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# The Effect of Language Interventions and Non-Invasive Brain Stimulation on Naming Deficits and Other Cognitive Skills in Patients with Alzheimer's Disease: A Scoping Review

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Review Article

## Abstract

**Introduction:** Alzheimer's disease (AD) is a progressive clinical syndrome characterized by the deterioration of higher mental functions, including memory, language, executive function, and attention. Among language impairments, naming deficits (anomia) are particularly prominent. While various studies have investigated treatments for these deficits, identifying the most effective intervention remains challenging. This study aims to review and compare the efficacy of therapeutic methods for naming deficits in patients with AD to assist researchers and clinicians in selecting optimal approaches.

**Materials and Methods:** A comprehensive search was conducted across international databases (Cochrane Library, ISI Web of Science, Scopus, ProQuest, PubMed, and ScienceDirect) and Persian databases [Scientific Information Database (SID), Magiran, IranDoc, and the Ministry of Health research registry]. The review included all studies involving adults, irrespective of gender or ethnicity, published in English or Persian from January 2010 to December 2022. Study designs ranged from clinical trials to case reports, and the level of evidence for each study was assessed.

**Results:** Following the screening of identified records based on inclusion and exclusion criteria, 10 studies were selected for review. Data were extracted using a structured checklist. Interventions were stratified into four categories: language-based, instrumental, cognitive, and combined instrumental-language therapies.

**Conclusion:** Although the existing literature is limited, current findings indicate that lexical-semantic stimulation – a language-based therapy – provides the highest level of evidence for the treatment of naming deficits in AD.

**Keywords:** Dementia; Naming; Treatment; Anomia; Alzheimer’s disease

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## Introduction

Alzheimer's Disease (AD) is the most common type of dementia. It is a progressive neurodegenerative disorder that gradually impacts memory, executive functions, spatial skills, and language (1). A progressive impairment in language functioning is one of the primary and predominant signs of the early stages of Alzheimer's disease (2). Among the language impairments observed in these individuals, naming disorders are the most significant and evident symptoms at disease onset, and their nature may evolve across different stages (3). Consequently, the

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naming errors exhibited by patients differ both qualitatively and quantitatively throughout the various stages of the disease (4, 5). According to the World Health Organization (WHO), it is projected that approximately 66 million people will be living with Alzheimer's disease by 2030, increasing to 115 million by 2050. About 58 percent of this population resides in low- or middle-income countries (6).

Furthermore, according to data from the Iran Alzheimer Association, it is estimated that approximately 500,000 individuals in Iran are affected by Alzheimer's (7). In Alzheimer's disease, the abnormal accumulation of the amyloid-beta protein outside nerve cells and the aggregation of the tau protein within these cells disrupt neural network communication and ultimately lead to neuronal degeneration, resulting in the onset of clinical symptoms (8). The medial, inferior, and subcortical regions of the temporal and parietal lobes, as well as the anterior regions of the occipital lobe, are among the areas where amyloid plaques initially form during the early stages of the disease (9). According to the new criteria established by the National Institute on Aging and the Alzheimer's Association (NIA/AA), the primary indicators of Alzheimer's include loss of recent memory, difficulty learning new information, and impairments in cognitive domains, particularly language. Language disorders, considered a core symptom of early-stage Alzheimer's, are pervasive; they typically emerge at the onset of the disease and persist throughout all its stages (5).

In the early stages of Alzheimer's disease, the prominent features of the patients' daily speech include naming deficits, word-finding difficulties, and impairments in semantics and verbal content (10). As the disease progresses, comprehension impairments occur, particularly regarding complex concepts. Syntactic structures become simplified, linguistic content turns ambiguous or occasionally meaningless, and neologisms and inappropriate repetitions become evident in their speech (11). In the advanced stages of Alzheimer's, language use is significantly reduced, or the patient may become completely mute. Although numerous linguistic symptoms are observed in these patients, naming difficulties can persist across various stages of the disease, with their underlying nature varying (12).

Naming is a fundamental human ability for communication, defined as the assignment of a verbal label to an object or concept (13). Naming is the outcome of three distinct processes: a) the observed object or image must be recognized and identified as the representative symbol of that concept within the individual's mental category; b) the appropriate name must be activated from among thousands of available words; and c) the proper planning and production of the selected name must occur (14). All these stages must happen efficiently, accurately, and within a specific timeframe (15, 16). Various brain regions are involved in naming a concept (14). In Alzheimer's disease, neuronal degeneration frequently occurs in the frontal and temporal lobes, which play a pivotal role in the naming process (17).

In recent decades, special attention has been directed toward non-pharmacological strategies, such as cognitive interventions, language-based interventions, and non-invasive brain stimulation (NIBS) in patients with Alzheimer's disease.

According to the cognitive approach, the American Psychiatric Association (APA) categorizes non-pharmacological interventions prescribed for various types of dementia, including Alzheimer's, into four groups: a) Cognition-oriented treatments (e.g., reality orientation, skills training); b) Emotion-oriented treatments (e.g., supportive psychotherapy, validation therapy, sensory integration, controlled multisensory stimulation—known as Snoezelen, and reminiscence therapy); c) Behavior-oriented approaches (behavioral therapy); and d) Stimulation-oriented treatments (e.g., activity or recreational therapy, art therapy, music therapy, exercise, and multisensory stimulation) (18). Since Alzheimer's is characterized by the onset of cognitive deficits that progress over time, these impairments in functional skills of daily living have a significant and often dramatic impact on the quality of life of both patients and their caregivers (19). Consequently, enhancing cognitive function in patients with Alzheimer's disease can delay hospitalization, reduce national healthcare costs (20), and improve the well-being of both patients and caregivers (21). The objective of cognitive therapeutic methods is to compensate for cognitive deficits, which are considered the most critical factor in Alzheimer's disease (22). Cognitive therapy is predominantly theory-driven and employs specific exercises that target particular cognitive functions to optimize performance and enhance daily living; it is increasingly used to treat various symptoms associated with dementia (23).

