

Notes on the Phonological Features of Persian-Speaking Parkinsonian Patients

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Abstract

Introduction: Idiopathic Parkinson is an age-related, common progressive neurodegenerative disease whose probable causes are yet unknown. Also, it is not yet clear whether specific language disturbances form part of Parkinson's disease (PD) cognitive profile. This disease leaves several impacts on the speech of its patients, many of such impacts have not undergone a serious study in different languages.

Methods and materials: The ultimate goal of this article is provision of the prosodic features of Persian – speaking Parkinsonian patients, using 4 major tasks to evaluate their production and perception impairments. The tasks include "spontaneous speech", "fluency task (DDK)", "production and perception of emotional prosody", and "production of high-low vs. low-high vowels". In order to carry out this research, the above-mentioned tasks were administered to 5 non-demented patients with idiopathic Parkinson and 5 healthy people, as the control group, and the results were compared and analysed.

Results: The results share the idea with the previous findings which indicated that these patients show greater deficiencies in language production. Especially they appear to have difficulties in producing emotional prosody as well as the production of low-high vowels. The findings of this research also reveal that such patients do not have much difficulty in perception of emotional prosody, which is in contrast with some previous findings such as that of Breitenstein et al.(2001), Davis Garret et al.(2002) and Harel et al.(2004).

Conclusion: This research concludes that the patients seem to have impairments in concentration during all stages. i.e., their cognitive abilities are mostly impaired due to their lack of selective attention. Based on the results of this research, it is inferred that some specific speech defects are common in moderate and advanced PD patients, including disturbances of respiration, phonation and articulation. Vocal tremor was identified on narrow band spectrogram for 2 subjects in early moderate and late moderate stage.

Keywords: Parkinson's disease (PD), prosodic features, emotional prosody, spontaneous speech, fluency task (DDK).

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Introduction

Language function involves comprehension, formulation and transmission of ideas and feelings by the use of conventionalized verbal symbols, sounds and gestures as well as their sequential ordering according to accepted rules of grammar.⁽¹⁾ Therefore, speech and language functions are of fundamental human significance, both with respect to social interactions, along with private intellectual life. Given the fact above, any disease process that interferes with speech or the understanding of spoken words may touch the core of the physician-patient relationship. Finally, the study of language disorders serves to illuminate the abstruse relationship between psychological functions and

the anatomy and physiology of the brain. Disturbances in dopamine regulation at the synaptic level in nigro-striatal pathway and basal ganglia have been associated with a number of organic degenerative disorders, one of which is Parkinson's Disease,⁽²⁾ an age-related progressive neurodegenerative condition that is associated with the depletion of dopamine (DA)- containing neurons in specific brain regions

Although no single causative factor has been identified for idiopathic PD, several mechanisms are thought to be involved in the etiology of it, ranging from mitochondrial defects to genetic factors.⁽³⁾ Generally, the risk factors of PD may be listed as below (See Evans 2003: 205):

Table1: Factors associated with risk of PD

- Aging
- Gender (Male)
- Race (whites)
- Farming
- Rural residence
- MPTP(1-Methyl-4-Phenyl-1,2,3,6-tetrahydropyridine) and MPTP-like compounds
- Infectious agents
- Pesticide and herbicide exposure

It should be noted that the essential neuropathological changes in PD are the results of a loss of melanine-containing dopaminergic neurons in substantia nigra pars compacta (SNc; 5). This results in a dysfunction of the basal ganglia circuitry, which is an integral part of cortico-basal-ganglia-

cortical loops that mediate motoric and cognitive functions.

