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“Memorare” a multidimensional intervention for people with major neurocognitive disorder

A series of six case studies

MASTER DISSERTATION

Mariana Castro Fernandes

MASTER IN CLINICAL HEALTH PSYCHOLOGY AND WELLBEING

UNIVERSIDADE da MADEIRA

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This thesis follows a scientific article-based model.
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Abstract

Cognitive and functional impairments in dementia significantly affect quality of life and autonomy, while current pharmacological treatments offer limited symptomatic relief. In recent years, non-pharmacological interventions have gained relevance, but many remain one-dimensional and lack clinical validation, personalization, or ecological validity. Technology-supported interventions, such as serious games, virtual reality, and interactive systems, are increasingly explored as accessible, person-centered alternatives for cognitive and emotional care in people with dementia.

This thesis is divided into two parts. Part I presents a systematic review of clinical studies integrating technology in neuropsychological interventions for people with dementia. Following PRISMA guidelines, 250 articles were screened from five databases (B-ON, PubMed, Google Scholar, ACM, and IEEE Xplore), yielding 11 eligible studies published between 2015 and 2025. The findings suggest that mobile applications, virtual environments, socially assistive robots, and biosensors have potential to improve engagement, cognitive stimulation, and mood, although most studies are small, exploratory, and lack randomized controlled designs. The review highlights critical gaps in the long-term efficacy, methodological rigor, and personalization of digital interventions for dementia.

Part II describes a feasibility study involving six male inpatients with major neurocognitive disorders of multiple etiologies, residing in a mental health institution. A six-week, multidimensional intervention — the Memorare program — was implemented, integrating three therapeutic modules: cognitive stimulation and reminiscence therapy via the Musiquence platform, and sensory stimulation using a textured panel. Pre- and post-intervention neuropsychological assessments (Mini-Mental State Examination, Geriatric Depression Scale – 15 items, Quality of Life in Alzheimer's Disease, Neuropsychiatric Inventory, Lisbon Battery for Dementia Assessment and Positive and Negative Affect Schedule) revealed a general decline in global cognition, as expected in progressive neurodegenerative conditions. However, reductions in neuropsychiatric symptoms and improvements in affective state and quality of life were observed

in several participants. PANAS data indicated consistently higher positive affect and reduced negative affect during cognitive stimulation sessions.

These findings suggest that multidimensional, personalized, technology-based interventions like Memorare can positively impact mood, engagement, and behavioral symptoms in dementia care, even in advanced stages. This dissertation reinforces the importance of integrating interactive, person-centered systems into non-pharmacological therapeutic strategies and identifies future directions for clinical research through controlled, larger-scale trials.

Keywords: *Dementia, cognitive stimulation, reminiscence therapy, sensory stimulation, technology-based interventions, case studies, systematic review*

Resumo

O comprometimento cognitivo e funcional na demência afetam significativamente a qualidade de vida e a autonomia, enquanto os tratamentos farmacológicos atuais oferecem um alívio sintomático limitado. Nos últimos anos, as intervenções não farmacológicas ganharam relevância, mas muitas continuam a ser unidimensionais e carecem de validação clínica, personalização ou validade ecológica. As intervenções apoiadas pela tecnologia, como os jogos sérios, a realidade virtual e os sistemas interativos, são cada vez mais exploradas como alternativas acessíveis e centradas na pessoa para os cuidados cognitivos e emocionais das pessoas com demência.

Esta tese está dividida em duas partes. A Parte I apresenta uma revisão sistemática de estudos clínicos que integram a tecnologia em intervenções neuropsicológicas para pessoas com demência. Seguindo as diretrizes PRISMA, foram selecionados 250 artigos de cinco bases de dados (B-ON, PubMed, Google Scholar, ACM e IEEE Xplore), resultando em 11 estudos elegíveis publicados entre 2015 e 2025. Os resultados sugerem que as aplicações móveis, os ambientes virtuais, os robôs de assistência social e os biossensores têm potencial para melhorar o envolvimento, a estimulação cognitiva e o humor, embora a maioria dos estudos sejam pequenos, exploratórios e careçam de desenhos randomizados e controlados. A revisão destaca lacunas críticas na eficácia a longo prazo, no rigor metodológico e na personalização das intervenções digitais para a demência. A Parte II descreve um estudo de viabilidade envolvendo seis indivíduos do sexo masculino com perturbações neurocognitivas graves de etiologia múltipla, internados numa instituição de saúde mental. Foi implementada uma intervenção multidimensional de seis semanas - o programa Memorare - que integrou três módulos terapêuticos: estimulação cognitiva e terapia de reminiscência através da plataforma Musiquence, e estimulação sensorial através de um painel com texturas. As avaliações neuropsicológicas pré e pós-intervenção (Avaliação Breve do Estado Mental, Escala de Depressão Geriátrica – 15 itens, Escala de Qualidade de Vida na Doença de Alzheimer, Inventário Neuropsiquiátrico, Bateria de Lisboa para Avaliação das Demências e Escala de Afetos Positivos e Negativos) revelaram um declínio geral da cognição global, tal como

esperado em condições neurodegenerativas progressivas. No entanto, foram observadas reduções nos sintomas neuropsiquiátricos e melhorias no estado afetivo e na qualidade de vida em vários participantes. Os dados da PANAS indicaram um afeto positivo consistentemente mais elevado e um afeto negativo reduzido durante as sessões de estimulação cognitiva.

Estes resultados sugerem que as intervenções multidimensionais, personalizadas e baseadas na tecnologia, como o Memorare, podem ter um impacto positivo no humor, no envolvimento e nos sintomas comportamentais nos cuidados da demência, mesmo em fases avançadas. Esta dissertação reforça a importância da integração de sistemas interativos e centrados na pessoa em estratégias terapêuticas não farmacológicas e identifica direções futuras para a investigação clínica através de ensaios controlados e de maior escala.

Palavras-chave: *Demência, estimulação cognitiva, terapia da reminiscência, estimulação sensorial, intervenções de base tecnológica, estudos de caso, revisão sistemática*

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List of Abbreviations

BLAD – Lisbon Battery for Dementia Assessment

CDR – Clinical Dementia Rating

EDA – Electrodermal activity

GDS-15 – Geriatric Depression Scale – 15 items

iCST – Individual Cognitive Stimulation Therapy

MMSE – Mini-Mental State Examination

NPI – Neuropsychiatric Inventory

PANAS – Positive and Negative Affect Schedule

PPG – Photoplethysmography

QOL-AD – Quality of Life in Alzheimer's Disease

RCT – Randomized Controlled Trial

vCST – Virtual Group Cognitive Stimulation Therapy

Brief presentation of the thesis

This dissertation investigates the role of technology-supported, non-pharmacological interventions for people with dementia. Given the limitations of pharmacological approaches, especially in advanced stages of the disease, person-centered, interactive, and multidimensional interventions emerge as promising alternatives to enhance cognitive, emotional, and functional outcomes.

The dissertation is organized into two main parts. Part I consists of a systematic review mapping clinical studies published between 2015 and 2025 on technology-based neuropsychological interventions for people with dementia. The review highlights the potential benefits of digital cognitive stimulation, reminiscence therapy, and socially assistive robots in improving engagement, mood, and cognitive performance.

Part II presents six case studies applying the Memorare program, developed to meet the literature findings, a multidimensional intervention integrating cognitive stimulation and reminiscence therapy using the Musiquence platform, combined with sensory stimulation via a panel of natural textures. The intervention was conducted in a mental health institution with male inpatients presenting major neurocognitive disorders of various etiologies. Despite the cognitive decline typical of the disease progression, participants showed improvements in affective states, quality of life, and reductions in neuropsychiatric symptoms. This article has been accepted for publication.

This dissertation contributes to the growing evidence on the feasibility and potential of multidimensional, interactive interventions in dementia care, reinforcing the value of person-centered, technology-supported approaches.

PART I

Part I: Technology-Based Neuropsychological Interventions for Dementia: A Systematic Review

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Abstract

This systematic review aimed to identify and analyse clinical studies incorporating technological interventions within neuropsychological care for individuals with dementia. A literature search was conducted following the PRISMA methodology across the B-ON, PubMed, Google Scholar, ACM Digital Library, and IEEE Xplore databases, covering publications from 2015 to 2025. The search strategy combined descriptors such as "Cognitive stimulation", "Reminiscence therapy", "Sensorial stimulation", "Technology", "Neuropsychological intervention", and "Dementia". Inclusion criteria comprised clinical trials and case studies involving participants with dementia, incorporating technological components, and including assessment measures. Out of an initial 250 articles, 11 met the eligibility criteria and were included in the final synthesis. The selected studies addressed technological approaches such as mobile applications, virtual reality and socially assistive robots. Results suggest that technology-assisted interventions have the potential to enhance cognitive stimulation, accessibility, and care engagement in dementia populations. Further large-scale, longitudinal, and controlled clinical trials are recommended to validate these preliminary findings and support their integration into clinical practice.

Keywords**:** *Cognitive stimulation, reminiscence therapy, sensorial stimulation, technology, neuropsychological intervention, dementia, case studies, clinical trial*

Introduction

Dementia is a progressive neurodegenerative condition that affects millions of people worldwide, significantly compromising cognition, behaviour, and functional autonomy (World Health Organization, 2021). As populations age, the global prevalence of dementia is expected to rise substantially in the coming decades, highlighting the urgent need for effective and accessible intervention strategies to mitigate its impact (Nichols et al., 2022). Among nonpharmacological therapeutic approaches, cognitive stimulation, reminiscence therapy, and sensorial stimulation have demonstrated benefits in maintaining and improving cognitive abilities, emotional well-being, and quality of life in people with dementia (Woods et al., 2018). In recent years, rapid technological advancements have facilitated the integration of digital resources into cognitive and neuropsychological interventions, promoting greater accessibility, personalization, interactivity, and continuity of care for people with dementia (Hung et al., 2021). Mobile applications, telehealth platforms, virtual environments, and assistive devices have been increasingly explored to complement traditional care practices, particularly in contexts where in-person services are limited (Cuffaro et al., 2020). Despite a growing body of evidence on technology-based interventions for dementia, gaps remain regarding their effectiveness, feasibility, and acceptability in both clinical and home settings (Indela et al., 2023). In this context, the present systematic review aims to identify, describe, and analyse clinical studies published between 2015 and 2025 investigating neuropsychological interventions mediated by technology for individuals diagnosed with dementia. This review follows the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) guidelines. It focuses on interventions involving cognitive

stimulation, reminiscence therapy, sensory stimulation, and other neuropsychological approaches supported by technology.

Method

This systematic literature review followed the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) methodology proposed by Moher et al. (2009). PRISMA is a framework consisting of 27 items and a flowchart designed to enhance the reporting quality of systematic reviews. The literature search was conducted electronically using the B-ON, PubMed, Google Scholar, ACM Digital Library, and IEEE Xplore databases. The following descriptors and Boolean operators were applied: "Cognitive stimulation", "Reminiscence therapy", "Sensorial stimulation", "Technology", "Neuropsychological intervention", "Dementia", "Case study", and "Clinical trial". Due to variations in search functionalities and indexing systems, the search strategy was adapted to each database's the specific syntax and filtering options. In B-ON, the search string was TX (("Cognitive stimulation" OR "Reminiscence therapy" OR "Sensorial stimulation") AND (Dementia OR "Major Neurocognitive Disorder")) AND TX "technolog*" AND TX (("case stud*" OR "clinical trial")) AND TX "Neuropsychological Intervention". In PubMed, Text Word (tw) and MeSH Terms were used where appropriate, with the following string: ("Cognitive stimulation"[tw] OR "Reminiscence therapy"[tw] OR "Sensorial stimulation"[tw]) AND ("Dementia"[MeSH Terms] OR "Major Neurocognitive Disorder"[tw]) AND (technolog*[tw]), applying filters for publication dates (2015–2025) and article types (clinical trials and case reports). In Google Scholar, a broader search strategy was necessary, considering the platform's limited advanced filtering features: ("Cognitive stimulation" OR "Reminiscence therapy" OR "Sensorial stimulation") AND (Dementia OR "Major Neurocognitive Disorder") AND (technology OR technological) AND ("Neuropsychological intervention") AND ("case study" OR "clinical trial"). Results were manually filtered by publication year (2015–2025).