Furthermore, cognitive approaches are also employed in rehabilitation, aiming to assist individuals with Alzheimer's during the early stages of the disease (24). Cognitive training focuses on guided exercises that target specific cognitive functions, such as memory, attention, or problem-solving (25). Among the cognitive interventions effective for naming in

individuals with Alzheimer's, Cognitive Training (CT) (26) and Multidomain Cognitive Training (MCT) (27, 28) are notable. Cognitive approaches—such as cognitive training, cognitive stimulation, and cognitive rehabilitation—aimed at promoting neuroplasticity, serve as potential strategies for the prevention and treatment of cognitive and behavioral symptoms in people with Alzheimer's (27). In most cognitive approaches, naming has been utilized as a tool for assessing memory and enhancing its performance.

The instrumental approach to non-invasive brain stimulation is a technique that can modulate spontaneous cortical activity (29). Two standard methods utilized in this approach are Transcranial Magnetic Stimulation (hereafter referred to as TMS) and Transcranial Direct Current Stimulation (hereafter referred to as tDCS) (30).

Recently, tDCS has been utilized as a method to improve the cognitive/linguistic abilities of patients with Alzheimer's disease (31, 32). tDCS is a device that provides non-invasive stimulation of the cerebral cortex by delivering a direct current to the scalp, activating the cortex through the principle of neuroplasticity (33). It has been established that tDCS can enhance language abilities in patients with brain injury without serious side effects (34). In practice, tDCS applies a very weak direct current (1-3 mA) to the scalp, which can alter the resting membrane potential of neurons in the stimulated area. The device consists of two electrodes: the cathode and the anode. In most studies, the area beneath the anode is stimulated (excited), while the area beneath the cathode is inhibited (35). Several studies have demonstrated that transcranial direct current stimulation is efficacious in improving performance in individuals with dementia (34, 36).

TMS is also a non-invasive method for stimulating focal regions of the brain. During a TMS procedure, a magnetic field generator, or coil, is placed near the individual's head. The coil produces small electrical currents in the specific brain region directly beneath it through electromagnetic induction. The coil is connected to a pulse generator (stimulator) that delivers the current (37). Similarly, the stimulation can be either inhibitory or excitatory (38). Studies have also shown that transcranial magnetic stimulation in dementia reduces symptoms. One drawback of the TMS device is its high cost (39).

Upon reviewing the literature regarding the impact of linguistic, cognitive, and instrumental interventions on naming deficits resulting from Alzheimer's disease, the researchers found no scoping reviews in either Persian or other languages in this field. Therefore, the purpose of this scoping review is to compile various non-pharmacological interventions—including cognitive, linguistic, instrumental, combined instrumental-cognitive, and combined instrumental-linguistic approaches—related to naming deficits in individuals with Alzheimer's and to evaluate their level of evidence. Currently, the level of evidence is of paramount importance in the healthcare system, as the selection of a therapeutic method is typically based on its evidentiary strength. The level of evidence for a treatment indicates the types of study designs employed in scientific research to investigate that method. The highest levels of evidence for a therapeutic intervention are meta-analyses and randomized clinical trials (40).

This study aims to assist researchers and clinicians in identifying, based on the synthesized evidence and current findings, which linguistic, cognitive, and instrumental therapeutic methods have been employed to treat naming disorders in individuals with Alzheimer's, and to determine the level of evidence for these interventions.

## Materials and Methods

*Study Type and Design:* The present study is a scoping review of various research designs, including Randomized Controlled Trials (RCTs), Non-randomized Controlled Trials, Cohort studies, Case-control studies, Single-subject studies, Case reports, and Case series. The review encompasses studies published from the beginning of 2010 to the end of 2022, focusing on various linguistic, cognitive, and instrumental therapeutic methods for treating naming deficits in patients with Alzheimer's disease. The target population consists of all interventional studies involving adult human subjects with Alzheimer's who, regardless of age, gender, or ethnicity, underwent rehabilitation treatments related to naming deficits. The intervention included various rehabilitation methods at the levels of confrontational naming and discourse, implemented based on three approaches: cognitive, linguistic, and instrumental. Given that this is a scoping review rather than a meta-analysis, no comparative analysis was conducted. The primary outcome of the intervention is improved naming skills in individuals with Alzheimer's.

*Study Setting and Duration:* The present study was conducted between 2019 and 2024 (1398–1402 SH) at the Communication Disorders Research Center, School of Rehabilitation Sciences, Isfahan University of Medical Sciences.

*Data Sources:* A comprehensive search was conducted across international databases, including the

Cochrane Library, ISI Web of Science, Scopus, ProQuest, Clinical Key, PubMed, and ScienceDirect, as well as Persian databases such as SID, Magiran, IranDoc, and the Iranian Biomedical Journals database, covering the period from 2010 to the end of 2022. These platforms were selected as the most comprehensive healthcare databases based on the research questions and the specialized scope of the study's core concepts.

