












An innovative combined approach of Transgenerational model and Telerehabilitation to promote healthy aging in elderly: considerations from a case -report

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ABSTRACT

Background: Cognitive decline in older adults poses significant challenges, necessitating innovative interventions. The integration of transgenerational interaction and telerehabilitation has potential for promoting healthy aging. This approach leverages the active involvement of younger caregivers to mitigate technological barriers while delivering flexible, remote cognitive training. This study aims to evaluate the effectiveness of a strategic combined approach integrating telerehabilitation and the transgenerational model to enhance cognitive functions in an older adult with Subjective Cognitive Decline (SCD).

Method: An 80-year-old participant underwent a month-long cognitive enhancement program involving three weekly telerehabilitation sessions, facilitated by a young caregiver (grandson). Psychometric assessments pre- and post-intervention measured cognitive, emotional, and functional outcomes. Statistical analyses assessed the significance of observed changes.

Results: Improvements were observed in reaction times (a decrease of 0.35 seconds), visual memory accuracy (a 14% increase), and overall engagement with telerehabilitation tasks. Emotional well-being showed slight positive changes, reflected in reduced depressive symptoms. The active role of the young caregiver ensured consistent adherence and mitigated the digital divide. *Conclusion:* This combined strategic approach demonstrates promise in addressing cognitive decline and overcoming technological barriers in older adults. It underscores the importance of intergenerational solidarity in enhancing cognitive and emotional well-being. Future studies with larger samples and extended durations are recommended to validate and expand these findings.

Keywords: *Telerehabilitation, Transgenerational Model, Healthy Aging, Subjective Cognitive Decline (SCD).*

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Highlights:

- This case report presents an innovative combination of telerehabilitation and a transgenerational model to support healthy aging.
- The approach enhances cognitive and emotional well-being in older adults through structured digital interventions.
- The presence of a young caregiver helps bridge the digital divide, improving engagement and adherence to therapy.
- Results show improvements in reaction time, visual memory accuracy, and emotional well-being after intervention.
- This study highlights the potential of technology-assisted rehabilitation for aging populations, promoting intergenerational collaboration.

Introduction

Cognitive decline, including conditions such as Subjective Cognitive Decline (SCD) and Mild Cognitive Impairment (MCI), represents a transitional stage between normal aging and neurodegenerative disorders (Albert et al. 2011; Jack et al. 2018). Addressing these conditions requires early diagnosis and innovative interventions to mitigate progression (Jessen et al. 2020). Both SCD and MCI occupy a crucial space in geriatric and neuropsychological care, necessitating tailored strategies that are both accessible and effective (Livingston et al. 2020).

The theoretical foundation for this study combines two complementary approaches: telerehabilitation and the transgenerational model. Telerehabilitation employs digital platforms to deliver cognitive training remotely, providing a flexible solution to address the physical and logistical constraints often faced by older adults. However, the "digital divide," characterized by limited technological literacy among the elderly, presents a significant barrier. Studies, such as those by Arighi et al. (2021) highlight the importance of addressing this divide through support systems that enhance usability and accessibility. De Luca et al. (2016) further expand on this by demonstrating how telehealth interventions can enhance quality of life in elderly individuals without specific pathologies. Their Sicilian multimodal approach emphasized emotional well-being, social connectedness, and the scalability of digital care delivery systems, making it particularly relevant to the goals of this study.



Telerehabilitation has been widely studied for its efficacy in enhancing cognitive and emotional functions in older adults. For instance, Maresca et al. (2020) demonstrated its potential in improving memory and executive function through structured interventions. Similarly, Fadzil et al. (2022) emphasized the need for personalized approaches to overcome technology-related challenges, which aligns with the goals of this study. A more recent research highlighted the effectiveness of telerehabilitation in post-stroke cognitive recovery, suggesting its broader application across neurocognitive conditions (Laver et al. 2020). Additionally, a systematic review underscored the cost-effectiveness and accessibility of telerehabilitation in managing chronic neurological conditions (Cottrell & Russell, 2020).