In the ACM Digital Library, the search string was: ("Cognitive stimulation" OR "Reminiscence therapy" OR "Sensorial stimulation") AND (Dementia OR "Major Neurocognitive Disorder") AND (technology OR technological) AND ("case study" OR "clinical trial"). In IEEE Xplore, the following string was applied: ("Dementia" OR "Major Neurocognitive Disorder") AND (technology OR technological) AND ("Cognitive stimulation" OR "Reminiscence therapy" OR "Sensorial stimulation"). In both ACM and IEEE, results were refined by publication year (2015–2025) and screened manually to select only clinical studies or case studies with technological interventions and outcome measures. These adjustments ensured that the functionality of each database was optimally utilized to identify the most relevant studies according to the predefined inclusion and exclusion criteria.

Inclusion and exclusion criteria

The inclusion criteria for article selection were: 1) publication date between 2015 and 2025; 2) studies addressing the defined research question through the selected keywords; 3) clinical studies or case studies including a technological intervention and assessment measures; and 4) studies conducted with participants diagnosed with dementia. Exclusion criteria included: 1) articles published before 2015; 2) studies that did not directly address the research question or were excessively specific to populations or contexts outside the scope of this review; 3) reviews, theoretical papers, protocols without described interventions or measures, conference abstracts or programs, and studies without technological intervention or not involving people with dementia.

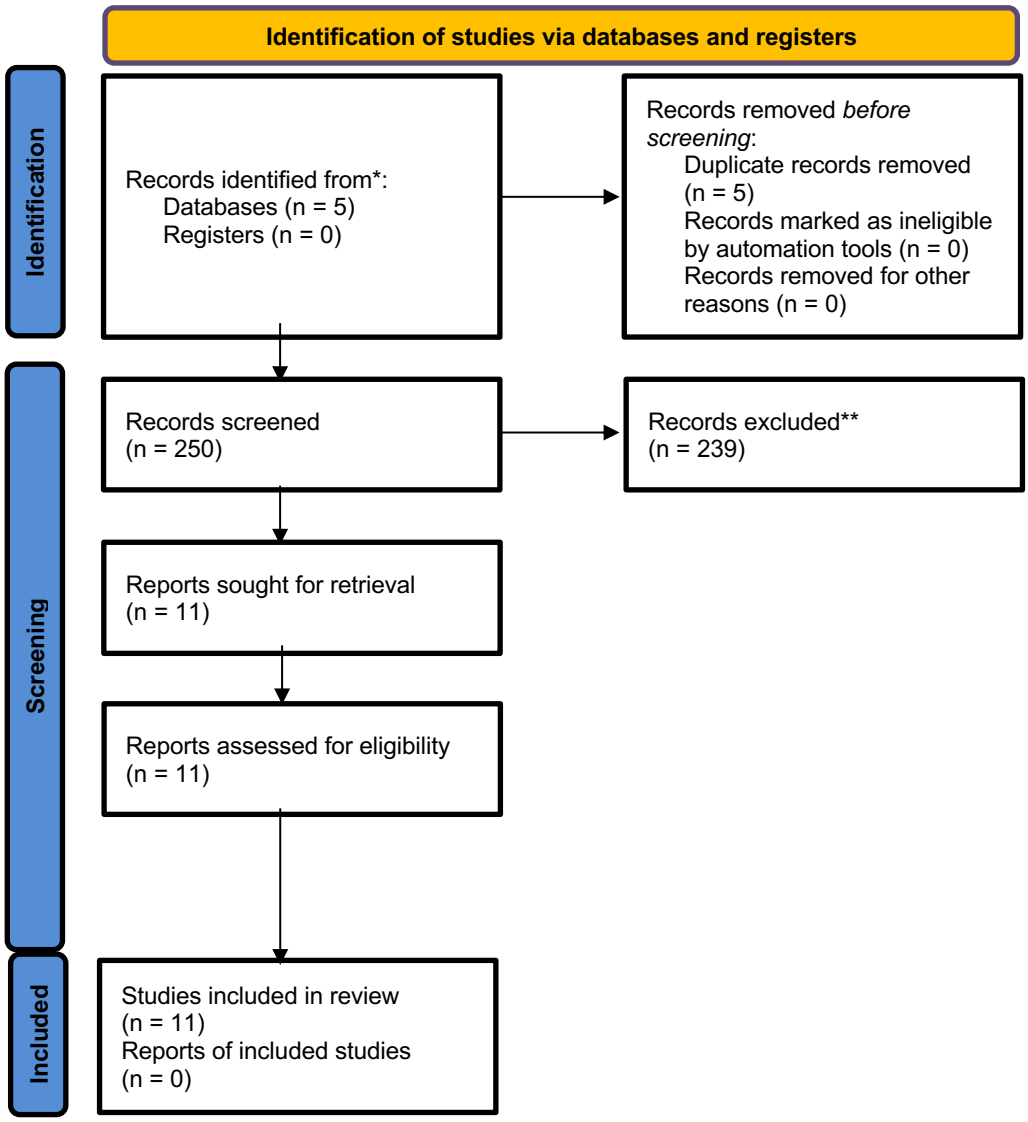
Procedure

The preliminary search identified a 250 articles: 92 from B-ON, 41 from PubMed, 40 from Google Scholar, 22 from ACM, and 55 from IEEE. Five duplicates were identified between the records retrieved from the five databases. After applying the inclusion and exclusion criteria, 11

articles were selected for the final sample. During the screening process, titles, abstracts, and keywords were reviewed to assess eligibility, excluding articles not meeting the criteria, such as those involving populations without dementia, lacking technological interventions, or being non-clinical/review papers. Additionally, no relevant studies were identified through manual searches of the reference lists of the included articles, ensuring comprehensive coverage of the selected databases. Consequently, 11 articles were included in this systematic review, all of which were read in full for data extraction. Figure 1 presents the methodological process using the PRISMA flowchart.

Figure 1

PRISMA 2020 flowchart for systematic reviews



The initial screening of the 250 identified articles was conducted by the primary investigator, who applied the predefined inclusion and exclusion criteria based on titles, abstracts, and keywords. Articles that did not meet the criteria were excluded. The remaining potentially eligible articles were then read in full to confirm eligibility. The final sample of 11 articles was selected for inclusion in the review. For each included study, the following data were extracted into an Excel spreadsheet: 1) name of the authors; 2) type of study; 3) type of technological intervention; and 4) main conclusions.

Results

Table 1

Summary of included studies

Reference	Type of study	Technological intervention	Main conclusions
Santos et al.	Experimental Study	Traditional methods & technology in cognitive stimulation	The study suggests incorporating technological tools alongside traditional cognitive stimulation methods can enhance engagement and effectiveness in elderly individuals, leading to improved cognitive performance and motivation.
Perugia et al.	Psychophysiological Study	Electrodermal activity for social robots	Electrodermal activity can be effectively used to measure users' emotional responses and engagement levels during interactions with social robots, providing valuable data for designing more adaptive and personalized robotic interventions.
Filoteo et al.	Behavioral Intervention	ReminX	ReminX is a promising digital reminiscence intervention that can effectively promote autobiographical memory recall and improve mood in older adults, particularly those with mild cognitive impairment.
Cruz-Sandoval et al.	Therapy Facilitation	Social Robot as therapy facilitator	Social robots can effectively be facilitators in therapeutic settings, improving patient engagement, motivation, and adherence to therapy protocols, especially in

			areas like physical rehabilitation or cognitive training.
Perugia et al.	Model Development	ENGAGE-DEM Model	The ENGAGE-DEM model provides a comprehensive framework for understanding and promoting engagement in digital interventions for people with dementia, integrating various factors influencing engagement and offering guidance for intervention design.
Rai et al.	Feasibility RCT	Individual Cognitive Stimulation Therapy App	The individual Cognitive Stimulation Therapy app is feasible and acceptable for individuals with mild to moderate dementia and their caregivers, showing potential for improving cognitive and psychosocial outcomes.
Muñoz et al.	Clinical Study	Cognitive stimulation program via new technologies	Cognitive stimulation programs delivered via new technologies effectively in improve cognitive functions and overall quality of life in older adults, offering a scalable and accessible alternative to traditional methods.
Gonzalez-Moreno et al.	Engagement Study	Technology-supported social interaction	Technology-supported social interaction platforms can significantly enhance social engagement and reduce loneliness in older adults, fostering a sense of connection and improving their overall well-being.
Yuan et al.	Cognitive Exercise	Social Robot for Cognitive Exercise	Social robots can effectively deliver cognitive exercises, improving cognitive performance and engagement in older adults, suggesting their potential as a supportive tool for maintaining brain health.
Spector et al.	Reminiscence Support	Digital Reminiscence System (Mnemosyne)	The Mnemosyne Digital Reminiscence System is a promising tool for supporting reminiscence in individuals with dementia, facilitating recall and communication, and potentially improving mood and quality of life.
Baumann et al.	Feasibility RCT/Experimental Study	Virtual group cognitive stimulation therapy (vCST)	Virtual group cognitive stimulation therapy (vCST) is feasible and acceptable, demonstrating similar benefits to traditional in-person CST in improving cognitive function and well-being in individuals with dementia.

Note. vCST = virtual Cognitive Stimulation Therapy; RCT = Randomized Controlled Trial.

This systematic review identified 11 studies published between 2015 and 2025 investigating technology-based neuropsychological interventions for individuals with dementia. The selected articles were grouped into six thematic categories based on the type of technological resource and intervention strategy employed: (1) Technology-based Cognitive Stimulation Therapies, (2) Technological Platforms for Group Cognitive Training, (3) Interventions with Social Robots, (4) Technological Reminiscence Therapies, (5) Engagement Assessment, and (6) Comparative Studies/Multiple Technologies.

Technology-based Cognitive Stimulation Therapies

Two of the studies explored cognitive stimulation interventions supported by digital tools. Rai et al. (2021) assessed the development and usability of Thinkability, a mobile application designed to deliver Individual Cognitive Stimulation Therapy (iCST) to people with dementia in their homes. The app offered personalized cognitive exercises tailored to users' abilities and preferences while involving informal caregivers in the sessions. The study reported high usability and participant satisfaction levels, noting the app’s accessibility and the relevance of the exercises. Although primarily focused on feasibility and usability, the authors emphasized the potential cognitive benefits of the intervention, suggesting future randomized controlled trials (RCTs) to assess long-term outcomes.

Similarly, Spector et al. (2024) conducted a feasibility RCT to evaluate Virtual Group Cognitive Stimulation Therapy (vCST), an online adaptation of the evidence-based Cognitive Stimulation Therapy program delivered via videoconference. The intervention involved structured group sessions targeting memory, attention, language, and orientation domains. Results indicated high

engagement and participant satisfaction, with the virtual format proving particularly valuable during periods when in-person services were unavailable. The authors recommended further large-scale trials to confirm the intervention's efficacy and explore its impact on psychosocial outcomes.

Technological Platforms for Group Cognitive Training

One study by Gonzalez-Moreno et al. (2022) evaluated a cognitive stimulation program delivered through digital technologies in a group format for individuals with moderate dementia. The program included multimodal exercises focused on memory, attention, calculation, and language, supported by audiovisual and interactive digital tools. The results demonstrated significant improvements in sustained attention and memory, with participants showing measurable gains in neuropsychological assessments after the intervention. The study reinforced the feasibility of digital platforms as effective supplements to traditional cognitive training programs, especially in settings with limited healthcare access or mobility constraints.

Interventions with Social Robots

Four studies investigated using socially assistive robots as facilitators of cognitive or emotional interventions for people with dementia. Cruz-Sandoval et al. (2020) reported on a nine-week intervention using the social robot Eva, which facilitated Cognitive Stimulation Therapy sessions incorporating music, reminiscence, and relaxation. The results indicated significant reductions in neuropsychiatric symptoms such as agitation, delusions, and euphoria, alongside qualitative caregiver feedback noting improved mood and engagement.

Yuan et al. (2023) conducted a study using a social robot to deliver cognitive exercises to individuals with Alzheimer's disease and related dementias. The robot-led activities were designed to promote cognitive engagement and social interaction. Findings showed that the robot-

based intervention was well-received, with high levels of adherence and positive feedback from both participants and caregivers.

