

Phonological and sociophonetic information in parkinsonian dysarthric speech: The analysis of two varieties of Italian

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Hypokinetic dysarthria may characterize Parkinson's Disease, resulting in reduced range and accuracy in the coordination of movements [1], including those of speech articulators. Such reduction affects the production of segments and prosody [2,3,4,5], inducing variability in speech. However, such variability goes along with typical patterns of variability that correspond to socio-phonetic variation, and a question arises as to the relation between the disease-related variability and the specific socio-phonetic characteristics.

The varieties of Italian spoken in Bari and Lecce (Southern Italy), for instance, belong to different dialectal isoglosses (South vs. Extreme South; [6]) and are characterized by different sociophonetic markers: a) affricates voicing and b) unvoiced plosive strong aspiration only in Lecce, and c) vowel reduction or deletion in pre- or post-tonic position in Bari (where the system is eptavocalic, while it is pentavocalic in Lecce; [7,8]). Some of the characteristics variably distributed in the two varieties go in the direction expected in dysarthric speech, that are difficulties in interrupting voicing in intervocalic consonants and variably phasing laryngeal and supralaryngeal gestures [9,10], such as in a) and b) in the Lecce variety, and tendency to reduce vowels, such as in c) for Bari Italian.

The main goal of the paper is analyzing speech produced by dysarthric parkinsonian and healthy control speakers from Bari and Lecce to verify if the disease-related variability has a different impact on dysarthric speech characteristics, possibly depending on the variety-specific phonological and phonetic features. In this work, a set of phonetic and phonological features is considered 1) to confirm the differences between dysarthric and control speech, observing vowel space areas and stop production accuracy, and 2) to correlate the dysarthric speech characteristics in the two varieties with the phonological and phonetic references as found in control speakers, observing post-tonic vowel reduction, consonant voicing and aspiration. We hypothesize that a) measures regarding the set of features differentiate dysarthric and control subjects, but b) characteristics of dysarthric and control's speech differ more where the reference, varietal feature is already shifted in the direction of reduction in range or accuracy, as if the reference system would somehow admit more variability in that expected direction (with less need for compensation-strategies that are often observed [15]).

Twenty Parkinsonian subjects with mild hypokinetic dysarthria (PDs, 10 from Bari; 10 Lecce – M, F balanced; DYS-TOM 3-4), and 5 control speakers for each variety (CTRs) participated in the study. They were not cognitively impaired (MoCA \geq 24), were from/lived in the Bari/Lecce, were age matched as much as possible (mean age: PDs 63 y.o., CTRs 59 y.o.) and presented a similar amount of everyday use of the local dialect. Subjects read 3 short passages (54+54+57 words=165), and 3 repetitions of sentences (20 words) and words (15) in isolation (Tot=270 wordsXsubj). We measured Vowel phonetic space (/i/-/a/-/u/) and post-tonic Vowel reduction: F1xF2 normalized [11] values and Vowel Articulation Index [12,13,14]; Accuracy in stop production: percentage of accurate closure, burst, and voicing realization; Aspiration (strong): percentage (auditory check) and VOT duration. Only descriptive statistics are applied as the study is exploratory (for a similar approach, [15]).

Preliminary results showed no relevant phonatory deficits and 1) consistently with the literature, the vowel space is reduced (Fig.1) and accuracy in stop production is diminished (Tab.1) in PDs comparison to CTRs; however, the vowel space in PDs from Bari shows a greater reduction along the vertical dimension, as /a/ seems more variable, possibly because [ə] is expected in the unstressed vowel system. 2) Post-tonic vowel reduction is found more in PDs from Bari more than in PDs from Lecce, while consonant voicing and aspiration characterize only speakers from Lecce, and PDs more than CTRs (Tab.1). These observations suggest that variety-specific phonological-phonetic features have an impact on the disease-related variability, and that more variation in PD speech may be found in case the reference system already presents features that go in the direction expected in dysarthric speech, as if the system would admit more variability in that direction. However, as the results are preliminary and the study is exploratory, a larger investigation is required in order to confirm the observations mentioned above and to give a robust answer to the research questions.