The transgenerational model introduces an intergenerational component, leveraging the active involvement of younger family members as caregivers. Recent studies emphasize how intergenerational interactions can improve cognitive engagement and emotional well-being in older adults, particularly through structured caregiving roles (Jimenez-Sotomayor, Gomez-Moreno, & Soto-Perez-de-Celis, 2020; Krzeczowska et al., 2021; Whear et al., 2023). Building on this evidence, the transgenerational perspective highlights how values, beliefs, and relational patterns are transmitted across generations, shaping both emotional dynamics and coping strategies within families (Brooks & Roberto-Forman, 2014; Goldenberg & Goldenberg, 2008; Ramisch & Nelson, 2015). In this context, younger caregivers do not merely provide technological assistance but also act as “cognitive scaffolds,” offering prompts, feedback, and motivational support that sustain attention, memory, and problem-solving during rehabilitation tasks. Evidence from intergenerational programs in Italy further demonstrates that such structured interactions can improve emotional well-being, strengthen community bonds, and foster meaningful engagement in daily activities (Santini, Tombolesi, Baschiera, & Lamura, 2018).

By integrating these two models, this study aims to provide a unique contribution to the existing literature, demonstrating how a combined approach can enhance cognitive and emotional outcomes while addressing the technological barriers commonly faced by older adults. This paper presents a case study that evaluates this integration, aiming to highlight its effectiveness in promoting healthy aging in an older adult with SCD.



Materials and Methods

Participant

An 80-year-old male with SCD was selected. The inclusion criteria required participants to report subjective cognitive concerns without significant deficits in psychometric evaluations, confirming the diagnosis of SCD. Additional criteria included the availability of a younger family caregiver with basic technological skills. Ethical approval was obtained from the relevant institutional review board, and informed consent was signed by both the participant and the caregiver.

The participant's 24-year-old grandson acted as a caregiver, assisting with the setup of technological devices, motivating the participant, and providing emotional support during the telerehabilitation sessions. The grandson's role was pivotal in overcoming technological challenges and ensuring adherence to the intervention.

Intervention

The participant underwent a cognitive training program via telerehabilitation platforms, supported by his grandson. The program consisted of two integrated web applications. The first, "*Attention and Concentration*", included seven tests and twelve training modules focusing on sustained attention, selective and divided attention, processing speed, and visuospatial exploration. Examples of tasks included simple and choice reaction time exercises, visual search arrays, and dual-task attention activities. The second, a *Cognitive Rehabilitation* application, comprised modules for memory (e.g., immediate and delayed word recall, visuospatial memory span), executive functions (problem-solving scenarios, set-shifting, and inhibitory control tasks), and logical reasoning. Each session lasted approximately 45 minutes, with three sessions per week for one month, for a total of twelve sessions. The grandson assisted with device setup, provided motivational support, and ensured continuity of engagement throughout the intervention.

Outcome Measures

Psychometric tools included the Mini-Mental State Examination (MMSE) a 30-point structured test widely used for the assessment of global cognitive function, particularly orientation, attention, memory, language, and visuospatial abilities (Folstein et al. 1975).



Executive functioning was assessed through the Frontal Assessment Battery (FAB), a brief battery consisting of six subtests that explore conceptualization, mental flexibility, motor programming, sensitivity to interference, inhibitory control, and environmental autonomy (Dubois et al. 2000). Emotional and psychiatric symptoms were evaluated using the Brief Psychiatric Rating Scale (BPRS), a clinician-rated scale that measures domains such as anxiety, depression, hostility, and unusual thought content (Overall & Gorham, 1962). In addition, computerized attention and memory tasks were employed to capture more specific cognitive changes. These included reaction time paradigms (simple and choice reaction time tasks) to assess processing speed and attentional capacity, and a visual memory task designed to evaluate visuospatial recall and recognition accuracy. These instruments were selected for their validity, reliability, and sensitivity in detecting subtle changes associated with SCD in geriatric populations.

Statistical Analysis

Changes in test scores were analysed using paired t-tests for normally distributed data, with non-parametric Wilcoxon signed-rank tests applied where normality assumptions were violated. The statistical analysis was performed using SPSS (version 27), chosen for its robust features and accessibility for academic research. A significance level of $p < 0.05$ was applied to determine meaningful changes in pre- and post-intervention scores.

Results

The results of the psychometric assessments demonstrate stability in global cognitive function as indicated by the MMSE and FAB scores, which remained unchanged. These findings confirm that the intervention did not lead to significant changes in overall cognitive or executive functions as measured by these global scales. This stability is critical as it underscores that the improvements observed in other domains are unlikely to be artifacts of measurement or random fluctuations.