Perugia et al. (2017) explored the psychophysiological correlates of engagement during social robot interventions using electrodermal activity (EDA) measurements. Results demonstrated significant associations between engagement indicators and EDA, providing evidence for the feasibility of integrating biosignal monitoring into robot-based dementia care interventions.

In a complementary study, Perugia et al. (2020) proposed the ENGAGE-DEM model, a theoretical framework specifying engagement components in dementia care activities. The model was tested using behavioural and physiological data from participants interacting with social robots and serious games. The findings supported the model's validity and highlighted its utility for developing adaptive, technology-assisted interventions tailored to individual engagement profiles.

Technological Reminiscence Therapies

Two studies examined the application of technology in reminiscence therapy. Mnemosyne, presented by Baumann et al. (2024), is a digital system designed to support reminiscence sessions in residential care settings through audiovisual materials. The study reported high user satisfaction and observed improvements in mood and social interaction during sessions, indicating the potential of technology-enhanced reminiscence activities.

Filoteo et al. (2018) evaluated ReminX, a digital reminiscence therapy application developed for individuals with mild to moderate dementia. The study highlighted significant improvements in cognitive performance and mood following use of the tool, reinforcing the value of personalized reminiscence interventions delivered via user-friendly digital platforms.

Engagement Assessment

One study focused on engagement measurement monitoring during technology-supported interventions. Muñoz et al. (2022) examined engagement in technology-assisted social interactions for people with dementia in residential care. Using observational measures, the study identified high engagement levels during activities supported by digital tools, emphasizing the importance of tailoring interaction designs to participant preferences and abilities.

Comparative Studies/Multiple Technologies

Finally, Santos et al. (2015) conducted a comparative experimental study evaluating traditional cognitive stimulation techniques versus technology-supported interventions in elderly individuals with dementia. The study found no significant differences in cognitive outcomes between the two conditions but highlighted higher satisfaction levels and engagement in the technology-supported group. The authors noted the importance of ensuring technology accessibility and adaptability to individual preferences and cognitive capacities.

Discussion

This systematic review highlights the increasing role of technology-based neuropsychological interventions in dementia care. The twelve studies demonstrated diverse technological approaches — including mobile applications, virtual environments, socially assistive robots, and digital reminiscence tools — applied in both clinical and home settings. An analysis of outcome patterns reveals that cognitive domains such as memory, attention, and executive function were most frequently targeted and benefited from these interventions. Reminiscence-based interventions and social robot interactions consistently reported improvements in mood and reductions in neuropsychiatric symptoms, particularly agitation and apathy. However, improvements in functional independence and daily living activities were seldom assessed, indicating a gap in the current evidence base. Significantly, the severity of dementia influenced

intervention effectiveness. Mobile applications and virtual group therapies demonstrated higher feasibility and engagement among individuals with mild dementia. At the same time, social robots and digital reminiscence systems appeared more suitable for participants with moderate cognitive impairment, particularly in institutional care settings. This suggests that intervention type and delivery context should be tailored to the cognitive and functional status of individuals with dementia to maximize effectiveness. Contradictions emerged across studies. While several trials reported positive cognitive outcomes, others found no significant cognitive improvements, focusing instead on feasibility, usability, and user satisfaction. This inconsistency underscores the need for larger, more controlled, and methodologically rigorous studies to confirm the effectiveness of these interventions across different dementia profiles and care environments. Moreover, the context of care delivery significantly influenced intervention outcomes. Home-based interventions offered greater flexibility and personalization but required substantial caregiver involvement, while institutional settings allowed for structured implementation and integration into daily routines, particularly for technologies like socially assistive robots. Despite the promising findings, the methodological quality of the included studies was generally modest. Sample sizes were small, typically ranging from 8 to 60 participants, and only three studies employed randomized controlled trial (RCT) designs. Most investigations were feasibility or pilot studies, often lacking control groups and standardized cognitive outcome measures. Follow-up periods were limited, and blinding procedures were rarely applied. This methodological heterogeneity limits the generalizability of the evidence. It underscores the necessity for well-powered, controlled, and rigorously designed clinical trials to validate the long-term efficacy of technology-based neuropsychological interventions in dementia care.

Implications for research

Future research should prioritize large-scale, randomized controlled trials (RCTs) to assess the long-term cognitive, emotional, and functional outcomes of technology-based neuropsychological interventions for dementia. Integrating engagement monitoring tools, such as biosensors, could offer valuable insights for personalizing therapy. Additionally, cost-effectiveness analyses and co-design approaches involving people with dementia and their caregivers are essential to ensure the accessibility, ethical integrity, and clinical viability of these technological solutions.

Implications for clinical practice

Despite promising preliminary evidence, few of the technologies reviewed are ready for immediate clinical integration. Virtual cognitive stimulation therapies and digital reminiscence applications with demonstrated usability and acceptability could be considered for adoption in care plans within residential settings and home care, particularly when in-person services are limited or inaccessible. Key barriers to implementation include the need for staff training, technical infrastructure, financial resources, and device accessibility for older adults with sensory, motor, or cognitive impairments. Furthermore, health systems must address concerns related to data privacy, ethical oversight, and digital literacy among caregivers and care recipients. Strategic investment in these areas is crucial to enable the scaling up of evidence-based digital interventions for dementia care.

Limitations

The small sample sizes and methodological heterogeneity of the included studies restrict the strength of conclusions drawn. Additionally, a significant limitation is the lack of consistent reporting of sociodemographic data, including age, gender, educational background, and dementia subtypes. This absence hinders the assessment of intervention applicability across diverse

populations and care contexts. Future research should address these gaps by reporting comprehensive participant profiles and stratifying outcomes by demographic and clinical variables.

Conclusion

The systematic review identified 11 studies published between 2015 and 2025 that investigated technology-based neuropsychological interventions for individuals with dementia. These studies utilized various technological approaches, including mobile applications, virtual reality, socially assistive robots, digital reminiscence tools, and biosensor-based systems. The interventions demonstrated promising outcomes in enhancing cognitive stimulation, increasing participant engagement, and improving care accessibility. While promising, the studies often focused on usability and engagement rather than long-term benefits. Further large-scale, longitudinal, and controlled clinical trials are recommended to validate these preliminary findings and support their integration into clinical practice.

Guided by these findings, the multidimensional Memorare program, described in Part II of this dissertation, was specifically developed to address the gaps and opportunities identified through the systematic review. Combining cognitive stimulation, reminiscence therapy, and sensory stimulation mediated by technology, Memorare represents a direct clinical application of the trends and recommendations emerging from the review. Although conducted in a small institutional sample, the program revealed improvements in mood, reductions in neuropsychiatric symptoms, and positive qualitative feedback from participants, supporting the feasibility and therapeutic potential of person-centered, technology-supported interventions. These preliminary results reinforce the conclusions drawn in this systematic review and illustrate how evidence-based frameworks can translate into clinically meaningful interventions for dementia care.

References

Baumann, A., Shaw, P., Trotter, L., Clinch, S., & Davies, N. (2024). Mnemosyne - Supporting Reminiscence for Individuals with Dementia in Residential Care Settings. *Proceedings of the CHI Conference on Human Factors in Computing Systems*, 1–17. https://doi.org/10.1145/3613904.3642783

Cruz-Sandoval, D., Morales-Tellez, A., Sandoval, E. B., & Favela, J. (2020). A Social Robot as Therapy Facilitator in Interventions to Deal with Dementia-related Behavioral Symptoms. *Proceedings of the 2020 ACM/IEEE International Conference on Human-Robot Interaction.* https://doi.org/10.1145/3319502.3374840

Cuffaro, L., Di Lorenzo, F., Bonavita, S., Tedeschi, G., Leocani, L., & Lavorgna, L. (2020). Dementia care and COVID-19 pandemic: a necessary digital revolution. *Neurological Sciences, 41*(8), 1977–1979. https://doi.org/10.1007/s10072-020-04512-4

Filoteo, J. V., Cox, E. M., Split, M., Gross, M., Culjat, M., & Keene, D. (2018). Evaluation of ReminX as a Behavioral Intervention for Mild to Moderate Dementia. *2018 40th Annual International Conference of the IEEE Engineering in Medicine and Biology Society (EMBC).* https://doi.org/10.1109/embc.2018.8513049

Giulia Perugia, Rodriguez-Martin, D., Marta Diaz Boladeras, Andreu Catala Mallofre, Barakova, E., & Matthias Rauterberg. (2017). Electrodermal activity: Explorations in the psychophysiology of engagement with social robots in dementia. *UPCommons (Polytechnic University of Catalonia).* https://doi.org/10.1109/roman.2017.8172464

Gonzalez-Moreno, J., Satorres, E., Soria-Urios, G., & Meléndez, J. C. (2022). Cognitive stimulation program presented through new technologies in a group of people with

moderate cognitive impairment. *Journal of Alzheimer's Disease, 88*(2), 513–519. https://doi.org/10.3233/jad-220245

Hung, L., Mann, J., Perry, J., Berndt, A., & Wallsworth, C. (2021). Engaging older adults in technology-supported dementia care: A narrative review. *Nursing Open, 8*(1), 2–14. https://doi.org/10.1002/nop2.612

Indela, R. K., Satheesh, K. K., Bharathi, G., & Sharma, V. K. (2023). Technology-assisted cognitive rehabilitation in dementia: A review. *Current Alzheimer Research, 20*(1), 16–30. https://doi.org/10.2174/1567205019666220919100437

Inelmen, E. M., Sergi, G., & Manzato, E. (2020). Innovative digital technologies for dementia: A narrative review. *International Journal of Environmental Research and Public Health, 17*(9), 3264. https://doi.org/10.3390/ijerph17093264

Livingston, G., Huntley, J., Sommerlad, A., Ames, D., Ballard, C., Banerjee, S., Brayne, C., Burns, A., Cohen-Mansfield, J., Cooper, C., Costafreda, S. G., Dias, A., Fox, N., Gitlin, L. N., Howard, R., Kales, H. C., Kivimäki, M., Larson, E. B., Ogunniyi, A., ... Mukadam, N. (2020). Dementia prevention, intervention, and care: 2020 report of the Lancet Commission. *The Lancet, 396*(10248), 413–446. https://doi.org/10.1016/S0140-6736(20)30367-6

Muñoz, D., Pedell, S., & Sterling, L. (2022). Evaluating Engagement in Technology-Supported Social Interaction by People Living with Dementia in Residential Care. *ACM Transactions on Computer-Human Interaction.* https://doi.org/10.1145/3514497

Nichols, E., Steinmetz, J. D., Vollset, S. E., Fukutaki, K., Chalek, J., Abd-Allah, F., ... & Murray, C. J. (2022). Estimation of the global prevalence of dementia in 2019 and forecasted

prevalence in 2050: An analysis for the Global Burden of Disease Study 2019. *The Lancet Public Health, 7*(2), e105–e125. https://doi.org/10.1016/S2468-2667(21)00249-8

Olazarán, J., Reisberg, B., Clare, L., Cruz, I., Peña-Casanova, J., Del Ser, T., Woods, B., Beck, C., Auer, S., Lai, C., & Muñiz, R. (2010). Nonpharmacological therapies in Alzheimer's disease: A systematic review of efficacy. *Dementia and Geriatric Cognitive Disorders, 30*(2), 161–178. https://doi.org/10.1159/000316119

Perugia, G., Diaz-Boladeras, M., Catala-Mallofre, A., Barakova, E. I., & Rauterberg, M. (2020). ENGAGE-DEM: A Model of Engagement of People with Dementia. *IEEE Transactions on Affective Computing,* 1–1. https://doi.org/10.1109/taffc.2020.2980275

Rai, H. K., Schneider, J., & Orrell, M. (2019). An individual cognitive stimulation therapy (iCST) application for people with dementia: Development and usability study of Thinkability (Preprint). *JMIR Aging*. https://doi.org/10.2196/17105

Santos, Calixto, M. F., de, P., Garcia, P. A., & Brasil, L. M. (2015). *Using traditional methods and technology in cognitive stimulation in the elderly: an experimental study with a control group.* 1–6. https://doi.org/10.1109/pahce.2015.7173349