According to Flowers et al. (1995) a behavioural change is often attributed to Parkinson's Disease (PD) which might be a reduction in verbal fluency or the ability to generate words of a given category spontaneously over a

short period of time. There are some disputes, however, as to whether the deficit is a genuine symptom of PD or not, and whether it applies to all forms of word fluency or only to an individual type of word-finding. Another study by Cheang and Pell (2004:21) holds that adults with idiopathic Parkinson's disease (PD) show expressive and receptive difficulties for speech prosody. Several other studies have also suggested that prosodic impairments may be due to specific processing deficits in PD which are not fully explained by a decline in cognitive or motor function [Blonder and Gur, 1989; as cited by.⁽⁸⁾]. Also Lieberman and Mattingly (1985) hold that compromised basal ganglia functioning in PD interferes with motor functioning as well as comprehension since both are mediated by the same motor structures of the brain, according to the motor theory of speech

- a. Weak phonation
- b. Minimal variation in pitch
- c. Low volume
- d. Hoarseness
- e. Accelerated rate
- f. Repetitive dysfluencies
- g. Imprecise consonants

The current study aims to examine the above-mentioned signs in Persian-speaking Parkinsonian patients using 4 major tasks including spontaneous speech, fluency task (DDK), Production and perception of emotional prosody, Production of high-low vs. low-high vowels.

perception. An alternative approach has focused on the claim that sentence processing requires executive resources such as working memory, selective attention, inhibition and planning to support sentence comprehension.⁽⁹⁾

Although PD is best known as a movement disorder, about half of such patients also suffer from cognitive deficits similar to those exhibited by patients with lesions in the prefrontal cortex. There are few studies addressing the linguistic comprehension and production deficits in PD patients.^(10; 9; 8; 11; 12; 13) It is noted that persons with PD commonly have deficits in the prosodic characteristics of speech⁽¹⁴⁾ Moreover, there is evidence indicating that prosodic comprehension in persons with PD is also impaired.⁽⁸⁾

According to Rosenfield (2003:51) the speech signs in Parkinson's Disease are as follows:

Methods

diagnosis of idiopathic PD without dementia was made by an experienced neurologist (Dr. B.Adibeik) who provided the MMSE (Mini-Mental-State Examination) scores as well as the severity measures for each patient. It seemed that all but one patient had

scored higher or at 24 on MMSE. The remaining patient (PS) was in the progressive stage and had scored 20 on MMSE.

It should be noted that the MMSE test was carried out during the " ON" rather

than" OFF" phase as the patients experienced fluctuations with respect to the medication. So all patients were tested during their optimally medicated ("ON") state. The PD patients' MMSE scores can be seen in Table 4.

Table 2: MMSE scores in PD patients

PD Patients	MA	AN	FG	AM	PS
MMSE Scores	25	24	24	24	20

Subjects

This study involved three groups: individuals in the Moderate and advanced stages of idiopathic Parkinson's disease, and a group of neurologically healthy adults. All participants were Persian speaking males and females, right-hand dominant. Participants were excluded if their medical record reported history of head injury, seizures, substance abuse, impaired auditory and visual acuity, documented exposure to neurotoxins, cerebrovascular event, aphasia, dementia or any developmental learning disability. Accordingly, 5 non-demented patients with idiopathic PD were enrolled in this study. There were 3 men and 2 women, aged between 40-76. The cardinal symptoms of the disease (i.e.

rigidity, tremor, bradykinesia, bradyphrenia, etc.) were noted in these patients. A control group of 5 normal subjects matched to the PD patients on chronological age, gender and educational background participated in the present study. All PD participants were taking dopaminergic agents for their motor disturbance but were not taking sedating medication at the time of data collection.

Materials

Background information

Information regarding age, education, sex and language abilities were assessed for each subject. Tables 3 and 4 show the demographic and clinical data of Parkinsonian patients and the matched control group.

