Analysis of Language Sensitivity in Alzheimer's Disease Based on Emotional Variables

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ABSTRACT

Patients with Alzheimer's disease are unable to say a word. Patients impaired in a language do not mean that patients lose their ability of auditory sense and language logical processing ability. The experiment set out from a phonetic to a word and then a sentence, the syllables can change the emotional environment by the resonance of the emotional environment as they are learning. 3,000 patients (N=3000) from mainland China, whose MMSE (Mini-mental State Examination) scores ranged from 10-27, were divided into six experimental groups (age range: 62-78). The patients were divided into two parts (each part, n=1500) consisting of three experimental groups in each part (each group, n=500) in terms of phonetics and semantics. Each experimental group recorded the times of their uttered "a~," "e~," "i~," "o~", etc., and marked their discharge zone in the brain using EPR (event-related potential). After the training, the researchers check their emotions using fMRI (functional magnetic resonance imaging). The researchers analysed the patients' emotions using fMRI data. The patients learned Chinese Mandarin and English in two parts. The first part would follow the "phoneme-word-sentence" training mode and the second part would follow the "semantic-sentence-text" training mode. The researchers changed the order of the modes in the next period. The data from the experiment showed that the patients tended to respond to the phonemes and that they could understand sentences well when they were broken down into semantemes. The patients would be impatient with the texts and long sentences. In the experimental processing, the emotion variables should be in a bad direction. Some patients were aggressive and even cry. The result indicates that Alzheimer's patients are sensitive to the simple linguistic unit and have a stable psychological state. When they are confronted with complex linguistic structures, they will experience negative emotions and be on guard to learn them.

Keywords: Linguistics, Language sensitivity, Emotion, Alzheimer's disease, Bilingual training.

1. INTRODUCTION

Alzheimer's disease affects language and pattern recognition. In the late stages, patients cannot recognise themselves in a room, but according to the experiment [1] they are not sensory impaired. Alzheimer's disease is characterised by the logopaedic variant of primary progressive aphasia (PPA) (Varma et al., 1999; Forman et al., 2006; Alladi et al., 2013) [2].

The first study on aphasia and language impairment is provided by Karbe 1993, the Profile of Aphasia and Primary Progressive Language Impairment. The result of the experiment connects the primary progressive aphasia with the neurological theory and confirms that the language impairment is caused by different areas of brain degeneration. Using CT, MRI, etc., the report shows us the size of the brain in Alzheimer's disease. The result suggests that language is related to several areas of the brain. (1993, Hans, etc., profiles) [3] In recent years, bilingual training based on different languages has been focused on by scientists. PPA (Primary Progressive Aphasia) becomes a typical clinical example of aphasia in Alzheimer's disease, which is attributed to its pathology in different brain areas dominated by processing logic and recognition. (2020, Brendan, et, al) At this stage, researchers take advantage of the neurons that are still functioning. What's more, there is a big difference between patients who uttered a word and those who uttered a sentence.

English-speaking people can say a word in one syllable or phonetically. But when they say two or more syllables, the relevant areas of the brain aren't activated. According to the latest study, negative emotions caused Aβ protein levels above normal numerical norms. (2018, Chiara). So how can we take both emotional variables and the effects of language training into account? Researchers should find a balance between training and emotion.

2. MATERIALS AND METHODS

2.1 Participants

The researchers selected 3,000 non-bilingual patients, aged 62 to 78, with mild or moderate dementia, characterised by intermittent memory loss. The patients were assessed using the MMSE. The symptoms of these patients have the same characteristics. Some of them express themselves word by word (the rate is 28%) and the worst of them were only able to say "i~", "a~", "u~", "o~", etc. In order to control the variables, the patients are examined by CT (computerised tomography), MRI (magnetic resonance imaging) and some biochemical tests of the brain to rule out other dementias. The relatives of the participants refused to crack their heads, and none of them showed the trauma on their skulls, none of them showed abnormal shapes on their heads. All the participants had different degrees of primary progressive aphasia (PPA), which manifested itself in speech impairment, stuttering and loss of literacy.