Initially, a search strategy was established, although it was subject to modification based on the specific requirements of each database. The database search was conducted using the following keywords:

(Alzheimer's OR "vascular dementia" OR "dementia, vascular" OR "semantic dementia" OR "primary progressive aphasia") AND (naming OR "word finding" OR "word retrieval" OR anomia OR "naming deficit" OR "naming disorder*") AND ("language therap*" OR "speech therap*" OR "naming treatment" OR "naming therap*" OR "cognitive intervention" OR "cognitive therap*" OR "cognitive training" Or "cognitive stimulation therap*" OR neurorehabilitation OR "neurological Rehabilitation" OR "transcranial magnetic stimulation" OR "transcranial direct stimulation" OR "transcranial direct current stimulation") in TITLE (alzheimer OR "vascular dementia" OR "dementia, vascular" OR "semantic dementia" OR "primary progressive aphasia") AND (naming OR "word finding" OR "word retrieval" OR anomia OR "naming deficit" OR "naming disorder*") AND ("language therap*" OR "speech therap*" OR "naming treatment" OR "naming therap*" OR "cognitive intervention" OR "cognitive therap*" OR "cognitive training" Or "cognitive stimulation therap*" OR neurorehabilitation OR "neurological rehabilitation" OR "transcranial magnetic stimulation" OR "transcranial direct stimulation" OR "transcranial direct current stimulation") in SUB/MESH

*Study Selection:* Initially, the researchers conducted the searches independently to determine the number of articles retrieved from each database. At this stage, it was required that the number of articles found by each researcher be identical; any discrepancies were investigated, and the search was repeated until consistency was achieved. Subsequently, the titles of articles from each database were screened. If a title aligned with the keywords and the study objectives, the abstract was reviewed, and, if deemed appropriate, the article was imported into EndNote. Once all databases were searched and articles were added to EndNote, duplicates were removed, and the full texts of the remaining articles were examined. The reference lists of the selected articles were also screened via cross-referencing; if an article was identified that had not been captured by the initial search strategy, the keywords were re-evaluated and updated, and the process was repeated. In cases where the full text of an article was unavailable, correspondence was initiated with the author(s) or the journal editor up to three times. To identify gray literature, specialized resources such as http://www.gateway.com/worldwide/, http://www.proquest.com/, http://www.trialscentral.com/, http://www.irct.ir, and other relevant websites were searched.

*Inclusion Criteria:* The criteria for inclusion in this study were as follows: 1) Studies published in English and Persian language journals from the beginning of 2010 to the end of 2022; 2) Studies involving adult participants with naming deficits resulting from Alzheimer's disease; 3) Studies whose titles included keywords such as dementia, treatment, naming disorders, and Alzheimer's, and whose objective—based on the abstract or full text—was the improvement of naming skills in individuals with Alzheimer's.

*Exclusion Criteria:* The exclusion criteria were as follows: 1) Lack of access to the full text of the article; 2) Articles published in languages other than English or Persian; 3) Articles that did not include interventions for naming deficits in individuals with Alzheimer’s.

*Quality Appraisal of Studies:* The researchers independently reviewed the full texts of the articles, and their content was analyzed against the research questions using a content analysis tool. Articles found to be inconsistent with the study objectives after a full-text review were excluded.

The Joanna Briggs Institute (JBI) critical appraisal checklists were used for quality assessment (41), with the checklist specific to each study design applied. For single-case studies in which a JBI checklist was unavailable, the Single-Case Experimental Design (SCED) Scale was employed (42). Based on these checklists, studies achieving a score of 50% or higher were retained. The final quality assessment was conducted through team consensus. Subsequently, the therapeutic interventions were categorized by level of evidence, with details on treatment protocols, participant characteristics, and clinical outcomes for each method. Data synthesis in this study was qualitative; following data extraction and quality appraisal, the results were synthesized and presented as a summary of findings or effects.

## Results

The study selection process is illustrated in Figure 1, based on the PRISMA flow diagram (43). In this study, the final articles were evaluated using the aforementioned checklists after applying the inclusion and exclusion criteria, and the researchers independently assessed the quality of the included papers.

