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Prosody may be defined as the patterned distribution of stress, intonation and other phonatory features in speech. Wennerstrom calls it the 'music of everyday speech'. Dysarthric Parkinson speech is characterized by impairment of expressive linguistic prosody. The origin of prosodic impairment must be seen in the light of the accompanying impairments of receptive prosody, for example, the inability to recognize intonational meaning and to make lexical distinctions based on stress contrasts.

The facilitating effect of music on motor coordination in patients suggests that music might have a similar effect on vocal behavior. In this study, an attempt was made to quantify the extent to which prosodic impairment was paralleled by melodic and rhythmic impairments while singing.

## SUBJECTS

15 Parkinson patients and 15 healthy controls matched for age and gender. Patients recruited via Parkinson website

- mean age: 65 years SD: 7.7 years
- mean duration: 8 years SD: 4 years
- mean Hoehn & Yahr: 2 SD: 0.66
- asymmetry: 8 left, 7 right
- gender: 9 female, 6 male
- none professional musician

## TASKS

1. Baseline measurement of speech impairment: monologue on a theme of subject's own choice
2. Recite the lyrics of a familiar song in the rhythm of the song
3. Sing a familiar theme or melody without lyrics (pom-pom-pom; la-la-la, etc.)
4. Improvise (vocally) a continuation to a phrase (pom-pom-pom; la-la-la, etc.)

## BASELINE

Recordings of the normal speaking voice were edited into short (20 - 30 s) soundbytes and presented to resident neurologists (n=5) from the UMCG in randomized order to determine whether the speech of Parkinson patients could be distinguished aurally from the speech of healthy subjects.

	PATIENT	CONTROL
Definitely Parkinson	20%	4%
Probably Parkinson	28%	17.3%
Maybe, maybe not	22.7%	25.3%
Probably NOT Parkinson	18.7%	22.7%
Definitely NOT Parkinson	10.7%	30.7%

FN: 29.4% FP: 21.3%  
X<sup>2</sup>: 23.383 p (same): < 0.001

## METHOD

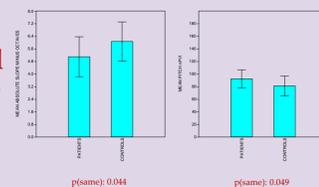
Recordings (WAV) were made in the home, using a Roland 05 handrecorder. Patients did not abstain from medication. Subjects chose lyrics (2) and melodies (3) themselves. Continuations (4) were prompted by a set of nine phrases, composed and sung by the researcher. The monologues (1) and the rhythmic recitation (2) were analyzed in PRAAT. Syllable onset was inserted manually in the textgrid. Singing was digitalized (0.01 s window) for analysis. Melody tones were computed on the basis of the median pitch between onsets.

## ANALYSIS

Pairwise and groupwise differences in pitch, pitch variability, pitch range, tempo, and rhythmic variability were investigated, contrasting: pitch, scale mean, density peak; mean interval, normalized pairwise variability index of pitch, mean absolute slope; pitch range; interonset interval; and normalized pairwise variability index of interonset interval.

## GROUP CONTRASTS

Significant differences between patient and control groups were found only in task 2 (smaller pitch variability in rhythmic speech) and in task 4 (slightly larger pitch variability while singing).



## PAIRWISE CONTRASTS

Significant pairwise differences between patient and control were found on average in 33% of cases, except in task 4: pitch nPVI: 87%. Pairwise differences were never consistently in one direction.

## CORRELATIONS

A significant, positive correlation (rs: 0.53) was found between Hoehn & Yahr score and pitch nPVI in task 3 and between patients and controls for mean pitch in task 3 (rs: 0.74) and task 4 (rs: 0.80), but not for task 1 and 2. No correlations were found with age.

## GENDER CONTRASTS

Significant differences of means were corroborated for all pitch parameters between males and females, for all tasks. Significant differences of pitch variability were found in task 1 (females > males) and in tasks 3 & 4 (males > females)

## GENDER x GROUP

Significant patient-control differences of means were found within one sex only for: task 1 & 2: pitch variability (male controls > male patients); task 4, pitch variability (female controls > female patients)

## TASK vs. TASK

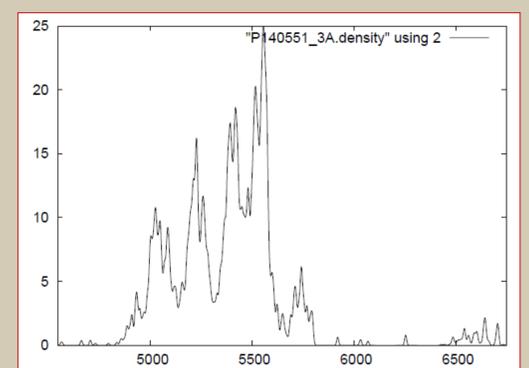
Contrasting task 1:2, task 3:2, and task 4:2, significant patient-control difference of the ratio between tasks was found for rhythmic variability, IOI nPVI (controls > patients)

**TASK 1:** While dysarthric Parkinson speech could be distinguished from the speech of healthy controls on the basis of aural perception alone, no significant group differences between patients and controls were found in pitch, pitch range, pitch variability, tempo or rhythmic variability.

**TASK 2:** patients exhibited less pitch variability and, in contrast with all other tasks, less rhythmic variability during rhythmic recitation.

**TASK 3:** no significant differences were found between the singing of patients and controls while singing familiar melodies (without lyrics).

**TASK 4:** With the exception of slightly larger pitch variability, no significant differences were found between patients and controls during vocal improvisation. In the comparison, only six Parkinson patients exhibited significantly larger pitch variability than the matched control.



density plot

The results of this study suggest that, in Parkinson's disease, in contrast with speech, singing may not be significantly impaired. Mean pitch and pitch range are not different from healthy controls. Mean sung interval is no different from healthy controls and pitch variability may even be slightly larger. Tempo is not reduced, nor is rhythmic variability. It seems that music facilitates vocal motor behavior as well as body movement. The results of the rhythmic recitation task suggest, however, that rhythm does not facilitate vocal behavior as well as melodic pitch variation.

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