Table 3: Demographic and clinical data for the patients with PD and the HC group

Variables	Group		
	Moderate PD group	Advanced PD Group	HC
Sample size(n)	3	2	5
Female/male	1/2	1/1	2/3
Age in years(Mean)	61.66	61.5	61.2
Duration of disease(in years, Mean)	5.3	13.5	N/A
Age at disease onset (Mean)	56.33	48	N/A

PD: Parkinson Disease
 HC: Healthy Control

Table 4: Clinical data of the patients suffering from PD

Patient	Sex	Age	Duration	Stage
MA	F	40	5	II
AN	M	76	6	II
FG	M	69	5	II
AM	M	55	8	III
PS	F	68	19	III

The healthy control group (n=5) was recruited by personal contact. It is noteworthy that none of the control subjects had a history of neurological or psychiatric disease or were taking medication affecting the central nervous system.

Tasks and procedures

In order to evaluate the linguistic production and perception impairments of the examinees, 4 major tasks were administered. The procedures were kept very similar for all subjects. After

they gave their consent to take part in this research, they were presented with a standardized set of demographic questions (age, education, etc.).

All participants were tested individually. Before starting the tests, the subjects were given a feedback on the tasks.

Spontaneous Speech Task

All subjects were asked to answer some general questions (Name, age, family, duration of the disease for patients,

their spoken languages or dialects, if any, as well as their educational background).

The results showed that the rate of speech in some PD patients were more than the healthy control subjects i.e. as the disease progresses, the speaking rate can either be abnormally accelerated or slowed. Table 5 clearly

presents the speech rate differences between the two groups. Also it may be noted that the healthy controls mostly had similar speech rates (Number of words/ min), whereas the PD examinees did not share the same speech rates. The mean score of the speech rates between HC and PD is also presented in Figure 1.

Table 5: Speech rate of HC and PD according to gender and age

Age	Sex	Healthy Control	PD patients
66-68	F	1.7	2.13
73-76	M	1.4	1.31
55-60	M	1.4	1.51
65-69	M	1.4	2
40-42	F	2.2	2.55

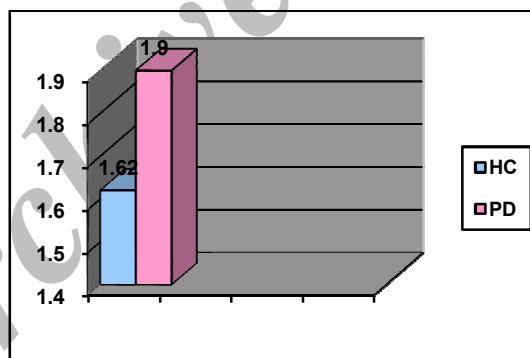


Figure 1: Mean score of speech rate between HC and PD

Fluency task (DDK)

According to the previous studies these patients suffered from imprecise articulation which can lead to changes in oral diadochokinetic (DDK) production. This task which was first introduced by Fletcher (1972) generally consists of producing rapid syllable trains containing consonant–vowel

combinations with bilabial, alveolar and velar places of articulation and it is used to examine a person's ability to make rapidly alternating articulatory movements. The subjects were asked to take part in a standard DDK rate task (Fluency Task) by repeating the following syllables as quickly as possible for 5 seconds:

pâpâ / pââtâkâ/ kâtâpâ /bepar bepar

The PD patients revealed greater deficiency in this respect. They produced maximal syllable repetition rates, which faded as the speakers went on through the task. In comparison with the control subjects, the PD patients produced smaller movement amplitudes of the lower lips concomitant with decreased peak velocity. Even adequately matched, syllable trains displayed reduced articulatory movements. Also a

diminished speech volume was observed during the repetition tasks. The results presented here support the idea that PD patients produce a genuine reduction in verbal fluency which were the main determinant of our patients' performance. Also the number of the syllable trains PD patients produced within 5 seconds was less than the healthy controls as it is presented in Figure 2.

