

The impact of a language stimulation program on maintaining verbal fluency in Alzheimer's disease

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Abstract

Aim of the study: Language deterioration in Alzheimer's disease (AD) involves word-finding difficulties which may hinder conversational abilities. A well-designed language program may support verbal fluency and highlight the potential of non-pharmacological interventions. This study assessed the effect of a self-designed language stimulating program on verbal fluency in mild and moderate AD.

Subject or material and methods: The study involved 54 Alzheimer's patients and a control group (ConG) of 34 patients with mild and moderate AD, with only intervention group (IntG) patients participating in the program. Every 3 months, category (CFT) and letter (LFT) fluency were assessed in both groups, along with clustering and switching evaluation across 60s time interval.

Results: The program enhanced verbal fluency in patients with AD, as evidenced in the VFT. Patients generated more words from broad categories, making few errors. The CFT results were higher than those of the LFT. Clustering was more frequent in semantic tasks, particularly in the animal category, while phonemic fluency involved more switching, suggesting differences in retrieval strategies.

Discussion: The study confirms that a structured language program supports verbal fluency in mild-to-moderate AD, although this finding is not consistent across the studies. Although there might be short-term benefits for patients, the long-term clinical significance requires further investigation. Maintaining motivation in AD persons is crucial for cognitive training effectiveness, as higher engagement correlates with improved outcomes.

Conclusions: Our findings highlight the importance of implementing language programs as part of non-pharmacological interventions in AD to maintain verbal fluency in phonemic and semantic categories.

dementia of the Alzheimer type; language training program; anomia; verbal fluency; language exercises

INTRODUCTION

In Alzheimer's disease (AD), episodic memory and language deficits coexist and become notice-

able relatively early [1]. As the disease progresses, language difficulties intensify within specific linguistic domains, including semantics, syntax, phonetics, morphology, and pragmatics [2]. Disturbances may affect semantic memory embracing world knowledge, facts as well as meanings and concepts. Even in the pre-clinical stage of Alzheimer's disease, semantic memory exhibits a subtle yet measurable decline [3]. The primary language deficit in AD is dysno-

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mia, which is characterized by naming difficulties and a tendency to use hypernyms (general terms encompassing a broader category, e.g., "animal" for "dog," "fruit" for "apple," or "furniture" for "chair") instead of hyponyms (more specific terms within a category, e.g., "poodle" for "dog," "granny smith" for "apple," or "armchair" for "chair"). Patients tend to use circumlocution, synonyms, and high-frequency words. As the disease progresses, their ability to list words within specific semantic or phonemic categories declines, leading to an increasingly limited vocabulary [4].

Verbal fluency tests (VFTs) are frequently administered in neuropsychological assessment to measure verbal abilities, specifically lexical retrieval and executive control in AD [5]. Since their development in the late 1960s, VFTs have been extensively used in both research and clinical settings. They are quick to administer and cost effective, making them valuable screening tools for cognitive decline. Participants are required to list as many words as possible according to a specified criterion within a time limit, most frequently focusing on words that begin with a certain letter (phonemic fluency) or belong to a given semantic category (category fluency) [6]. Participants need to concentrate on the task and avoid repetition. These abilities are consistently impaired in AD [1]. Therefore, non-pharmacological interventions are frequently implemented to maintain cognitive functioning, by primarily influencing language, attention, and memory.

Cognitive stimulation therapy (CST) is increasingly being recognized as an effective non-pharmacological intervention. The 2018 NICE (National Institute for Health and Care Excellence) dementia guidelines under 'interventions to promote cognition, independence and wellbeing' recommend that individuals with mild to moderate dementia, regardless of dementia type or medication received, should be given the opportunity to join a structured group cognitive stimulation program or cognitive rehabilitation to promote cognition, independence and wellbeing [7]. This recommendation supports CST as the preferred non-pharmacological treatment for cognitive symptoms in dementia. It is based on strong evidence of its effectiveness, such as the clinical trial by Spector and colleagues [8-

9]. By involving patients in structured group-based sessions or home-based training with caregiver support, including activities such as word games, storytelling, and reminiscence exercises, CST may enhance cognitive abilities, resulting in measurable improvements on standard cognitive assessments and facilitating better communication in daily life [10-11]. Its theoretical foundation is rooted in the concept of cognitive reserve, wherein mental stimulation fosters neuroplasticity, helping to strengthen or preserve neural networks, while social interaction serves as a key mechanism for enhancing cognitive performance [12].

Although most CST programs are group psychosocial interventions, there is also evidence that home-based programs supported by family caregivers may benefit the person with dementia and the caregiver [13]. In the area of language, a review of existing studies indicates the beneficial effects of CST on mild-to-moderate dementia, particularly in areas such as naming, word retrieval, and word comprehension [14-15]. However, additional high-quality research is needed to further investigate interventions aimed at language skills in patients with dementia and, especially, their long-term effects. We designed a year-long language stimulation program targeting Alzheimer's patients with mild-to-moderate dementia and evaluated its effects on the maintenance of their verbal fluency abilities.

METHOD

Participants and procedures

The study was approved by the Bioethics Committee of the Pomeranian Medical University in Szczecin, Poland. All participants were informed of the study procedures and provided written informed consent. The research was conducted at the Medical Centre for Dementia Diagnosis and Treatment Euromedis in Szczecin. Based on the inclusion criteria (i.e. Alzheimer's disease, age ≥ 50 years, MMSE score > 11) and exclusion criteria (a diagnosis of mental or neurological conditions preventing doing language exercises and tests at home), an intervention group (IntG, 54 patients) and a control group (ConG, 34 patients) were formed. Groups were also differen-

tiated by motivation level for language training (scale 0-10; 10 – very motivated to perform language exercises; 5 – moderately motivated; 0 – not motivated), assessed by a clinician at the onset of the study (IntG: 6-10; ConG: 1-5). Based on the MMSE [16], Clock Drawing Test (CDT) [17], and neurologist and caregiver interviews, par-

ticipants were further divided into mild (MMSE 19-23) and moderate (MMSE 12-18) Alzheimer’s dementia subgroups: IMild, CMild, IMod, and CMod. Statistically significant differences (SSDs) in motivation level were found, with the IMild subgroup showing the highest motivation and the CMod subgroup the lowest (see Table 1).

