Language use of patients with early-onset Alzheimer's Disease: An analysis of basic sentences

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Abstract

Alzheimer's disease (AD) which is the most common cause of dementia, has two subtypes: early-onset and late-onset AD. Early-onset AD affects people younger than age 65 and memory dysfunction, cognitive impairment, executive dysfunction and language problems are relatively more common on patients with early-onset AD. Based on the language disturbances, the aim of this study is to examine basic sentences of patients with early-onset AD by using four different language tests and to compare all the results with a control group. Considering the power analyses, 23 patients with early-onset AD from Dokuz Eylul University, Faculty of Medicine, Department of Neurology and an age/education-matched control group are included in this study. The data were analyzed using t test and Mann-Whitney U test. It was found that patients with early-onset AD used more basic sentences in Random Speech test compared to the control group. The other finding was about the nominal and the verbal sentences. It was revealed that there was a statistically significant difference between the patients with early-onset AD and the control group in terms of nominal sentences in the Picnic Picture description test, Cookie Theft Picture description test and the Story Picture Sequencing test. In terms of verbal sentences, it was found that there was a statistically significant difference between the patients with early-onset Alzheimer's disease and the control group in all language tests. In conclusion, the syntactic ability is preserved in AD. However, working memory problems can make the syntactic processing worse. Due to this process, patients with early-onset AD tend to use basic sentence structures more frequently.

Keywords: alzheimer, early-onset alzheimer's disease, basic sentences, nominal sentences, verbal sentences.

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1. Introduction

Dementia is defined as a serious impairment of higher cortical functions of the brain including memory loss and the loss of sensory motor skills. Depending on dementia, problem solving ability about the activities of daily living and social activities decreases considerably. Apart from these issues, loss of emotional control can be observed in dementia (Tufan, 2012). Memory loss in normal aging causes some problems to distinguish normal aging and age-related neurodegenerative disease like dementia (Fjell, McEvoy, Holland, Dale, Walhovd, & Alzheimer's Disease Neuroimaging Initiative, 2014).

Dementia has different types the most common of which is Alzheimer's disease. Alzheimer's Disease (AD) has some symptoms which are thought to be a direct reflection of the loss of function of multiple brain systems for memory, executive function, visuospatial function, language, praxis, and other abilities, and are thought to result, at least in part, from the accrual of pathologic alterations in multiple regions of cerebral cortex (Bakkaur, Morris, Wolk & Dickerson, 2013). One of the most important problems that can be seen in AD is about language. Word finding difficulties, decline in semantic and pragmatic levels, phonological and syntactic difficulties, writing disorders are some of the examples for language problems observed in AD. These language problems vary with the different stages of AD. In the early stages, language impairment involves lexical retrieval problems, loss of verbal fluency, and breakdown in comprehension of higher order written and spoken languages. In the moderate and severe stages of AD, the loss of verbal fluency is profound, with breakdown of comprehension and literal and semantic paraphrases prominent; in very severe AD, speech is often restricted to echolalia and verbal stereotypy (Ferris & Farlow, 2013).

There are two main types of AD: Early-onset and Late-onset Alzheimer Disease. Early onset Alzheimer's affects people younger than age 65. Late-onset Alzheimer's is the most common form of the disease, which happens to people aged 65 and older. The language impairment of early and late-onset AD has been examined in various research studies. Several kinds of language functions were described as more severely deteriorated in early rather than late-onset patients. However; other studies reported more profound language dysfunctions in late-onset patients. Due to the result of one or more methodological factors including lack of statistical power caused by small sample size, inappropriate measures and the presence of uncontrolled variables, differences about language impairment between early and late-onset Alzheimer's Disease could not be described well (Immamura et al., 1998). Early onset differs in the areas of the brain which are targeted, rather than only in the rate of progression. The early onset patients appear to be hit harder in attention-related areas of memory, while the late onset patients appear to have more damage in areas related to recall and recognition (Kensinger, 1996).