Spector, A., Abdul Wahab, N. D., Stott, J., Fisher, E., Hui, E. K., Perkins, L., Leung, W. G., Evans, R., Wong, G., & Felstead, C. (2024). Virtual group cognitive stimulation therapy for dementia: Mixed-methods feasibility randomized controlled trial. *The Gerontologist, 64*(8). https://doi.org/10.1093/geront/gnae063

Topol, E. J. (2019). High-performance medicine: The convergence of human and artificial intelligence. *Nature Medicine, 25*(1), 44–56. https://doi.org/10.1038/s41591-018-0300-7

Woods, B., O'Philbin, L., Farrell, E. M., Spector, A. E., & Orrell, M. (2018). Reminiscence therapy for dementia. *Cochrane Database of Systematic Reviews,* (3). https://doi.org/10.1002/14651858.CD001120.pub3

World Health Organization. (2021). *Dementia*. https://www.who.int/news-room/fact-sheets/detail/dementia

Yuan, F., Boltz, M., Bilal, D., Jao, Y.-L., Crane, M., Duzan, J., Abdurhman Bahour, & Zhao, X. (2023). Cognitive Exercise for Persons With Alzheimer's Disease and Related Dementia Using a Social Robot. *IEEE Transactions on Robotics, 39*(4), 3332–3346. https://doi.org/10.1109/tro.2023.3272846

PART II

"Memorare" a multidimensional intervention for people with major neurocognitive disorder: a series of six case studies

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Abstract

In response to the aging population and the rise in neurological and psychiatric disorders, innovative, person-centered interventions are crucial for enhancing the quality of life. This study explores the effects of a novel multidimensional program in cognitive, mood, behavior and quality of life outcome measures in a sample of major neurocognitive disorders from multiple etiologies. Six participants, recruited from a mental health institution and aged 72 on average, underwent the Memorare program, which integrates three modules: 1) cognitive stimulation and 2) reminiscence therapy through the Musiquence platform, an interactive system that personalizes cognitive activities using music and reminiscence; and 3) sensory stimulation with natural textures. Over six weeks, participants engaged in tailored, interactive activities, followed by pre- and post-intervention assessments. Despite overall cognitive declines expected for neurodegenerative conditions, two participants showed a decline on neuropsychiatric symptoms and an improve on quality of life. These findings underscore the potential of interactive systems like Musiquence to enhance therapeutic outcomes and patient well-being.

Keywords: *Multidimensional intervention, major neurocognitive disorder, case studies, cognitive stimulation, reminiscence therapy, sensory stimulation*

1 Introduction

1.1. Neurological and psychiatric disorders

As the global population ages, the prevalence of neurological and psychiatric disorders continues to rise, posing significant challenges for healthcare systems worldwide (Dementia, n.d.). Among the myriad conditions impacting older people, cognitive deficits—frequently stemming from alcohol-related neurological damage—have emerged as a critical area demanding innovative, effective, and patient-centered therapeutic strategies (Koch et al., 2019). The increasing burden on healthcare infrastructure and the multifaceted nature of cognitive impairments require multidimensional approaches that extend beyond conventional interventions. The complexities of cognitive deficits are deeply interwoven with patients' daily functioning and quality of life. These impairments often encompass memory loss, diminished problem-solving abilities, reduced adaptability and disruption of social life—symptoms that hinder autonomy and heighten caregiver dependency (Kitwood & Bredin, 1992; Meyer & O'Keefe, 2020). Accordingly, neurological conditions, marked by disturbances in neuronal circuits, frequently present with psychiatric symptoms that blur traditional diagnostic categories and highlight the importance of adopting more multidimensional approaches to patient care (Maristany et al., 2024). In this context, our research delves into a multifaceted program designed to address these pressing needs, offering fresh insights into therapeutic efficacy and patient outcomes.

1.2. Cognitive decline

According to the American Psychological Association, cognitive decline can reduce one or more cognitive abilities, such as memory, awareness, judgment, and mental acuity, across the adult lifespan (American Psychological Association, n.d.). The presence and degree of decline can differ with the cognitive ability being measured, while fluid abilities often show more significant declines than crystallized abilities. Although cognitive decline is a part of normative healthy aging; a severe decline is not normative and could be symptomatic of disease since it is the

primary symptom of disease-induced major neurocognitive disorder (American Psychological Association, n.d.). Cognitive decline, often a precedent and a consequence of major neurocognitive disorder, can be associated with different objective levels of cognitive and functional impairment, which can be revealed by clinical and neuropsychological examinations (Jessen et al., 2020). Besides, people with cognitive decline may have marked deficits in remembering their past or envisioning their future in a detailed, concise manner, which may also impact their self-identity. Adding to cognitive and functional decline, different behavioral changes manifest with increasing severity over time, leading to significant management challenges for caregivers and healthcare professionals. Moreover, almost all patients are affected by neuropsychiatric symptoms at some point, and in some cases, symptoms occur before diagnosis of the significant neurocognitive disorder. Included are the disruptive symptoms such as agitation, aggression, hallucinations and delusions combined with apathy and depression (Robert et al., 2012).

1.3. Major neurocognitive disorder

Several studies have shown a relationship between the development of cognitive impairment and major neurocognitive disorders with lifestyle-related risk factors such as physical inactivity, tobacco use, unhealthy diets and harmful use of alcohol (World Health Organization, n.d.). Indeed, in observational studies focusing on populations, particularly older adults, heavy alcohol consumption has occasionally been linked to a higher risk of major neurocognitive disorder. However, other research has reported no significant relationship between heavy alcohol use and the likelihood of developing a major neurocognitive disorder (Visontay et al., 2021). According to the DSM-V, major neurocognitive disorder exists on a spectrum of cognitive and functional impairment, where the main characteristic is an acquired cognitive decline in one or more cognitive domains (American Psychiatric Association, 2022). Consequently, changes in mood and behavior occur even before memory problems manifest. Nonetheless, a primary

neurocognitive condition tends to be compounded by depression or anxiety, a sense of apathy or discouragement (Kitwood & Bredin, 1992). Symptoms get worse over time, and inevitably, most people with major neurocognitive disorders need others to help with daily activities (Dementia, n.d.). It is the leading cause of institutionalization of the elderly (Takeda et al., 2012). Hence, major neurocognitive disorder is a leading cause of disability and dependency among older adults worldwide, stemming from a variety of causes and manifesting in different forms (Dementia, n.d.).

Primary types of major neurocognitive disorders can include Alzheimer's disease, vascular major neurocognitive disorder, major neurocognitive disorder with Lewy bodies, and frontotemporal major neurocognitive disorder. Among these, Alzheimer's disease is the most prevalent, followed by vascular major neurocognitive disorder and major neurocognitive disorder with Lewy bodies (Dementia, n.d.).

1.4. Treatment alternatives

Although numerous clinical trials have been carried out over the years, there is no effective treatment or cure for major neurocognitive disorder (Ritchie et al., 2015). Pharmacotherapy is often the primary intervention implemented to improve symptoms or delay the progression of major neurocognitive disorder syndromes. The available agents vary concerning their therapeutic actions and are supported by different levels of evidence for efficacy (Takramah & Asem, 2022). Nonetheless, pharmacological treatment isn't enough. Several guidelines recommend that non-pharmacological interventions be tried first, followed by using the least harmful medication for the shortest possible duration since pharmacological treatment options require careful consideration of the benefits and limitations of each drug class (Robert et al., 2012). Various non-pharmacological approaches can assist in managing patients with major neurocognitive disorders. These include cognitive stimulation, rehabilitation, multisensory stimulation, reality orientation, reminiscence

therapy, validation therapy, physical activity, light therapy, music therapy, aromatherapy, animal-assisted therapy, and doll therapy (Takeda et al., 2012).

Reminiscence therapy is frequently used for patients with impaired memory, paying respect to the life and experiences of the individual to help the patient remember his past. It involves discussing past activities, events and experiences, usually with tangible prompts such as photographs, household items from the past and music (Subramaniam & Woods, 2016). More recently, digital storage and presentation of pictures, music and video clips have become widely used in one approach: participants are guided by a trained person to reflect various aspects of their lives (Takeda et al., 2012). Reminiscence therapy can be helpful for older adults with major neurocognitive disorders since they usually hold a better memory for past experiences than recent ones. It has been used inside and outside institutions, delivered by psychologists and nurses since the Eighties, and uses resources that aim at memory triggers. Thus, to recall autobiographical events promoting the life experiences of older adults (Cammisuli et al., 2022).

The limited effectiveness of drug treatments and the brain's plasticity has fueled a growing interest in non-pharmacological interventions for primary neurocognitive disorder patients, including sensory stimulation. Sensory stimulation originates from the "Snoezelen method," developed in the Netherlands during the 1970s (Boccadamo et al., 2021). This approach promotes patient relaxation by alleviating the stress and tension they often experience in group housing settings. These environments can be challenging due to the constant presence of other residents, whose unique behaviors—such as screaming or aggression—may contribute to heightened levels of anxiety and discomfort (Boccadamo et al., 2021). In 2020, a systematic review concerning sensory stimulation for nursing home residents analyzed that sensory stimulation can improve sleep quality and reduce nocturnal restlessness in nursing home residents with major neurocognitive disorder (Prins et al., 2020). The multisensory stimulation environment (MSSE) is knowingly suitable for neurological and psychiatric inpatients. The MSSE usually occurs in a relaxing room –

the Snoezelen room. This room offers auditory, tactile and olfactory stimulation through lights, fiber-optic cables, water columns, aroma therapy, different music/sounds, tactile objects and screen projectors. This room allows patients to engage with the sensory stimuli of their choice. Snoezelen aims to stimulate the primary senses without the patient's need for intellectual activity. This is an advantage for dealing with people with major neurocognitive disorders in more advanced stages (Baker et al., 2001; Milev et al., 2008; Sánchez et al., 2016). A recent study showed that olfactory stimuli could support the identity of people with major neurocognitive disorders as they enhance autobiographic memories and access to self-concept. Several interventions have used smell-based stimuli to stimulate the olfactory sense of people with major neurocognitive disorders. These may include household items such as soap and oils (D'Andrea et al., 2022; Sowndhararajan & Kim, 2016). Although it has benefits, since the Snoezelen room isn't as accessible as desired, a sensory panel of sensory textures for stimulation could be created.

In a recent randomized controlled pilot trial using a multidimensional program, there seemed to be some potentially clinically meaningful findings in improving neuropsychiatric symptoms in areas such as gait and physical activity (Hasselgren et al., 2024). The limited efficacy of pharmacotherapy and the plasticity of the brain, even in degenerative conditions , are the two main reasons that can explain the growing search and investment in non-pharmacological intervention for patients with major neurocognitive disorder (Saragih et al., 2022; Takeda et al., 2012). Aguirre et al. showed a consistent significant benefit to cognitive function following treatment. The benefits appeared to be over and above any medication effects, having remained evident at follow-up up to three months after treatment. This means there is promising evidence that cognitive stimulation interventions benefit cognitive function and aspects of well-being; consequently, cognitive stimulation should be made more widely available in major neurocognitive disorder care (Aguirre et al., 2013). Making cognitive stimulation accessible and personalized to the person's needs is an important challenge. Over the last few years, interactive

technologies have been gathering evidence of their benefits as an intervention methodology (Goodall et al., 2021).

Musiquence (music + sequence) is an interactive technology development platform that allows the creation, adaptation, and personalization of cognitive activities based on music and reminiscence according to the patient's needs. This framework shows excellent technological compatibility with a population without experience using computers since it can be projection-based and shows enormous advantages for people with major neurocognitive disorders, from bringing meaningful content (images, music and physical objects) to being possible to manipulate specific components to avoid erroneous decision-making in people with major neurocognitive disorder. Concerning reminiscence, the platform allows the use of real photos or real objects to complete activities that can amplify therapeutic outcomes (Ferreira et al., 2019).

When it comes to care, a person-centered approach can explain and predict individual exceptions based on who the person is - their context, history, family and loved ones, and personal strengths and weaknesses (Ekman et al., 2011). A systematic review and meta-analysis showed that person-centered care interventions appear to reduce agitation, neuropsychiatric symptoms, and depression and to improve the quality of life, despite that the effects were primarily short-term and lasted 6 weeks on average. Person-centered care interventions, which engage the person as an active partner in the process, are significant in the care of people with a major neurocognitive disorder and can effectively reduce agitation in the short term using intensive and activity-based intervention (Ekman et al., 2011; Kim & Park, 2017). Based on a review of systematic reviews of Meyer & O'Keefe, the most substantial evidence for reducing responsive behaviors were music, sensory stimulation, simulated presence and validation therapies (Meyer & O'Keefe, 2020).