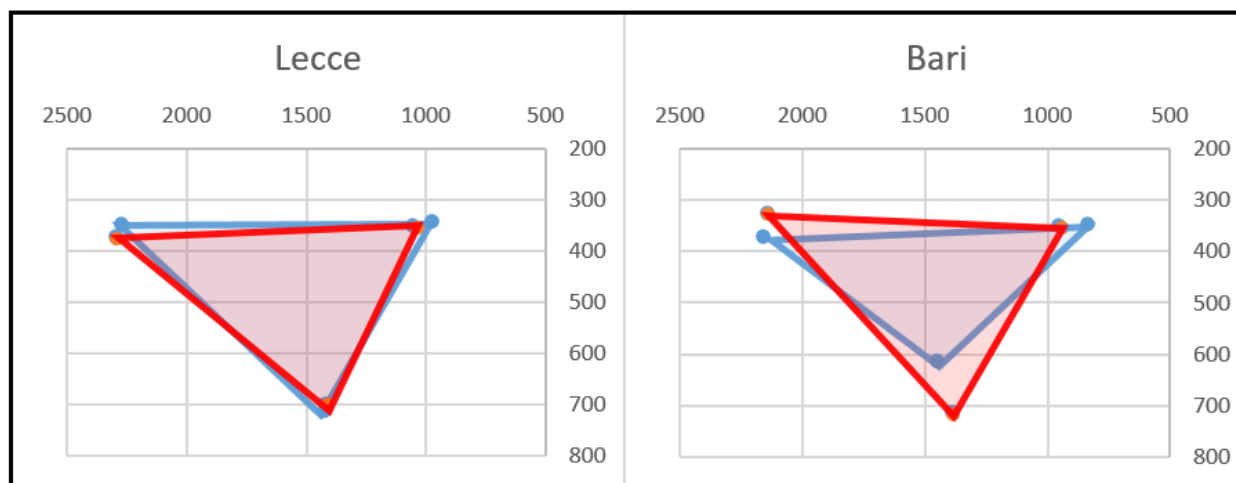


Fig. 1. Acoustic vowel space showed with reference to F1 and F2 vowel formants for /i/-/a/-/u/, for PD-dysarthric (blue) and matched controls (red) from Lecce (left) and Bari (right). Vowel formant values were averaged across productions, controlling for factors such as stress.

Table 1. Percentages of accuracy in stop closure and VOT (aspiration) realization.

	/t/		/tt/		/p/		/k/	
SPK	Accuracy	Aspiration	Accuracy	Aspiration	Accuracy	Aspiration	Accuracy	Aspiration
PD_LE	24/24 100%	24/24 100%	41/41 100%	41/41 100%	46/46 100%	2/46 4.34%	14/23 60,86%	2/23 8.69%
CTR_LE	17/17 100%	12/17 70.58%	34/34 100%	28/34 82.35%	32/32 100%	0/32 0%	13/17 76.47%	0/17 0%
PD_BA	20/20 100%	0/20 0%	39/39 100%	1/39 2.56%	38/42 90.48%	0/42 0%	5/20 25%	0/20 100%
CTR_BA	14/14 100%	0/14 0%	26/26 100%	4/26 15.38%	28/28 100%	0/28 100%	6/14 42.85%	0/14 0%

References

- [1] Darley, F.L., Aronson, A. & J.R. Brown. (1975). *Motor speech disorders*. Philadelphia: WB Saunders Company.
- [2] Canter, G.J. (1963). Speech characteristics of patients with Parkinson's disease: Intensity, pitch and duration. *Journal of Speech Hearing Disorders*, 28, 217-2243.
- [3] Monrad-Krohn, G.H. (1947). Dysprosody or altered melody of language. *Brain*, 70, 405-415.
- [4] Teston, B., & F. Viallet. (2001). L'évaluation objective de la prosodie in Les dysarthries. In P. Auzou, C. Ozsancak & V. Brun (Eds), *Problèmes en médecine* (pp. 109-121). Paris: Masson.
- [5] Duez, D. (2006). Syllable structure, syllable duration and final lengthening in parkinsonian French speech. *Journal of Multilingual Communication Disorders*, 4/1, 45-57.
- [6] Rohlfs, G. (1949). *Historische Grammatik der Italienischen Sprache und ihrer Mundarten*. Vol. 1. Lautlehre. Bern: Francke (ed. it. Grammatica storica dell'italiano e dei suoi dialetti. Fonetica, 439-446, Torino: Einaudi, 1966).
- [7] Loporcaro, M. (1997). Puglia and Salento. In M. Maiden & M. Parry (Eds.), *The Dialects of Italy* (pp. 338-348). London: Routledge.
- [8] Romano, A. & F. Manco. (2008) Incidenza di fenomeni di riduzione vocalica nel parlato spontaneo a Bari e a Lecce. In F. Albano-Leoni, F. Cutugno, M. Pettorino & R. Savy (Eds.), *Il Parlato Italiano* (pp.1-25). Atti del Convegno Nazionale "Il parlato italiano". Napoli, 13-15 febbraio 2003.
- [9] Best, C.T. (1995). A direct realist view of cross-language speech perception. In Strange, W. (Ed.), *Speech perception and linguistic experience: issues in cross-language research* (pp.171-204). York: York Press.
- [10] Browman, C.P. & L. Goldstein. (1986). Articulatory gestures as phonological units. *Phonology*, 6, 151-206.
- [11] Lobanov, B.M. (1971). Classification of Russian vowels spoken by different listeners. *Journal of the Acoustical Society of America*, 49, 606-608.
- [12] Roy, N., Nissen, S.L., Dromey, C. & S. Sapir. (2009). Articulatory changes in muscle tension dysphonia: evidence for vowel space expansion following manual circumlaryngeal therapy. *Journal of Communication Disorders*, 42, 124-135.
- [13] Sapir, S., Ramig, L.O., Spielman, J.L. & C. Fox. (2010). Formant Centralization Ratio: A Proposal for a New Acoustic Measure of Dysarthric Speech. *Journal of Speech, Language, and Hearing Research*, 53, 114-125.
- [14] Skodda, S., Visser, W. & U. Schlegel. (2011). Vowel Articulation in Parkinson's Disease. *Journal of Voice*, 25, 467-72.
- [15] Thies T., Hermes A., & D. Mücke (2022). Compensation in Time and Space: Prominence Marking in Aging and Disease. *Languages*, 7, 21.