Table 1. Sex, dementia severity, age, education and level of motivation in Intervention and Control groups.

Group	Intervention group	Control group	Total
N	54	34	88
Women	32 (59.26%)	18 (52.94%)	50
Men	22 (40.74%)	10 (47.06%)	38
Severity of dementia – N			
Mild	IMild – 28 (51.85%)	CMild – 20 (58.82%)	48
Moderate	IMod – 26 (48.15%)	CMod – 14 (41.18%)	40
Age	74.78 ± 7.82 IMild – 72.00 ± 7.33 IMod – 77.77 ± 7.32	77.24 ± 5.12 CMild – 75.10 ± 5.01 CMod – 80.29 ± 3.56	
Education			
Elementary	4 (7.41%)	1 (2.94%)	5
Secondary	17 (31.48%)	18 (52.94%)	35
Higher	33 (61.11%)	15 (44.12%)	48
Motivation level (0–10)			
2–4	2 (3.70%)	34 (100%)	36
5–7	22 (40.74 %)		22
8–10	30 (55.56%)		30

IMild, Intervention group with mild dementia; IMod, Intervention group with moderate dementia; CMild, Control group with mild dementia; CMod, Control group with moderate dementia.

Verbal fluency assessment battery

The VFT was used to evaluate the patients’ language abilities at the onset of the study and after 3, 6, 9, and 12 months. We assessed category fluency (CFT) and letter fluency (LFT) using traditional quantitative scoring methods, including total word count and errors (e.g. words inconsistent with the criteria, repetitions, and perseverations), as well as qualitative methods sensitive to frontal and temporal lobe processing, such as clustering and switching, within a 60-second time frame. A cluster, as defined by Troyer et al. [18], consists of two or more consecutive semantically or phonemically related words, such as those starting with the same

consonant compound, differing by one vowel, rhyming, or homophones, particularly in the phonemic variant. In the semantic variant, clusters refer to semantically related words that share common attributes, such as categories like animals or colors. Switching refers to the ability to shift efficiently between categories after exhausting the current category. In this study, we analysed hard switches, defined as transitions between unrelated words and clusters, whose higher usefulness in assessing cognitive functioning was highlighted by Mayr [19]. In the LFT, we analyzed performance on a low-frequency letter (F) and a high-frequency letter (K) in Polish as guided by Szepietowska et al. [20] and Daniluk and Szepietowska [21]. The selec-

tion of these letters was based on the frequency of words beginning with each letter in Polish, with F being less frequent than K. For the CFT, we examined performance across a broad category (animals) and a narrow one (sharp items), which are commonly applied in Polish-language studies, e.g. by Łucki [22], Piskunowicz et al. [23] as well as Daniluk and Szepietowska [24]. Semantic and phonemic fluency were evaluated alternately, starting with a semantic category, as suggested in the literature, which posits that semantic categories are more natural and intuitive, and may help participants ease into the task [25]. All tests were conducted in Polish.

The characteristics of a language training program

Our proprietary language program was designed to meet the specific needs of AD patients. We developed 12 booklets containing exercises targeting language areas primarily affected by AD. The exercises were tailored to preserve the ability to interpret word meaning and included tasks such as: 1) matching words to a given context; 2) providing superordinate terms, antonyms, and completing idiomatic expressions or proverbs; 3) forming or completing words with provided letters or syllables; 4) memorizing words paired with numbers; and 5) creating semantic associations. The lexical material focused on commonly used vocabulary from various semantic categories, including the ones tested in the VFT.

The program was specifically designed for home-based therapy to be conducted in a familiar environment. During the initial visit, both patients and their caregivers received comprehensive instructions on how to perform the exercises. Caregivers were advised to provide assistance as needed, while patients were encouraged to complete the exercises independently whenever possible, seeking support from their caregivers only when necessary. Patients from the IntG received 12 booklets, each containing 20-25 pages of language exercises, one for every consecutive month of the study, totalling 215 pages and 360 tasks. Progress was monitored by reviewing each patient's completed booklet every three months. At each visit, the IntG participants were assessed using a VFT battery. ConG participants also underwent the VFT at the same

intervals but did not participate in the language program.

Statistics

Continuous variables were assessed for normality using the Kolmogorov-Smirnov test. Descriptive statistics included means, standard deviations, medians, quartiles, and ranges (minimum and maximum values). For comparative analysis, the Student's t-test and Mann-Whitney test were used for two groups, while ANOVA variance (ANOVA) was applied for multiple groups. Discrete variables were described by counts and frequencies, and statistical dependencies were analyzed using Pearson's chi-square test or Fisher's exact test. To examine correlations, Spearman rank correlation was used to assess relationships between discrete (ordinal and nominal) and continuous variables, reporting the correlation coefficient (rs) and the p-value. All statistical analyses were performed using STATA version 11 (2009).

RESULTS

Phonemic fluency performance in VFT for letters K and F

Figure 1 shows the mean scores for letters K and F in mild (IMild, CMild) and moderate (IMod, CMod) AD patients in the intervention (IntG) and control (ConG) groups.

As anticipated, all patients produced more words starting with the high-frequency letter K. However, only the IMild group met the Verbal Fluency Test (VFT) screening protocol criteria at month 12, with an average score of 15.89, slightly lower at months 6 and 9, with scores of 14.39 and 14.50, respectively. After 12 months, IMod's performance for letter K improved by 1.93, reaching 11.35, whereas CMod's score declined by 2.14 to 6.43. In CMild, the score dropped by 2.90, reaching 10.65 at the end of the study. For letter F, the mean score in IMild increased from 9.79 at baseline to 12.46 in 12th month. In contrast, CMild's score declined from 9.15 to 7.20 over the same period. IMod showed a slight increase from 7.15 to 8.31, whereas CMod's score decreased by 1.43 in 12th month. Overall, the av-