According to the literature, multidimensional interventions are suggested to be more effective. Nevertheless, traditional therapeutic modalities frequently adopt a one-dimensional approach, focusing narrowly on cognitive exercises without fully accounting for the broader spectrum of

patient needs. Our study sought to bridge this gap by developing and implementing a six-week intervention program that integrates three distinct yet complementary therapeutic modules: cognitive stimulation, reminiscence therapy, and sensory stimulation. By tailoring the intervention to each patient's unique needs and capabilities, we aimed to create a comprehensive approach that addresses cognitive and functional domains.

2 Objectives

This study centered on six male inpatients, with a mean age of 72, who were residing in a mental health institution in Madeira Island. The participants presented varying degrees of cognitive decline, needing a flexible and adaptive intervention model. The program's cognitive stimulation and reminiscence components present exercises through Musiquence, an interactive platform for cognitive activities based on music and reminiscence according to people with major neurocognitive disorder needs (Ferreira et al., 2019). Simultaneously, reminiscence therapy fostered emotional engagement by encouraging patients to revisit meaningful life experiences, promoting cognitive stimulation through personal and cultural narratives. Lastly, the sensory stimulation component introduced multisensory experiences—including mainly tactile and visual elements— stimulating basic senses. We aim to explore the Memorare program's impact on the mood and well-being of participants with major neurocognitive disorders.

3 Methods

3.1. Case Studies Description

Case 1. Patient 1 is an 88-year-old male individual with severe vision impairment. The patient has a 6th-grade education and a history of working as a panel beater. Although the patient does not have a formal diagnosis, the medical team suspects that he has a major neurocognitive disorder due to alcohol consumption. Patient 1 has been hospitalized in the mental health institution for 9 years. Due to Patient 1's vision difficulties, all the activities were adapted, with the researcher

dictating any question-and-answer option and in the evaluations, where all the items that required drawing or reading were not counted in the patient's evaluation. Despite the visible memory deficits, Patient 1 is very communicative, usually in a good mood, and willing to participate in activities.

Case 2. Patient 2 is a 66-year-old male individual with major facial dullness. The patient has a 6th-grade education and a history of working as a bus collector. Just like Patient 1, this patient has a major neurocognitive disorder caused by heavy alcohol consumption. Hospitalized for 8 years, the patient had to retire early due to disability. Patient 2 was generally uncommunicative but seemed more communicative as he carried out the activities.

Case 3. Patient 3 is a 68-year-old male individual with a 12th-grade level of education. The patient has a history of working as an accountant and managing a bakery. The patient has also been linked with a major neurocognitive disorder due to alcohol abuse and has been hospitalized for 10 years. The patient had to retire early due to disability and of the six patients, he was the one who showed more anxiety symptoms.

Case 4. Patient 4 is a 71-year-old male individual with a 4th-grade education. The patient worked all his life in a cemetery. The patient has also been linked with a major neurocognitive disorder due to alcohol abuse and has been hospitalized for 5 years. Occasionally the patient showed some confusion and concern about his relatives.

Case 5. Patient 5 is a 69-year-old male individual. This patient has a major neurocognitive disorder caused by vascular etiology and has been hospitalized for 2 years. The patient has a 4th-grade education and a history of working as a warehouse manager. This patient frequently reported anxiety symptoms. The patient also has a history of depression and severe alcohol consumption since a young age.

Case 6. Patient 6 is a 70-year-old male individual hospitalized for 2 years. The patient has a 4th-grade education and a history of working as a carpenter. The patient is linked with a major

neurocognitive disorder resulting from a serious accident at work which led to the patient retiring early due to disability. The patient has very slow speech and reasoning.

3.2. Neuropsychological Assessment Measures

To participate in the clinical study, all six case studies were administered a neuropsychological assessment protocol at two different moments: baseline and post-intervention. In addition to the neuropsychological tests, all participants' primary caregivers gave their consent to fill a sociodemographic questionnaire to collect information, such as: date of hospitalization, current medication, diagnosis and other information relevant to the study. The protocol comprised the Portuguese versions of the following instruments:

- **Mini Mental State Examination (MMSE)** (Folstein et al., 1975; Guerreiro et al., 1994), a widely used 30-point questionnaire designed to measure cognitive impairment in older adults and assess its progression;
- **Geriatric Depression Scale (GDS-15)** (Barreto et al., 2008; Yesavage et al., 1982), a 15-item self-report assessment used to identify depression in older adults. It's a shortened version of the original 30-item scale, focusing on mood-related questions;
- **Positive and Negative Affect Schedule (PANAS)** (Lopes & Lemos, 2004; Watson et al., 1988), a psychometric scale consisting of two 22 items, measuring positive and negative affect, helping to assess a person's emotional state. PANAS was applied for a total of 10 weeks. Each week, the nurse filled in the schedule for each patient. The PANAS was filled out before, during and after the Memorare program to understand possible changes in behaviour and emotions;
- **Quality of Life-Alzheimer's Disease (QOL-AD)** (Logsdon et al., 2002; Medeiros et al., 2008), a 13-item scale explicitly designed to measure the quality of life in individuals with Alzheimer's Disease, including patient and caregiver input on various life domains;
- **Neuropsychiatric Inventory (NPI)** (Cummings et al., 1994; Sousa et al., 2005), a tool used to assess a wide range of behavioural and psychological symptoms in individuals with neurodegenerative disorders, such as major neurocognitive disorder, covering areas like delusions,

hallucinations, and agitation;

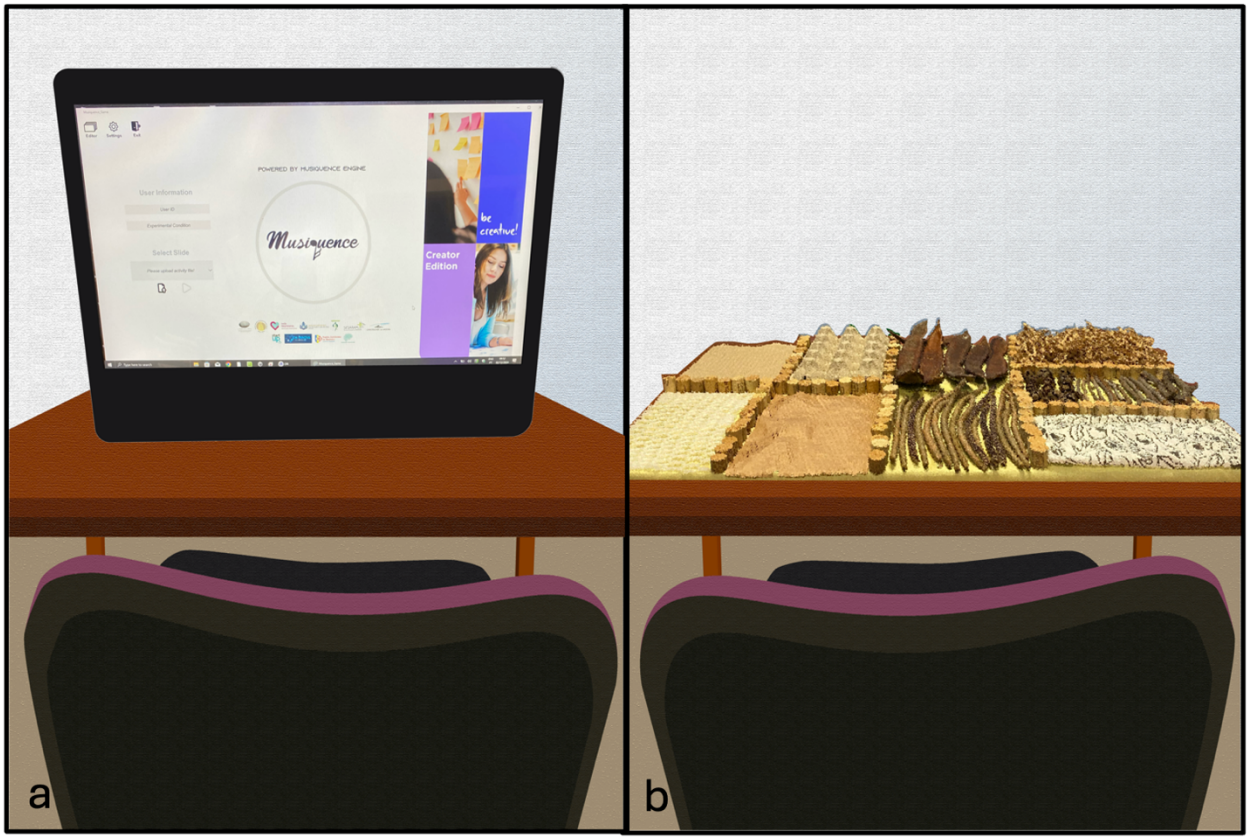
- **Lisbon Battery for the Assessment of Dementias (BLAD)** (Almeida & Silva, 2007), a comprehensive cognitive assessment tool developed to diagnose and differentiate various forms of major neurocognitive disorder;
- **Clinical Dementia Rating (CDR)** (Mendes & Almeida, 2005; Penn & Mangieri, 1993), a scale used to quantify the severity of symptoms of dementia, ranging from none to severe, based on six domains of cognitive and functional performance. The CDR was mainly used to understand the stage of each patient.

3.3. Procedure

Following written informed consent, all participants completed three phases: baseline neuropsychological assessment, a six-week multidimensional program, and post-neuropsychological assessment. Neuropsychological assessments were performed at two different time points and the primary author conducted the Memorare program. All six sessions of the Memorare program were conducted at the mental health institution, where all six participants were living. The participants were seated on a chair in all sessions (Fig. 1). Each session lasted 20 to 30 minutes maximum and consisted of cognitive stimulation and reminiscence therapy through the Musiquence platform (Fig. 1a), which was run on an Acer (UT220HQL 21.5" LED) with Windows OS (Acer Incorporated, Taiwan), as well as sensorial stimulation using a sensory panel of textures (Fig. 1b).

Figure 1

(a) plan view of the sessions with Musiquence; (b) plan view of the sessions with the sensorial panel.



3.4. Structure of the Memorare Program

The sessions occurred weekly for 6 weeks; each module ran for two consecutive weeks (Table 1), and at the end of each session, the participants were asked about whether they enjoyed the session, if there were any difficulties or questions and if they wanted to continue to comply with the intervention schedule. The protocol order was randomized through Randomizer (https://www.randomizer.org/) for each participant to reduce order effects. The study was approved by the mental health institution where the study took place and by the ethics committee of the University of Madeira.

Table 1

Structure of the Memorare program

Session nr.	Component	Duration (min)
1 - 2	Baseline Neuropsychological Assessment	60
3 - 4	Cognitive Stimulation with Musiquence	20 - 30
5 - 6	Reminiscence Therapy with Musiquence	20 - 30
7 - 8	Sensory Stimulation with texture panel	20 - 30
9 - 10	Post-intervention Neuropsychological Assessment	60

3.5. Intervention Components

The cognitive stimulation sessions were carried out entirely through the Musiquence platform (Fig. 2a). The first questions always focused on temporal orientation and spatial orientation. Then, the activities relating to the theme of the session began. The first cognitive stimulation session concerned the history of bananas on the island of Madeira. In contrast, the second session corresponded to the history of the grape harvest on the island of Madeira. The reminiscence sessions were also carried out entirely on the Musiquence platform (Fig. 2b). As with the cognitive stimulation sessions, these sessions began with temporal and spatial orientation. The sessions were fully customized according to each patient's preferences. Patient 1 had a session on festivities on the island of Madeira and Portuguese music. Patient 2 had a session about the bus company he worked for and the areas of Madeira where he passed through when he worked. Patient 3 had an accounting session and another on computers. The sensory stimulation sessions were carried out using the sensory stimulation panel (Fig. 2c). In this panel, patients touch with their hands and fingers while the researcher asks questions such as “Is this texture soft or rough?”. In the first sensory stimulation session, the patients had their eyes open, and in the second session, the researcher asked them to close their eyes. While selecting the textures we would use, we opted to use textures more linked to nature, given that the six participants have lived most of their lives on Madeira Island, and its

nature very much characterizes the island. We decided that using materials that could be more easily recognized would be more effective. The textures used in the panel were various, such as tree branches, cork stoppers, carob pods, paper with different textures and even a pattern.