The aim of this study is to examine basic sentences of patients with early-onset Alzheimer's disease by using four different language tests and to compare all the results with a control group. For this purpose, basic sentences used by the early-onset AD in four different language tests were examined first. Then, all these basic sentences were studied in detail in order to reveal how many of them are nominal and verbal sentences. The data were compared within the groups and the tests.

2. Materials and Methods

2.1. Participants

A power analysis was used to determine the sample size of the study first. Then, 23 patients with early-onset Alzheimer's disease from Dokuz Eylul University, Faculty of Medicine, Department of Neurology and an age/education-matched control group consisting of 26 normal people were included

in the study. Patients with early-onset Alzheimer's Disease (EOAD) were diagnosed between the ages of 45 and 64. During the study, the average age of the patients was 59.8. The ages of the control group were similar to the subject (treatment) group. Education levels of all the participants are similar, too (at least secondary level).

2.2. Procedures

An informed consent was obtained from all the participants after the aims and procedures of the investigation were fully explained. For EOAD patients who were incapable of providing consent on their own behalf, a legal representative provided the informed consent. Each patient had a structured clinical interview, physical and neurological examination by using Mini-Mental State Examination (MMSE) (Folstein, Folstein & McHugh, 1975), Auditory Verbal Learning Test (AVLT) (Rey, 1964). Verbal Fluency Test (VFT) and Clinical Dementia Rating (CDR) by a neurologist and psychologist. In deciding whether all these patients are available for this study, these tests were helpful. In order to describe the linguistic performance of patients with EOAD, four different language tests were used. These tests were Picnic Picture description test, Cookie Theft Picture description test, the Story Picture Sequencing test and Random Speech test. A pilot study was conducted to reveal the validity of these tests. The description abilities of the patients were evaluated with two Picture description tests: Picnic Picture (Western Aphasia Battery, Revised: Kertesz, 2007) and Cookie Theft (Boston Diagnostic Examination of Aphasia, Goodglass and Kaplan, 1983). As Bayles and Kaszniak (1987) stated, these tests are the most sensitive materials to assess the language performance of AD patients. By using as a Story Picture Sequencing test, it was aimed to examine the sequencing ability of AD patients. This test was designed by Abdülkadir Gürol who was working as a graphic design specialist in the Ministry of Education. In order to test the validity of this Story Picture Sequencing test, a pilot study was conducted, too. In the last stage, a Random Speech test was performed by posing a question to the subject and control groups. This test did not restrict the patients, so there were more volunteers to talk to in the last stage. By this test, we were able to assess the spontanous speech of EOAD patients. Patients were interviewed for approximately 10 minutes each with four tests. All of the language tests performed by the patients were recorded with a tape recorder and transcribed based on the DuBois' Discourse Transcription Symbols (1993). After analyzing the sentences, just grammatically acceptable sentences were included (Grammatically Unacceptable Sentences; Subject Group: 9.56 % / Control Group: 8.11 %). Except for these sentences, all the other sentences were analysed based on basic sentence structures. The data of the patients with EOAD were compared within the groups and the tests.

2.3. Statistical Analysis

Statistical analysis was performed using Statistical Package for the Social Sciences (SPSS) version 16.0 for Windows. Non-parametric analyses were performed as there was no equivalence in number, normal distribution, or homogeneity of variances (Qui-square and U-Mann–Whitney). There was a symmetrical distribution for the basic sentence structures related with the group comparisons, t test was performed.

3. Results

The study sample consisted of 23 patients with EOAD and 26 normal people. The characterization of the study sample and details of both subgroups are provided in Table 1. For this description the following variables were considered: age, gender, education level and MMSE mean scores.

Table 1. Comparisons of demographic and clinical variables in both groups: EOAD and CG

	EOAD (n=23)	CG (n=26)	p
Age	59.86	62.88	0.292
Education	14	5	0.309
Gender♀	10	14	0.469
MMSE	19	30	<0.005

*EOAD: Early-onset Alzheimer's Disease/CG: Control Group

The comparisons of basic sentence structures obtained in four language tests are presented in Table 2. Results suggest that patients with EOAD performed significantly poorly than the control group in Picnic Picture, Cookie Theft and Story Picture Sequencing tests. Although not reaching statistical significance, a high mean of the basic sentence structures was noticed. On the other hand, there is a statistically significant difference between patients with EOAD and control group in Random Speech test ($p=0.001$).