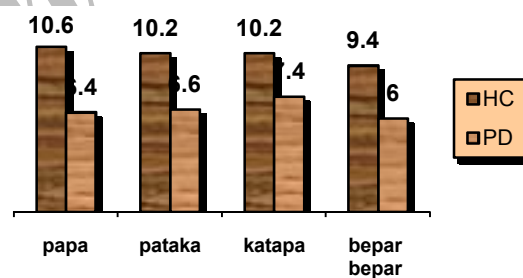


Figure 2: Mean scores of HC and PD in fluency task(DDK)

2.3.3. Production and perception of emotional prosody

For many decades, PD has been associated with flat emotional and nonemotional speech. In order to

examine the subjects' ability to produce and comprehend the emotional prosody, 5 types of sentences with different emotional prosody were produced. The participants were asked

to produce them as they heard it and say what the emotional tone it bore:

belaxare umadi (angry)

“you have showed up, at last?”

če ajab (surprise)

“what a surprise!”

vây be hâlet agar dir mikardi (threat)

“Had you been late, you'd have another think coming”.

hâlâ ke injâm (neutral)

“I am here now”.

xeyli xoš umadin (Happy)

“You are most welcome”.

The HC group were able to produce all the abovementioned sentences with the same emotional prosody whereas the performance of PD patients showed meaningful differences with this respect. Figure 3 shows that only 40% of patients with early-moderate PD were able to produce the angry and threat tone. While only 20% of them could produce the surprising tone. From this figure we can clearly notice two extremities : None of them were capable of producing the happy tone whereas all of them were able to produce the neutral tone just like the HC group.

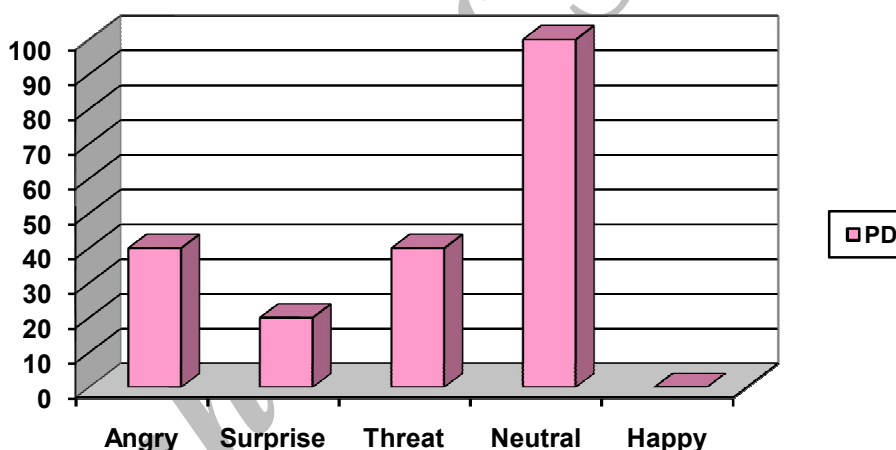


Figure 3: PD patients' performance in producing the emotional prosody

Table 6: Percent of emotional prosody in HC and PD subjects

Emotional prosody	HC	PD
Angry	100%	40%
Surprise	100%	20%
Threat	100%	40%
Neutral	100%	100%
Happy	100%	0 %

Here it should also be noted that eventhough the patients had difficulties

in producing these sentences, they seemd to perceive them quite well.

Because they were all able to comprehend and distinguish which tone was a happy tone and which one was an angry one, so on and so forth. Additionally, we may infer that the prosodic competence model would further be supported by poor performance of the PD participants, relative to age-matched neurologically healthy controls, on an acoustic perception task that isolates manipulations in pitch, volume, and duration which was also mentioned by Davis Garret (2002).

