ACOUSTIC CORRELATES OF MONOTONE SPEECH IN PARKINSON'S DISEASE

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INTRODUCTION

One of the most frequently perceived symptoms in Parkinson's disease (PD) is monotone speech[1,2]. Speech in PD is often described as monotonous or lacking in emotional expressiveness. Terms such as monopitch (flatness in vocal pitch) and monoloudness (flatness in vocal loudness) are also used to describe the monotone speech of PD[1]. Acoustic studies of PD speech have suggested that monotone speech may be associated with a reduction in frequency variation and intensity variation during spoken sentences[3,4]. However, only one report has attempted to correlate these acoustic measures with perceptual ratings of monotone speech[5]. Unfortunately, this study[5] failed to observe a significant correlation between the acoustic and perceptual measures of monotone speech. Thus, the results of these previous studies indicate that the acoustic correlates of monotone speech remain to be determined. The purpose of the present study was to continue to investigate the acoustic correlates of monotone speech in PD using a variety of novel acoustic measures. One such measure that has not previously been examined in PD speech is fundamental frequency (F0) declination. In normal speech production, F0 declination is typically seen as a gradual decrease in pitch (F0) from the beginning to the end of a sentence. F0 declination has received attention in several previous studies of normal speech[6,7,8]. However, the relationship between F0 declination and the perception of monotone PD speech has not been previously examined.

METHODS

Perceptual ratings and acoustic measures of speech were obtained from 3 groups of subjects: 10 PD patients with mild monotone speech, 10 PD patients with severe monotone speech, and 10 age-matched normals. All subjects read aloud a paragraph (the grandfather passage)[1]. The second sentence from this paragraph was used to obtain both the perceptual and acoustic measures. A direct magnitude estimation procedure[9], involving 5 listeners, was used to obtain perceptual measures of monotone speech. In particular, perceptual ratings were obtained for two dimensions: monopitch and monoloudness.

Several acoustic measures were obtained from the fundamental frequency (F0) and intensity contours of the subjects' spoken utterances. All acoustic measures were obtained using the Computer Speech Lab (CSL) program (Kay Elemetrics, Inc.). One set of measures examined the overall variability of the F0 and intensity contours. These included the standard deviation, the range, and the coefficient of variability of F0 and intensity contours. A second set of measures examined the declination pattern of the F0 and intensity contours. These included estimates of the slope of the F0 and the slope of the intensity contours across various segments of the utterance.

RESULTS

The severe PD patient group was perceived to have significantly higher monopitch and monoloudness scores than the mild PD patients and the normals (Table 1). The severe PD patient group was also found to have significantly lower F0 slope values than the other two groups (Table 1.)

The acoustic measures of the declination pattern were found to have the highest correlations with the perceptual measures of monotone speech (Table 2). In particular, the slope of the F0, estimated across an entire phrase, was found to have the highest correlation (r=.70) with the perceptual ratings of monopitch and monoloudness.

DISCUSSION

These results indicate that PD patients with severe monotone speech show a significantly different F0 declination pattern than less severe PD patients and normals. In particular, these monotone PD patients showed a much more gradual F0 declination (almost a flat F0) than was seen in the normal and mild PD subjects (see Figure 1). The finding of a fairly high correlation between F0 declination and monotone PD speech has not been previously reported. In the one previous report that examined the acoustic correlates of monotone speech in PD, the results were disappointing[5]. In particular, Ludlow and Bassich[5] failed to find a significant correlation between several measures of F0 change in sentences and perceived monopitch (r= -.10 to .32). The present results suggest that a potentially important psychoacoustic relationship may exist between F0 declination and perceived monotone speech in PD. Previous clinical efforts to treat monotone PD speech have not focused on the F0 declination patterns[10,11]. The present findings suggest that the systematic modification of F0 declination needs to be evaluated in future studies of monotone PD patients.

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Table 2. Correlations between the perceptual and acoustic measures of monotone speech (Pearson r values obtained using data from all 30 subjects).

	Monopitch	Monoloud
Monopitch	--	--
Monoloud	.92	--
Slope F0	-.69	-.59
Slope Intensity	-.26	-.21
Stand. Dev. F0	-.47	-.36
Range F0	-.14	.08
Stand. Dev. Intensity	-.22	-.24
Range Intensity	.10	.13

Table 1. Mean perceptual and acoustic measures for the normal and PD groups (*= significant t-test, p<.05).

	Normals	Mild PDs	Severe PDs
Monopitch	66.5 (20.2)	53.0 (15.1)	183.5 (33.7)*
Monoloud	65.0 (17.2)	66.5 (19.5)	182.0 (19.8)*
Slope F0	-6.17 (1.33)	-6.58 (1.54)	-0.56 (1.72)*
Slope Intensity	-1.11 (1.71)	-0.72 (1.01)	-0.47 (0.60)
Stand. Dev. F0	16.0 (3.78)	16.6 (6.51)	12.5 (5.50)
Range F0	88.6 (24.5)	82.1 (30.5)	87.4 (53.7)
Stand. Dev. Intensity	3.59 (0.92)	3.53 (0.64)	3.57 (0.62)
Range Intensity	19.3 (2.91)	19.3 (3.24)	19.5 (2.68)

Figure 1. Estimates of F0 declination and the mean F0 slope values for the PD and normal subject groups.