**SENTENCE ANALYSIS OF PATIENTS WITH DEMENTIA OF THE ALZHEIMER'S TYPE**

***ABSTRACT***

 *Alzheimer’s disease (AD)is the most common cause of neurodegenerative dementia. It is characterized by memory loss and cognitive impairment. Although memory loss is often considered the signature symptom of AD, language impairment may also appear in its early stages. Phonological, semantic, discursive and syntactic, aspects of language may also be affected other than memory in AD. Syntactic features of AD patients are often preserved in the early stages and become severely affected in the later stages. Analysis of sentences may give information about the diagnosis of AD. In this respect the aim of this study was to identify the use of declarative and affirmative sentences in oral narratives of late-onset AD who were in mild or moderate stage of AD. 39 patients with late-onset AD narrated a story based picture description and a random speech test. All data was recorded and transcribed using transcript symbols following Du Bois. All results were compared with an age/education-matched control group. It was revealed that there was a statistically significant difference about the use of sentences witnin groups. The results showed that late-onset patients used more affirmative and interrogative sentences in two language tests. However, the control group produced more affirmative and negative sentences in each tests. Within tests late-onset AD patients produced more negative sentences only in random speech test.*

***Keywords:*** *Alzheimer’s disease, late-onset, sentence analysis, oral narratives*

**1. INTRODUCTION**

Alzheimer’s Disease (AD) is the most commonly known cortical dementia (Obler and Gjerlow, 2000). AD has two subtypes depending on its onset: early-onset which is diagnosed at the age of 65 or younger / late-onset which is diagnosed after the age of 65 (Soukup, 1996; Swain, 2001; Ikejima et al., 2009; Zhu et al., 2015). However, late-onset is more common (Soukup, 1996). It has been shown that there is a correlation between the age of onset of clinical symptoms and the severity of the disease; hence, older patients tend to have a slower disease progression and less severe pathology at death (Mamede-Rosa, 2008). Symptoms are often gradual, irreversible, and signiﬁcant enough to affect daily functioning (Masrani, 2018).

Language is a valuable source of clinical information in AD, as it declines concurrently with neurodegeneration. Speech and language data have been extensively studied in connection with its diagnosis (Ross, Cummings and Benson, 1990; Garcia, Ritchie and Luz, 2020).

AD affects brain cells responsible for learning, reasoning, and memory (Franz, 2001). Impairments in language abilities are usually the result of a decline either in the semantic or pragmatic levels of language processing. Semantic processing is related to the content of language and involves words and their meaning. Pragmatic processing is concerned with the inappropriate use of language in social situations (Pompili et al., 2020).

Although memory loss is often considered the signature symptom of AD, language impairment may also appear in its early stages (Garcia, Ritchie and Luz, 2020). Investigations to date into language breakdown in AD have noted that as the disease progresses, any aspect of language can be affected (i.e. phonological, lexical, syntactic or discursive). In the early stages, word-finding difficulties appear in spontaneous speech. This becomes more frequent in the middle stages, along with the appearance of paraphasias, and spontaneous speech is said to become more “fragmented” and sometimes incoherent. In the latter stages, speech becomes increasingly nonfluent, and all aspects of language are disturbed (De Lira et al., 2011).

The dominant theoretical position is that phonological processing is well preserved until late stages of AD. Empirical support for this assumption has been derived from studies showing that speech production in AD is similar to healthy control participants on tasks such as reading orthographically regular words aloud, and producing connected speech (Reilly, Troche and Grossman, 2011).

The conclusion that grammar is spared in AD is also based on two kinds of evidence: (1) spontaneous correction of grammatical errors in sentence repetition; (2) spontaneous speech that contains a normal range of simple and complex phrase structure types, with no evidence of function word omissions and/or grammatical substitutions (Bates et al., 1995).

Within this framework, the aim of this study was to analyse the sentence types of LAD patients via four different language tests and to compare all the results with an age/education-matched control group that has no neurological and psychological problems.