2.2 Methods of Research

Researchers determined two parts of the trial period. The researchers divided 3,000 patients into six experimental groups. The researchers trained the first group to learn pronunciations in the alphabet and phonemes in IPA (International Phonetic Alphabet), the second group to learn pronunciations of words from less than two syllables to more than two syllables, and the third group to learn to speak a complete sentence from a simple sentence to a compound sentence. These groups used the phoneme-word-sentence training mode. As a control group, the researchers chose the "semantic-sentence-text" training mode. The first semantic group arranged to learn the semanteme of a word that was uttered and written by the researchers, and the second learned a complete sentence that was expressed in at least one sense group by writing it on the paper, showing the paper to the participants, and reading it to the researchers.

The third showed the text to the participants using the same operations as the second, but the text was made up of more sense groups and two more sentences. The researchers recorded the participants' learning status using EPR (event-related potential) (N400-P300-N400-P300, 500ms) to confirm that the participants were in learning status. After training, the researchers sent the participants to fMRI to analyse their emotional state. According to the emotional dimension, the researchers can analyse whether the participants are in a pleasant, high arousal dimension. Combined with the results of the MRI and EPR, the researchers can draw a universal and objective conclusion. In order to avoid the randomness of the experiment, the participants were selected from China with a low level of education and no experience of learning a second language. The dialogue is set up to test their training, which aims to evaluate their reaction to the long sentence dialogue. The experiment divided their responses into three levels. The first is the utterance of a single phoneme such as "a, o, i". The second uttered a word such as "ni hao" in Chinese or "hello" in English. The third is to babble a sentence such as "wo ming zi" in Chinese or "me / my name" in English. Even though these were not complete sentences, they were constructing a primary language structure. To make sure the participants were not in a bad mood, the researchers monitored their mood changes using fMRI and EPR. If the machine shows they are in an anxious mood, the researchers will stop the experiment and do the relaxation training and record the study details and states. The researchers will reduce the training if the participants show negative emotions.

2.3 Clinical Definitions

Linguistic training effects are demonstrated by the neurologist and clinician (C.Z., E.S., S.T.), but bilingual training effects are a vacuum for language therapy. There should be more evidence. Approaches to delay the progression of the disease are medical. Clearly, drug therapy is a negative and limited approach to patients. In the primary phase, non-pharmacological treatment is the best way to intervene in the course of the disease. So far, hardly anyone has systematically presented bilingual education. Discourse of AD (Alzheimer's disease) patients focused by a Taiwanese, essay compared healthy normal seniors and AD seniors. Alzheimer's patients can be recognised by the researchers, and the main differences between Alzheimer's patients and healthy seniors are the fluency of their speech,

Innovation Humanities and Social Sciences Research, Volume 3, ISSN 2949-1282

Proceedings of The 9th International Conference on Education, Language, Art and Inter-cultural Communication (ICELAIC 2022-2)

http://journals.isccac.org/journals/ihssr

pronunciation and ability to process long words. The PLI (Primary Language Impairment) also appears by stuttering and babbling a word or a sentence. Because of the damage to the brain's language processing nerve, Alzheimer's can only be postponed and not cured. The variety of emotions is an essential factor for Alzheimer's patients interested in linguistic research. In the research on centenarians, one researcher (W. B., China) demonstrated that in the non-pathological degeneration brain, negative emotions take up a large proportion of time.

2.4 Discourse Between Patients and Researchers

72% of patients can communicate in the researchers' guide, but many of them stammer in the middle of a sentence. Some words spoken by patients cannot form a sentence or make grammatical mistakes. The discourse between researchers and patients use a simple method and infer the meaning of the half-sentence or fragmentary words. 28% of the patients have MLI (Middle Language Impairment) and all of them can only say one word or even some phonemes. The researchers record the phonemes and the words to speculate on the direction of the vocabulary. Amnesia in Alzheimer's disease is always considered from the most recent to the most recent. In the "Text" and "Sentence" groups (N=1,000), a rhyme for the child is used to evoke resonance in the patients. Language impairment can be progressive or discontinuous. When confronted with patients with discontinuous amnesia, researchers insert memories or evoke recollection through language guidance. This is one of our objectives.

