Research Paper

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Analysis of VOT in the Speech of Parkinson's Disease

Medical Science

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ABSTRACT

Parkinson's disease is a hypokinetic dysarthria. Loss of dopamine in the corpus stratia is the primary defect in Parkinson's disease. The present study included 12 normal persons and 12 persons with Parkinson's disease. All normal persons were normal in terms of Speech, Language and Hearing and had no history of neurological problems. Persons with Parkinson's disease were diagnosed by a neurologist after a MRI/CT scan. Participants were asked to narrate the picture story "The Thirsty Crow". Speech samples were recorded and analyzed with Praat software. Results revealed significant difference between normal persons and persons with parkinson's disease on voice onset time.

Introduction

Parkinson disease (PD) is a neurological disorder which is caused by loss of dopaminergic neurons in the basal ganglia (substantia nigra) and brainstem. PD is a type of dysarthria especially hypokinetic dysarthria, mostly based on rigidity and hypokinesia (Gentil & Pollak, 1995) and may have deficits in respiration, phonation, articulation, and prosody (Darley, Aronson, & Brown, 1969; Goberman & Coelho, 2002). Reduced dopamine can have an effect on speech production (Goberman & Coelho, 2002). Perceptual features of hypokinetic dysarthria include monopitch, monoloudness, and voice quality deficits (Darley, Aronson, & Brown, 1969). PD symptoms initiates commonly with tremor. The tremor of Parkinson's disease take place in the distal extremities of the body and it occurs at rest. Persons having tremor as the initial symptoms show slower progression of the disease in the first 10 years (Hoehn & Yahr, 1967). In the early part of the course of the disease, the Person might notice increasing difficulty in repetitive or alternating movements such as walking. This rigidity affects all striated muscles, causing difficulties in respiration, facial expression, swallowing mastication, and speech. Progression of rigidity can lead to flexion contractures of the fingers, elbows, cervical spine, hips, and knees with ensuing loss of mobility. Parkinson's disease is more common in men than in women.

Prior to treatment with levodopa, over one-quarter of persons with parkinson's disease were dead or severely disabled within five years of their diagnosis; eighty percent were in this category after 10 to 14 years of observation, nearly three times that of the normal population (Hoehn & Yahr, 1967). Different stages of Parkinson's disease (Hoehn & Yahr, 1967) have been identified and described which are as follows

Stage I- symptoms mostly on one side of the body with little loss of function.
Stage II- symptoms on both sides of the body, but balance is normal.
Stage III- symptoms on both sides of the body, and balance is imperfect.
Stage IV- severe impairment of movement and balance but still able to walk without help.
Stage V- severe impairment of movement; unable to walk without help or even confined to bed and chair.

Researchers have shown varied results on voice onset time (VOT) in persons with PD. Forrest, Weismer, and Turner (1989) reported longer VOT in persons with PD compare to controls. He examined two consonants /p/ and /b/ in nine persons with PD. They found 7-9 ms longer VOT for persons with PD compared to normal persons. There were no significant differences between groups for /p/. However, there were significant differences noticed between groups for /b/. In addition, Bunton and Weismer (2002) examined VOT in 10 persons with PD, 10 age matched controls, and 15 persons with other neurological disorders. They found no significant difference between persons with PD and the other disorder groups in VOT. They also noticed that there were no significant differences between persons with PD and control group.

Many other researchers shown shorter VOT in persons with PD compared to controls (Flint, Black, Campbell-Taylor, Gailey, & Levinton, 1992; Weismer, 1984). Harel, Cannizzaro, Cohen, Reilly & Snyder (2004) conducted acoustic analyses on samples of speech produced over a 10-year period surrounding the time of disease diagnosis. Analyses revealed that decrease in fundamental frequency (F_0) variability during free speech was detected prior to clinical diagnosis for both PD cases. Changes in F0 variability and voice onset time (VOT) were also detected upon the initiation of symptomatic treatment. Previous research examining VOT in persons with PD has shown higher VOT (Forrest, Weismer, & Turner, 1989), lower VOT (Weismer, 1984), and no change in VOT (Bunton & Weismer, 2002) compared to controls.

Several attempts have been made to study the speech of PD based on acoustic analyses. However, studies correlating the findings of VOT are scanty. Further, not much information is available in Indian context on VOT in persons with PD. Hence, the present study was taken up with the aim of determining the changes in VOT in the speech of PD.

