Contents lists available at www.innovativejournal.in

INNOVATIVE JOURNAL OF MEDICAL AND HEALTH SCIENCE

Journal homepage: http://innovativejournal.in/ijmhs/index.php/ijmhs

ISSN No. 2277-4939

Research Paper

EFFECT OF SPEAKING RATE MODIFICATION ON ARTICULATION AND PAUSE CHARACTERISTICS IN INDIVIDUALS WITH PARKINSON'S DISEASE

Yukti Ajwani*[1], Rohini Chand-Mall *[2]

*[1]Speech Language Pathologist and Audiologist-Grade 1, Pt. Jawahar Lal Nehru Medical College, Jail Road, Moudhapara, Raipur, Chattisgarh, India

*[2]Assistant Professor (SLP), School of Audiology and Speech Language Pathology, Bharati Vidyapeeth Deemed University, Pune, India.

ARTICLE INFO

Corresponding Author:
Rohini Chand-Mall
Assistant Professor (SLP)
School of Audiology & Speech Language Pathology, Bharati Vidyapeeth Deemeed University, Pune, Maharastra, India

Key Words: Dysarthria, Parkinson's diseases, speaking rate, articulation rate, pause, acoustic.

DOI:http://dx.doi.org/10.15520/ijmhs.2017.vol7.iss4.172.

ABSTRACT

The purpose of this study was to examine effect of rate modification on parameters of rate in individuals with idiopathic Parkinson's disease. Fifteen native Marathi speakers within the age range of 50 – 80 years with Idiopathic Parkinson's Disease (PD) and fifteen healthy controls (HC) participated in the study. The participants read a Marathi passage at three rate conditions; habitual, fast and slow. Speaking rate, articulation rate, pause duration, and pause frequency was extracted for the two speaker groups using PRAAT software. Findings of the study show that for PD speakers, the average speaking rate, & articulation rate was reduced but pause duration and pause frequency was increased as compared to HC speakers. The PD speakers altered their rate and pause characteristics in a similar way as done by HC speakers to achieve speaking rate changes, however, the extent of change was lesser for PD speakers.

©2017, IJMHS, All Right Reserved

INTRODUCTION

Parkinson's disease is a chronic neurodegenerative disorder characterized by the progressive loss of dopaminergic neurons in the substantia nigra [1]. Parkinson's disease is a slowly progressive idiopathic neurologic disease that affects approximately 50 people per 100,000 older than age of 50. It usually begins mid-to-later life; survival from symptom onset is approximately 9 yrs. Dysarthria is seen in Parkinson's disease. However, it does not emerge for several years after the onset of other signs of PD [2]. As the disease progresses in individuals with PD, approximately 60% to 70% of the individuals with PD develop speech symptoms. Parkinson's disease is most commonly the cause of hypokinetic dysarthria. A study analysed speech characteristics of dysarthric speakers with Parkinson disease [3]. PD speakers excessively used short phrases, short rushes, pauses and variable speech rate. Reduction in the intensity of the speech, stress, intonation patterns, abnormal voice qualities, distorted consonantal sounds are the few speech abnormalities observed in individuals with PD [4]. Review of literature on speech rate suggests that speech rate deficits are exhibited by individuals with dysarthria [4], [3], [5], [6], [7], [8], [9]. The results of the studies showed that most Parkinson disease patients speak at a rate that is at least somewhat different from unimpaired speakers (too slow, too fast, and variable). Variable rate is also one of the speech symptom in hypokinetic dysarthria which gives an impression of fast rate of speech and articulatory undershoot [10].

