

Cognitive skills and prominence production: Highlighting prominent elements in the speech of patients with Parkinson's disease

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Introduction: Patients with idiopathic parkinsonism suffer from a neurodegenerative disorder of the nervous system. Due to a progressive loss of dopaminergic cells in the substantia nigra patients with Parkinson's disease (PD) develop problems with motor and non-motor functions. On the motor level the dysfunctions defect the voluntary movements and lead to symptoms like: rigidity, resting tremor and bradykinesia [1]. On the level of cognition PD patients have problems with the executive functions, cognitive flexibility, working memory and control of attention [2]. Furthermore, the speech system gets affected which often leads to dysarthric speech. This hypokinetic dysarthria impacts the phonation, articulation and the respiratory system. The speech deficits include monoloudness, monopitch, reduced stress, imprecise articulation, variability of speech rate, disfluencies and voice tremor [3, 4, 5].

PD affects communication as well as other related functions such as cognition, but complex prosodic aspects such as focus marking are less well studied. Prominence marking in German requires changes in intonation and articulation [6]. Speakers use multiple cues in the phonetic domain to regulate prosodic marking [7], e.g. modulation of F0 and syllable duration. Furthermore, there is insufficient literature on the impact of cognition on these phonetic aspects of prominence marking. The aim of this study is to analyse how prosodic prominence correlates with motoric and cognitive abilities in patients with Parkinson's disease in the complex process of speech production.

Method: In the present study, we are investigating the prosodic marking strategies of PD patients and compare them to the productions of neurotypical speakers. Therefore, we investigate the production of target words in divergent focus structures, contrastive focus and background. We recorded 38 German speakers: 19 patients with idiopathic Parkinson, 13 males and 6 females, aged between 50 – 80, and 19 healthy aged and gender matched controls. For the patient group we assessed severity of the disorder, motoric activity level (UPDRS III, [8]) and speech intelligibility [9]. Further, all speakers were classified in terms of their level of cognition (TMT for executive functions and processing speed, [10], BTA for attention control [11], digit span for working memory [12]).

As speech material, we used a question-answer scenario presented on a computer screen to manipulate focal structure by means of contextualizing contexts. Nine target words were placed in either contrastive focus or background position in sentences such as <Die Fliege hat die grüne Nase berührt.> ("The fly has touched the green nose.") related to pictures on a computer screen. Target words were always disyllabic (CV.CV structure), containing one of the three long vowels /i:/, /a:/ or /o:/, in the accented syllable, such as <Nase> /na:z@/. In total, we recorded 1368 tokens (9 target words x 38 speaker x 2 focus structures x 2 adjectives). For acoustic measurements, we analysed the overall pitch range, the pitch height of rising pitch accents, syllable duration, vowel formants and intensity means.

Results: The results show that, in line with [13], PD patients with mild dysarthric symptoms can convey contrastive focus by increasing pitch, intensity and syllable duration. Furthermore, they adjust their articulatory movements in terms of formant changes and increase their vowel space in prominent positions. We did not find overall group differences between patients and controls comparing the phonetic parameters: pitch, syllable duration and intensity. However, patients have a smaller vowel space than the control participants. Regarding cognitive abilities, we found no

differences in terms of attention control and working memory. But the groups differed significantly according to their processing speed and executive functioning.

Furthermore, we determined influencing factors affecting prominence marking in the patient's group like motoric and cognitive dysfunction. The more severe the executive dysfunction the more intensity and F0 get modulated. The motoric abilities influence the vowel articulation leading to a decrease in vowel space due to motoric impairment.

For the dynamic speech system this reflects abnormalities in the regulation mechanism of expressing prosodic prominence, constantly mediating between linguistic structure and the physical control system. There are some systems which are hyperarticulating (overmodulation of phonetic parameters) and some which are hypoarticulating (undermodulation of phonetic parameters) to produce a communicative output. We will discuss that the patients' system is out of balance, because there is too much effort in the glottal and subglottal system and less effort in the supraglottal system. This leads to an inefficient way of marking prominence. For clinical and therapeutic practice, we assume beneficial effects of cognitive training to preserve communicative function.

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