**2. METHODS**

This research was conducted after the permission obtained from the Non-Interventional Ethics Committee in Dokuz Eylül University, Faculty of Medicine.

**2.1. Participants**

A power analysis was performed before the implementation of the tests and it was revealed that this study could be done with the number of 39 patients with LAD. They have mild or moderate AD. The control group (CG) was from Dokuz Eylul University, Faculty of Medicine, Department of Neurology. The ages of all the groups were similar (LAD: 78,5/CG: 62.88) as well as their education.

**2.2. Language Tests**

In order to analyse the sentence types of LAD patients, two different language tests were used. These tests are Story Picture Sequencing Test and Random Speech Test.

**2.3. Data Collection**

The interviews lasted approximately 10 minutes and they were recorded with a tape recorder and transcribed based on the DuBois’ Discourse Transcription Symbols (1993). Just grammatically acceptable sentences were analysed (grammatically unacceptable sentences: LAD 9.56 % / CG 8.11%). As sentence types, only declarative and interrogative sentences were analysed by using some statistical tests such as Qui-square and median test. In order to compare these sentence types within groups Qui-square was used and in order to reveal if the difference between these groups was statistically significant median test was used.

**3. RESULTS**

Firstly, demographic and clinical variables in both groups were compared in order to reveal if all participants were suitable for the comparisons and it was found out that there was no statistically difference between LAD and CG.

**Table 1:** Comparisons of demographic and clinical variables in both groups: LAD and CG

|  |
| --- |
|  **LAD (n=39) CG (n=26) p**  |
| **Age** 78.5 62.88 0.150 |
| **Education** 5 15 0.223 |
| **Gender♀** 10 14 0.126 |
|  |

After this comparison, LAD patients and CG were compared in terms of declarative and interrogative sentences.

**Table 2:** Comparisons of declarative and interrogative sentences of LAD and CG

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Language Tests**  | **N**  | **Group**  |  | **Interrogative** **f (%)**  | **p**  |
| **Afirmative**  | **Negative**  |
| **f (%)**  | **f (%)**  |
| **Story-Picture Sequencing**  | 2639  | CGLAD  | 84.389.8  | 13.74.3  | 25.9  | 0.000  |
| **Random Speech**  | 2639  | CGLAD  | 93.988.9  | 5.38.6  | 82.5  | 0.048  |

As seen in table 2, in each language tests there was a statistically significant difference between the use of declarative and interrogative sentence types. In all tests, both LAD patients and CG used more affirmative sentences compared to the negative and interrogative sentence types. However, in all tests LAD patients used interrogative sentences as secondly higher rate compared to the negative sentences. In contrast, CG used negative sentences as secondly higher rate compared to the interrogative sentences.

**Table 3:** Results of median test (LAD and CG)

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Language Tests**  | **N**  | **Group**  | **Afirmative** **p**  | **Negative** **p**  | **Interrogative** **p** |
| **Story-Picture Sequencing**  | 2639  | CGLAD  | 0.000  | 0.032  | 0.025  |
| **Random Speech**  | 2639  | CGLAD  | 0.004  | 0.411  | 0.008  |

In all language tests, there was a statistically significant difference between LAD and CG in terms of the use of affirmative and interrogative sentences. In terms of the use of negative sentences, only in story-picture sequencing test, there was no a statistically significant difference bertween the two groups.

**Table 4:** Comparison of declarative and interrogative sentences within tests

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | **Group**  | **N** | **Story-Picture****Sequenzing** **f (%)** | **Random** **Speech** **f (%)** | **p** |
| **Affirmative**  | CG | 26  | 26.6  | 24.7  | 0.000 |
| LAD | 39 | 26.1  | 21.1  | 0.001  |
| **Negative**  | CG | 26  | 50  | 16.3  | 0.000 |
| LAD | 39 | 19  | 31  | 0.001  |
| **Interrogative**  | CG | 26  | 26.1  | 8.7  | 0.000  |
| LAD | 39 | 69.4  | 8.2  | 0.001 |

As seen in table 4, there was a statistically significant difference within tests. LAD patients produced more affirmative and interrogative sentences in Story-Picture Sequencing test whereas they produced more negative sentences only in random speech test. However, CG produced more declarative and interrogative sentences in Story-Picture Sequencing test.