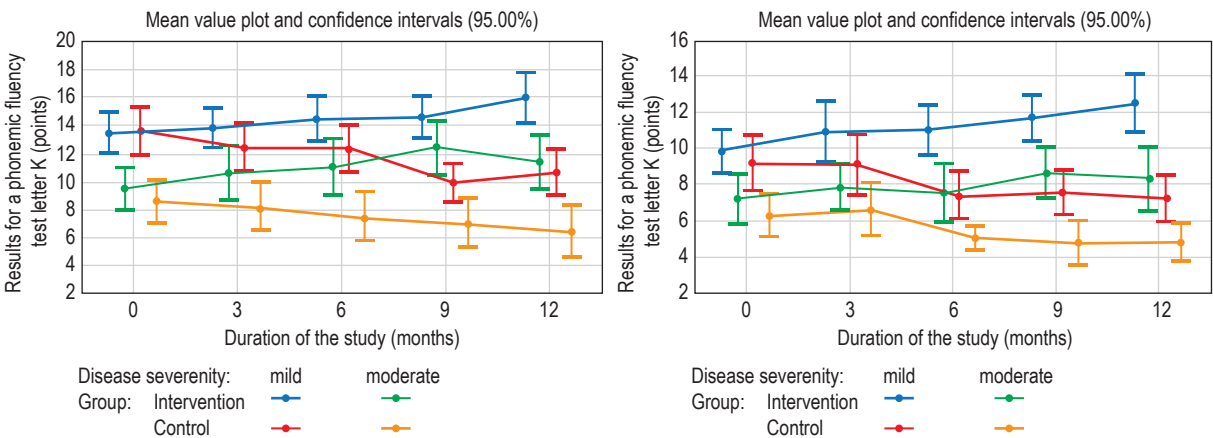


Figure 1. Results for the phonemic fluency test. Mean values (K) in mild and moderate dementia in IntG and ConG. Mean values (F) in mild and moderate dementia in IntG and ConG.

erage scores for letter K throughout the year were 12.70 in the IntG and 10.00 in the ConG, whereas for letter F, it was 9.50 in the IntG and 6.90 in the ConG. SSDs between the IntG and the ConG emerged from month 6 for both phonemic variants.

We analyzed the number of errors made by patients in the IntG and ConG groups (the results can be made available by the corresponding author in the form of the supplementary material). In the IntG, the number of errors remained similar until the 9th month, with a slight decrease in the 12th month. Most patients made only one error, and by the end of the year, eight more patients had error-free results compared with the first test. In the ConG, the error count increased in the 6th month, decreased in the 9th month, and rose again at the end of the study. In general, more patients in the ConG made two or more er-

rors. For the VFT with letter F, five more patients in the IntG achieved error-free results after one year, while the number of patients with two or more errors remained unchanged. In contrast, in the ConG, the number of patients with error-free results decreased from 19 to 16, with five more patients making two or more errors. Although SSDs between the groups were observed in certain months, these results do not represent a distinctive feature that differentiate the two groups.

Since verbal fluency is a multifactorial task, we also analyzed clustering and switching (see Figures 2 and 3). for letters K and F in the IntG and ConG. For clarity, we represent the data based on a simple division between the IntG and ConG. The number of clusters in both phonemic variants remained similar throughout the year in both groups, averaging 2.04 for the IntG and 1.60 for the ConG with letter K, and 1.37

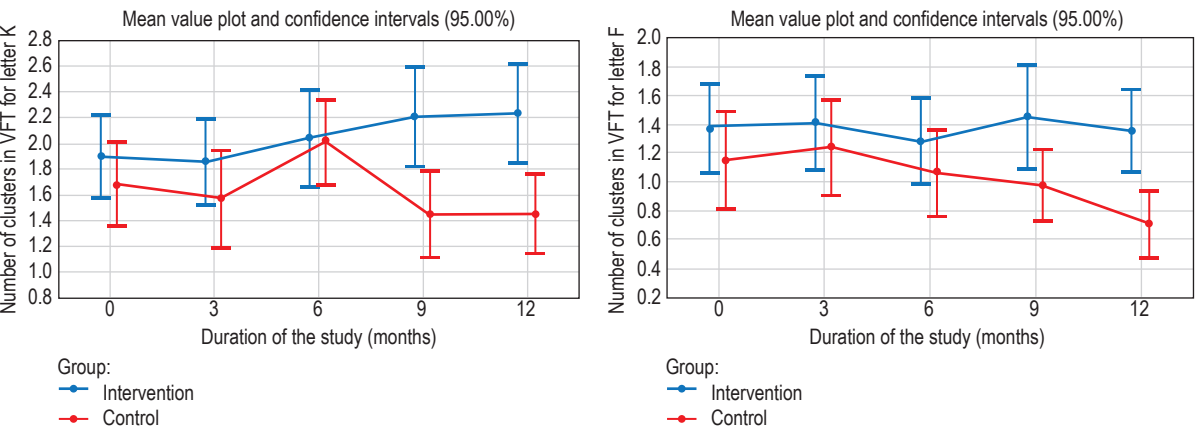


Figure 2. Results for clustering performance in the phonemic fluency test for letters K and F in IntG and ConG. Mean values for clustering in VFT (K) in IntG and ConG. Mean values for clustering in VFT (F) in IntG and ConG.