2.5 Bilingual Lexical Training Both in Chinese and English

The lexical training (N=1000) gives priority to the noun that appeared frequently in the patients' vision. Concrete words that can be caught, touched, smelled and tasted and processed into sense by the brain can be easy to approach to memorise in the brain. Verb on the direct sense formed basic language structure in the brain can instruct dynamic awareness formation and affect his behaviours. Lexical training based on concrete words such as possessive pronoun "wo" (我), "ni" (你), "ta" (他)"na" (拿), which 28% of MLI patients were subjected to train, can activate the interest in language. Lexical training based on abstract words

and phrases can be used for 72% of patients with mild cognitive impairment to delay the progression of Alzheimer's disease. In the elementary stage of Alzheimer's disease, patients tend to be accompanied by primary mild cognition. The first task of a speech therapist is to build up basic linguistic logic. Patients who attended a second foreign language changed their training mode. Adapting to target words written on paper and uttering the sounds of words, this experimental method can be used for all groups of lexical training of English training and nobody can be peculiar to this method.

2.6 Control Variables on Emotion

Emotional training is effective, while the minds of the elderly tend to ignore health and focus on health itself. In China, people pay more attention to physical health and ignore mental health. Alzheimer's patients are characterised by casual attention, accumulation of negative emotions, barrier in communication and bad mood. All the negative emotions made seniors have poor appetite, lost temper, insomnia and symptoms, leading to a vicious circle of emotions. Mental health contributed to 38% of senior death rate in China. Mental health is a killer directly or indirectly led to senior death (W.Z.,2012) Alzheimer's patients are unable to recognise their emotions. Researchers record their status on study based on EPR by an electronic signal. The abnormal state is monitored by the machine when they are in the wrong signals. The criterion is N400-P300-N400-P300.500ms. The duration of the training is usually determined by the patient's status and ranges from 30 minutes to 1 hour. When the negative emotion appeared, the researchers stopped the experiment and did relaxation training, including listening to music or nature sounds and playing games. fMRI wasf used to record the emotional status after a period of training. The test is administered about once every 30 minutes. Patients with Alzheimer's disease tend to express their emotions in an uninhibited way, getting excited quickly but calming down slowly. When male patients showed aggressive behaviour and female patients cried or screamed, this indicated that the researchers should stop the experiment and do relaxation training. Apart from annoyance, the other two emotional states were more likely to occur in a clinical experiment. These were fear and anxiety. Intermediate stages of Alzheimer's disease are complex and synthetic. Patients are accompanied by agraphia, alexia, agnosia and severe amnesia.

The patient is frightened to confront the strange but familiar environment. Patients were to stay in a quiet and familiar room and nature sounds were to be played to put patients in a calm mood. All in all, when negative emotions appeared, the researchers stopped the experiment and did the relaxation training.

2.7 Two Parts for the Experiment to Prevent the Occasionality

The experiment was adapted to be divided into two parts, and each part was run by different researchers in different periods and training in a different language. The solution to accidental incidents is planned including avoiding environmental disturbance, educated level and inherent medical history to be considered. Bringing the trainees to a quiet place surrounded by relaxing music was a prerequisite for learning. The room is equipped with some simple devices. The educational level ensured them under the senior high school. According to the survey, patients stayed in the countryside with no second language study experience. The relatives deny the inherent medical history, and the patients have done the test related to the gene. Brain volume ranging from $1m^3$ to $1.25m^3$ was checked by CT. English as a second language is a little difficult to train. Therefore, the researchers selected some basic words and included them in the corpus. According to the patients' reactions, it is decided whether they would be included in the corpus. Six groups formed one part and one part is divided into two categories. One follows the "semantic-sentence-text" training mode. The other follows the 'phoneme-word-sentence' training mode. The reason for the division into categories is to explore which is the best training mode between the auditory sense and the visual sense.

2.8 Methods for Collecting Data

Two training catalogues had different calculation methods. Phonetic training should assess whether patients can pronounce correctly and fluently. Some patients should be tested whether they can speak independently. Semantic training should test whether patients understand the meanings. Some patients should infer meanings after reading. For phonetic training, researchers take a training corpus to show them and ask patients to utter the phonemes or Pinyin or words or sentences before training. If they are uttered correctly and fluently, the researchers mark them as two points. If they are uttered correctly but not fluently, the researchers will give them one point. A total of fifty items are used for testing, and the points are calculated as a criterion for judging the patients' language ability. After the training, the researchers change the items to test the effect of the training. The form of the test is the same as the first test. Before and after the training, the researchers conduct a dialogue with the patients to check the language logic, but this wouldn't be used for 28% of the MLI (Middle Language Impairment) patients. Fifty items are included in the examination about the basic details of the training. 1 item is an additional test in the form of a dialogue to check the language ability of 72% of the PLI patients. The dialogue is computed in an independent item. The examination mode is also used for semantic training. Twenty items are the words cut out from a complete sentence and ordered by grammatical meaning. Twenty items are sentences cut out of a text. Ten items are the texts cut out of an article. A total of fifty items are used to test the patient's comprehension skills. Two points are given if the patient can infer the text. One point is awarded if the patient can only repeat the text.

