



The effect of intensive speech rate and intonation therapy on intelligibility in Parkinson's disease



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ABSTRACT

Purpose: Most studies on treatment of prosody in individuals with dysarthria due to Parkinson's disease are based on intensive treatment of loudness. The present study investigates the effect of intensive treatment of speech rate and intonation on the intelligibility of individuals with dysarthria due to Parkinson's disease.

Methods: A one group pretest–posttest design was used to compare intelligibility, speech rate, and intonation before and after treatment. Participants included eleven Dutch-speaking individuals with predominantly moderate dysarthria due to Parkinson's disease, who received five one-hour treatment sessions per week during three weeks. Treatment focused on lowering speech rate and magnifying the phrase final intonation contrast between statements and questions. Intelligibility was perceptually assessed using a standardized sentence intelligibility test. Speech rate was automatically assessed during the sentence intelligibility test as well as during a passage reading task and a storytelling task. Intonation was perceptually assessed using a sentence reading task and a sentence repetition task, and also acoustically analyzed in terms of maximum fundamental frequency.

Results: After treatment, there was a significant improvement of sentence intelligibility (effect size .83), a significant increase of pause frequency during the passage reading task, a significant improvement of correct listener identification of statements and questions, and a significant increase of the maximum fundamental frequency in the final syllable of questions during both intonation tasks.

Conclusion: The findings suggest that participants were more intelligible and more able to manipulate pause frequency and statement-question intonation after treatment. However, the relationship between the change in intelligibility on the one hand and the changes in speech rate and intonation on the other hand is not yet fully understood. Results are nuanced in the light of the operated research design.

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Learning outcomes: The reader will be able to: (1) describe the effect of intensive speech rate and intonation treatment on intelligibility of speakers with dysarthria due to PD, (2) describe the effect of intensive speech rate treatment on rate manipulation by speakers with dysarthria due to PD, and (3) describe the effect of intensive intonation treatment on manipulation of the phrase final intonation contrast between statements and questions by speakers with dysarthria due to PD.

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1. Introduction

Parkinson's disease (PD) is a common, slowly progressive idiopathic neurologic disease caused by basal ganglia circuit control pathology. The majority of individuals with PD develop speech symptoms as the disease progresses (Adams & Dykstra, 2009; Skodda, Rinsche, & Schlegel, 2009). PD is prototypically associated with hypokinetic dysarthria, a perceptually distinctive motor speech disorder, the characteristics of which are most evident in articulation, voice, and prosody (Duffy, 2005). Dysprosody in parkinsonian dysarthria is caused by alterations in speech rate, pause time, speech intensity, and pitch variation (Skodda et al., 2009) leading to variable speech rate, short phrases, short rushes of speech, inappropriate silences, reduced stress, monoloudness, and monopitch (Duffy, 2005). Such prosody breakdowns have a potentially detrimental impact on speech intelligibility (De Bodt, Hernández-Díaz Huici, & Van De Heyning, 2002; Patel, 2011) and speech naturalness (Patel, 2011), which may lead to a reduced ability to communicate properly and thus function fully in society (Baylor, Burns, Eadie, Britton, & Yorkston, 2011).

Since the eighties, a substantial number of studies have examined the effect of behavioural speech therapy on the prosodic skills of individuals with PD, as can be deduced from reviews covering this topic (Atkinson-Clement, Sadat, & Pinto, 2015; Hargrove, Anderson, & Jones, 2009; Herd et al., 2012; Yorkston, Hakel, Beukelman, & Fager, 2007). As reduced loudness is often considered a classical perceptual feature of hypokinetic dysarthria in PD (Adams & Dykstra, 2009; Yorkston et al., 2007), it is not surprising that the overwhelming majority of these studies deals with treatment of loudness. Ramig, Countryman, Thompson, and Horii (1995), Ramig, Sapir, Fox, and Countryman (2001), and Ramig, Sapir, and Countryman (2001) conducted a systematic line of treatment research based on the Lee Silverman Voice Treatment (LSVT) programme, a well described high-effort speech treatment protocol aimed at increasing vocal loudness. LSVT focuses on training this single target in order to enhance the voice source and trigger improvement across the entire speech production system (Fox, Ebersbach, Ramig, & Sapir, 2012). LSVT is an intensive therapy programme consisting of four one-hour sessions each week during four weeks. Treatment effectiveness in PD has predominantly been demonstrated in terms of acoustic measures, such as intensity and fundamental frequency (F_0) variation (e.g. Ramig et al., 1995; Ramig, Countryman, O'Brien, Hoehn, & Thompson, 1996; Ramig, Sapir, Fox, et al., 2001; Ramig, Sapir, & Countryman, 2001), and also utterance and pause duration (Ramig et al., 1995), but a few studies also report effectiveness in terms of functional measures, such as intelligibility (e.g. Cannito et al., 2012; Ramig et al., 1995; case study by Theodoros, Thompson-Ward, Murdoch, Lethlean, & Silburn, 1999). An alternative treatment programme for remedying loudness in PD is the Pitch Limiting Voice Treatment (PLVT) by de Swart, Willemse, Maassen, and Horstink (2003). They considered that LSVT ('speak loud') may lead to a high-pitched, strained, screaming voice. PLVT ('speak loud and low') is designed to prevent an increase of pitch and of laryngeal muscle tone and resistance, in order to maintain a socially acceptable, natural sounding voice.

Although reduced loudness is generally considered to be one of the cardinal speech symptoms in PD, not all individuals with dysarthria due to PD are perceived as speaking with reduced loudness (Adams & Dykstra, 2009; Ludlow & Bassich, 1984). Moreover, poor outcomes of LSVT in individuals with significant rate disorders were recently advanced as being one of the limitations of this programme by the founders themselves (Fox et al., 2012). In such cases, loudness-based therapy programmes such as LSVT or PLVT may not be the most appropriate treatment option, and the literature provides arguments for focusing treatment on other aspects of speech, such as intonation or speech rate.

Concerning intonation, Anand and Stepp (2015) demonstrated that monopitch and speech naturalness are highly correlated in PD speech, and the authors suggest integrating intonation as a therapeutic target to improve speech naturalness and consequently social communication and quality of life. Another reason for treating monopitch is that intonation also conveys meaning. Ma, Whitehill, and So (2010), for instance, studied the intonation contrast between questions and statements in a group of 14 Cantonese speakers with hypokinetic dysarthria due to PD, and found that not all speakers were able to mark this contrast clearly enough. More precisely, listeners were able to identify statements quite accurately (95.83% correct), but failed to identify questions correctly (44.86% correct), mainly due to the absence of a clear F_0 rise at the final syllable of questions. The authors suggest directing treatment at improving the ability of F_0 variation in speakers who are unable to systematically vary F_0 to mark the statement-question contrast. We consider this a relevant therapy goal, because it has the potential to enable listeners to better understand prosodic meaning expressed by speakers with PD.

Concerning speech rate, rate abnormalities can be a prominent and highly distinctive feature of hypokinetic dysarthria, and individuals with PD can be perceived to speak both abnormally slow or abnormally fast (Duffy, 2005), the last condition apparently being unique for hypokinetic dysarthria (Darley, Aronson, & Brown, 1975). Speech rate is sometimes considered

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