Method

The present study was conducted with the aim of determining the VOT in parkinson's disease. The mean VOT was compared between parkinson's disease and normal matched subjects.

Participants

Participants were divided into two groups: experimental group and control group. Experimental group included 12 subjects (8 males and 4 females) in the age range 45-70 years (mean age 60.58 years). All the subjects were under medication.

Inclusion Criteria:

The subjects were diagnosed as having Parkinson's disease by a qualified neurologist after MRI/CT scan/other necessary evaluations. The onset of symptoms was 3 - 5 years and stage II and III. The subjects did not present any additional medical or neurological conditions such as CVA that could contribute to the observed speech disorder. None of the subjects presented with a history of hearing loss. As per the medical records and personal history revealed that subjects hypertension (Blood pressure) and diabetes (Blood sugar level) was under control.

Control group

Age and sex matched adults with no sensory/ speech /language

and hearing problem served as the control group. This was ensured using informal testing of the subjects for speech, language and sensory impairments. Mini Mental Status Examination (Folstein, Folstein & McHaugh, 1975) was administered to rule out cognitive-linguistic deficits if any.

For data collection i.e. speech samples from each subject of both the groups, the following procedure were used

Procedure

A story title "The Thirsty Crow" was used to elicit spontaneous speech for all the subjects of both the groups served as the test material. The data was collected one hour prior to the intake of the medicine or eight hours after the medicine. The subjects were made to be seated comfortably with the microphone connected to the Lenovo laptop at a distance of 5 cm from the mouth of the subject. The samples were recorded in a quiet environment with no distractions. The PRAAT software version 4.4.13 was used to analyze the VOT of /b/, /d/, & /g/.

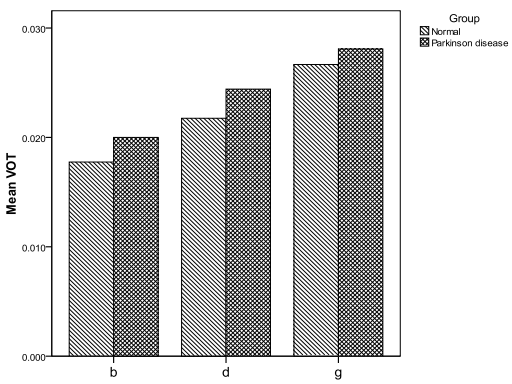
Results and Discussion

The present study incorporated an Ex-Post facto design where in the persons with Parkinsonism were selected and compared with normal matched persons on VOT. Graph 1 indicates that the mean VOT for /b/, /d/, and /g/for persons with parkinson's disease were longer compared to the normal. Results of Mann Whitney test to compare the values indicated statistically significant for consonant /b/ and /d/. However, there were no significant difference between Persons with parkinson's disease and normal persons for consonant /g/. The longer VOT in parkinson's disease may be because of slow rate of speech. Several researches have reported that changes in speaking rate have an effect on VOT. In a similar study done by Forrest, Weismer, & Turner (1989) found a significantly longer VOT in persons with PD for the voiced sound /b/.

"Graph 1 about here"

Bunton and Weismer (2002) found no changes in VOT for Parkinson's disease compared to control group. Author reported that similar VOT for parkinson's disease may be because of compensating for slow movement of the articulators by reducing the range of articulatory movements. Another reason for longer VOT in PD may be because of having difficulty in initiating speech and coordination in laryngeal movements (Forrest, Weismer, & Turner, 1989). Contrary to this Weismer (1984) and Flint, Black, Campbell-Taylor, Gailey, & Levinton (1992) both reported shorter VOT in PD compared to normal persons. They reported that this could be due to stiffness of the laryngeal musculature in the PD group, causing a reduction in vocal fold opening.

The present study also found that consonant /b/ has shorter VOT than consonant /d/ followed by /g/. The place of articulation also has an effect on VOT. Bilabial stops have shorter VOT than velar stops. Previous literature also reported that VOT is affected by place of articulation (Kent & Read, 2002; Kessinger & Blumstein, 1997; Klatt, 1975; Lisker & Abramson, 1964). The results of the study are significant in understanding the deviant temporal parameter (VOT) in persons with Parkinsonism.



Graph 1: Comparison of Mean VOT of normal persons and persons with Parkinson's disease.

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