Abnormal behaviour and EPR show the state of the patient's mood. If the EPR shows abnormal electrical activity, the researchers stop the study and play games with the patient. Most abnormal moods result from boring training. The researchers record the details of the training as it happens. Researchers arrive at a universal and objective result by analysing the emotional variables. Researchers label the words that patients hate.

2.9 Conclusion on Language Sensitivity and Emotion

Researchers collect data on training scores to compare with pre-training scores. Finally, the researchers test language skills through dialogue. The dialogue is recorded and some words are asked to the patients. The dialogue is scored according to the criteria of fluency, integrity, pronunciation and logic. Fluency includes speed of speech and consistency; integrity includes complete meaning, complete sentence and complete emotional expression in a sentence; pronunciation includes enunciation, correct word pronunciation and integrity of word pronunciation; logic includes correct answer to a question, no contradiction of statements and no long modal particle. The researchers follow the criterion and give the score of the dialogue. An emotional evaluation is carried

out during a training period to assess the details of the training and whether it is acceptable to the patients. Negative emotions that appear after training are important for us to change the training details and to teach some complex language structures to the patients.

2.10 Statistical Analyses

Before training, the Language Ability Test (LAT) is used to assess the patient's language impairment. After training, the LAT is used to assess the bilingual training effect. Functional Magnetic Resonance Imaging (FMRI) collects language tests for emotion. Negative emotion status data is recorded by fMRI and selected training data in a negative mood. Calculate K2 to test for process independence.

3. RESULTS

3.1 Participants

The average pre-training language ability test is shown in "Table 1". Participants had primary language impairment and MMSE scores ranged from 10 to 27. People with language impairments ranged from 62 to 78. After training, the participants' language skills improved to varying degrees. Lexical training in Mandarin showed the best effect, and phonetic training of words accepted by patients can be much easier. Participants' improvement is concentrated on lexical cognition and speaking ability, but there is some growth in reading ability and comprehensive ability. Participants fluctuated on the MMSE after training. Some of them jumped up on the MMSE (N=1265), but some of them only showed a small increase (N=1641). A small number of people appeared to decrease on the MMSE (N= 94). Emotional status is monitored with fMRI. If the number of participants is 80%, the researchers assume that this group is in a negative mood. The result of this number is 2820 (percentage: 94%). A small proportion of the participants are in a manic state and some remained calm.

Table 1. Language ability test in average before training

	Group1	Group2	Group3	Group4	Group5	Group6
Number	500	500	500	500	500	500
MMSE (average)	23.2	22.7	23.8	24.2	20.2	23.5
Lexical cognition	21.5	22.1	10.2	12.3	15.6	15.8
Reading ability	18.8	13.2	15.8	13.2	16.7	16.9
Comprehensive ability	16.8	10.3	18.2	15.3	14.3	20.5
Speaking ability	15.2	13.2	19.3	17.9	12.2	20.8
Emotion status (AVG)	12.3	16.2	16.2	19.6	15.8	19.9

3.2 Contrasting Phonetic Groups with Semantic Groups

Phonemes-words(semantemes) groups(n=1000)

The researchers play the recording for the participants and show them the phonemes. Participants were presented with different reflections on different phonemes. The following phonemes are used in the experiment and the most three times of the participants' emotion.

Pinyin

1.a------ma (means mother) --------exciting, sorrowful, expressionless

2.o------wo (means me) --------exciting, expressionless, depressed

3.e------ke (means thirsty) -------delighted, expressionless, impulsive

4.i-------ni (means you) --------expressionless, calm, exciting

5.u------nu (means angry) -------curious, expressionless, exciting

6.v-------lv (means donkey) --------exciting, curious, expressionless

International Phonetic Alphabet

1.a------- anxiety, expressionless, annoying

2.b-------anxiety, expressionless. annoying

3.c-------anxiety, expressionless, annoying

4.d-------anxiety, expressionless, annoying

5.e-------anxiety, expressionless, annoying

6.f--------anxiety, expressionless, confusing

Thus, participants are presented with monotonous negative emotions in the foreign language and express different types of emotions in their native language. The researchers can infer that familiar phonemes can evoke the participant's emotional expression.