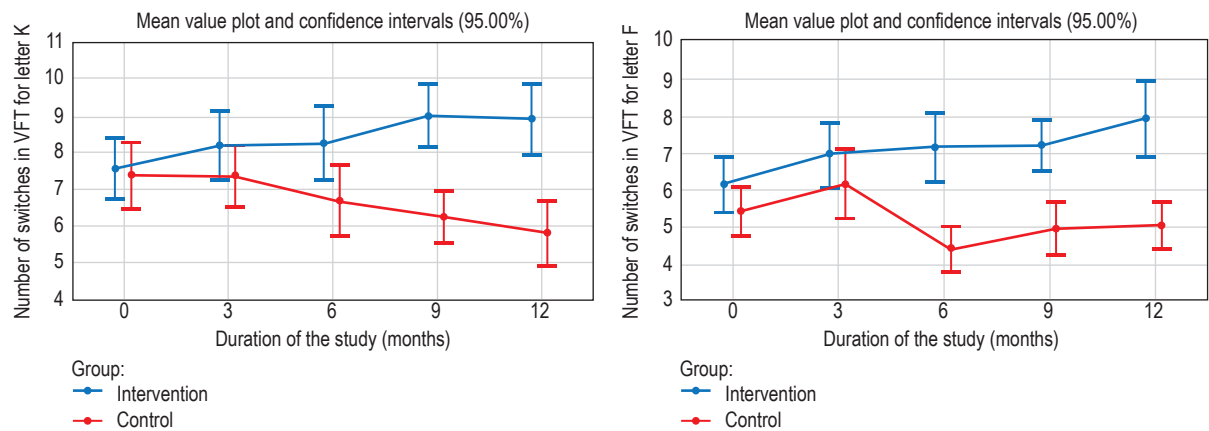


Figure 3. Results for switching performance in the phonemic fluency test for letters K and F in IntG and ConG. Mean values for switching in VFT (K) in IntG and ConG. Mean values for switching in VFT (F) in IntG and ConG.

for the IntG and 1.02 for the ConG with letter F. For letter K, the number of clusters in the IntG slightly increased by 0.33 over the year, while in the ConG it decreased by 0.24. For letter F, SSD was observed only in the 12th month. The number of clusters generated by the IntG remained the same, whereas those of the ConG showed a slight decline. Despite these differences, the results from both phonemic variants did not clearly distinguish between the groups, as the overall number of clusters produced remained low across all groups analyzed.

A greater SSD between the IntG and ConG was observed in the hard-switching analysis. The difference in the average scores between the two groups was significant at the 6th, 9th and 12th months for both phonemic variants (see Figure 3). By the end of the year, the number of switches increased in the IntG by 1.35 for letter

K, with an average score of 8.91 at month 12, and by 1.78 for letter F, with an average score of 7.93 at the same time point.

Semantic fluency performance in VFT for animals and sharp items categories

Figure 4 presents the mean scores for generating words from two semantic categories: animals and sharp items. The analysis of verbal fluency for the “animals” category showed improvement in the IntG after one year. Patients with mild AD produced 17.82 words, an increase of 2.82 words compared to the initial test, while patients with moderate AD generated 13.46 words on average, an improvement of 2.27 words over the year. In contrast, the ConG showed a decline, with mild AD patients producing 3.40 few-

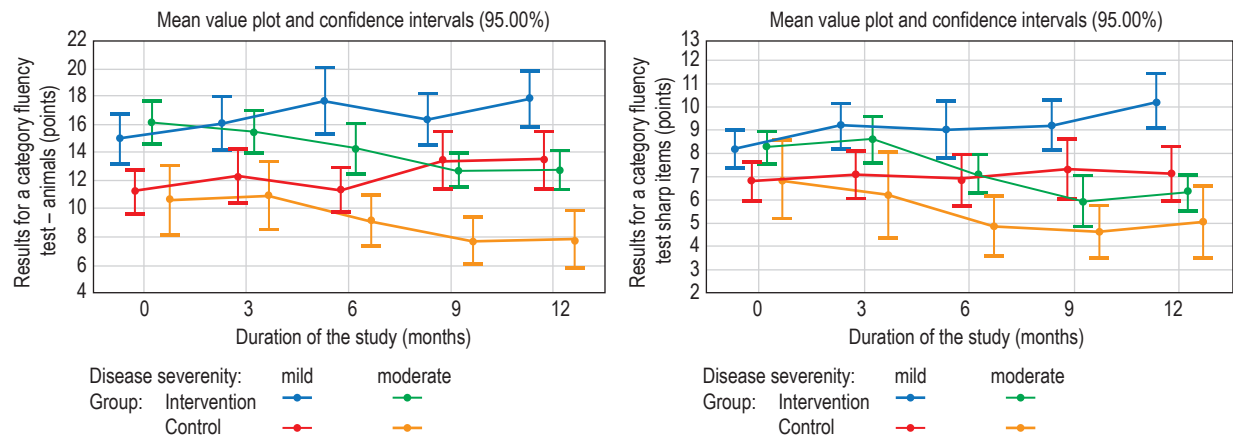


Figure 4. Results for the category fluency test. Mean values in VFT in the animals category in mild and moderate dementia in IntG and ConG. Mean values in VFT in the sharp items category in IntG and ConG.

er words and moderate AD patients generating 2.71 fewer words on average. In the final test, mild and moderate AD patients in the ConG produced 12.75 and 7.86 words, respectively. SSDs between the results of mild and moderate patients in the IntG and ConG were observed at the 6th, 9th, and 12th months.

In the analysis of the “sharp items” category, SSDs between the IntG and ConG emerged from the 6th month onward. In the IntG, mild AD patients produced an average of 10.21 words in the 12th month, an increase of 2.03 words compared to the first test. In patients with moderate AD, the result remained stable, with an average of 7.08 words after a year, which was slightly higher than the 6.81 words at the onset. In contrast, the ConG experienced declines, with mild AD patients showing a decrease of 1.95 words and moderate AD patients a decrease of 1.79

words over the same period. Overall, the IntG patients performed significantly better in generating words from a broader category, with higher results in the final test compared to their initial performance.

The number of errors in the two semantic categories remained relatively stable over the year in the IntG (the results can be made available by the corresponding author in the form of the supplementary material). By the 12th month, 47 patients had made no errors in the “animals” category, with only seven patients committing one error. For the “sharp items” category, 93% of the patients were error-free. These results were significantly better than those observed for phonemic variants. SSDs between the IntG and ConG were found in the 3rd, 9th, and 12th months for the “animals” category and in the 3rd and 12th months for the “sharp items” category.