Speaking rate has been observed to be a significant perceptual feature which is impaired in individuals with dysarthria associated with PD. Slower than typical rate technique has been used to improve intelligibility of dysarthria speakers but not all speakers with dysarthria exhibits improved intelligibility when their rate is reduced. For altering speaking rate, one may change articulation time or pause time or both. Researchers in western context have studied ability of dysarthria speakers with PD, ALS, and Multiple sclerosis (MS) to voluntarily alter speech rate at different conditions, and whether they use articulation rate and pause characteristics in a way similar to neurologically intact individuals [11], [12], [13], [14]. Speech and pause characteristics associated with voluntary rate reduction in Parkinson's disease (PD) and multiple sclerosis (MS) was investigated and was compared with neurologically intact talkers. The parameters measured were speech rate, articulation time, pause duration, and pause frequency. Descriptive statistics suggested that articulatory rate and

Author(s) agree that this article remain permanently open access under the terms of the Creative Commons Attribution License 4.0 International License

speech rate was least for MS group as compared to PD and control group in habitual condition. However, in slow condition highest articulatory rate was found for PD group. Pause duration was highest for PD group in habitual and slow condition. All the speakers tried to adjust their articulation time and pause time to reduce the overall rate in the slow condition. When speakers tried to slow their speech rate than normal, articulation rate was reduced; shorter speech runs and longer and frequent pauses were used. These results suggest that dysarthria training programs can enhance the existing skills used by the patients for the rate reduction [14].

There are few studies reporting relationship between articulation rate and pause characteristics as a function of speaking rate. However, in Indian context there are no studies analyzing rate parameters in individuals with dysarthria to best of researcher's knowledge. There is limited knowledge about how individuals with dysarthria voluntarily alter their speaking rate. Therefore, analysis of speaking rate in dysarthria is required which may extend our understanding of how individuals with dysarthria voluntarily alter speaking rates. Hence, the current study was planned to analyze rate parameters in individuals with dysarthria associated with Parkinson Disease.

Aim: The study the effect of speaking rate modification on parameters of rate in individuals with dysarthria associated with Parkinson's disease.

Material and Method

Participants: Participants of the study were divided into two groups. The first group consisted of individuals with dysarthria associated with Parkinson's disease (PD) and the second group (HC) consisted of healthy individuals. Individuals with confirmed medical diagnosis of Parkinson's disease were selected. The participants were within the age range of 50-80 years with mean age of 59.8 years. Severity of dysarthria was assessed by SLP on a rating scale of mild to severe (1-mild, 2-moderate, 3-severe) and individuals with the severity of mild degree were considered (Table I). The participants with PD who had very limited or no speech output and the one with normal speech intelligibility were not considered in the study. All the participants were able to read and speak Marathi fluently. Participants had no known associated language, cognition, and vision and hearing difficulties. In order to avoid the effect of medication on speech, it was ensured that the speech samples were recorded at least eight hours post-medication. For the HC group, individuals within the age range of 50-80 years were selected. Individuals without any neurological problems and no known associated hearing, speech, language, cognitive and visual problems were considered. All the participants were able to read and speak Marathi fluently.

Material and recording procedure: The stimuli included a Marathi passage consisted of 152 words and including all the phonemes in Marathi language. The printed passage was given to the participants and they were asked to read the passage once for familiarity. The participants were instructed to read the passage in three speaking conditions i.e., Habitual (H), fast (F) and slow (S). In Habitual speaking condition, patients were instructed to read the passage at their normal speed. Following the habitual condition, participants were instructed to voluntarily speak as fast as possible and as slow as possible. A rest period of 5 minutes was given to the participants between the three recordings. The speech recording for PD was done at least four hours after the consumption of anti-Parkinson's medication to avoid its effect on speech.

Acoustic Analysis: The recorded sample from each participant was subjected to acoustic analysis. The parameters extracted using PRAAT software (version 4.1.21) was Speaking rate, Articulation rate, Pause duration, and Pause frequency. The working definitions are: (a) Speaking rate is defined as words per minute for a given sample of speech; (b) Articulation is defined as the total number of the syllables produced by the articulation time (time during which speech segments are produced) and is expressed in syllables/second; (c) Pause duration was measured from the offset to the onset of the two consecutive speech runs. It is defined as a silent period in the speech waveform of at least 200 milliseconds; (d) Pause frequency was considered to be the number of pauses in the speech sample.