The researchers instructed the participant to feel the meaning of a word, e.g. bed, the researchers showed the participants their feelings and instructed them to recognise them. The following words were used in the experiment.

Chinese words

床(bed)--------positive emotion

枕头(pillow)------positive emotion

门(door)-----------positive emotion

After teaching some words that are easy to recognise, the researchers used some words that are not easy to recognise.

Chinese words

西瓜(watermelon)---------positive emotion

哈密瓜(cantaloupe)--------positive emotion

甜瓜(muskmelon)-------positive emotion

The researchers chose some English words that are easy to recognise so that the participants can remember them for a long time.

Name------positive emotion

Window -----positive emotion

Curtain------positive emotion

The words that can be felt by the participants can be easily accepted by the participants. But if the researchers increase the abstract level of the words, participants would be angry, frightened, impatient and annoyed. Researchers even create a barrier between participants and researchers. The following words were used in the experiment.

universe----- negative emotion

world------negative emotion

ocean------negative emotion

According to the experiment, Alzheimer's patients are sensitive to the words that can be formed in their minds.

Researchers may find that if they want to train speech rather than phonemes. Word teaching is the best choice for patients to adapt to daily communication.

Words(pronunciation)-sentence(meaning)(N=1000)

Contrast teaching the pronunciation of words with the meaning of some simple sentences. The aim is to find out which method is better for people with Alzheimer's disease to improve their language skills by stimulating them with sounds or sentence elements.

The researchers prepared two groups of words. One plays the recording for the patients. In the other, they were shown the words that can form a sentence in a certain order. The researchers observed the Alzheimer's patients' reflections.

Alzheimer's patients have the ability to hear sounds. They also have the ability to recognise words by sight. The researchers played the recording for the participants while showing them words on paper. In this group, the researchers arranged some tests to check how much the participants had learned in the experiment through dialogue with the words that the researchers had shown them. [4]

In the phonetic group, the researchers played the recording and observed the participant's status. The difficulty of the words was ordered from easy to difficult. The researchers only made the participants listen to the sound and don't show them the meaning of the words. The following words were the example of the experiment and the emotional state of the participants.

种群(crowd)----------half of them are positive

睡觉(sleep)---------positive emotion

吃饭(eat)---------positive emotion

工作(work)------positive emotion

马(horse)--------positive emotion

The same corpus of words was translated into English and played back to the participant. The participants showed annoyance, confusion, anxiety, fear of the researchers. Some of them were aggressive towards the researchers. It is reasonable that extreme emotions appear on participants after English training. English training is a pressure event for the study disabled person. The pronunciation of words can capture their attention for a short time; on average, participants started to feel disgusted after 10 seconds. The researchers conclude that people with Alzheimer's disease pay little attention to the sound of foreign language.

Researchers cut a sentence and put the words in a particular order. The researchers tried to give the participants the meaning of each word and then put them together in a sentence. The following words were examples.

我 爱 你 (I Love You)

我 会 交 流 (I Can Communication)

The participants did not have any negative emotions.

The same form was used in the English group. Translate into English; participants were listening. Participants' eyes focused on the paper with the words printed on it.

Participants preferred to understand the meaning of the words. Sentence (meaning) training tends to capture their attention and stimulate cognitive function. Sentence(meaning) training has a much better effect than expected.

By contrasting words (pronunciation) with sentence (meaning), researchers can find that participants are sensitive to sentence (meaning) training. AD patients are strong on short sentences, but confused on a long sentence.

- Sentence (sound) - text (meaning)

The researchers played sentence recordings, recorded the patient's response and collect the emotional information. As participants were impatient, researchers tried to use simple sentences and sensed words to attract them. The recording was usually played slowly. Because of the complexity, variety and continuity of the sentences, the researchers slowed down the speed of the recording so that they could hear the words. The form of training was the same as other training, I wouldn't show more. Many of them (N=467) gave a good response. Some of them expressed their rebellion and confusion (N=33). Negative emotions appeared in AD patients. Not only because language learning is a big challenge for them, but also because of their personality. Some patients were so angry and furious about learning a foreign language that when the researchers played recordings of long sentences, the patients showed extreme impatience and aggression. AD patients tend to avoid the anxiety of processing complex language structures. The sentence (sound) group was stopped in advance because most of them gave negative feedback.