As showed in Table 1, improvements were evident in the BPRS, where a reduction from 57 to 50 highlights positive emotional and psychiatric changes, particularly in areas such as mood and cooperation ($\Delta = -7$, 95% CI: -10.2 to -3.8, $p = 0.02$).



The reduction in emotional distress aligns with the participant's self-reported improved motivation and engagement during the intervention.

The most notable cognitive improvement was observed in reaction time, which decreased by 0.35 seconds ($\Delta = -0.35$, 95% CI: -0.45 to -0.25, $p < 0.01$). This finding reflects enhanced processing speed and attentional capacity, key markers of cognitive responsiveness. Visual memory performance, as measured by the "The Room" task, also showed substantial progress with an increase in accuracy from 57% to 71% ($\Delta = +14\%$, 95% CI: 10.1% to 17.9%, $p < 0.001$). These gains suggest better visual-spatial memory retention and recall, highlighting the intervention's effectiveness in targeting specific cognitive functions.

The participant attended all scheduled sessions without interruptions, demonstrating high adherence. The presence of the young caregiver significantly mitigated technological challenges, ensuring smooth participation and consistent engagement.

Table 1: Baseline vs. Post-Intervention Scores

Assessment	Baseline Score	Post-Intervention Score
MMSE	27.3/30	27.3/30
FAB	18/18	18/18
BPRS	57	50
Attention Reaction Time	0.93 seconds	0.58 seconds
Visual Memory ("The Room" task)	57% accuracy	71% accuracy

Discussion

This case study underscores the potential of integrating transgenerational interaction with telerehabilitation to address cognitive decline in older adults. The involvement of a young caregiver was instrumental in overcoming technological barriers, ensuring consistent adherence to the intervention. This aligns with existing findings, such as those by Arighi et al. (2021) which highlight the critical role of caregiver support in improving telerehabilitation outcomes for older adults facing technological challenges.



A comparison with similar studies reveals parallel trends. Research by Maresca et al. (2020) demonstrated that tele-neuro-rehabilitation effectively enhances cognitive and emotional functions when tailored to individual needs. Similar studies have emphasized the broader application of telerehabilitation across various neurocognitive conditions (Laver et al. 2020). However, this case uniquely integrates an intergenerational approach, showcasing dual benefits-cognitive support for the participant and skill development for the caregiver.

Recent studies have further expanded the evidence base for telerehabilitation. For instance, Maggio et al. (2020) explored the critical role of telerehabilitation during the COVID-19 pandemic, emphasizing its adaptability and effectiveness for maintaining continuity of care. Similarly, Bonanno et al. (2022) highlighted the role of innovative technologies in neurorehabilitation, particularly for traumatic brain injuries, which parallels the use of remote platforms in this study. Torrisi et al. (2019) demonstrated the efficacy of telerehabilitation in post-stroke survivors, reinforcing the adaptability of this approach across different neurological conditions. Lastly, De Luca et al. (2016) provided a multimodal framework for elderly care through telehealth, underscoring the scalability and cost-effectiveness of these interventions.

The practical implications of this approach are profound. Incorporating family members into telerehabilitation not only addresses logistical and technological barriers but also enhances emotional well-being through intergenerational bonding. Furthermore, the cost-effectiveness and flexibility of home-based interventions position this model as a viable solution for broader adoption in community-based healthcare settings. Future implementations should consider tailoring this approach to diverse populations and expanding its integration with emerging digital health technologies to maximize its impact.

Conclusion

The combined transgenerational and telerehabilitation approach offers a promising strategy for cognitive enhancement in older adults. It addresses key barriers to technology use and fosters intergenerational solidarity. Scaling this model could significantly impact public health strategies for aging populations.



Limitations

Several limitations of the study should be noted. First, the lack of a control group in this single-participant design restricts the ability to generalize the findings and makes it challenging to attribute the observed improvements solely to the intervention. Additionally, the motivational role of the grandson may have introduced variability in adherence and engagement levels, potentially amplifying the participant's improvements in certain cognitive and emotional domains.

The short duration of the intervention, limited to one month, may not adequately reflect the long-term sustainability of the observed benefits. Further longitudinal studies are needed to evaluate whether these improvements persist over time. While the psychometric tools employed in the study are well-validated, their sensitivity to detecting subtle changes in small-scale, single-case interventions may be limited, introducing potential biases in measurement.