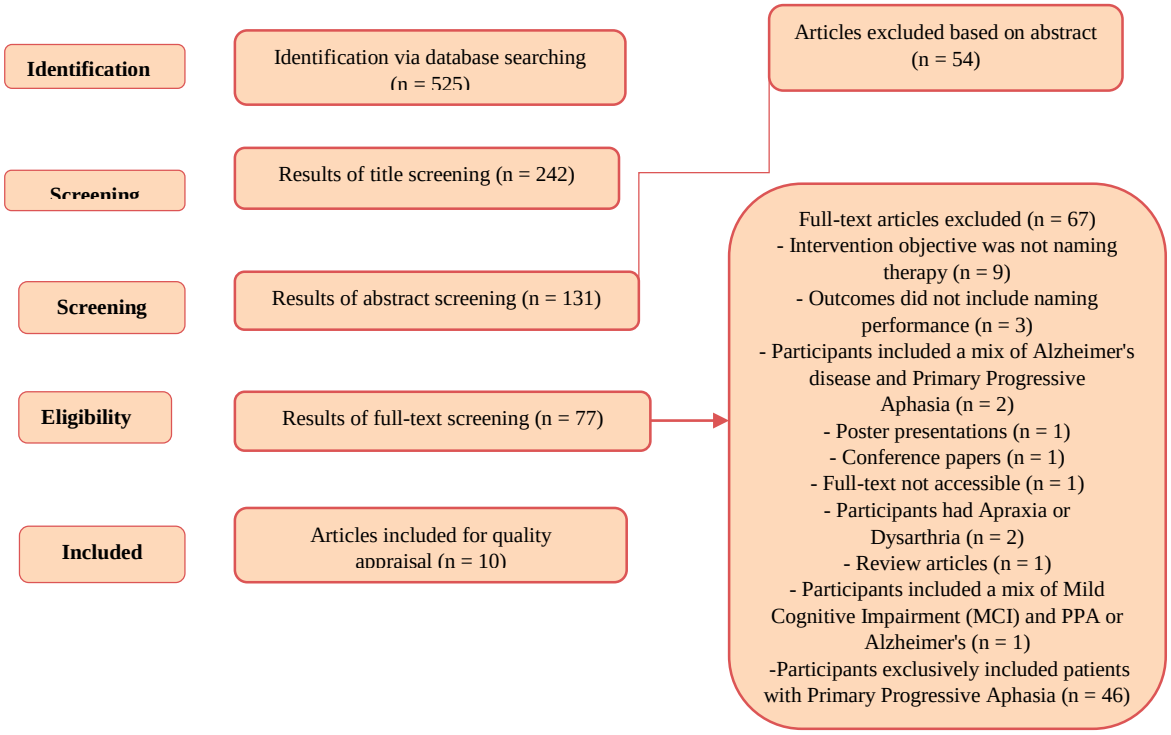


**Figure 1.** PRISMA flow diagram of the study screening and selection process

The search results in the databases are summarized in Table 1. The researchers' findings were compared after the results were announced. There was 90% agreement between the results, and any discrepancies were resolved through consultation with the senior supervisor. All identified articles were imported into EndNote software. The PubMed search was conducted using titles, MeSH terms, and Title/Abstract. Additionally, the search strategy in the Web of Science database was performed across both Title and Topic fields.

Results from the ClinicalKey database were excluded due to the complexity of its search methodology, the lack of precise search options, significant overlap with articles from Scopus, ScienceDirect, and other databases, and overly broad results. Ultimately, 525 articles were retrieved from various databases using the defined search strategy. Following the removal of 242 duplicates, 131 articles were screened by title, 77 abstracts rigorously evaluated against the inclusion criteria, and 10 studies selected after full-text review. The selection process is detailed in Figure 1, according to the PRISMA flow diagram. It should be noted that retrieved articles related to Mild Cognitive Impairment (MCI) were excluded from this study.

**Table 1.** Number of selected articles at each stage of the database search

| Database | Total initial results | Results after removing duplicates | Remaining after title screening | remaining after abstract screening | Remaining after full-text review |
|---|---|---|---|---|---|
| PubMed | 99 | 13 | 10 | 6 | 1 |
| Web of Science | 98 | 74 | 36 | 23 | 2 |
| ScienceDirect | 95 | 75 | 18 | 5 | 1 |
| Scopus | 146 | 52 | 54 | 39 | 5 |
| ProQuest | 34 | 8 | 3 | 1 | 1 |
| Cochrane | 52 | 20 | 10 | 3 | 0 |
| Magiran | 1 | 0 | 0 | 0 | 0 |
| SID | 0 | 0 | 0 | 0 | 0 |
| IranDoc | 0 | 0 | 0 | 0 | 0 |
| Total | 525 | 242 | 131 | 77 | 10 |

Ten studies were analyzed. Participants' ages ranged from 45 to 87 years, and the duration since the onset of Alzheimer's disease (AD) varied from 1 to 18 years. Studies that did not focus exclusively on naming but included naming in their assessment and results sections were also included. Conversely, articles that mentioned naming in the text but failed to report specific naming scores in the results section were excluded. Studies investigating dementia-related treatments were excluded if the target population included individuals with Mild Cognitive Impairment (MCI) or Primary Progressive Aphasia (PPA) [mixed with AD]. Furthermore, studies involving a combined cohort of AD and PPA patients were excluded. Additionally, articles reporting participants with comorbid disorders, such as dysarthria or apraxia, were excluded.

It should be noted that the full text of only one retrieved article was inaccessible; the corresponding author was contacted to obtain it. The summaries of the studies selected for inclusion after the full-text review are presented below.

Determining the Level of Evidence and Types of Therapeutic Approaches Used in the Treatment of Naming Deficits in Patients with Alzheimer's Disease.

Ten studies investigated therapeutic interventions for naming deficits in Alzheimer's disease. Of these, four studies focused on linguistic interventions (Table 2), two on instrumental treatments (Table 3), and four on cognitive therapeutic approaches (Table 4). No studies were identified regarding combined therapeutic modalities in this area.

### A) Language Interventions

As shown in Table 2, one study investigated the efficacy of Lexical-Semantic Stimulation (LSS) therapy compared to unstructured cognitive stimulation; one study compared the effects of Errorless Learning (EL) and Errorful Learning (EF); another study examined the effectiveness of Semantic Feature Analysis (SFA) training; and one study evaluated a training program designed to stimulate language functions. Regarding the level of evidence, two studies were clinical trials. One study included 40 participants and had follow-up periods ranging from 3 to 9 months (48). The other study involved 88 participants with follow-up assessments at 1, 3, 6, 9, and 12 months (47). Additionally, two studies were case reports; one involved 8 participants with follow-up assessments at 1 and 5 weeks post-treatment, while the other was conducted on 3 subjects with a 6-week post-treatment follow-up (45, 46)

### B) Instrumental Interventions

As illustrated in Table 3, one study investigated the efficacy of tDCS on cognitive and linguistic performance in individuals with Alzheimer's disease. In this research, the anode electrode was positioned over the left dorsolateral prefrontal cortex (DLPFC). Another study examined the effectiveness of cathodal tDCS over the dorsolateral prefrontal cortex. Regarding the level of evidence, one study was a randomized controlled clinical trial (RCT) involving 18 participants with a 6-month follow-up period (48). The other study was a clinical trial that applied cathodal tDCS over the dorsolateral prefrontal cortex, combined with a phonological fluency task; it involved 40 subjects and did not include a follow-up period (30).