The researchers divided a text into many sentences and used the sentence as a basic structure to introduce the meaning of a text. Participants felt confused, they liked to describe it as "dizzy". When researchers took a sentence out of a text, they couldn't explain it well. But when researchers put it into the text, participants felt "dizzy". Researchers don't find that the other sentences in the text can interfere with the understanding of a sentence. The participants express a low ability to analyse the text. Researchers stop the experiment because little effective data can be collected.

3.3 Exam Analysis

The researchers looked at the ability of all the participants and how much they had improved in language processing (Full score=50). "Figure 1" shows the status of the participants after six groups of language training. After the training, the researchers found that the participants improved their language skills in every aspect.
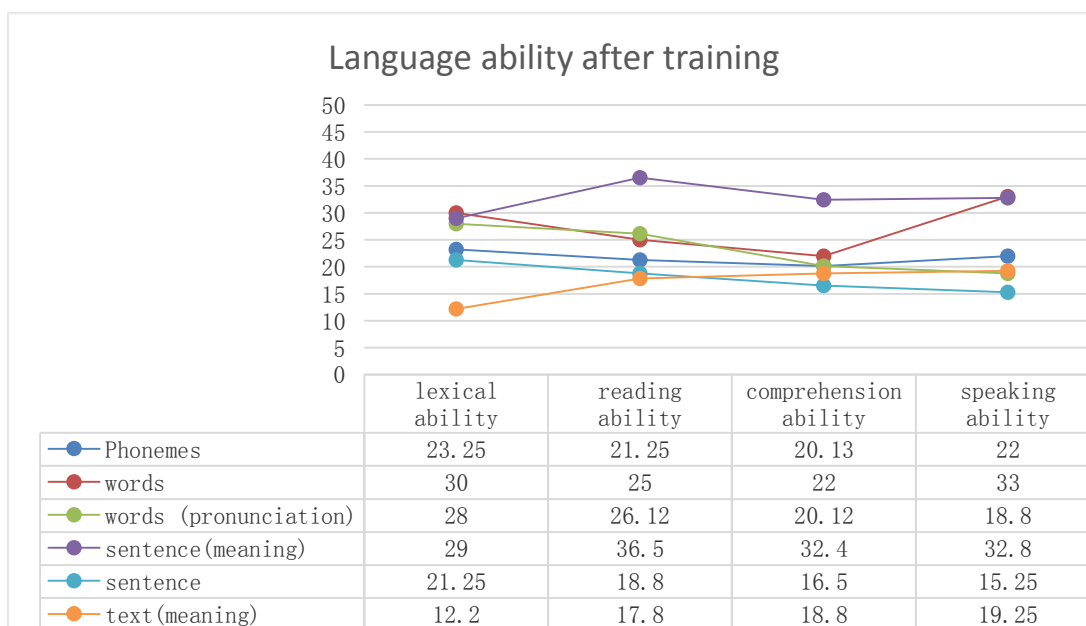
Figure 1 Language ability after training.

4. CONCLUSION

From the whole experiment, the researchers clearly prove that language training can affect Alzheimer's patients. The researchers summarise the different forms of language cognition of the awake patients. Language sensitivity is related to language frequency. In terms of speech frequency, PLI patients have a better advantage. [5] But what do Alzheimer's patients usually process when they hear the sentence?

In the study of bilingual training, semantic training groups are the best. Patients with Alzheimer's disease have difficulty forming long sentences and remembering long words. For the therapist, the most effective communication is to cut a long sentence into words in order. Speech is the first challenge in aphasia. Teaching aphasia patients IPA or Pinyin is considered an effective way to stimulate their brains to speak. PLI and MLI patients mainly stumble and babble. The therapist focuses on practicing uttering a complete word and guiding the patient to utter a complete sentence. Semantic training is consistent with the patient's cognitive logic and is suitable for use in new language learning or in the area of old language recovery. The results suggest that word training is more appropriate for people with Alzheimer's disease.

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