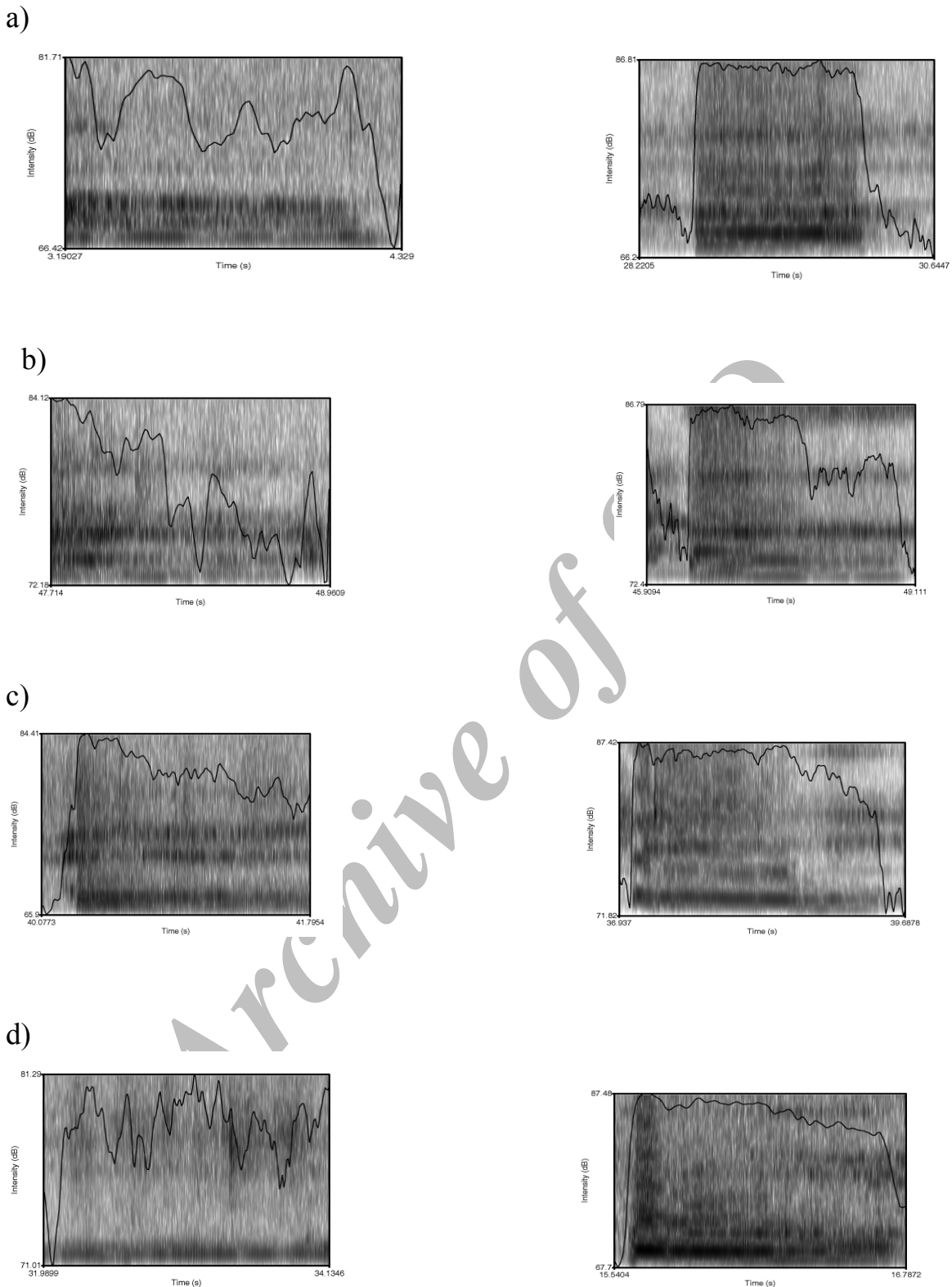
Production of high-low vs. low-high vowels

This task was administered in order to demonstrate the subjects' abilities in producing high-low vs. low-high vowels.

According to the previous studies the PD patients suffered from weak phonation and low volume in their speech. The patients, however, had a

reduced capacity of completing articulatory occlusion. This might have reflected a reduction in movement amplitude of the articulators. That is they were unable to produce low-high vowels and all they could produce was a vowel in a flat tone. Moreover, the acoustic discrimination screening was devised as a baseline measure to identify the extent to which perception of pitch, duration, and volume of speech contributes to comprehension of prosody.