### C) Cognitive Interventions

As illustrated in Table 4, among the four studies examining the impact of cognitive methods on naming in individuals, one investigated the effect of combining cognitive training and cognitive rehabilitation strategies on naming ability.

**Table 2.** Summary of included studies on the impact of linguistic interventions on naming deficits in individuals with Alzheimer's disease

| Author(s) | Study Type | Intervention/Comparison | Outcomes/Results |
|---|---|---|---|
| Jelcic et al., (44) | Observer-blinded randomized Controlled | Lexical-Semantic Stimulation (LSS) therapy versus Unstructured Cognitive Stimulation (UCS) therapy | Superior efficacy of LSS in naming improvement |
| Noonan et al., (45) | Case series | Errorless Learning (EL) versus Errorful Learning (EF) | - Both treatments showed efficacy in naming improvement.<br>- No selective advantage was found for EL over EF learning. |
| Flanagan et al., (46) | case series using a single-subject experimental design | Semantic Feature Analysis (SFA) Training | Efficacy of SFA in treating anomia associated with AD |
| Potemkowski et al., (47) | Quasi experimental | Language Function Stimulation Program using Lexical and Semantic Prompts | A language stimulation program for mild-to-moderate AD helps maintain global cognition and enhances language skills, specifically naming. |

**Table 3.** Summary of included studies on the effects of instrumental interventions on naming deficits in individuals with Alzheimer's Disease

| Author(s) | Study Type | Intervention/Comparison | Outcomes/Results |
|---|---|---|---|
| J. Jamie Im et al., (48) | RCT | tDCS | Left DLPFC anodal tDCS enhances naming performance. |
| Smirni et al., (30) | CT | Cathodal tDCS over the DLPFC during a Verbal Fluency Task | tDCS over the DLPFC can improve performance on a verbal fluency task in patients with AD. |

Another study focused on cognitive training/ cognitive stimulation, one examined multidomain cognitive training, and one investigated cognitive training alone. Regarding the level of evidence, three studies were clinical trials, and one was a case study. One of these studies included 55 participants and a 1-year post-treatment follow-up (49). Another study involved 50 subjects with no follow-up (27), and the subsequent study involved 140 subjects with a 6-month post-treatment follow-up (26). The case study was conducted on a single individual with a long-term follow-up (11 months and 5 years) (50).

## Discussion

The present scoping review was conducted to investigate naming therapy methods for naming deficits in patients with Alzheimer's disease; accordingly, 10 studies were ultimately selected for full-text analysis. These studies yielded varying results, leading to the classification of therapeutic methods into four categories: linguistic approaches, instrumental therapies, cognitive therapies, and combined interventions.

In linguistic therapeutic approaches, most studies involved patients attending a clinic where the therapist delivered the intervention directly. In contrast, some studies focused on home-based therapy, with the therapist providing treatment via computers or tablets. Cognitive therapies primarily focused on cognitive skills, utilizing naming both as a facet of memory and as an assessment metric. Furthermore, combined interventions were implemented by integrating instrumental and linguistic therapies.

### Therapeutic methods (cognitive, linguistic, and instrumental) and levels of evidence in the treatment of naming disorders in patients with Alzheimer's disease

Overall, 10 studies were reviewed. The limited number of studies collected regarding the treatment of individuals with Alzheimer's Disease (AD) is due to the primarily cognitive nature of the pathology. In this review, four studies were identified for linguistic therapy, two for instrumental therapy, and four for cognitive therapy. However, no studies were found regarding combined interventions.

Alzheimer's disease is a progressive cognitive disorder that affects an individual's cognitive and linguistic skills, significantly compromising communication abilities (51).

**Table 4.** Summary of included studies on the effects of cognitive interventions on naming deficits in individuals with Alzheimer's Disease

| Author(s) | Study Type | Intervention/Comparison | Outcomes/Results |
|---|---|---|---|
| Tsantali et al., (50) | Case study | A combination of cognitive training and cognitive rehabilitation strategies | Long-term cognitive programs reverse mAD symptoms, appear to maintain patient independence, and hold the potential to delay institutionalization. |
| Tsantali et al., (49) | RCT | Cognitive Training/Cognitive Stimulation | Naming ability was improved through semantic memory training using deep information processing techniques, rehearsal, and errorless learning. |
| Nousia A et al., 2018 (27) | RCT | Multidomain Cognitive Training (MCT) | Comparison between the training and control groups demonstrated that MCT has a significant beneficial effect on delayed memory, naming, semantic fluency, visuospatial ability, executive functions, attention, and processing speed. |
| Trebbastoni, A. et al., (26) | RCT | Cognitive Training | During treatment, patients performed better than the untreated control group; however, after treatment discontinuation, some skills—including naming—declined over time. Therefore, intervention for patients with Alzheimer's Disease must be long-term and continuous. |

It is widely believed that memory impairment is the primary factor underlying the difficulties these individuals face (52). In recent decades, in addition to pharmacological treatments, non-pharmacological interventions have gained attention in managing this disorder. Although scientific evidence suggests that language and communication interventions may benefit individuals with Alzheimer's, limited research has been conducted in this area (53). The findings of the present study further emphasize this point. In the following sections, the identified studies are presented separately, categorized by the treatment method for each disorder.