Results and Discussion

The mean and standard deviation obtained through descriptive statistics for the selected rate parameters at each condition for both the groups are given in the Table . A difference in the mean scores was observed between DYSPD and HC group each rate condition for all rate parameters namely, speaking rate, articulation rate, pause duration, and pause frequency. Average speaking rate and articulation rate were reduced in DYSPD group as compared to HC group. Whereas an increase in pause duration and pause frequency was noted in DYSPD group as compared to HC group. For both the groups mean speaking rate, and articulation rate for a speech run was highest for fast condition followed by habitual and slow rate. MANOVA was done to compare the selected rate parameters between DYSPD and HC group separately for each condition. Statistically significant main effect was noted for the selected rate parameters between the DYSPD and HC group for habitual condition ($F(1,28)=51.71$, $p<0.01$), Fast condition ($F(1,28)=36.16$, $p<0.01$) and Slow condition ($F(1,28)=50.77$, $p<0.01$) was observed. There was a statistical significant difference between the groups for speaking rate ($p<0.01$), articulation rate ($p<0.01$), pause duration ($p<0.01$), and pause frequency ($p<0.01$) for each rate condition was seen. Repeated measure ANOVA was done for each rate parameter across the rate conditions separately for DYSPD and HC group.

Speaking rate: Overall speaking rate was slower for DYSPD group compared to HC group although the mean speaking rate increased from slow to habitual to fast rate condition for both groups (figure 1). Statistical analysis of speaking rate showed a significant main effect ($F(1,14)=16.17$, $p<0.01$) for rate conditions within DYSPD group and within HC group. For both groups, post hoc analysis revealed a significant difference between the three rate condition pairs i.e., H-F, H-S and F-S ($p<0.01$).Both the groups were able to voluntarily modify their speaking rates; reduce rate from habitual to slow and increase from habitual to fast condition; the DYSPD individuals could not change the rate to the extent as the healthy controls. Previous studies on speaking rate have been done in speakers with dysarthria of various neurological diagnosis like with PD, ALS and MS. Results of few studies suggests that speakers with PD are able to voluntarily reduce their speech rate from habitual to slow condition but the magnitude was smaller compared to controls and MS [14] which supports our findings,

whereas, another study [15] found contrary findings that dysarthria speakers of different neurological diagnosis were not able to speak 'slowly on demand' compared to the other rate control methods used. A study on ALS report that speakers were able to alter their speaking rate for a reading passage from habitual to slow condition but ALS speakers' rates were slower than normal speakers in habitual condition [11]. The current study supports the previous findings that speakers with PD can voluntarily alter their speaking rate. But the strategies used are different for the groups during reducing the rate. DYSPD individuals increased duration of pauses while HC individuals used frequent pauses.

Articulation rate*:* Figure 2 indicates slower articulation rate for PD group as compared to HC group. The average articulation rate showed an increase from slow to habitual to fast rate conditions for both the groups. A statistical significant main effect ($F(1,14)=21.74$, $p<0.01$) was seen for articulation rate within PD group and HC group. Post hoc analysis indicated a significant difference ($p<0.01$) between H-F and F-S condition but not for H-S for both the groups ($p>0.05$). Results indicate that both DYSPD and HC individuals were able to voluntarily alter articulation rate from habitual to slow and from habitual to fast condition but extent of change was reduced for them when compared to HC for all the conditions. But these results are not unique as studies analyzing effect of voluntary rate modification by PD speakers and healthy controls indicate mixed results. Studies done in past report similar findings that PD speakers can voluntarily reduce their articulatory rate for a short reading passage in presence of external pacing device [16], increase the articulatory rate from habitual rate to fast and decrease from habitual to slow [13] and reduce the mean articulatory rate from habitual to slow condition [14]. However, their findings [14] are contrary to the above findings in that magnitude of reduction in articulatory rate was lesser (18 %) for PD speakers compared to control group (35 %). In the present study, DYSPD group was able to voluntarily decrease their speaking rate from habitual however contradictory results have been found [15], [16] where speakers with dysarthria did not reduce their speaking rate. This could be attributable to the language or cultural differences and cross-study variances in the studies reported earlier may help to explain different results observed in the study. The present study reports data for Marathi speakers, while other studies have been conducted in Belgium [15], English speakers [16], [13].