On the other hand, we noted that they showed less difficulty in producing high-low vowels. Spectrograms in figure 4 below are taken from patients F.G and A.N which provide information on the abovementioned claim. A closer look at the spectrograms displays that the voice intensity of patient FG in producing all these vowels is less than the voice intensity of patient AN.



**Figure 4: Spectrogram of patient F.G. (left) and Spectrogram of patient A.N.(right)
(a) Producing the vowel /a- from low-high (b) Producing the vowel /æ- from high- low (c)
Producing the vowel /i- from high-low (d) Producing the vowel /u- from low –high**

Results

The purpose of the present paper was to study the phonological impairments of Persian-speaking Parkinsonian patients.

In spontaneous speech task the PD patients showed either accelerated speech rate or decreased speech rate as compared to the healthy controls. The results of this task share the idea with the previous findings (17; 18; 14).

In Fluency task (DDK) all the PD patients unlike the HC group revealed speech hastening and impaired self-paced repetitions during this task and there was a "gap" while they were producing the syllables given to them. In other words the PD scores were lower than the HC group as it had been presented in Figure 2. The results confirm the former studies (6; 15; 14) which demonstrated that the PD patients show noticeable dysfluencies when compared with the control subjects. According to Flowers et al. (1995:43) while voice disorders are often noted as a feature of Parkinson's disease this shows mostly as a deterioration in voice quality and power. Also the overall impression is that the fluency deficit is an expression of bradyphrenia occurring in parallel to the bradykinesia of movement, both representing some central deficit of voluntary expression. On the whole it appears from the results of this task that PD patients produced smaller number of syllable trains within the certain time.

The results of the production and perception of emotional prosody task,

however, revealed a meaningful distinction between the two groups. The researchers noted that 2 of the patients who were in their early-moderate stage were able to produce the angry and threatening voice. While none of the patients were able to produce a happy tone, they were all capable in producing the neutral tone in a monotonous way. It was also found out that the PD patients were only impaired in producing emotional prosody and not in comprehending and distinguishing them. These findings were in contrast with some other works (8; 16; 19; 14) who had stated that the PD patients were impaired in both production and perception of emotional prosody.

The results of the final task clearly show that the PD patients were unable to produce low-high vowels whereas they were capable of producing high-low vowels. This was because of their lack of ability in lengthening their voice and increasing their speech volume. The spectrograms in Figure 4 show the vocal tremor on narrow band spectrogram for 2 subjects in early moderate and late moderate stage of the disease. Our findings also confirmed some previous studies (15; 20; 14), which indicated that the PD had low volume in their speech and were unable to increase their voice.

Conclusion

The overall linguistic performance of the Persian PD patients monitored in

this research is suggestive of certain universal and language-specific phonological features. Among universal features, the data from the five PD patients tend to show deficiency in producing low-high vowels and in producing most of the prosodic features. Weak phonation, minimal variation in pitch, low volume, hoarseness in speech, accelerated rate, repetitive dysfluencies, imprecise consonants were also noted in such patients. These general features are in line with data reported from other languages (15; 20; 14). As for language-specific phonological features, the present data suggest greater vulnerability in the production and perception of emotional prosody as opposed to the HC. The disruptions in PD patients manifested their weakness in producing 5 types of sentences with different emotional prosody. However, they didn't seem to be impaired in comprehending emotional prosody which is in contrast with the previous findings (8; 16; 14). Based on the results of this research, it is inferred that some specific speech defects are common in moderate and advanced PD patients, including disturbances of respiration, phonation and articulation. With regard to the disruption of PD acoustic features, the spectrograms in figure 4 display the vocal tremor on narrow band spectrogram for FG and AN in early moderate and late moderate stage. Finally, as the Persian data so far are limited to these cases; these

conclusions will have to be verified by further research.