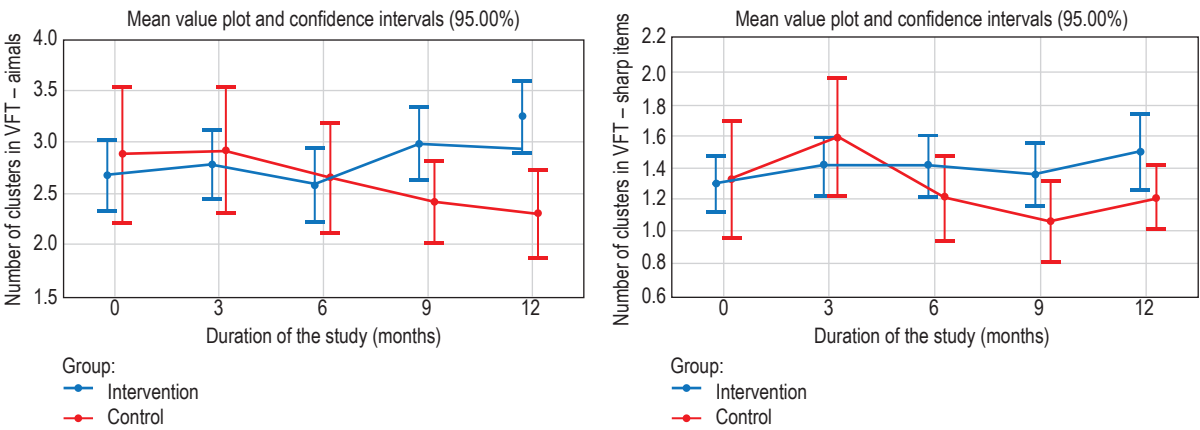


Figure 5. Results for clustering performance in the semantic fluency test for animal and sharp items categories in IntG and ConG. Mean values for clustering in VFT (animals) in IntG and ConG. Mean values for clustering in VFT (sharp items) in IntG and ConG.

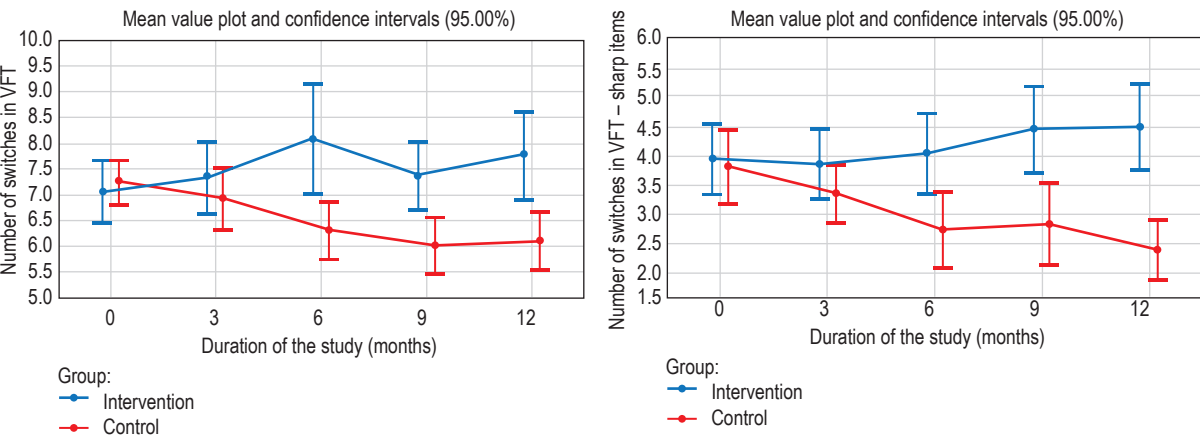


Figure 6. Results for switching performance in the semantic fluency test for animal and sharp items categories in IntG and ConG. Mean values for switching in VFT (animals) in IntG and ConG. Mean values for switching in VFT (sharp items) in IntG and ConG.

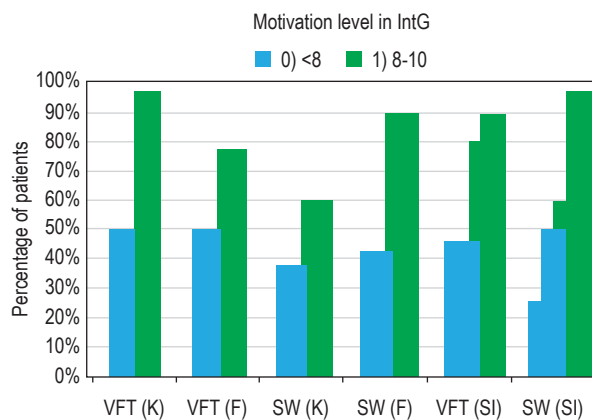


Figure 7. Improvement of results in VFT in 12th month (IntG) taking into account motivation level
SW – switching, SI – sharp items

Figures 5 and 6 show the mean scores for clustering and switching performance in the two semantic categories for both the IntG and ConG groups, respectively. The number of clusters generated by both groups remained similar until the 6th month, with no significant differences between the groups. The average number of clusters produced was 2.7 in the IntG and 2.6 in the ConG. However, both groups generated more switches than clusters in both semantic categories, with SSDs emerging in the 6th, 9th, and 12th months. Despite these differences, the total number of switches remained relatively unchanged when the first and last tests were compared. On average, the IntG produced 7.5 switches, while the ConG produced 6.5.

A key factor that strongly correlated with VFT outcomes in the 12th month was the patients' motivation to participate in the program (see Figure 7). SSDs were noted between motivation levels and training effects in the IntG, with higher motivation leading to better outcomes, a finding consistent with previous studies [26].

DISCUSSION

In AD, cognitive deficits primarily affect episodic and semantic memory, leading to increasingly restricted vocabulary as the disease progresses. Our findings suggest that implementation of our self-designed language stimulation program contributes to maintaining language skills in patients with mild and moderate AD, as evidenced by the VFT. The observed improvement

indicates that such programs should be considered valuable components of non-pharmacological therapies for AD.

However, interventions targeting language functioning in patients with AD have yielded mixed results. Some researchers have argued that their impact on general vocabulary is limited [27-28]. A recent comprehensive review highlighted potential short-term cognitive therapy benefits for dementia patients, but the long-term clinical significance of such programs requires further investigation [29]. Nevertheless, studies on cognitive therapies in AD have consistently shown improvements in language skills [10,11,30]. Researchers at San Diego University reported positive effects following a language-focused program for AD patients [31]. After 3 and 6 months of language exercises, 56 patients exhibited improvements in short-term memory, phonemic fluency, and semantic fluency, unlike the control group.