The evaluation of the evidence level for each category of Alzheimer's treatment methods was conducted according to the Greenhalgh Evidence Pyramid (Figure 2) (54). In terms of evidence hierarchy, the studies are ranked as follows: randomized clinical trials, cohort studies, case-control studies, single-subject designs, and finally, case reports and case series.

## Linguistic Treatments, Levels of Evidence, and Their Efficacy on Naming in Individuals with Alzheimer's Disease

Among the four linguistic studies identified, two focused on lexical-semantic stimulation therapy. In one of these studies, lexical-semantic stimulation was compared with unstructured cognitive stimulation. In this study, naming performance and cognitive skills were evaluated as primary outcomes, while cognitive functions such as memory and attention were assessed as secondary outcomes. The results indicated that lexical-semantic stimulation was more effective for improving naming than the alternative method (44). Another study provided a training program designed to stimulate language functions through lexical-semantic stimulation and reported similar findings. Furthermore, treatment outcomes were maintained over time. Given that the hallmark deficit in Alzheimer's primarily involves difficulties in accessing lexical-semantic information, lexical-semantic stimulation therapy encompasses rehabilitation exercises aimed at enhancing verbal-semantic processing (45).

One study investigated errorless learning therapy (through reading and repetition) compared to errorful learning therapy (using phonological/orthographic cues) in eight individuals with Alzheimer's. The findings showed that both treatments were effective in improving naming skills, with neither demonstrating a specific advantage over the other (46). Errorless learning eliminates the likelihood of errors during intervention and is grounded in the established principles of learning and memory (55).

Another study focused on Semantic Feature Analysis (SFA). The results of this study, conducted on two individuals with Alzheimer's, revealed that training semantic features is effective for treating naming deficits in this population. Both participants demonstrated post-treatment improvements in naming, and one participant maintained the treatment effects at a 6-week follow-up.

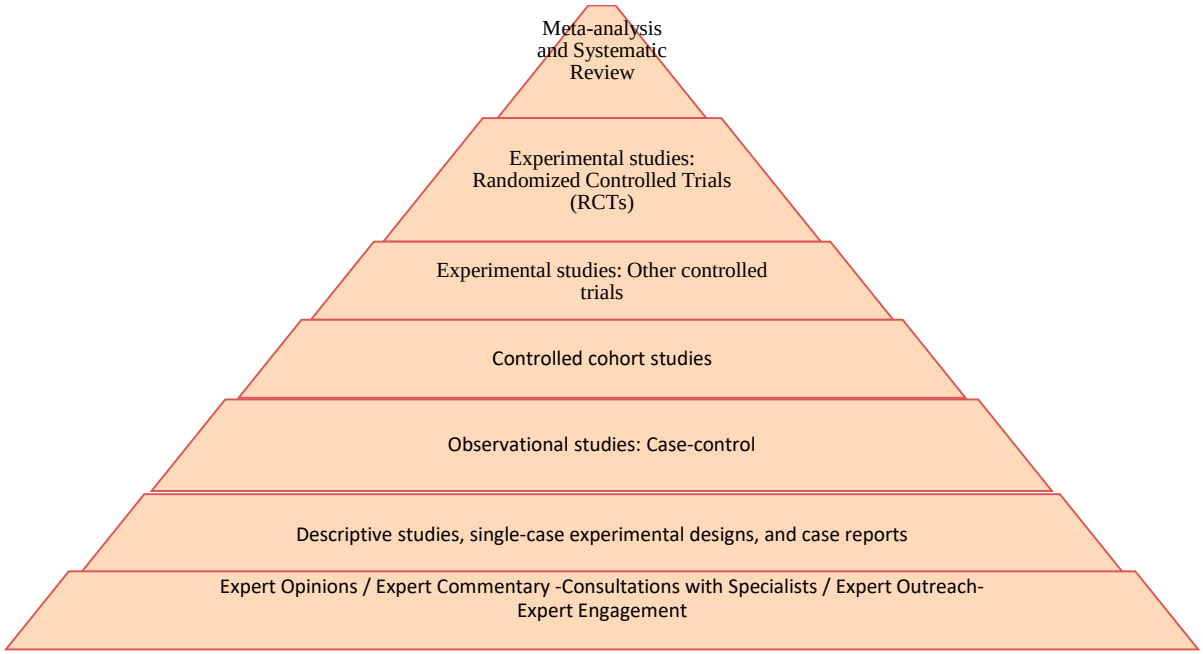


**Figure 2.** Greenhalgh's Hierarchy of Evidence Classification (54)

Since the loss of semantic features worsens as the disease progresses, this treatment focuses on retraining and acquiring these features (47). As the results indicate, the majority of linguistic intervention studies for individuals with Alzheimer's have employed semantic stimulation, with a primary focus on semantic features.

As previously mentioned, four studies were identified in this field. Although the number of studies is limited, they provide strong evidence.