Pause duration: The average pause duration increased from fast to habitual to slow rate conditions for both the groups is shown in the figure 3. A statistical significant main effect ($F(1,14)=147.56$, $p<0.01$) was seen for pause duration within PD group and within HC group. Post hoc analysis indicated a significant difference ($p<0.01$) between Habitual Vs. Fast and Fast Vs. Slow condition but not for Habitual Vs. Slow for HC group ($p>0.05$). However, pause duration was significantly ($p<0.01$) different between Habitual Vs. Fast, Habitual Vs. Slow and Fast Vs. Slow rate conditions for DYSPD group. Present study indicates that DYSPD used longer pauses for each rate condition when compared with HC. Similar findings have been reported in other studies analyzing pause duration in PD speakers [3], [16], [9]. But the pause duration tended to become longer as the rate decreased and became shorter with increase in rate for both the groups. Similar reports are shown by a study where the PD speakers used longer pause duration while voluntarily decreasing the rate from habitual to slow condition [14].

Pause frequency: Figure 4 shows the pause frequency across the rate conditions for both the group. The average pause frequency was found to be highest in slow condition and lowest in fast condition in both the groups. A statistical significant main effect was seen for pause frequency within PD group and HC group. Post hoc analysis indicated a significant difference ($p<0.01$) between Habitual vs. Fast and Fast vs. Slow condition but not for Habitual vs. Slow for HC group. However, pause frequency was significantly different between Habitual vs. Fast and, Fast vs. Slow rate conditions. However, for Habitual vs. Slow a non-significant difference ($p>0.05$) was observed for PD group. Similar findings have been reported by a study [14] suggesting increased pause frequency in PD group as compared to controls.

In summary, rate parameters were compared between DYSPD and HC group across three rate conditions i.e., habitual, fast, and slow in this study. The DYSPD individuals altered their articulation rate, pause duration, and pause frequency group in a similar manner as done by HC individuals to achieve speaking rate changes. Although, the both groups were able to voluntarily modify their speaking rates; reduce rate from habitual to slow and increase from habitual to fast condition; the DYSPD individuals could not change the rate to the extent as the healthy controls. Overall the DYSPD individuals spoke slowly as compared to HC individuals. For both the groups, increase in speaking rate was associated with increase in articulation rate, decrease in pause duration, pause frequency and breath group. Whereas, while reducing the rate, DYSPD individuals increased pause duration and breath group, and while HC individuals increased the breath group and used frequent pauses. Although, both the groups were able to manipulate their breath group while reducing the rates, DYSPD achieved it by using longer pauses while HC increased frequency of pauses. Moreover, DYSPD group gave pauses at grammatically inappropriate locations at each rate condition compared to HC.

Table I. Information regarding age, gender, year since onset of Parkinson's disease and severity of individuals with dysarthria associated with Parkinson's disease.

DYSPD Group	*Age/Sex*	*Dysarthria Severity*	*Yeas since onset*
D1	65/F	Mild	10 Years
D2	68/M	Mild	15 Years
D3	62/M	Mild	10 Years
D4	62/M	Mild	12 Years
D5	58/F	Mild	5 Years
D6	62/M	Mild	10 Years
D7	68/M	Mild	10 Years
D8	68/M	Mild	8 Years
D9	65/M	Mild	7 Years
D10	62/F	Mild	7-8 Years
D11	68/M	Mild	10 Years
D12	65/M	Mild	10 Years
D13	65/M	Mild	8 Years
D14	65/M	Mild	10 Years
D15	62/F	Mild	7 Years

Table II. Mean and SD values of the rate parameters between DYSPD and HC.