In Poland, extensive research on language functioning in AD has been conducted by Prof. Aneta Domagaa [32], a speech therapist, who developed therapeutic approaches tailored to the needs and possibilities of AD patients with disnomia, such as the fading cues method [33-34]. Based on Prof. Domagała's research, we adapted some exercises to include the provision of first letters or syllables and observed that the fading cues method improved patients' satisfaction and motivation by increasing the number of correct responses. The effectiveness of this method is grounded in the theory that naming difficulties in AD patients stem not from a loss of semantic knowledge but from impaired metalinguistic abilities [35]. This explains why patients recalled names or definitions after receiving additional prompts. Metalinguistic abilities, which are part of executive functions, relate to language use and control. Similarly, a study by Cuetos et al. [36] found that AD patients tend to respond "I don't know" at the stage where word recall is still possible but requires encouragement and more time to think.

In our study, a key focus in observing language function was to assess patients' progress in the VFT. Our findings show that patients with AD tend to generate more words in broad categories in both phonemic (K) and semantic (animals) variants, a trend not consistently observed

in other studies [37]. Some studies suggest that patients with AD experience greater difficulty retrieving words from animate than inanimate categories [38], while Garrard et al. [39] found better performance in animate categories, although only in some patients. Gonnerman et al. [40] observed that early-stage AD patients struggled more with naming objects, but as the disease advanced, retrieving animate words became more challenging.

The CFT is considered more sensitive to neurodegenerative changes in AD than phonemic fluency, as semantic memory is more closely linked to posterior temporal lobe functioning [6,37,41,42], whereas phonemic fluency is primarily influenced by frontal lobe efficiency [43]. This distinction could provide insights for differential diagnoses [44-47]. These findings suggest that deficits in category fluency likely reflect damage to the semantic memory store, rather than general controlled retrieval disruption [37]. However, in our study, the results in the semantic variant were higher than those in the phonemic variant, possibly due to the influence of our language intervention program. Differences in letters and category selection across fluency tasks may also account for these discrepancies.

Recent research suggests that phonemic tasks are more effective in identifying errors associated with mild cognitive impairment (MCI) and AD [44,46]. One factor contributing to poor phonemic fluency performance may be the testing procedure and letter choice. In English-language studies, patients are first asked to list words beginning with F, A, and S, followed by animal naming. Another reason could be that semantic categories, being more concrete, are easier to retrieve than abstract letter categories. However, cross-sectional research has not consistently supported the predictive power of semantic-phonemic fluency discrepancies [48,49], and some studies have failed to demonstrate this pattern altogether [50]. Similarly, a meta-analysis by Laws et al. found no significant difference in effect sizes between controls and AD patients when comparing results from category and letter fluency tasks across 50 studies [51].

Another criterion applied in our study was error counting. Although the patients produced few errors across all variants, some researchers suggest that simply counting errors can pro-

vide valuable insights into detecting cognitive impairments in AD, particularly in phonemic tasks [44]. This method may help identify early cognitive decline by highlighting difficulties in word retrieval and task execution.

The analysis of clustering and switching in our study did not reveal significant differences between semantic and phonemic categories in the IntG, although phonemic fluency showed a slightly higher number of switches. Patients tended to group words into clusters more often in the category fluency task, particularly in the animal category, which aligns with the findings of other studies [52]. Our results also partially support research indicating that clustering and switching are more vulnerable to degeneration in category fluency than phonemic fluency in AD [52-54].

Additionally, we observed a small number of clusters across both VFT variants, likely owing to the more frequent use of hard switches. This may reflect a different organization of semantic memory in category-based tasks. Furthermore, we noted that the patients frequently produced words from superordinate categories and rarely used less common words. The preservation of semantic networks for high-frequency words, despite the overall vocabulary limitations, could be valuable in designing vocabulary training programs for patients with AD.

Ensuring sustained motivation in individuals with Alzheimer's disease is essential for the effectiveness of cognitive training programs, as our findings indicate a strong correlation between motivation levels and improvements in verbal fluency. Higher motivation was associated with better outcomes, highlighting the importance of designing interventions that actively engage participants. Strategies such as incorporating personally meaningful activities, fostering a supportive environment, and providing consistent positive reinforcement may enhance adherence and maximize therapeutic benefits. Given that motivation emerged as a key factor influencing progress in our intervention group, future cognitive training programs should integrate structured approaches to maintain engagement and encourage long-term participation.

Limitations of the study

This study primarily focused on verbal fluency, overlooking broader aspects of commu-

nication, such as discourse and pragmatic language use, which are crucial in daily interactions. A comprehensive language stimulation program should also target verbal language to enhance functional communication. Future research should assess both verbal and written language to better understand cognitive-linguistic decline in AD. Additionally, task selection, letter and category choice, and individual variability may have influenced the results, warranting cautious interpretation. Importantly, the long-term effects of our language program remain uncertain due to the absence of follow-up assessments.