**4. DISCUSSION AND CONCLUSION**

The present study investigated the declarative and interrogative sentence types that were obtained from the speech of late-onset Alzheimer’s disease in two different language tests and the results were compared to the age/education matched control group. According to the results, the use of affirmative and interrogative sentences were higher compared to the negative sentences in contrast to the findings of control group. LAD patients produced more interrogative sentences in two language tests while the control group produced more affirmative and negative sentences in two language tests.

The second finding was about the comparison of language tests. According to this comparison, it was revealed that LAD patients produced more affirmative sentences and interrogative sentences story picture sequencing test, more negative sentences in random speech test. However, the CG produced more declarative and interrogative test in story picture sequencing test.

Complexity and diversity are related notions that reflect the distribution of structures produced. With regard to grammatical ability, complexity can be evaluated in free narratives by computing the proportion of complex versus simple structures (e.g., sentence types, verb types). Complexity can also be evaluated in structured language tasks if the measures used are designed to measure it. Some tests, for example, elicit production of both simple and complex sentences as well as verbs based on the number of arguments required. Diversity reflects the range of structures produced (as cited in Mack et al., 2020). In this context, in order to analyse the syntactic abilities of AD patients, lots of researches were conducted. Only a small portion of studies have investigated AD abilities on sentence production and morphosyntactic production abilities (as cited in Curti, 2020). In some researches, the sentence production of AD patients were analysed and it was revealed that AD patients tended to use simple sentence structures more compared to the complex sentence structures (Can and Kuruoglu, 2017, 2018a, 2018b, 2019a, 2019b).

Regarding to our findings, there are no studies related with declarative and interrogative sentences in literature, There are considerably few studies which are about the perception of vocabularies as positive, negative and neutral (Phelps et. al., 1997, Kensinger et. al., 2002). There are several studies supporting that the degree of lexical complexity and content words are impaired in AD, whereas syntactic complexity is affected only until later stages (Kemper et al., 1994, 2001; Emery, 2000; Ahmed et al., 2013; Fraser et al., 2016). In our study, all patients were in the moderate stage. To conclude, the use of the declarative and interrogative sentences were different from the healthy subjects. Within the tests, the use of these sentence types also changed. LAD patients tended to use interrogative sentences to clarify their perception. The use of negative sentences was also higher and it was believed to be related to their psychological condition.

**REFERENCES**

Ahmed, S., Haigh, A.-M.F., de Jager, C.A., & Garrard, P. (2013). Connected speech as a marker of disease progression in autopsy-proven Alzheimer’s disease. Brain, 136, 3727–3737.

Bates, E., Harris, C., Marchman, V., Wulfeck, B. and Kritchevsky, M. (1995). Production of complex syntax in normal ageing and Alzheimer's disease. Language and Cognitive Processes, 10(5), 487-539.

Can, E. and Kuruoglu, G. (2017). Sentence Length of Turkish Patients with Early and Late-Onset Alzheimer’s Disease. Humanities and Social Sciences Review, 06(02), 69–78.

Can, E. and Kuruoglu, G. (2018a). A comparison of Sentence Production of Turkish Patients with Early and Late-Onset Alzheimer’s Disease. International Journal of Psycho-Educational Sciences, 7(1).

Can, E. and Kuruoglu, G. (2018b). Assessment of Syntactic Complexity in Alzheimer’s Disease. Proceedings Book of Eurasian Conference on Language and Social Science (pp. 539–549). Antalya

Can, E. and Kuruoğlu, G. (2019a). Language Changes in Late-Onset Alzheimer’s Disease. Psycholinguistics, 25(2), 50-68.

Can, E. and Kuruoğlu, G. (2019b). Spontaneous Speech in Dementia. Psycholinguistics, 26(2), 175-189.