Figure 2

a) cognitive stimulation with Musiquence platform; (b) reminiscence with Musiquence platform; (c) sensorial stimulation

4 Results

Overall, MMSE scores declined in all patients, indicating a reduction in global cognitive function following the intervention. The decreases ranged from 2 to 6 points, with Patient 4 showing the largest decline (25 to 19). Depressive symptoms, as measured by the GDS-15, increased in four of the six patients. Notably, Patient 6 exhibited a significant increase from a score of 3 to 10, and Patient 3 from 5 to 8. Only Patient 5 showed a slight increase (1 to 2), while Patient 1's score remained unchanged. In terms of quality of life (QOL-AD), results were mixed. Three patients (2, 5, and 4) experienced changes: Patient 2 and 5 showed improvements (e.g., 31 to 36 and 35 to 39 respectively), while Patient 4 saw a slight decline (31 to 28). The remaining patients showed stable scores. The neuropsychiatric symptoms (NPI) either remained stable or decreased in severity. Patient 4 showed a complete reduction in symptoms (3 to 0), and Patient 5 exhibited a reduction from 12 to 6. No patient experienced an increase in NPI scores. Functional ability, as assessed by the BLAD scale, improved in three patients (Patients 4, 5, and 6), with Patient 6 showing the most notable improvement (95 to 122). However, some patients exhibited

mild declines, particularly Patient 3 (138 to 121). In summary, while cognitive performance and depressive symptoms showed a general trend toward decline post-intervention, some improvements were observed in quality of life, behavioral symptoms, and daily functioning, suggesting a nuanced effect of the intervention across domains (Table 2).

Table 2

Raw scores on the neuropsychological instruments across the two time points (baseline and post-intervention)

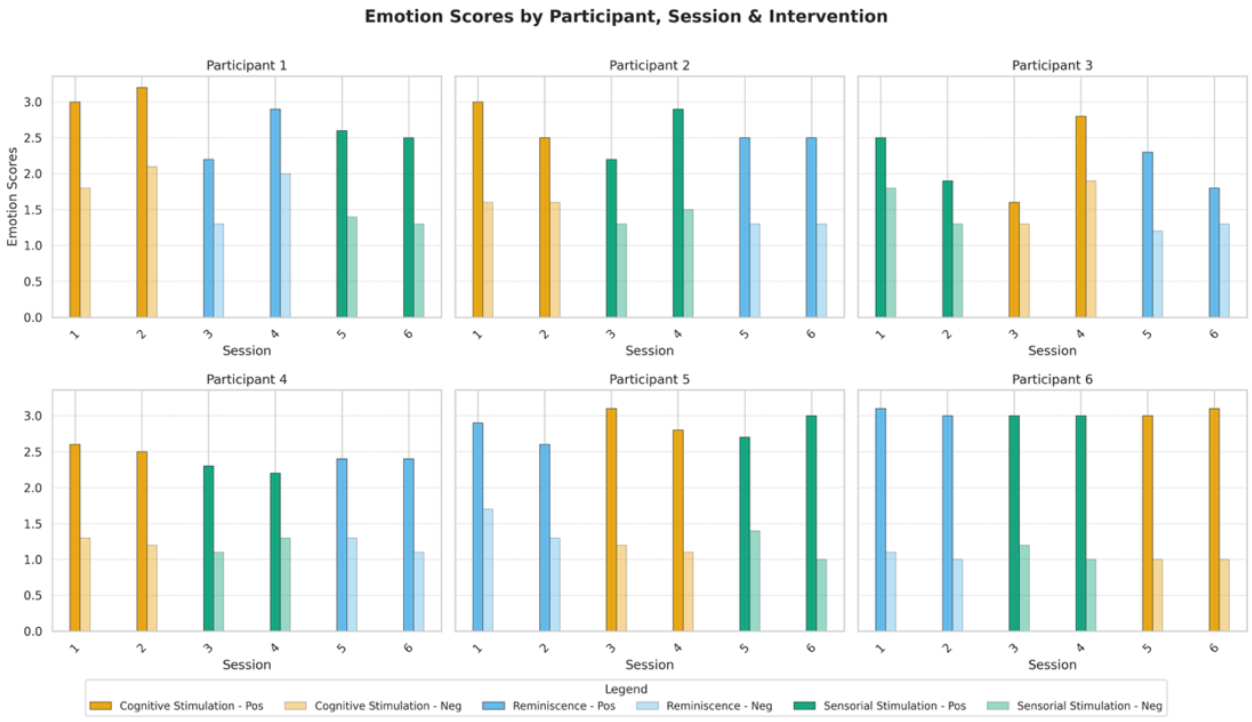
Neuropsychological Assessment instruments	Baseline (T1)	Post (T2)
Patient 1		
MMSE	25	20
GDS-15	3	3
QOL-AD	37	36
NPI	0	0
BLAD	103	100
Patient 2		
MMSE	27	24
GDS-15	3	3
QOL-AD	31	36
NPI	4	4
BLAD	91	88
Patient 3		
MMSE	28	23
GDS-15	5	8
QOL-AD	36	36
NPI	0	0
BLAD	138	121
Patient 4		
MMSE	25	19
GDS-15	1	7
QOL-AD	31	28
NPI	3	0
BLAD	99	86
Patient 5		
MMSE	30	28
GDS-15	1	2
QOL-AD	35	39
NPI	12	6
BLAD	115	122
Patient 6		
MMSE	27	25
GDS-15	3	10

Neuropsychological Assessment instruments	Baseline (T1)	Post (T2)
QOL-AD	33	28
NPI	0	0
BLAD	95	122

The analysis of the PANAS scores, related to positive and negative affect, displayed in Figure 3, reveals a clear pattern across the six participants regarding the type of intervention that elicited the highest levels of positive emotions. Across the three intervention modalities – Cognitive Stimulation, Reminiscence Therapy, and Sensory Stimulation – the Cognitive Stimulation sessions consistently produced the highest positive affect scores for the majority of participants. Specifically, five out of six participants (Participants 1, 2, 3, 5, and 6) reported their highest positive affect values during the Cognitive Stimulation sessions. Even in the case of Participant 4, although Reminiscence Therapy showed slightly higher values, Cognitive Stimulation remained comparable and was among the top two in affective impact. In contrast, negative affect scores were generally lowest during the Cognitive Stimulation sessions for all participants, indicating that this intervention not only promoted more positive emotions but also helped reduce negative emotional states. Reminiscence Therapy and Sensory Stimulation produced varied emotional responses, with no consistent pattern of elevated positive affect across all participants. These findings suggest that, within this sample, Cognitive Stimulation had the most consistent and favorable emotional impact among the three intervention types, reinforcing the importance of structured cognitive engagement activities in promoting emotional well-being in individuals with major neurocognitive disorder.

Figure 3

Negative and positive affect scores by participant over time, as assessed by the PANAS (Lopes & Lemos, 2004; Watson et al., 1988)



5 Discussion

This study sought to investigate the impact of a six-week multidimensional program tailored for individuals with major neurocognitive disorder. In addition to this primary aim, we also sought to explore the preliminary efficacy of the Memorare program on the mood and behaviour outcomes of the participants. The intervention aimed to provide a comprehensive therapeutic approach by integrating cognitive stimulation, reminiscence therapy, and sensory stimulation, personalized to meet each patient's individual needs. The pivotal discovery of the study was the strong correlation between task personalization and patient involvement. It became evident that the more a task was tailored to the specific interests and histories of the participants, the more engaged they became in the activity. Although developing personalized activities can be time-intensive, this method proved to be the most beneficial for the participants, suggesting that

customization is crucial for the effectiveness of therapeutic interventions in similar contexts. Feedback from the participants provided valuable insights into the therapeutic potential of reminiscence activities. During the final session, all six participants explicitly stated that the activities reminded them of their past, which they found to be a positive and meaningful experience. For example, one of the patients mentioned, “This is good to remember the old days.” In fact, to remember, in Portuguese - “remember” was the word that gave rise to the program's name - *Memorare* (a Latin word), because it was the most repeated word by the participants. This reinforces the idea that connecting with personal history can have a profound emotional impact, fostering a sense of continuity and comfort. Interestingly, despite the initial anxiety observed in some participants at the beginning of sessions, there was a consistent pattern of reduced anxiety by the end of each session. This suggests that the structured and familiar environment provided by the Memorare program played a significant role in alleviating symptoms of agitation and anxiety. Such findings support the idea that well-structured interventions, along with the establishment of a therapeutic relationship, can offer a sense of stability and security, which is particularly beneficial for patients who are prone to anxiety when exposed to new or unfamiliar activities.

5.1. Limitations

Throughout the program, several factors emerged that had significant implications for the study's outcomes. Notably, one participant received a cancer diagnosis during the second week of the intervention. This diagnosis likely influenced his psychological state and could have affected his engagement and response to the program. Such unforeseen medical developments underscore the complexity of working with populations with significant health vulnerabilities and the need to consider these factors in future similar studies. An essential limitation of this study was the small sample size, consisting of only six case studies. While these individual cases provided valuable insights into the program's potential impact, the small number of participants restricts the generalization of the findings. Future studies with more significant, more diverse samples would help validate the results and provide a clearer understanding of the

broader applicability of the Memorare program for individuals with cognitive and mood challenges. Nevertheless, the fact that the six participants are already in the advanced stages of dementia can make it more difficult to achieve any changes in behavior and mood outcomes. All six participants in the study were using neuroleptic medication, which is commonly prescribed for managing symptoms associated with severe psychiatric disorders. The presence of these medications introduces another layer of complexity, as they may have interacted with the cognitive and mood interventions administered through the Memorare program. This raises important questions about how pharmacological treatments might modulate the efficacy of non-pharmacological interventions. For example, two of the patients showed no neuropsychiatric symptoms, which may be questionable at such an advanced stage of the disease; however, since both are medicated with neuroleptics, it is to be expected that the symptoms will be contained. Another limitation was having different evaluators to administer the Mini-Mental State Examination (MMSE) from baseline to post-intervention. The variation in how different evaluators applied the MMSE could have affected the scores and potentially contributed to the observed cognitive decline. This inconsistency highlights the need for standardized assessment procedures to ensure the reliability of cognitive evaluations across sessions. Lastly, as seen by Miklitz et al., because of profound cognitive deficits, patients with major neurocognitive disorders have limited access to evaluating their life satisfaction. Therefore, using ecological momentary assessments to measure happiness and subjective well-being could be a better alternative in the future (Miklitz et al., 2024). All the study's findings and limitations emphasize the importance of personalized, structured, and contextually sensitive interventions for individuals with major neurocognitive disorders.

5.2. Future Work

Considering the promising results of this study, future research should aim to expand the scope and methodological rigor of the Memorare program's evaluation. One of the primary directions for future work is the implementation of a randomized controlled trial (RCT) to systematically assess the efficacy of the multidimensional intervention compared to standard care or isolated therapeutic modalities. An RCT would provide higher-level evidence regarding the program's effects on cognitive, emotional, and behavioral outcomes. Moreover, increasing the frequency and duration of the intervention sessions should be explored.

A more intensive program might enhance therapeutic outcomes, particularly regarding mood and neuropsychiatric symptoms, which showed varied responses in this study. Extending the intervention period could also help determine the sustainability of observed benefits and potentially mitigate the cognitive and emotional decline commonly observed in this population. Additionally, the adoption of alternative and complementary assessment tools would be valuable. In particular, the integration of ecological momentary assessments to capture real-time fluctuations in mood and behavior could offer a more nuanced understanding of the participants' experiences, as suggested by Miklitz et al. (2024). Incorporating technology-based measures, wearable sensors, or caregiver-reported ecological data may also enhance the ecological validity and comprehensiveness of future evaluations. Finally, expanding the sample size and including participants with diverse etiologies of major neurocognitive disorder would allow for subgroup analyses and a broader generalization of findings.