Parameters	*Group*	*Habitual*		*Fast*		*Slow*	
		Mean	*SD*	*Mean*	*SD*	*Mean*	*SD*
Speaking rate	DYSPD	112.27	9.80	127.53	4.27	106.13	4.27
	HC	121.3	6.62	137.4	5.46	101.0	1.57

		3		0		7	
Articulation rate	DYSPD	10.07	0.35	13.26	0.76	9.42	0.21
	HC	11.76	0.40	20.09	1.25	11.97	0.59
Pause duration	DYSPD	550.48	6.98	477.52	6.79	621.55	7.84
	HC	418.47	10.11	364.54	6.46	438.30	10.31
Pause frequency	DYSPD	33.6	1.12	23.26	1.77	35.20	1.28
	HC	23.2	0.82	15.8	0.97	27.20	1.07

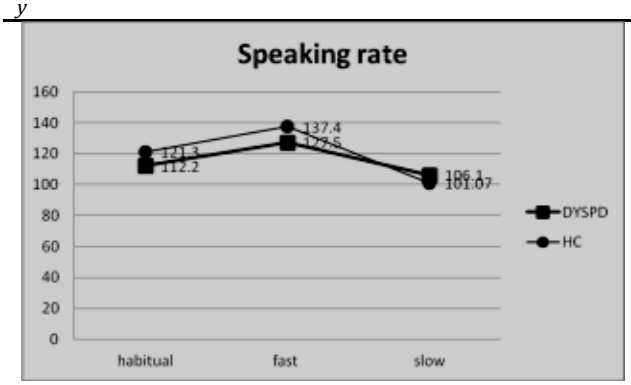

Figure 1: shows the speaking rate across the rate conditions for DYSPD and HC.

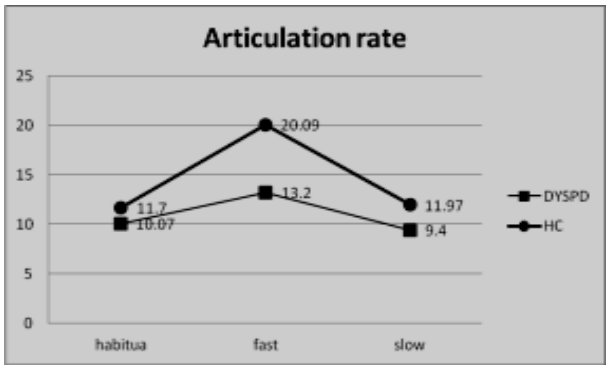

Figure 2: shows the articulation rate across the rate conditions for DYSPD and HC group.

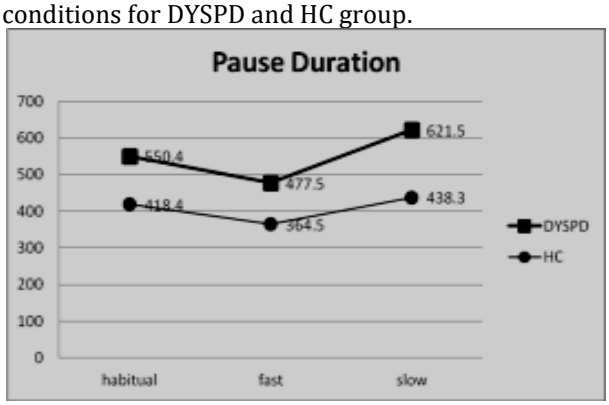

Figure 3: shows the pause duration across the rate conditions for DYSPD and HC group.

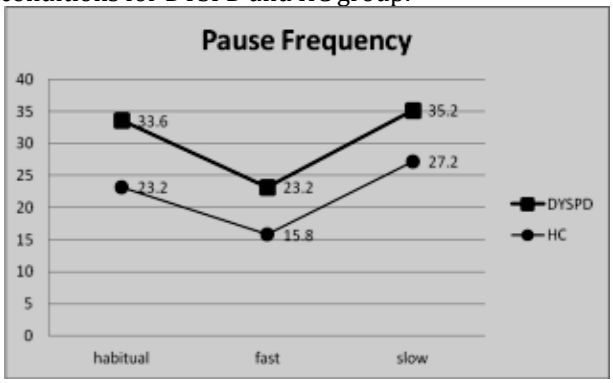

Figure 4: shows the pause frequency across the rate conditions for DYSPD and HC group.