Curti, S. (2020). The Morphosyntax Interface in Alzheimer's Disease.

De Lira, J. O., Ortiz, K. Z., Campanha, A. C., Bertolucci, P. H. F., & Minett, T. S. C. (2011). Microlinguistic aspects of the oral narrative in patients with Alzheimer's disease. International Psychogeriatrics, 23(3), 404-412.

Emery, V.O. (2000). Language impairment in dementia of the Alzheimer type: a hierarchical decline? Int. J. Psychiatry Med, 30, 145–164.

Franz, J. F. (2001). Alzheimer’s Disease. Gale Encyclopedia of Nursing and Allied Health. Editors Kristine M. Krapp. Detroit: Thomson Gale.

Fraser, K.C., Meltzer, J.A., & Rudzicz, F. (2016). Linguistic features identify Alzheimer’s disease in narrative speech. Journal of Alzheimer’s Disease, 49(2), 407–422.

Garcia, S. D. L. F., Ritchie, C., & Luz, S. (2020). Artificial Intelligence, speech and language processing approaches to monitoring Alzheimer's Disease: a systematic review. arXiv preprint arXiv:2010.06047.

Ikejima C, Yasuno F, Mizukami K, et al. (2009). Prevalence and causes of early-onset dementia in Japan: a population-based study. Stroke 40: 2709–2727.

Kemper, S., Anagnopoulos, C., Lyons, K., & Heberlein, W. (1994). Speech accommodations to dementia. Gerontol, 49, 223–229.

Kemper, S., Greiner, L.H., Marquis, J.G., Prenovost, K., & Mitzner, T. (2001). Language Decline Across the Life Span: Findings from the Nun Study. Psychology and Aging, 16, 227–239.

Kensinger, E.A., Brierley, B., Medford, N., Growdon, J.H., & ve Corkin, S. (2002). Eff ects of normal aging and Alzheimer’s disease on emotional memory. Emotion, 2(2), 118–134.

Mack, J. E., Barbieri, E., Weintraub, S., Mesulam, M. M., & Thompson, C. K. (2020). Quantifying grammatical impairments in primary progressive aphasia: Structured language tests and narrative language production. Neuropsychologia, 107713.

Mamede-Rosa, M. L. (2008). Alzheimer’s Disease. Alzheimer's Disease Research Trends. Editor A. P. Chan. New York: Nova Science Publishers.

Masrani, V. (2018). Detecting dementia from written and spoken language (T). University of British Columbia. Retrieved from https://open.library.ubc.ca/collections/ubctheses/24/items/1.0362923.

Obler, L.K., & Gjerlow, K. (2000). Language and the Brain. Cambridge University Press.

Phelps, E.A., LaBar, K.S., & ve Spencer, D.D. (1997). Memory for emotional words following unilateral temporal lobectomy. Brain and cognition, 35(1), 85–109.

Pompili, A., Abad, A., de Matos, D. M., & Martins, I. P. (2020). Pragmatic Aspects of Discourse Production for the Automatic Identification of Alzheimer's Disease. IEEE Journal of Selected Topics in Signal Processing, 14(2), 261-271.

Reilly, J., Troche, J. and Grossman, M. (2011). Language Processing in Dementia. The handbook of Alzheimer's disease and other dementias (Vol. 7). A.E. Budson and N. W. Kowall (Eds.). John Wiley & Sons.

Ross, GW, Cummings, JL, and Benson, DF (1990) Speech and language alterations in dementia syndromes: Characteristics and treatment. Aphasiology, 4(4):339–352.

Soukup, J. E. (1996). Alzheimer's Disease: A Guide to Diagnosis, Treatment, and Management. USA: Praeger Publishers

Swain, L. (2001).Aging and the aged. Gale Encyclopedia of Nursing and Allied Health. Editors Kristine M. Krapp. Detroit: Thomson Gale.

Zhu XC, Tan L, Wang H. F. et al. (2015). Rate of early onset Alzheimer’s disease: a systematic review and meta-analysis. Ann Transl Med 3: 38 –43.