6 Conclusion

This study presents the Memorare program, a multidimensional intervention tailored to individuals with major neurocognitive disorders secondary to alcohol consumption. By integrating cognitive stimulation, reminiscence therapy, and sensory stimulation, the program aimed to address the complex needs of this population through personalized and adaptive therapeutic approaches.

The findings, though derived from a small sample size of six case studies, indicate the potential benefits of such a multidimensional framework. Despite the overall cognitive decline observed, mood, engagement, and quality of life improvements were noted, mainly when tasks were highly personalized. These results underscore the value of designing interventions responsive to patients' histories and preferences, fostering greater involvement and therapeutic effectiveness.

However, several limitations, such as the small sample size and the variability in assessment procedures, highlight the need for further research. Future studies with larger, more diverse populations and standardized evaluation protocols must validate these findings and refine the intervention.

Using the platform of Musiquence, the previous works used reminiscence and music to perform cognitive stimulation and improve other patients' life dimensions. Although these methods significantly impacted cognition, functionality and mood, we believe a Musiquence-mediated intervention can be enhanced by

adding other therapeutic approaches, such as sensorial stimulation. Our research highlights the impact of a multidimensional approach and emphasizes the importance of continued innovation in therapeutic design. By reshaping and refining such interventions, we can better equip healthcare systems to promote well-being across diverse populations, creating more inclusive and effective care paradigms.

The Memorare program contributes to the broader discourse on interactive systems in healthcare, demonstrating how technology can be harnessed to create meaningful and engaging therapeutic experiences. By advancing the integration of interactive design in clinical settings, this study lays the groundwork for future innovations to enhance the quality of life for individuals with major neurocognitive disorders.

Acknowledgments

We want to thank each of our participants and participating mental health institution team who worked with us and are so often overlooked. This work is supported by UID/04516/NOVA Laboratory for Computer Science and Informatics (NOVA LINCS) with the financial support of FCT.IP. Additionally, it received funding from the European Union and national funds through the Institute for Supporting Small and Medium-sized Enterprises and Innovation (IAPMEI) and the Recovery and Resilience Plan under the application no 761 submitted to the measure Polos de Inovação Digital (DIH) under the terms of AAC no. 03/C16-i03/2022.

References

Almeida, O. P., & Silva, R. (2007). Bateria de Lisboa para Avaliação de Demência (BLAD). *Revista Portuguesa de Psiquiatria e Saúde Mental, 4*(2), 33–39.

Aguirre, E., Woods, R. T., Spector, A., & Orrell, M. (2013). Cognitive stimulation for dementia: a systematic review of the evidence of effectiveness from randomised controlled trials. *Ageing Research Reviews, 12*(1), 253–262. https://doi.org/10.1016/j.arr.2012.07.001

American Psychiatric Association. (2022). *Diagnostic and statistical manual of mental disorders: Text revision* (DSM-5-TR). American Psychiatric Publishing.

American Psychological Association. (n.d.). *Cognitive decline*. Retrieved from

https://dictionary.apa.org/cognitive-decline

Baker, R., Bell, S., Baker, E., Gibson, S., Holloway, J., Pearce, R., Dowling, Z., Thomas, P., Assey, J., & Wareing, L. A. (2001). A randomized controlled trial of the effects of multi-sensory stimulation (MSS) for people with dementia. *British Journal of Clinical Psychology, 40*(1), 81–96. https://doi.org/10.1348/014466501163508

Barreto, J., Leuschner, A., Santos, F., & Sobral, M. (2008). Escala de depressão geriátrica: Tradução portuguesa da Geriatric Depression Scale. In A. Mendonça & M. Guerreiro (Eds.), *Escalas e testes na demência* (pp. 37–43). Grupo De Estudos De Envelhecimento Cerebral E Demência.

Boccadamo, A., De Luca, A., Palamà, L., Sancarlo, D., Leone, A., Diraco, G., Siciliano, P., Toma, A., Maffia, M., De Riccardis, L., D'Alessandro, L., Borrelli, G., & Pistoia, M. (2021). Multi sensorial stimulation lab: A new approach for severe dementia. In *Lecture Notes in Electrical Engineering* (pp. 65–81). Springer International Publishing.

Cammisuli, D. M., Cipriani, G., Giusti, E. M., & Castelnuovo, G. (2022). Effects of reminiscence therapy on cognition, depression and quality of life in elderly people with Alzheimer's disease: A systematic review of randomized Controlled Trials. *Journal of Clinical Medicine, 11*(19), 5752. https://doi.org/10.3390/jcm11195752

Cummings, J. L., Mega, M., Gray, K., Rosenberg-Thompson, S., Carusi, D. A., & Gornbein, J. (1994). The Neuropsychiatric Inventory: comprehensive assessment of psychopathology in dementia. *Neurology, 44*(12), 2308–2314. https://doi.org/10.1212/wnl.44.12.2308

D'Andrea, F., Tischler, V., Dening, T., & Churchill, A. (2022). Olfactory stimulation for people with dementia: A rapid review. *Dementia, 21*(5), 1800–1824. https://doi.org/10.1177/14713012221082377

Dementia. (n.d.). *Who.int*. Retrieved January 20, 2025, from https://www.who.int/news-room/fact-sheets/detail/dementia

Ekman, I., Swedberg, K., Taft, C., Lindseth, A., Norberg, A., Brink, E., Carlsson, J., Dahlin-Ivanoff, S., Johansson, I. L., Kjellgren, K., Lidén, E., Öhlén, J., Olsson, L. E., Rosén, H., Rydmark, M., & Sunnerhagen, K. S. (2011). Person-centered care—ready for prime time. *European Journal of Cardiovascular Nursing, 10*(4), 248–251. https://doi.org/10.1016/j.ejcnurse.2011.06.008

Ferreira, L. D. A., Cavaco, S., & Badia, S. B. (2019). Musiquence: a framework to customize music and reminiscence cognitive stimulation activities for the dementia population. In *5th Experiment International Conference (exp. at'19)* (pp. 359–364).

Folstein, M. F., Folstein, S. E., & McHugh, P. R. (1975). "Mini-mental state." *Journal of Psychiatric Research, 12*(3), 189–198. https://doi.org/10.1016/0022-3956(75)90026-6

Goodall, G., Taraldsen, K., & Serrano, J. A. (2021). The use of technology in creating individualized, meaningful activities for people living with dementia: A systematic review. *Dementia, 20*(4), 1442–1469. https://doi.org/10.1177/1471301220928168

Guerreiro, M., Silva, A. P., Botelho, M. A., Leitão, O., Castro-Caldas, A., & Garcia, C. (1994). Adaptação à população portuguesa da tradução do "Mini Mental State Examination" (MMSE). (1994), 147–157.

Hasselgren, L., Conradsson, M., Lampinen, J., Toots, A., Olofsson, B., Nilsson, I., Gustafsson, M., Lindelöf, N., Holmberg, H., Gustafson, Y., & Littbrand, H. (2024). Feasibility of a person-centered multidimensional, interdisciplinary rehabilitation program in community-dwelling people with dementia: a randomised controlled pilot trial. *BMC Geriatrics, 24*(1), 794. https://doi.org/10.1186/s12877-024-05372-9

Jacobson, N. S., & Truax, P. (1991). Clinical significance: A statistical approach to defining meaningful change in psychotherapy research. *Journal of Consulting and Clinical Psychology, 59*(1), 12–19. https://doi.org/10.1037/0022-006X.59.1.12

Jessen, F., Amariglio, R. E., Buckley, R. F., van der Flier, W. M., Han, Y., Molinuevo, J. L., Rabin, L., Rentz, D. M., Rodriguez-Gomez, O., Saykin, A. J., Sikkes, S. A. M., Smart, C. M., Wolfsgruber, S., & Wagner, M. (2020). The characterisation of subjective cognitive decline. *Lancet Neurology, 19*(3), 271–278. https://doi.org/10.1016/S1474-4422(19)30368-0

Kim, S. K., & Park, M. (2017). Effectiveness of person-centered care on people with dementia: a systematic review and meta-analysis. *Clinical Interventions in Aging, 12,* 381–397. https://doi.org/10.2147/CIA.S117637

Kitwood, T., & Bredin, K. (1992). Towards a theory of dementia care: personhood and well-being. *Ageing & Society, 12*, 269–287. https://doi.org/10.1017/s0144686x0000502x

Koch, M., Fitzpatrick, A. L., Rapp, S. R., Nahin, R. L., Williamson, J. D., Lopez, O. L., DeKosky, S. T., Kuller, L. H., Mackey, R. H., Mukamal, K. J., Jensen, M. K., & Sink, K. M. (2019). Alcohol consumption and risk of dementia and cognitive decline among older adults with or without mild cognitive impairment. *JAMA Network Open, 2*(9), e1910319. https://doi.org/10.1001/jamanetworkopen.2019.10319

Logsdon, R. G., Gibbons, L. E., Mccurry, S. M., & Teri, L. (2002). Quality of life in Alzheimer's disease: Patient and caregiver reports. *Journal of Mental Health and Aging, 8*(3), 281–292.

Lopes, P. N., & Lemos, M. S. (2004). Adaptação e validação da versão portuguesa do Positive and Negative Affect Schedule (PANAS). *Revista Portuguesa de Psicologia, 39*(1), 73–82.

Maristany, A. J., Sa, B. C., Murray, C., Subramaniam, A. B., & Oldak, S. E. (2024). Psychiatric manifestations of neurological diseases: A narrative review. *Cureus, 16*(7), e64152. https://doi.org/10.7759/cureus.64152

Medeiros, F. C., Nogueira, A. I., & Santana, I. (2008). Adaptação e validação da versão portuguesa do questionário Quality of Life in Alzheimer's Disease (QOL-AD). *Revista Brasileira de Terapias Cognitivas e Comportamentais, 4,* 5–14.

Mendes, L., & Almeida, O. P. (2005). Adaptação e validação da Clinical Dementia Rating (CDR) para a população portuguesa. *Revista Portuguesa de Psiquiatria e Saúde Mental, 6*(1), 33–40.

Meyer, C., & O'Keefe, F. (2020). Non-pharmacological interventions for people with dementia: A review of reviews. *Dementia, 19*(6), 1927–1954. https://doi.org/10.1177/1471301218813234

Miklitz, C., Fliessbach, K., & McCormick, C. (2024). Happiness, positive emotions, and subjective well-being in dementia. *Frontiers in Neurology, 15*. https://doi.org/10.3389/fneur.2024.1422354

Milev, R. V., Kellar, T., McLean, M., Mileva, V., Luthra, V., Thompson, S., & Peever, L. (2008). Multisensory stimulation for elderly with dementia: a 24-week single-blind randomized controlled pilot study. *American Journal of Alzheimer's Disease and Other Dementias, 23*(4), 372–376. https://doi.org/10.1177/1533317508316681

Penn, R. D., & Mangieri, E. A. (1993). Stiff-man syndrome treated with intrathecal baclofen. *Neurology, 43*(11), 2412. https://doi.org/10.1212/wnl.43.11.2412

Prins, A. J., Scherder, E. J. A., van Straten, A., Zwaagstra, Y., & Milders, M. V. (2020). Sensory

stimulation for nursing-home residents: Systematic review and meta-analysis of its effects on sleep quality and rest-activity rhythm in dementia. *Dementia and Geriatric Cognitive Disorders, 49*(3), 219–234. https://doi.org/10.1159/000509433

Ritchie, C. W., Terrera, G. M., & Quinn, T. J. (2015). Dementia trials and dementia tribulations: methodological and analytical challenges in dementia research. *Alzheimer's Research & Therapy, 7*(1), 31. https://doi.org/10.1186/s13195-015-0113-6

Robert, P., Dechamps, A., Sacco, G., & David, R. (2012). 65 Management of neuropsychiatric symptoms in dementia. *Neurobiology of Aging, 33,* S28–S29. https://doi.org/10.1016/j.neurobiolaging.2012.01.083

Sánchez, A., Marante-Moar, M. P., Sarabia, C., de Labra, C., Lorenzo, T., Maseda, A., & Millán-Calenti, J. C. (2016). Multisensory stimulation as an intervention strategy for elderly patients with severe dementia: A pilot randomized controlled trial: A pilot randomized controlled trial. *American Journal of Alzheimer's Disease and Other Dementias, 31*(4), 341–350. https://doi.org/10.1177/1533317515618801

Saragih, I. D., Tonapa, S. I., Saragih, I. S., & Lee, B. O. (2022). Effects of cognitive stimulation therapy for people with dementia: A systematic review and meta-analysis of randomized controlled studies. *International Journal of Nursing Studies, 128,* 104181. https://doi.org/10.1016/j.ijnurstu.2022.104181

Sousa, R. M. P., Almeida, M. R., Guerreiro, M., & Silva, M. R. (2005). Adaptação e validação do Inventário Neuropsiquiátrico (NPI) para a população portuguesa. *Revista Portuguesa de Psicologia, 40,* 1–17.