REFERENCES

- Berente DB, Kamondi A, Horvath AA. The assessment of visuospatial skills and verbal fluency in the diagnosis of Alzheimer's disease. *Front Aging Neurosci.* 2022; 13: 737104.
- Szatloczki G, Hoffmann I, Vincze V, Kalman J, Pakaski M. Speaking in Alzheimer's disease, is that an early sign? Importance of changes in language abilities in Alzheimer's disease. *Front. Aging Neurosci.* 2015; 7:195.
- Marra C, Piccininni C, Masone Iacobucci G, Caprara A, Gainotti G, Costantini EM, et al. Semantic memory as an early cognitive marker of Alzheimer's disease: role of category and phonological verbal fluency tasks. *J Alzheimers Dis.* 2021; 81(2): 619–627.
- Henry JD, Crawford JR, Phillips LH. Verbal fluency performance in dementia of the Alzheimer's type: a meta-analysis. *Neuropsychol.* 2004; 42(9): 1212–1222.
- Olmos-Villaseñor R, Sepulveda-Silva C, Julio-Ramos T, Fuentes-Lopez E, Toloza-Ramirez D, Santibañez RA, et al. Phonological and semantic fluency in Alzheimer's disease: A systematic review and meta-analysis. *J. Alzheimers Dis.* 2023; 95(1): 1–12.
- Wright LM, De Marco M, Venneri A. Current understanding of verbal fluency in Alzheimer's disease: Evidence to date. *Psychol Res Behav Manag.* 2023; 5;16: 1691–1705.
- Dementia: assessment, management and support for people living with dementia and their carers. NICE guideline NG97. [homepage on the Internet]. National Institute for Health and Care Excellence. [updated 2018 June 20; cited 2025 Feb 15]. Available from <https://www.nice.org.uk/guidance/ng97/chapter/Recommendations#interventions-to-promote-cognition-independence-and-wellbeing>.
- Spector A, Thorgrimsen L, Woods B, Royan L, Davies S, Butterworth M, et al. Efficacy of an evidence-based cognitive stimulation therapy programme for people with dementia: Randomised controlled trial. *Br J Psychiatry.* 2003; 183(3): 248–254.
- Spector A, Woods B, Orrell M. Cognitive stimulation for the treatment of Alzheimer's disease. *Expert Rev Neurother.* 2008; 8(5): 751–757.
- Justo-Henriques SI, Pérez-Sáez E, Marques-Castro AE, Carvalho JO. Effectiveness of a year-long individual cognitive stimulation program in Portuguese older adults with cognitive impairment. *Aging, Neuropsychology, development, and cognition. Section B, Aging, neuropsychology and cognition.* 2023; 30(3): 321–335.
- Trebbastoni A, Imbriano L, Podda L, Rendace L, Sacchetti ML, Campanelli A, et al. Cognitive training in patients with Alzheimer's disease: Findings of a 12-month randomized controlled trial. *Curr Alzheimer Res.* 2018; 14;15(5): 452–461.
- Stern Y. What is cognitive reserve? Theory and research application of the reserve concept. *J Int Neuropsychol Soc.* 2002; 8(3): 448–460.
- Orrell M, Yates L, Leung P, Kang S, Hoare Z, Whitaker C, et al. The impact of individual Cognitive Stimulation Therapy (iCST) on cognition, quality of life, caregiver health, and family relationships in dementia: A randomised controlled trial. *PLoS Med.* 2017; 28;14(3): e1002269.
- Morello ANDC, Lima TM, Brandão L. Language and communication non-pharmacological interventions in patients with Alzheimer's disease: a systematic review. *Communication intervention in Alzheimer. Dement Neuropsychol.* 2017; 11(3): 227–241.
- Xiang C, Zhang Y. Comparison of cognitive intervention strategies for individuals with Alzheimer's disease: A systematic review and network meta-analysis. *Neuropsychol Rev.* 2024; 34(2): 402–416.
- Folstein MF, Folstein SE, McHugh PR. "Mini-mental state". A practical method for grading the cognitive state of patients for the clinician. *J Psychiatr Res.* 1975; 12(3): 189–198.
- Sunderland T, Hill JL, Mellow AM, Lawlor BA, Gundersheimer J, Newhouse PA, et al. Clock drawing in Alzheimer's disease. A novel measure of dementia severity. *J Am Geriatr Soc.* 1989; 37(8): 725–729.
- Troyer AK, Moscovitch M, Winocur G, Alexander MP, Stuss D. Clustering and switching on verbal fluency: the effects of focal frontal – and temporal-lobe lesions. *Neuropsychologia.* 1998; 36(6): 449–504.
- Mayr U. On the dissociation between clustering and switching in verbal fluency: comment on Troyer, Moscovitch, Winocur, Alexander and Stuss. *Neuropsychologia.* 2002; 40(5):562–566.
- Szepietowska EM, Hasiec T, Jańczyk-Mikoś A. Fluencja słowna i niewerbalna w różnych stadiach i formach choroby Parkinsona. *Psychogeriatrya Polska.* 2012; 9(4): 137–148.
- Daniluk B, Szepietowska EM. Płynność semantyczna i literowa osób w różnych fazach dorosłości – część I. *Annales Universitatis Mariae Curie-Skłodowska. Sectio J – Paedagogia-Psychologia.* 2009a; 22: 97–110.