Jelcic et al. (2012) conducted a single-masked randomized controlled trial involving 40 participants that compared lexical-semantic stimulation therapy with unstructured cognitive stimulation. The results demonstrated that linguistic lexical-semantic stimulation was more effective than cognitive therapy for improving naming abilities. During the follow-up assessment (3 to 9 months post-intervention), the results further indicated that lexical-semantic stimulation led to a significant improvement in the mean scores of primary outcomes, including naming. Among the secondary outcome measures, only working memory and the speed of an executive function task (Stroop Test) showed improvement following lexical-semantic stimulation. In contrast, the unstructured cognitive stimulation intervention did not improve any cognitive domain. Six months after discontinuation of treatment, the mean Mini-Mental State Examination (MMSE) score remained significantly higher than baseline (44).

Furthermore, Potemkowski et al. (2017) conducted a quasi-experimental study involving 88 patients with various follow-up periods (1, 3, 6, 9, and 12 months) to evaluate the efficacy of lexical-semantic stimulation therapy. The results of this study demonstrated that implementing a training program designed to stimulate linguistic functions in patients with mild to moderate Alzheimer 's-type dementia helps maintain general cognitive functions and improves language skills, specifically naming. The findings also indicated a positive correlation between patient motivation and program efficacy. While skills were maintained during follow-up, the intervention group experienced fewer difficulties than the control group, yet performance declined over time. These results suggest that linguistic therapy facilitates the improvement of language deficits in individuals with Alzheimer's. Consequently, lexical-semantic stimulation is a treatment supported by substantial evidence, and clinicians can use this approach with patients with Alzheimer's disease (45).

A single-case study involving three individuals with Alzheimer's was conducted by Flanagan et al. (2016). Participants were evaluated 6 weeks after the intervention ended. The results indicated that Semantic Feature Analysis (SFA) is effective for treating anomia in Alzheimer's disease; both participants exhibited post-treatment improvements in naming, and one sustained the therapeutic effects at the 6-week follow-up (47). However, the small sample size and relatively short follow-up period limit the generalizability of these findings.

On the other hand, a case series study was conducted to compare errorless learning (EL) with errorful learning (EF) in eight individuals with Alzheimer's disease. The findings by Noonan et al. (2012) indicated that both interventions were effective in improving naming. There was no evidence of a selective advantage of errorless learning over errorful learning; however, when deciding whether to provide errorless or errorful relearning interventions, both the severity of the disease and the potential to maintain treatment effects in a post-clinical home environment are crucial factors (46). This study did not provide a demographic table for participants, and, given the short follow-up period, the evidence for this type of treatment remains weak, necessitating further research.

**Instrumental Therapies in Individuals with Alzheimer's Disease and Their Efficacy on Naming**

Regarding instrumental therapies, two tDCS studies were identified. In one study, the anode (excitatory) electrode was placed over the left dorsolateral prefrontal cortex (DLPFC), while the cathode (inhibitory) electrode was positioned over the right DLPFC. This treatment was administered daily and continuously for 6 months. The research findings indicated that tDCS with this excitatory protocol is efficacious in improving cognitive and linguistic functions, including naming, in individuals with Alzheimer's disease (48). In another study, the impact of tDCS on verbal fluency tasks was examined. In this study, the cathodal electrode was alternately placed over the left and right DLPFC. The results demonstrated that cathodal tDCS over the right DLPFC significantly improves phonological fluency in individuals with mild Alzheimer's. This study utilized an inhibitory protocol and successfully inhibited the right dorsolateral prefrontal cortex (30).

Two studies with high levels of evidence were also identified. A randomized controlled clinical trial was conducted by Jamie Im et al. (2019) involving 18 individuals with Alzheimer's disease. In this study, anodal tDCS was applied over the left dorsolateral prefrontal cortex (DLPFC). The follow-up period lasted 6 months, and the results demonstrated that anodal tDCS over the left DLPFC enhanced naming performance (Boston Naming Test scores increased in the active tDCS group compared to the sham group)

(48). However, this study has certain limitations, as the results may have been influenced by potential concurrent medication use. Further research in this area is warranted.

A quasi-experimental study was also conducted in 2021 by Smirni et al. involving 40 individuals with Alzheimer's disease. In this study, the cathode was placed over both the left and right dorsolateral prefrontal cortex (DLPFC) to inhibit these regions. They employed a verbal fluency task (VFT) concurrently with the stimulation. The results demonstrated that inhibiting the right DLPFC improved performance on verbal fluency tasks in patients with mild Alzheimer's. Conversely, no significant difference was observed before and after treatment when inhibiting the left DLPFC during the aforementioned task (30). The findings of this study have limited generalizability due to its small sample size and lack of a follow-up period; therefore, more robust, extensive studies are required in this field.

## Cognitive Therapies in Individuals with Alzheimer's Disease and Their Efficacy on Naming

Four studies were identified regarding cognitive therapy, utilizing cognitive training and cognitive rehabilitation approaches. These studies examined naming as a facet of memory, and the results demonstrated that these interventions improved naming performance (26, 27, 49, 50). The primary objective of cognitive training is to maintain or enhance specific aspects of cognitive functioning (such as memory or attention) through structured, guided exercises that can be administered individually or in group settings (56).

Of the four studies on the impact of cognitive therapeutic methods on naming among individuals with Alzheimer's, the levels of evidence range from three randomized controlled clinical trials to one case study.