Conclusions

Findings of this study indicates that DYSPD speaker's can voluntarily alter their speaking rates but the extent of changes made in articulation and pause characteristics were limited when compared with healthy controls. DYSPD individuals relied on pause duration for reducing rate although less pauses were placed at grammatically appropriate locations. So, the existing strategies used by individuals with dysarthria associated with PD can be used in the treatment focusing on rate control. Therefore, the treatment programs focusing on voluntary rate modification in dysarthria might incorporate speaking fewer syllables per breath while pausing frequently and placing pauses at appropriate grammatical locations. Pause placement training might be helpful because the current results indicated that individuals with dysarthria relied on pause duration to alter their rate but paused inappropriately.

References

[1] Hornykiewicz, O., 1998. Biochemical aspects of Parkinson's disease. *Neurology*, 51(2 Suppl 2), pp.S2–9.

[2] Müller, J. et al., 2001. Progression of dysarthria and dysphagia in postmortem-confirmed parkinsonian disorders. *Archives of neurology*, 58(2), pp.259–264.

[3] Darley, F.L., Aronson, A.E. & Brown, J.R., 1969. Differential diagnostic patterns of dysarthria. *Journal of speech and hearing research*, 12(2), pp.246–269.

[4] Canter, G.J., 1963. Speech characteristics of patients with Parkinson's disease: I. intensity, pitch and duration. *The Journal of Speech and Hearing Disorders*, 28, pp.221–229.

[5] Van Lancker, D. & Canter, G.J., 1981. Idiomatic versus literal interpretations of ditropically ambiguous sentences. *Journal of speech and hearing research*, 24(1), pp.64–9.

[6] Ludlow, C.L., & Bassich, C.J. 1984. The results of acoustic and perceptual assessments of two types of dysarthria. *Clinical Dysarthria*, ed. By W.R. Berry, 121-154. San Diego: College-Hill Press.

[7] Volkmann, J. et al., 1992. Impairment of temporal organization of speech in basal ganglia diseases. *Brain and Language*, 43(3), pp.386–399.

[8] Tjaden, K., 2000. A preliminary study of factors influencing perception of articulatory rate in Parkinson disease. *Journal of speech, language, and hearing research*, 43(4), pp.997–1010.

[9] Niimi, M. & Nishio, S., 2001. Speaking rate and its components in dysarthric speakers. *Clinical Linguistics & Phonetics*, 15(4), pp.309–317.

[10] Darkins, A.W., Fromkin, V.A. & Benson, D.F., 1988. A characterization of the prosodic loss in Parkinson's disease. *Brain and Language*, 34(2), pp.315–327.

[11] Turner, G.S., & Weismer, G., 1993. Characteristics of speaking rate in the dysarthria associated with Amyotrophic Lateral Sclerosis. *Journal of Speech Language and Hearing Research*, 36, pp. 1134-1144.

[12] Turner, G.S., Tjaden, K. & Weismer, G., 1995. The Influence of Speaking Rate on Vowel Space and Speech Intelligibility for Individuals With Amyotrophic Lateral Sclerosis. *Journal of Speech Language and Hearing Research*, 38(5), pp.1001–1013.

[13] McRae, P.A., Tjaden, K. & Schoonings, B., 2002. Acoustic and perceptual consequences of articulatory rate change in Parkinson disease. *Journal of Speech, Language, and Hearing Research*, 45(1), pp.35–50.

[14] Tjaden, K. & Wilding, G., 2011. Speech and pause characteristics associated with voluntary rate reduction in Parkinson's disease and Multiple Sclerosis. *Journal of Communication Disorders*, 44(6), pp.655–665.
[15] Van Nuffelen, G. et al., 2009. The effect of rate control on speech rate and intelligibility of dysarthric speech. *Folia Phoniatrica et Logopaedica*, 61(2), pp.69–75.
[16] Hammen, V.L. & Yorkston, K.M., 1996. Speech and pause characteristics following speech rate reduction in hypokinetic dysarthria. *Journal of Communication Disorders*, 29(6), pp.429–445.