Sowndhararajan, K., & Kim, S. (2016). Influence of fragrances on human psychophysiological activity: With special reference to human electroencephalographic response. *Sciencia Pharmaceutica, 84*(4), 724–751. https://doi.org/10.3390/scipharm84040724

Subramaniam, P., & Woods, B. (2016). Digital life storybooks for people with dementia living in care homes: an evaluation. *Clinical Interventions in Aging, 11,* 1263–1276. https://doi.org/10.2147/CIA.S111097

Takramah, W. K., & Asem, L. (2022). The efficacy of pharmacological interventions to improve cognitive

and behavior symptoms in people with dementia: A systematic review and meta-analysis. *Health Science Reports, 5*(6), e913. https://doi.org/10.1002/hsr2.913

Takeda, M., Tanaka, T., Okochi, M., & Kazui, H. (2012). Non-pharmacological intervention for dementia patients: Editorial. *Psychiatry and Clinical Neurosciences, 66*(1), 1–7. https://doi.org/10.1111/j.1440-1819.2011.02304.x

Visontay, R., Rao, R. T., & Mewton, L. (2021). Alcohol use and dementia: new research directions. *Current Opinion in Psychiatry, 34*(2), 165–170. https://doi.org/10.1097/YCO.0000000000000679

Watson, D., Clark, L. A., & Tellegen, A. (1988). Development and validation of brief measures of positive and negative affect: The PANAS scales. *Journal of Personality and Social Psychology, 54*(6), 1063–1070. https://doi.org/10.1037/0022-3514.54.6.1063

World Health Organization. (n.d.). Retrieved January 20, 2025, from https://iris.who.int/bitstream/handle/10665/312180/9789241550543-eng.pdf?sequence=17

Yesavage, J. A., Brink, T. L., Rose, T. L., Lum, O., Huang, V., Adey, M., & Leirer, V. O. (1982). Development and validation of a geriatric depression screening scale: A preliminary report. *Journal of Psychiatric Research, 17*(1), 37–49. https://doi.org/10.1016/0022-3956(82)90033-4

Appendices

Appendix A

Informed Consent

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Consentimento Informado, Esclarecido e Livre para Participação em estudos de Investigação

Identificação do Investigador: Mariana Castro Fernandes

Título do estudo: Promoting Wellness in Inpatient Settings: The Role of Cognitive Stimulation and Exergaming for Neurological and Psychiatric Patients.

Enquadramento: Tese de Mestrado em Psicologia Clínica, Saúde e Bem-Estar.

Explicação do estudo: O objetivo deste estudo é avaliar o impacto cognitivo, emocional e funcional de um programa de estimulação cognitiva implementado em realidade virtual, baseado na reminiscência, na música e na estimulação sensorial. Trata-se de uma série de estudos de caso, implementando uma intervenção multidimensional baseada na estimulação cognitiva e sensorial. Será uma intervenção longitudinal em que será realizada uma sessão por semana, entre aproximadamente um mês e um mês e meio, com uma duração estimada de 30 minutos de estimulação cognitiva. Na primeira sessão serão recolhidos dados sociodemográficos e clínicos para a seleção de participantes e destes serão recolhidos dados acerca das funções cognitivas (MoCA - Montreal Cognitive Assessment Test; ADAS-Cog - Alzheimer's Disease Assessment Scale-Cognitive), das aptidões funcionais e dados acerca das dimensões do humor (ADAS - Alzheimer's Disease Assessment Scale-Non-Cognitive; NPI - Neuropsychiatric Inventory) e da qualidade de vida (QoL-AD - Quality of Life-Alzheimer's Disease Scale). O estudo será realizado na Casa de Saúde São João de Deus.

Condições e financiamento: A participação será voluntária e sem nenhuma contrapartida de recompensação. Este estudo foi apreciado e aprovado pela Comissão de Ética da Universidade da Madeira. Este trabalho será apoiado por fundos da União Europeia e nacionais através do Instituto de Apoio às Pequenas e Médias Empresas e à Inovação (IAPMEI) e do Plano de Recuperação e Resiliência no âmbito da candidatura nº 761 submetida à medida Polos de Inovação Digital (DIH) nos termos do AAC nº. 03/C16-i03/2022. Os recursos informáticos a serem utilizados neste estudo são financiados pelo projeto MACBIOIDI (INTERREG program MAC/1.1.b/098).

Anonimato e confidencialidade: A confidencialidade dos dados está totalmente garantida. As respostas apenas serão usadas para efeitos de investigação. O estudo estará em conformidade com os seguintes procedimentos no que diz respeito ao tratamento de dados pessoais:

- Os dados não serão recolhidos sem autorização. Antes do recrutamento, todos os voluntários serão informados verbalmente e por escrito sobre os pormenores do ensaio a ser realizado, incluindo qualquer risco envolvido. Todos os pacientes assinarão um Consentimento Informado (em anexo) antes da participação no ensaio;

- Nomes, datas de nascimento e outros dados sensíveis e passíveis de identificação serão encriptados para proteger a privacidade do paciente e dos dados recolhidos;
- A informação recolhida será utilizada apenas para o propósito do projeto e não será retida para outros fins;
- Nenhuma informação pessoal será tornada pública ou cedida a terceiros;
- Serão aplicados controlos técnicos estritos para garantir que a informação não seja disponibilizada inadvertidamente a organizações de marketing direto ou outras terceiras entidades.

Por favor, leia com atenção esta informação. Se achar que algo está incorreto ou que não está claro, não hesite em solicitar mais informações.

Se concorda com a proposta que lhe foi feita, queira assinar este documento.

Assinatura do representante legal do paciente com demência: _____

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Declaração de Consentimento do Participante

Eu, _____ declaro ter lido e compreendido este documento, bem como as informações verbais que me foram fornecidas pela/s pessoa/s que acima assinam. Foi-me garantida a possibilidade de, em qualquer altura, recusar participar neste estudo sem qualquer tipo de consequências. Desta forma, aceito participar neste estudo e permito a utilização dos dados, que de forma voluntária forneço, confiando em que apenas serão utilizados para fins científicos e publicações que delas decorram e com as garantias de confidencialidade e anonimato que me são dadas pelo/a investigador/a.

Assinatura legível e manuscrita do representante legal do paciente com demência:

_____

Data: ___ / ___ / _____

Appendix B

Survey Questionnaire

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Promoting Wellness in Inpatient Settings: The Role of Cognitive Stimulation and Exergaming for Neurological and Psychiatric Patients. O presente questionário encontra-se inserido no âmbito da Dissertação de Mestrado em Psicologia Clínica, da Saúde e Bem-estar do departamento de Psicologia da Universidade da Madeira, tem como objetivo principal compreender o impacto cognitivo, emocional e funcional de um programa de estimulação cognitiva e sensorial, auxiliado pela realidade virtual, baseado em reminiscência e na música personalizada através de uma plataforma de jogos sérios Musiquence, em pessoas portadoras de demência. As informações recolhidas e respetivo tratamento de dados serão confidenciais, anónimos e restritos apenas aos fins académicos. Agradecemos o tempo disponibilizado no preenchimento do questionário que nos ajudará a personalizar a intervenção da pessoa com demência a seu cuidado. Qualquer dúvida ou esclarecimento adicional poderá ser dirigido à orientadora do projeto: Prof. Doutora Ana Lúcia Faria, através do e-mail: anafaria@staff.uma.pt ou à mestranda Mariana Castro Fernandes, através do e-mail: 2020220@student.uma.pt.

Consente e disponibiliza fotos, álbuns familiares e/ou objetos pessoais significativos para utilizarmos na personalização da intervenção?

Preencher com uma cruz.

Sim ☐

Não ☐

Assinatura do próprio ou representante legal: _____

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Dados Demográficos

1. **Género (**Preencher com uma cruz):

   Masculino: ☐

   Feminino ☐

2. **Idade:** _____

3. **Profissão/Ocupação:** _____

4. **Habilitações Literárias (**Preencher com uma cruz):

   1.º Ciclo do ensino básico (4 anos de escolaridade): ☐

   2.º Ciclo do ensino básico (6 anos de escolaridade): ☐

   3º Ciclo do ensino básico (9.º ano): ☐

   Ensino Secundário (12.º ano) Outro: ☐

Dados Clínicos

1. **Data do Diagnóstico: __/__/___**

2. **Tempo de Institucionalização:** _____

3. **Medicação atual:** _____

_____

_____

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4. **Possuí algum problema de saúde?** _____

_____

5. **Como se encontra a sua capacidade visual? (**Preencher com uma cruz):

Sem capacidade visual	☐	☐	☐	☐	☐	Boa capacidade visual
	1	2	3	4	5	

6. **Como se encontra a sua capacidade auditiva?** (Preencher com uma cruz):

Sem capacidade auditiva	☐	☐	☐	☐	☐	Boa capacidade auditiva
	1	2	3	4	5	

7. **Tem dificuldade em ler? (**Preencher com uma cruz):

Sim ☐

Não ☐

8. **Tem dificuldade em escrever? (**Preencher com uma cruz):

Sim ☐

Não ☐

Appendix C

Creation of the Sensory Panel

Figure C1

Initial arrangement of selected materials for the sensory panel

Figure C2

Preparation stage with layout adjustments

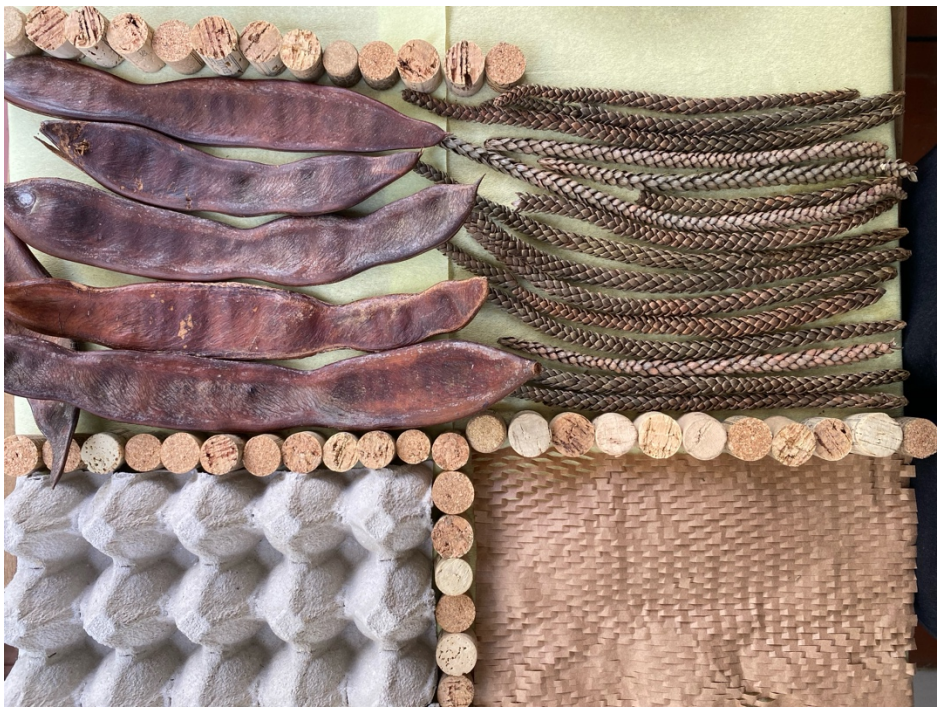

Figure C3

Progress of the sensory panel assembly, with materials partially fixed to the base

Figure C4

Final touches with detailed placement of elements