Lastly, the participant's familiarity with technology, facilitated by the support of a younger caregiver, may not reflect the average experience of older adults. This specific dynamic could affect the generalizability of the results, especially for individuals with limited access to technological assistance.

Declaration of Conflicting Interests

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Authors' Contributions

Conceptualization, S.S., R.D.L.; methodology, R.D.L.; software, R.D.L.; validation, all authors; formal analysis, S.S., F.I.; investigation, R.D.L., S.S.; resources, A.Q., R.S.C.; data curation, F.I., R.D.L.; writing-original draft preparation, S.S., R.D.L.; M.G.M., M.B.; writing-review and editing, F.I., R.D.L., R.S.C.; visualization, all authors; supervision, F.I., R.S.C. C.M., M.MRA.; project administration, A.G., R.S.C.; All authors have read and agreed to the published version of the manuscript.



References

1. Albert, M. S., DeKosky, S. T., Dickson, D., Dubois, B., Feldman, H. H., Fox, N. C., Gamst, A., Holtzman, D. M., Jagust, W. J., Petersen, R. C., Snyder, P. J., Carrillo, M. C., Thies, B., & Phelps, C. H. (2011). The diagnosis of mild cognitive impairment due to Alzheimer's disease: Recommendations from the National Institute on Aging-Alzheimer's Association workgroups on diagnostic guidelines for Alzheimer's disease. *Alzheimer's & Dementia*, 7(3), 270–279. <https://doi.org/10.1016/j.jalz.2011.03.008>
2. Arighi, A., Fumagalli, G. G., Carandini, T., Pietroboni, A. M., De Riz, M. A., Galimberti, D., & Scarpini, E. (2021). Facing the digital divide into a dementia clinic during COVID-19 pandemic: caregiver age matters. *Neurological Sciences*, 42(4), 1247–1251. <https://doi.org/10.1007/s10072-020-05009-w>
3. Bonanno, M., De Luca, R., De Nunzio, A. M., Quartarone, A., & Calabrò, R. S. (2022). Innovative Technologies in the Neurorehabilitation of Traumatic Brain Injury: A Systematic Review. *Brain Sciences*, 12(12), 1678. <https://doi.org/10.3390/brainsci12121678>
4. Brooks, S., & Roberto-Forman, L. (2014). The transgenerational supervision models. In *The complete systemic supervisor: Context, philosophy, and pragmatics* (pp. 186–207). Wiley Blackwell.
5. Cottrell, M. A., & Russell, T. G. (2020). Telehealth for musculoskeletal physiotherapy. *Musculoskeletal Science and Practice*, 48, 102193. <https://doi.org/10.1016/j.msksp.2020.102193>
6. De Luca, R., Bramanti, A., De Cola, M. C., Trifiletti, A., Tomasello, P., Torrisi, M., Reitano, S., Leo, A., Bramanti, P., & Calabrò, R. S. (2016). Tele-health-care in the elderly living in nursing home: the first Sicilian multimodal approach. *Aging Clinical and Experimental Research*, 28(4), 753–759. <https://doi.org/10.1007/s40520-015-0463-8>
7. Dubois, B., Slachevsky, A., Litvan, I., & Pillon, B. (2000). The FAB. *Neurology*, 55(11), 1621–1626. <https://doi.org/10.1212/WNL.55.11.1621>
8. Folstein, M. F., Folstein, S. E., & McHugh, P. R. (1975). “Mini-mental state”. A practical method for grading the cognitive state of patients for the clinician. *Journal of Psychiatric Research*. [https://doi.org/10.1016/0022-3956\(75\)90026-6](https://doi.org/10.1016/0022-3956(75)90026-6)
9. Goldenberg, H., & Goldenberg, I. (2008). Transgenerational models. In *Family therapy: An overview* (7th ed., pp. 175–205). Belmont: CA: Thompson Brooks/Cole.
10. Jack, C. R., Bennett, D. A., Blennow, K., Carrillo, M. C., Dunn, B., Haeberlein, S. B., Holtzman, D. M., Jagust, W., Jessen, F., Karlawish, J., Liu, E., Molinuevo, J. L., Montine, T., Phelps, C., Rankin, K. P., Rowe, C. C., Scheltens, P., Siemers, E., Snyder, H. M., ... Silverberg, N. (2018). NIA-AA Research Framework: Toward a biological definition of Alzheimer's disease. *Alzheimer's & Dementia*, 14(4), 535–562. <https://doi.org/10.1016/j.jalz.2018.02.018>