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یافته‌هایی در مورد ویژگی‌های آوایی بیماران مبتلا به پارکینسون فارسی زبان

آرزو آدی‌بیک، دکتر بهروز محمودی بختیاری

فصلنامه علوم مغز و اعصاب ایران، سال هفتم، شماره ۲۶ و ۲۷، تابستان و پاییز ۱۳۸۸، ۵۴۸-۵۳۵

چکیده

سابقه و هدف: پارکینسون ایدیوپاتیک یک بیماری پیشرونده عصبی است که با افزایش سن بروز می‌کند و دلایل رخداد آن هنوز کاملاً شناسایی نشده‌اند. همچنین هنوز روشن نیست که آیا برخی اختلالات زبانی را می‌توان در زمره نشانه‌های ابتلا به پارکینسون دانست یا خیر. پارکینسون تاثیراتی بر گفتار مبتلایانش بر جا می‌گذارد، که هنوز بسیاری از آنها در زبان‌های مختلف مورد بررسی دقیق قرار نگرفته‌اند.

روش بررسی: هدف اصلی این تحقیقی ارائه برخی مولفه‌های نوایی در گفتار بیماران پارکینسونی فارسی زبان است، و به منظور دستیابی به این هدف، از چهار آزمون مهارت به منظور ارزشیابی میزان آسیب‌های ادراکی و تولیدی آنها بهره گرفته شده است. این آزمون‌های مهارتی عبارتند از: «تست گفتار خودانگیخته»، «روانی گفتار» (DDK)، «تولید و ادراک نوای عاطفی در گفتار»، و نهایتاً «تولید واژه‌های افتاده - افراشته در مقابل واژه‌های افراشته - افتاده». به منظور انجام این پژوهش، موارد فوق‌الذکر بر روی ۵ بیمار مبتلا به پارکینسون ایدیوپاتیک (بدون دمانس) و ۵ فرد سالم به عنوان گروه کنترل سنجیده شد، و نتایج حاصل مورد مقایسه و تحلیل قرار گرفتند.

یافته‌ها: نتایج حاصل از این پژوهش با دستاوردهای پژوهش‌های پیشین همسویی دارد؛ که بر اساس آنها، بیماران پارکینسونی مشکلات قابل توجهی در حوزه تولید گفتار از خود نشان می‌دهند. به طور مشخص، این افراد در تولید نواهای مختلف عاطفی و تولید واژه‌های افتاده - افراشته با مشکلاتی مواجهند. با وجود این یافته‌های این پژوهش نشان می‌دهند که این بیماران مشکل چندانی در ادراک نوای عاطفی ندارند، که این مورد با یافته‌های مطالعاتی چون Breitenstein et al.(2001), Davis Garret et al.(2002), Harel et al.(2004) همسویی ندارد.

نتیجه‌گیری: از این پژوهش می‌توان نتیجه گرفت که ظاهراً بیماران مبتلا به پارکینسون در تمامی مراحل بیماری خود از اختلال و آسیب در تمرکز رنج می‌برند؛ به این مفهوم که توانایی‌های شناختی آنها عمدتاً به

دلیل فقدان دقت انتخابی‌شان دچار آسیب هستند. بر اساس یافته‌های این پژوهش، مشخص شد که برخی از آسیب‌های گفتاری (مانند واک‌سازی و برخی تولیدات آوایی) در بیماران مبتلا به پارکینسون ملایم و پیشرفته مشترک است. همچنین پدیده لرزش آوایی بر روی طیف‌نگاشت گفتار دو مورد از بیماران در دو سطح ملایم و پیشرفته مشاهده گردید.

واژگان کلیدی: پارکینسون ایدیوپاتیک، مولفه‌های نوایی، نوای عاطفی، گفتار خودانگیخته، آزمون روانی گفتار (DDK).

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