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Short communication

Are individuals with Parkinson's disease capable of speech-motor learning? – A preliminary evaluation

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ABSTRACT

Introduction: The benefits of different practice conditions in limb-based rehabilitation of motor disorders are well documented. Conversely, the role of practice structure in the treatment of motor-based speech disorders has only been minimally investigated. Considering this limitation, the current study aimed to investigate the effectiveness of selected practice conditions in spatial and temporal learning of novel speech utterances in individuals with Parkinson's disease (PD).

Methods: Participants included 16 individuals with PD who were randomly and equally assigned to constant, variable, random, and blocked practice conditions. Participants in all four groups practiced a speech phrase for two consecutive days, and reproduced the speech phrase on the third day without further practice or feedback.

Results: There were no significant differences ($p > 0.05$) between participants across the four practice conditions with respect to either spatial or temporal learning of the speech phrase. Overall, PD participants demonstrated diminished spatial and temporal learning in comparison to healthy controls. Tests of strength of association between participants' demographic/clinical characteristics and speech-motor learning outcomes did not reveal any significant correlations.

Conclusions: The findings from the current study suggest that repeated practice facilitates speech-motor learning in individuals with PD irrespective of the type of practice. Clinicians need to be cautious in applying practice conditions to treat speech deficits associated with PD based on the findings of non-speech-motor learning tasks.

1. Introduction

The role of different practice conditions in limb rehabilitation of individuals with Parkinson's disease (PD) has been extensively investigated [1]. However, the role of structure of practice in speech-motor learning remains unknown in PD. As individuals with PD present with motor learning deficits [2], examining the role of practice structure in speech-motor learning is particularly relevant. The current study aimed to compare the benefits of selected practice conditions (constant, variable, random, and blocked practice) in both spatial and temporal learning of novel utterances in individuals with PD. An important aspect to be considered in pursuing this line of research is the influence of non-motor symptoms (hearing loss and cognitive impairment), and clinical/demographic characteristics, especially severity of motor impairment and age, on speech-motor learning. The current study also explored the strength of association between these variables and speech-motor learning outcomes.

2. Methods

Sixteen participants with PD (12 males & 4 females) consented to participate. They were recruited from a local branch of the New Zealand Parkinson's Society. The mean age of the participants was 70 years (range = 57–84 years). The onset of PD ranged from 4 to 12 years. All of the participants were on dopamine replacement

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therapy, but the information on Levodopa Equivalent Dosage was unavailable at the time of participant recruitment. Data for the present study were collected when participants were in a self-reported "on" state. A regional ethics committee approved the current study.

Participants did not undergo a formal audiological evaluation but none complained of difficulties in daily listening conditions. In addition, the researcher informally evaluated the participants' speech recognition by asking them to repeat 5–7 sentences produced behind them at an average conversation loudness level. All participants were able to repeat the sentences without difficulty. Participants were not given a neuropsychological assessment but the researcher informally evaluated participants' cognitive domains of recent memory, language skills, executive function, and visual spatial function by engaging participants in conversations about their recent events, involving them in a serial naming task, asking them how they would prepare to go on a vacation, and the geographical location of their house, respectively. No significant cognitive deficits were revealed. In addition to the motor subsection, the participants were also administered the cognition subsection of the Movement Disorder Society–Unified Parkinson's Disease Rating Scale (MDS-UPDRS) prior to the experiment. Except for two participants who scored '1' on the cognition subsection, all participants scored a '0', suggesting that none of the participants had significant cognitive deficits. Caregivers also did not report any concerns about the participants' cognitive abilities. Demographic details, MDS-UPDRS scores, and Hoehn and Yahr staging scores of the participants are presented in Table 1.

Participants were randomly and equally assigned to one of four practice conditions. The practice conditions were (1) constant practice, (2) variable practice, (3) blocked practice, and (4) random practice. A non-PD group of 80 healthy individuals (21 males and 59 females) in the age range of 40–80 years ($M = 59$ years) served as a comparison group [3]. These participants performed the same tasks and were grouped in a similar fashion to the PD groups. Their data are included in the present study for comparison purposes.

2.1. Speech stimuli

Participants in each of the four practice conditions were required to learn a target meaningless speech phrase "*Thak glers wur vasing veen arad moovly*". A meaningless phrase was chosen to avoid ceiling effect in learning the speech phrase. The speech phrase incorporated both spatial and temporal aspects of motor learning. Along with the target phrase, two "alternate" speech phrases were created. The first phrase contained the same non-words as the target speech phrase but varied in temporal duration. This phrase was used for the variable practice condition. The second alternate phrase was "*Ang haky deebs reciled tofently roovly*". This phrase was used for random and blocked practice conditions, which involved learning two or more motor tasks of different motor plans. For task training, the target and alternate phrases were pre-recorded by a young adult male speaker of New Zealand English.

2.2. Procedure

The experiment took place over three consecutive days. The first two days constituted the acquisition phase, and the third day served as the retention phase. Each practice session lasted 60–90 min. Participants were involved in a practice regime of 50 trials per task, during each day of the acquisition phase. Prior to the practice sessions, participants were instructed to match their productions to the target phrase as accurately as possible in terms of both spatial and temporal characteristics during the practice trials. The practice regime was carried out via a PowerPoint presentation. A total of 50 slides were used to generate 50 practice trials. Each PowerPoint slide provided an orthographic as well as an audio representation of the speech phrase. The visual and auditory representations of the speech phrase containing words as well as the word and pause durations are shown in Fig. 1. The complete production following the provision of orthographic/visual and auditory representations comprised one practice trial.

After completion of 10 consecutive trials, the researcher provided feedback to the participants regarding their spatial and temporal accuracy. Across the two consecutive days each participant received 10 instances of feedback on their phrase productions. During the retention phase, participants were required to produce the target phrase without further practice or feedback. All task attempts during the retention phase were audio-recorded for acoustic analyses. The entire retention phase lasted 10–15 min. Participants in constant practice were involved in a practice regime of 50 trials of the target phrase during each day of the acquisition phase and received feedback after every 10 trials. On the third day, participants returned for the retention phase, and reproduced 5 trials of the target phrase without any practice or feedback. Participants in variable practice condition practiced 25 trials of the target phrase and 25 trials of the alternate phrase during each day

Table 1
Descriptive data of the participants in the clinical group including age, sex, MDS-UPDRS scores, Hoehn & Yahr staging scores, and practice conditions. Mean scores are indicated at the bottom of the table. Standard deviation are indicated in parentheses.

Participants	Age	Sex	Motor UPDRS	Speech UPDRS	Hoehn & Yahr	Practice conditions
1	84	M	48	2	2	Constant
2	80	M	53	1	1.5	Constant
3	69	M	60	3	2	Constant
4	71	F	61	2	2	Constant
5	74	M	41	1	1.5	Variable
6	62	M	59	2	3	Variable
7	71	M	34	2	1.5	Variable
8	57	F	32	1	1	Variable
9	71	M	32	2	1.5	Random
10	67	M	42	2	1.5	Random
11	71	M	39	1	2	Random
12	69	M	40	1	1.5	Random
13	71	F	21	1	1	Blocked
14	58	M	61	2	2.5	Blocked
15	81	M	55	1	2.5	Blocked
16	64	M	48	1	2	Blocked
Mean (SD)	70 (7.58)		45.37 (12.2)	1.56 (0.63)	1.81 (0.54)	

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