Tsantali et al. (2017) conducted a randomized controlled clinical trial involving 55 individuals with Alzheimer's disease, featuring a one-year follow-up period. This study investigated the efficacy of cognitive training and cognitive stimulation on semantic memory, naming, and retrieval abilities. The results indicated that naming ability improved through semantic memory training using deep information-processing techniques, rehearsal, and errorless learning. Furthermore, the capacity for relearning and accessing faded information was enhanced. Improvements were also observed in related abilities not directly targeted by the cognitive training program (such as prospective memory and person-naming). This finding suggests that proficient performance in delayed memory tasks correlates with better prospective memory, as the latter is considered a form of delayed memory for the future. Participants in the cognitive training group exhibited significant improvement in general cognitive status, with moderate gains in the targeted memory domains (semantic memory, naming, and retrieval) 12 months post-baseline compared to the other two conditions. Additionally, cognitive training appeared to generalize to other non-targeted cognitive abilities, showing slight gains in domains such as prospective memory, face recognition, and person-naming, relative to cognitive stimulation therapy. While participants in both training and stimulation conditions eventually exhibited significant general cognitive decline, cognitive training was shown to ameliorate the trajectory of this decline (49).

Another randomized clinical trial was conducted by Nousia et al. (2018) involving 50 individuals with Alzheimer's disease, which investigated the impact of multidomain cognitive training on cognitive skills and naming. Comparison between the training and control groups revealed that multidomain cognitive training significantly improves delayed memory, naming, semantic fluency, visuospatial ability, executive functions, attention, and processing speed (27). However, this study is limited by a short follow-up period and by inadequate control of confounding factors. Consequently, further research with longitudinal follow-up periods is warranted in this field.

A single-blind study conducted by Trebbastoni et al. (2018) involving 140 participants aimed to investigate the effects of cognitive training supported by oral and written confrontation naming, error correction, and repetition. The results indicated that patients performed better during the treatment period than the untreated control group; however, after treatment ended, specific skills, including naming, declined. This suggests that intervention in Alzheimer's patients must be long-term and continuous. Notably, this study utilized a six-month follow-up period, which is considered relatively robust (26).

Another study was conducted by Tsantali et al. in 2014. This study involved a single participant (case study) and featured follow-up periods of 11 months and 5 years, utilizing a combination of cognitive training and cognitive rehabilitation strategies. The results from the first follow-up (11 months later) showed significant improvements in memory, categorical verbal fluency, comprehension, and written narrative ability, even in non-trained functions (behavioral and functional abilities). Results from the second follow-up (5 years later) indicated that improvements in delayed memory tasks, language, and overall cognitive status were sustained (50). While the

two-stage, long-term follow-up is a notable strength of this study, the generalizability of the findings is limited due to the small sample size and the level of evidence. Overall, the collective studies in this field provide strong evidence that cognitive therapies focused on linguistic skills are effective in improving language abilities in individuals with Alzheimer's disease.

## Limitations

Considerable time was devoted to developing the search string; various iterations were tested across multiple databases to determine the most effective configuration ultimately. Another limitation of this study was the COVID-19 pandemic, which coincided with the research process. This situation led to the postponement of in-person meetings with the research team until the epidemic was brought under control. Additionally, intermittent internet connectivity and poor access were further constraints encountered during the study.

## Recommendations

The primary recommendation derived from this study is that researchers use high-quality research designs, particularly randomized controlled trials (RCTs), to compare the efficacy of linguistic therapies versus cognitive therapies for naming abilities in individuals with Alzheimer's disease. Furthermore, the authors suggest that future research investigate the impact of integrating linguistic and instrumental treatments on naming performance within this population.

## Conclusion

The results of this study indicate a growing emphasis on non-pharmacological interventions for Alzheimer's disease. However, the number of studies in this field remains limited, making it difficult to assert with certainty that naming therapy can definitively reduce or postpone the symptoms of Alzheimer's. Although the existing studies—despite their limited number—provide strong evidence regarding linguistic, cognitive, and instrumental therapies, several limitations persist. These include short follow-up periods, a lack of intervention-outcome assessments at varying time points, and unequal sample sizes between the intervention and control groups. Consequently, more extensive and longitudinal investigations are essential to generalize these results to the target population.

Regarding linguistic therapeutic approaches, lexical-semantic stimulation therapy—focusing on semantic features—has strong evidence supporting its effectiveness in improving naming performance. Due to its robust evidence base, this method serves as a viable option for Speech-Language Pathologists (SLPs) treating individuals with mild to moderate Alzheimer's.

Studies on instrumental treatments, though few, also provide strong evidence, suggesting that this approach could support naming therapy. Nevertheless, further research with larger sample sizes and more extended follow-up periods is required.

Similarly, while the number of studies on cognitive therapy in Alzheimer's is small, the level of evidence is high. This intervention, by focusing on cognitive and linguistic skills, enhances both general cognitive functions and naming abilities. However, the implementation of cognitive therapy by Speech-Language Pathologists remains a subject of debate, and definitive conclusions cannot yet be drawn.

Furthermore, no studies were identified concerning combined treatment modalities for individuals with Alzheimer's. Given the positive outcomes of linguistic, instrumental, and cognitive therapies when applied independently, a combination of these methods might yield superior results.

Regarding regulatory approval, two major global bodies—the U.S. Food and Drug Administration (FDA) and the European Medicines Agency (EMA)—oversee the validation of treatment methods. Currently, neither has approved the use of transcranial Direct Current Stimulation (tDCS) for the clinical treatment of Alzheimer's, restricting its use to research purposes only (57). Despite the strong evidence supporting this tool, it is advisable to exclude it from standard treatment protocols for early-stage Alzheimer's until international scientific assemblies recognize it as a conventional therapy.

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## Conflict of Interest

The authors did not have a conflict of interest.

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