were generated using AI, implicit biases in AI generators could have influenced name selection, affecting recall performance (Ferrara, 2023). While these discrepancies between ethnic groups were not significant at a p-value of .1003, the difference is still relevant; It suggests that cultural and demographic factors may influence the effectiveness of digital cognitive training, necessitating tailored approaches for diverse populations. While these results partially support the hypothesis, they also indicate a need for further research to understand demographic influences on training efficacy. These findings are consistent with previous research, which suggests that cultural familiarity with names may influence the ability to form and recall face-name associations (Choi et al., 2017).

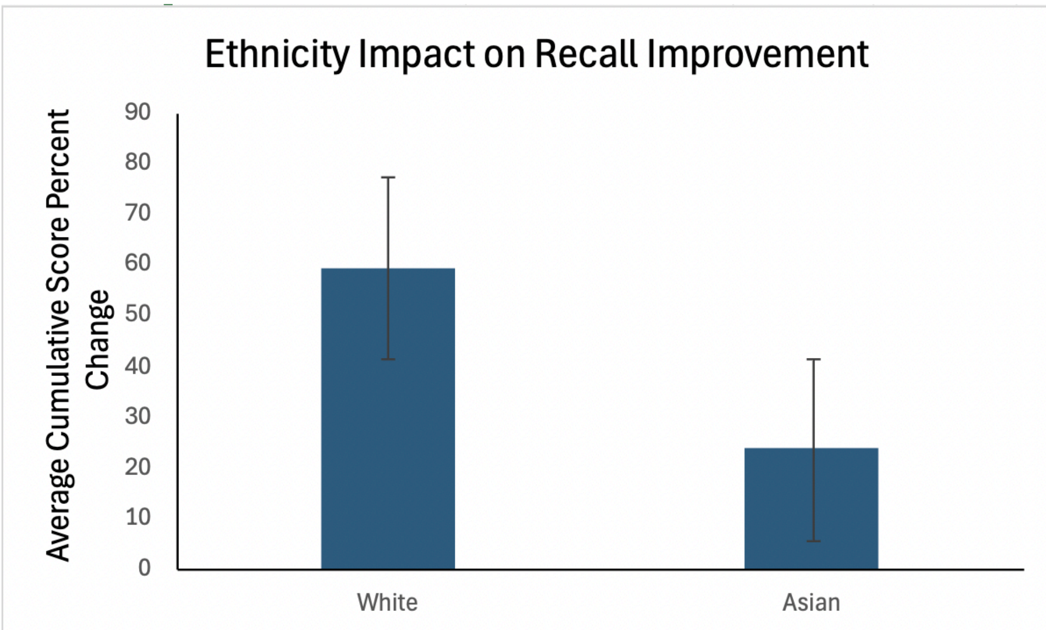

Figure 7 (Ethnicity Impact on Recall Improvement): *This graph represents the difference in percent change, from first to last session, in average cumulative score (min possible score: 0, max possible score: 30) between White and Asian ethnicities. It also shows error bars depicting the overall range of percentage changes for each group. As shown, there was a 59.63% average increase in recall accuracy for White participants (n=8), compared to a 23.79% increase for Asian participants (n=14). The differences in performance, with some Asian participants even showing a decrease, suggest potential cultural or demographic influences on training efficacy, although the p-value of 0.1003 derived from t-tests indicates no statistical significance.*

Further Analysis was done to understand the diversity of names used in the FNAME-CogniFuse platform. Names were categorized into two groups: Western/White names, typically associated with English-speaking or Western cultures, and non-Western names, linked to multicultural or diverse origins. To ensure the reliability of this classification, online name classification tools, including databases like the 'Behind the Name' database, which provides cultural and ethnic information, were used. After assigning each name to its respective group, the names in each category were counted and analyzed. This led to the conclusion that approximately 85% of the names were of Western/White origin, while about 15% were from diverse cultural backgrounds. This method, based on well-established naming conventions, provides a reasonable estimate of the diversity within the model, although it's important to note that names can be used across multiple cultural contexts.

Table 1 (AI-Generated Names used in the Training Model): *Depicts the AI-generated names used in the FNAME-CogniFuse model. Based on further estimate-analysis, around 85% of the names are associated with Western/White backgrounds, while only 15% are from diverse cultural backgrounds. This highlights a discrepancy between the intended diversity and the actual representation of names in the training model.* **** refers to a name that was sourced to be from a Non-Caucasian background.***

Version 1	***Version 2***	***Version 3***	***Version 4***
*Amelia Khan	Miranda Jenkins	Riley Brooks	Camilla Knight

*Charlotte Ramirez	Lydia Hayes	Reagen Shaw	*Amara Sutton
Harper Sullivan	Julia Collins	Morgan Tate	Gwen Monroe
*Isabella Martinez	Eliza Turner	Avery Reid	Marcella Brooks
Sebastian Lee	Hannah Abbot	Peyton Rhodes	Emma Davis
Olivier Johnson	Nathan Stewart	Sawyer Bennett	Jasper Reid
Ethan Clarke	Adam Mitchell	Jordan Flynn	Everett Cole
*Jackson Patel	Derek Parker	Cameron Foster	Tobias Grant
Elijah Wright	Owen Carter	Isaac Zimmerman	Benjamin Lewis
*Sophia Kim	Lucas Morgan	Dorian Ellis	Ethan Palmer

Conclusion

4.1 Conclusion

The hypothesis that FNAME-CogniFuse would enhance memory retention in cognitively healthy individuals was supported by the results of this study. Significant improvements in recall accuracy were observed across various memory domains, particularly in associative memory and answer confidence, which underscores the effectiveness of the platform in enhancing memory retention. While free recall did not show significant improvement, the overall findings validate the platform's potential for cognitive enhancement. The engineering goal of creating a digital platform for memory enhancement was also achieved, as the system demonstrated its capacity to produce measurable improvements in memory performance.

The data supports the platform’s efficacy and potential for future applications in clinical settings, especially with populations such as those with Mild Cognitive Impairment. By analyzing the data on overall memory enhancement and the demographic influences observed, FNAME-CogniFuse can be tailored to fit diverse populations, making it a valuable tool for cognitive training. These results work together to demonstrate that the platform’s digital training approach is not only accessible but effective in enhancing memory and building confidence.

4.2 Applications

The FNAME-CogniFuse platform has significant potential as both an at-home cognitive training tool for healthy individuals and a clinical tool for MCI patients. For healthy users, it offers an accessible way to enhance memory retention through engaging face-name association exercises. With further validation, on the other hand, the platform could support MCI patients in clinical settings by providing personalized and measurable memory training that helps maintain cognitive function and slow decline. The platform's adaptability makes it a promising option for both preventative care and clinical intervention.

4.3 Future Research

The next steps in research should focus on expanding the participant pool to include MCI patients to assess the platform's effectiveness in clinical settings. This would provide insight into whether FNAME-CogniFuse can help maintain cognitive function and slow the progression of memory decline in individuals at risk for Alzheimer's disease and other dementias. Additionally, a larger and more diverse demographic should be tested to explore further how cultural and demographic factors influence training outcomes. This includes investigating the role of implicit bias in the AI name generation process and how cultural name familiarity may affect recall performance. Understanding these factors will be critical to improving the platform's efficacy across various populations and ensuring it is equitable for all users.

4.4 Closing

The FNAME-CogniFuse platform has demonstrated extremely significant potential in enhancing memory retention, with applications for healthy individuals and patients with Mild Cognitive Impairment. This research marks a pivotal step toward digital cognitive training that could one day play a key role in clinical therapies and at-home memory support.

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