Table 2. Comparisons of basic sentence structures on four language tests of EOAD and CG

Language Tests	N	Group	Mean	Standart Deviation	p
Picnic Picture	26	CG	9.615	4.833	0.872
	23	EOAD	9.391	4.812	
Cookie Theft	26	CG	5.846	3.662	0.748
	23	EOAD	5.521	3.328	
Story Picture Sequencing	26	CG	5.615	4.233	0.314
	23	EOAD	6.956	4.986	
Random Speech	26	CG	2.653	1.547	0.001
	23	EOAD	5.304	3.036	

The comparisons of nominal and verbal sentence structures obtained in four language tests are presented in Table 3 and 4. It was found that there was a statistically significant difference about the nominal sentence structures between the EOAD and control groups in Picnic Picture, Cookie Theft and Story Picture Sequencing tests ($p=0.001$, $p=0.020$, $p=0.003$). However, there was no difference in Random Speech test within the groups.

Table 3. Comparisons of nominal sentence structures on four language tests of EOAD and CG

Language Tests	N	Group	p
Picnic Picture	26	CG	0.001
	23	EOAD	
Cookie Theft	26	CG	0.020
	23	EOAD	
Story Picture Sequencing	26	CG	0.003
	23	EOAD	
Random Speech	26	CG	0.142
	23	EOAD	

Results in Table 4 suggest that there is a statistically significant difference in all language tests within the groups (p=0.037, p=0.019, p=0.009, p=0.002).

Table 4. Comparisons of verbal sentence structures on four language tests of EOAD and CG

Language Tests	N	Group	p
Picnic Picture	26	CG	0.037
	23	EOAD	
Cookie Theft	26	CG	0.019
	23	EOAD	
Story Picture Sequencing	26	CG	0.009
	23	EOAD	
Random Speech	26	CG	0.002
	23	EOAD	

The comparison within the tests was done and in order to show the relation between the tests and basic sentence structures Chi-square test (χ^2) was used (Table 5).

Table 5. Comparison of language tests based on basic sentence structures within groups

Groups	Picnic Picture f (%)	Cookie Theft f (%)	Story Picture Sequencing f (%)	Random Speech f (%)	p
CG	40.5%	24.6%	23.7%	% 11.2	0.000
EOAD	34.6%	20.3%	25.6%	% 19.5	0.001

Considering the EOAD group and control group, it was found that there was a significant positive correlation between language tests and basic sentence structures (p=0.001, p=0.000). It means that the use of basic sentence structures of EOAD patients and the control group were changed within tests. The highest percent of basic sentence use of EOAD patients and the control group is in Picnic Picture test and the lowest percent is in Random Speech test.

4. Discussion

Our results show that patients with EOAD use more basic sentence structures than the control group considering four language tests. Although not reaching statistical significance, it is clear that patients with EOAD tend to use basic sentences in their speeches. A justification for these findings was offered by some authors like Hier, Hagenlocker, & Shindler (1985); Croisile, Ska, Brabant, Duchene, Lepage, Aimard, & Trillet (1996), Waters and Caplan (1997, 1999, 2001). They examined the sentence structures of AD patients and it was revealed that they used less complex sentence structures compared to the control group. In several studies, it was stated that the syntactic ability is preserved in AD. The stages of AD are determinant of the language impairment in AD and the impairment is just observed in the complex sentence structures (Caramelli, Mansur & Nitrini, 1998; Emery, 2000). The performance of AD patients becomes worse when the complex sentence structures occur more frequently (Caplan and Waters, 1999).

Apart from these studies, there are several studies which compare patients with early and late-onset Alzheimer Disease. Some of these studies indicate that the linguistic difference between the two subtypes are not clear (Seines, Carson, Rovner & Gordon, 1988; Swearer, O'Donnell, Drachman &

Woodward, 1992) Seines et al. (1988) stated that they couldn't find any significant differences in the severity of language dysfunction between the two groups, particularly after controlling for greater attention/concentration deficits in the early-onset group. They also pointed out that previous reports of differences in language dysfunction between early and late-onset AD may have been due to small sample sizes and nonstandardized testing.