22. Łucki W. Zestaw prób do badania procesów poznawczych u pacjentów z uszkodzeniami mózgu. Warszawa: Pracownia Testów Psychologicznych Polskiego Towarzystwa Psychologicznego; 1995.
23. Piskunowicz M, Bieliński M, Zgliński A, Borkowska A. Testy fluencji słownej – zastosowanie w diagnostyce neuropsychologicznej. *Psychiatr Pol.* 2013; 47(3): 475–485.
24. Daniluk B, Szepietowska EM. Płynność semantyczna i literowa osób w różnych fazach dorosłości – czynniki modyfikujące wykonanie zadań fluencji słownej – część II. *Annales Universitatis Mariae Curie-Skłodowska. Sectio J – Paedagogia-Psychologia* 2009b; 22: 111–128.
25. Lezak MD, Howieson DB, Bigler ED, Tranel D. *Neuropsychological assessment* (5th ed.). Oxford University Press; 2012.
26. Edwards JD, Xu H, Clark D, Ross LA, Unverzagt F. The ACTIVE study: What we have learned and what is next? Cognitive training reduces incident dementia across ten years. *Alzheimer's & Dementia.* 2016; 12(7): P212.
27. Croot K, Nickels L, Laurence F, Manning M. Impairment – and activity/participation-directed interventions in progressive language impairment: Clinical and theoretical issues. *Aphasiology.* 2009; 23(2): 125–160.
28. Nickels L. Therapy for naming disorders: Revisiting, revising, and reviewing. *Aphasiology.* 2002; 16(10–11): 935–979.
29. Woods B, Rai HK, Elliott E, Aguirre E, Orrell M, Spector A. Cognitive stimulation to improve cognitive functioning in people with dementia. *Cochrane Database of Systematic Reviews* 2023; 31;1(1): CD005562.
30. Pagnoni I, Gobbi E, Premi E, Borroni B, Binetti G, Cotelli M, et al. Language training for oral and written naming impairment in primary progressive aphasia: a review. *Transl Neurodegener.* 2021; 16;10(1): 24.
31. Quayhagen MP, Quayhagen M, Corbeil RR, Roth PA, Rodgers JA. A dyadic remediation program for care recipients with dementia. *Nurs Res.* 1995; 44(3): 153–159.
32. Domagała A. Zachowania językowe w demencji. Struktura wypowiedzi w chorobie Alzheimer. Lublin: Ed. University of Maria Curie-Skłodowska; 2007.
33. Domagała A. The Fading cues method in logopedic diagnosis and therapy of dementia patients. *Logopedia.* 2011; 39–40: 197–206.
34. Domagała A, Sitek EJ. Usprawnianie komunikacji słownej w wybranych wariantach choroby Alzheimer: typowym i językowym. *Poznańskie Studia Polonistyczne. Seria Językoznawcza.* 2022; 29(2): 213–229.
35. Harley TA, Jessiman LJ, MacAndrew SGB, Astell A. I don't know what I know: Evidence of preserved semantic knowledge but impaired metalinguistic knowledge in adults with probable Alzheimer's disease. *Aphasiology.* 2008; 22(3): 321–335.
36. Cuetos F, González-Nosti M, Martínez C. The picture-naming task in the analysis of cognitive deterioration in Alzheimer's disease. *Aphasiology.* 2005; 19: 545–557.
37. Whatmough C, Chertkow H, Murtha S, Templeman D, Babins L, Kelner N. The semantic category effect increases with worsening anomia in Alzheimer's type dementia. *Brain Lang.* 2003; 84(1): 134–147.
38. Krumm S, Berres M, Kivisaari SL, Monsch AU, Reinhardt J, Błatow M, et al. Cats and apples: Semantic fluency performance for living things identifies patients with very early Alzheimer's disease. *Arch Clin Neuropsychol.* 2021; 19;36(5): 838–843.
39. Garrard P, Patterson K, Watson PC, Hodges JR. Category specific semantic loss in dementia of Alzheimer's type. Functional-anatomical correlations from cross-sectional analyses. *Brain.* 1998; 121: 633–646.
40. Gonnerman LM, Andersen ES, Devlin JT, Kempler D, Seidenberg MS. Double dissociation of semantic categories in Alzheimer's disease. *Brain Lang.* 1997; 57(2): 254–279.
41. Clark LJ, Gatz M, Zheng L, Chen YL, McCleary C, Mack WJ. Longitudinal verbal fluency in normal aging, preclinical, and prevalent Alzheimer's disease. *Am J Alzheimers Dis Other Dement.* 2009; 24(6): 461–468.
42. Vonk MJ, Bouteloup V, Mangin JF, Dubois B, Blanc F, Gabelle A, et al. MEMENTO cohort Study Group. Semantic loss marks early Alzheimer's disease-related neurodegeneration in older adults without dementia. *Alzheimers Dement (Amst).* 2020; 5;12(1): e12066.
43. Birn RM, Kenworthy L, Case L, Caravella R, Jones TB, Bandettini PA, et al. Neural systems supporting lexical search guided by letter and semantic category cues: A self-paced overt response fMRI study of verbal fluency. *Neuroimage* 2010; 49(1): 1099–1107.
44. Wajman JR, Cecchini MA. A simple counting of verbal fluency errors discriminates between normal cognition, mild cognitive impairment and Alzheimer's disease. *Aging, Neuropsychology, development, and cognition. Section B, Aging, neuropsychology and cognition.* 2023; 30(3): 370–387.
45. Vaughan RM, Coen RF, Kenny R, Lawlor BA. Semantic and phonemic verbal fluency discrepancy in mild cognitive impairment: Potential predictor of progression to Alzheimer's disease. *J Am Geriatr Soc.* 2018; 66(4): 755–759.
46. Wright LM, De Marco M, Venneri A. Verbal fluency discrepancies as a marker of the prehippocampal stages of Alzheimer's disease. *Neuropsychology.* 2023; 37(7): 790–800.
47. Chasles MJ, Tremblay A, Escudier F, Lajeunesse A, Benoit S, Langlois R, et al. An examination of semantic impairment in amnesic MCI and AD: What can we learn from verbal fluency? *Archives of Clinical Neuropsychology.* 2019; 24;35(1): 22–30.
48. Teng E, Leone-Friedman J, Lee GJ, Woo S, Apostolova LG, Harrell S, et al. Similar verbal fluency patterns in amnesic mild cognitive impairment and Alzheimer's disease. *Archives of Clinical Neuropsychology.* 2013; 28(5): 400–410.
49. Cerhan JH, Ivnik RJ, Smith GE, Tangalos EC, Petersen RC, Boeve BF. Diagnostic utility of letter fluency, category fluency

- cy, and fluency difference scores in Alzheimer's disease. *The Clinical Neuropsychologist*. 2002; 16(1): 35–42.
50. Rinehardt E, Eichstaedt K, Schinka JA, Loewenstein DA, Mattingly M, Fils J, et al. Verbal fluency patterns in mild cognitive impairment and Alzheimer's disease. *Dement Geriatr Cogn Disord*. 2014; 38(1–2): 1–9.
51. Laws KR, Duncan A, Gale TM. 'Normal' semantic-phonemic fluency discrepancy in Alzheimer's disease? A meta-analytic study. *Cortex*. 2010; 46(5): 595–601.
52. Raoux N, Amieva H, Le Goff M, Auriacombe S, Carcaillon L, Letenneur L, et al. Clustering and switching processes in semantic verbal fluency in the course of Alzheimer's disease subjects: Results from the PAQUID longitudinal study. *Cortex* 2008; 44(9): 1188–1196.
53. Weakley A, Schmitter-Edgecombe M. Analysis of verbal fluency ability in Alzheimer's disease: the role of clustering, switching, and semantic proximities. *Archives of Clinical Neuropsychology*. 2014; 29(3): 256–268.
54. Rofes A, de Aguiar V, Jonkers R, Oh SJ, DeDe G, Sung JE. What drives task performance during animal fluency in people with Alzheimer's disease? *Front Psychol*. 2020; 21;11:1485.