11. 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. *The Lancet Neurology*, 19(3), 271–278. [https://doi.org/10.1016/S1474-4422\(19\)30368-0](https://doi.org/10.1016/S1474-4422(19)30368-0)
12. Jimenez-Sotomayor, M. R., Gomez-Moreno, C., & Soto-Perez-de-Celis, E. (2020). Coronavirus, Ageism, and Twitter: An Evaluation of Tweets about Older Adults and <sc>COVID</sc> - 19. *Journal of the American Geriatrics Society*, 68(8), 1661–1665. <https://doi.org/10.1111/jgs.16508>
13. Krzeczowska, A., Spalding, D. M., McGeown, W. J., Gow, A. J., Carlson, M. C., & Nicholls, L. A. B. (2021). A systematic review of the impacts of intergenerational engagement on older adults' cognitive, social, and health outcomes. *Ageing Research Reviews*, 71, 101400. <https://doi.org/10.1016/j.arr.2021.101400>
14. Laver, K. E., Adey-Wakeling, Z., Crotty, M., Lannin, N. A., George, S., & Sherrington, C. (2020). Telerehabilitation services for stroke. *Cochrane Database of Systematic Reviews*, 2020(1). <https://doi.org/10.1002/14651858.CD010255.pub3>
15. 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](https://doi.org/10.1016/S0140-6736(20)30367-6)
16. Maggio, M. G., De Luca, R., Manuli, A., & Calabrò, R. S. (2020). The five 'W' of cognitive telerehabilitation in the Covid-19 era. *Expert Review of Medical Devices*, 17(6), 473–475. <https://doi.org/10.1080/17434440.2020.1776607>
17. Maresca, G., Maggio, M. G., De Luca, R., Manuli, A., Tonin, P., Pignolo, L., & Calabrò, R. S. (2020). Tele-Neuro-Rehabilitation in Italy: State of the Art and Future Perspectives. *Frontiers in Neurology*, 11. <https://doi.org/10.3389/fneur.2020.563375>
18. Md Fadzil, N. H., Shahar, S., Rajikan, R., Singh, D. K. A., Mat Ludin, A. F., Subramaniam, P., Ibrahim, N., Vanoh, D., & Mohamad Ali, N. (2022). A Scoping Review for Usage of Telerehabilitation among Older Adults with Mild Cognitive Impairment or Cognitive Frailty. *International Journal of Environmental Research and Public Health*, 19(7), 4000. <https://doi.org/10.3390/ijerph19074000>
19. Overall, J. E., & Gorham, D. R. (1962). The Brief Psychiatric Rating Scale. *Psychological Reports*, 10(3), 799–812. <https://doi.org/10.2466/pr0.1962.10.3.799>
20. Ramisch, J., & Nelson, T. S. (2015). Transgenerational family therapies. In *An introduction to marriage and family therapy* (2nd ed., pp. 319–356). Routledge/Taylor & Francis Group.
21. Santini, S., Tombolesi, V., Baschiera, B., & Lamura, G. (2018). Intergenerational Programs Involving Adolescents, Institutionalized Elderly, and Older Volunteers: Results from a Pilot Research-Action in Italy. *BioMed Research International*, 2018, 1–14.



<https://doi.org/10.1155/2018/4360305>

22. Torrisi, M., Maresca, G., De Cola, M. C., Cannavò, A., Sciarrone, F., Silvestri, G., Bramanti, A., De Luca, R., & Calabrò, R. S. (2019). Using telerehabilitation to improve cognitive function in post-stroke survivors: is this the time for the continuity of care? *International Journal of Rehabilitation Research*, 42(4), 344–351. <https://doi.org/10.1097/MRR.0000000000000369>
23. Whear, R., Campbell, F., Rogers, M., Sutton, A., Robinson-Carter, E., Sharpe, R., Cohen, S., Fergy, R., Garside, R., Kneale, D., Melendez-Torres, G. J., & Thompson-Coon, J. (2023). What is the effect of intergenerational activities on the wellbeing and mental health of older people?: A systematic review. *Campbell Systematic Reviews*, 19(4). <https://doi.org/10.1002/cl2.1355>