In contrast to the above findings, other studies show that there is a difference between the linguistic performance of the patients with early and late-onset Alzheimer's Disease. In one of these studies, the spontaneous speech of the AD patients was evaluated considering the syntactic properties and it was revealed that patients with late-onset AD performed poorly compared to the patients with early-onset AD (Sevush et al., 1993). This finding was proved in some other studies (Bayles, 1991, 1992, 1993). On the contrary, another study proves that language impairment of the patients with early-late onset AD is faster and worse compared to the late-onset AD patients (Romero & Kurz, 1996). This finding was proved in many studies (Seltzer and Sherwin, 1983; Sevush, Leve, & Brickman 1993; Binetti, Magni, Padovani & Cappa, 1993; Goldblum, Tzortzis, Michot, Panisset & Boller, 1994; Becker, Huff, Nebes, Holland & Boller 1988; Chui, Teng, Henderson & Moy, 1985; Filley, ., Kelly & Heaton, 1986). In addition to these studies, some studies reveal not only similarities but also differences between early and late-onset AD considering their linguistic performance. For example, Koss, Edland, Fillenbaum, Mohs, Clark, Galasko and Morris(1996) found out that naming, repetition and some other linguistic performance of the early and late-onset AD patients were similar. However, in some aspects there were also some differences within the groups. Considering the syntactic properties of AD patients, Kertesz (2004) found out that in the early stages of AD, these properties were preserved; however; in the severe stages language impairment became worse and the patients had lots of problems about sentence production.

Studies which are about age-related effects of sentence production reveal some important results. For example, Kemper, Thompson and Marquis (2001a) state that older adults' linguistic abilities are affected by working memory limitations on the production of complex syntactic constructions. In another study, it was indicated that the production of complex sentence structures became less due to the age and these patients used basic sentence structures more frequently (Kemper, Greiner, Marquis, Prenovost & Mitzner, 2001b). Other age-related studies also show that there is a relation between age and sentence production and elderly patients use more basic sentences compared to younger patients (Kemper, Herman & Lian, 2003; Sung, 2015).

In our study, nominal and verbal sentence structures were also analysed within tests and groups. Results show that the number of nominal and verbal sentences used by the EOAD patients differs from the control group. EOAD patients prefer nominal sentences more compared to the control group. In literature, very few studies investigated these sentence structures related to AD. Some studies just analysed verb and noun production and they indicated that verb production deficits in AD seemed to be driven more by semantic than by executive impairment. They suggest that picture naming is a task predominantly dependent on temporal or posterior brain areas, whereas verbal fluency is more dependent on frontal or frontal subcortical brain areas. Even though patients with AD have no frontal brain atrophy, they do experience difficulty in naming and fluency tasks involving verbs (Beber, Cruz, & Chaves, 2015).

In our study, basic sentence structures of EOAD patients were analysed and it was found out that these patients used more basic sentences in their speech. It is believed that this preference is related to working memory problems. Working memory, which provides storing and manipulating visual images or verbal information, is not only fast, but also a complex process. Especially for linguisic performance, this process is vital (Akoglu and Acarlar, 2014). Working memory is a cognitive system that is related to sentence processing and provides linguistic information for this process (Sung, Kyung & Hyang, 2013). It is known that AD patients have working memory problems due to the deficits in neural interconnections between the posterior and frontal brain areas. These problems can also cause

difficulties in sentence comprehension and sentence production (Altmann and McClung, 2008). Some studies related to sentence processing indicate a left-temporal network for syntactic processing and bilateral tempro-frontal networks for semantic processing (Lukic, Bonakdarpour, Den Ouden, Price & Thompson, 2013).

In conclusion, in this study EOAD patients' speech examined through four different language tests and it was revealed that these patients tended to use basic sentences and nominal sentences more frequently. It is believed that AD patients have different sentence processing compared to normal people due to the working memory problems.

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