Influence of speech task and utterance length on the measurement of pitch variability in the speech of Parkinson’s disease patients after deep brain stimulation

Jan van Doorn\(^1\) and Fredrik Karlsson\(^2\).
\(^1\)Department of Clinical Sciences, and \(^2\)Department of Language Studies, Umeå University, Sweden.

Objective

To investigate the effects of

- (1) speech task (spontaneous or read speech) and
- (2) utterance length (≤ or >10 words)

on measures of pitch variability in Parkinson’s disease (PD) patients who have been treated with deep brain stimulation (DBS) of either the subthalamic nucleus (STN) or the caudal zona inserta (cZi).

Background

Patients with PD often show reduced pitch variability in their speech. Patients with PD who have undergone deep brain stimulation of the subthalamic nucleus (DBS-STN) have been reported to show increased pitch variability with stimulation, measured during a 30 second monologue\(^3\) and a read speech task\(^4\).

For PD patients with neurostimulation of an alternate target, the caudal zona inserta (DBS-cZi), no change in pitch variability was found for the same read speech task\(^5\).

Pitch variability in non-disordered speech depends on factors such as speech content and utterance type, which should, therefore, be considered in investigations of PD speech.

Method

Patients

- Twenty PD patients
- 10 treated with STN-DBS, 10 with cZi-DBS.

Speech recording conditions

- Four recording occasions
- Off- and on-stimulation conditions, 1.5 hour apart, in the patient’s normal medication state, 6 and 12 months after operation.

Speech samples

- 1276 utterances of varying lengths (2 to 25 words) extracted from two speech tasks in each recording condition
- spontaneous conversation
- reading of a standard passage.

Measurement of pitch variability

- Utterances were first randomised, then marked and transcribed in two iterations by independent markers who were blinded to patient group, recording session and stimulation condition.

- Fundamental frequency (fo) contour was extracted for each utterance using Praat speech analysis software (see Figure 1).

- Mean (µ) and standard deviation (SD) of fo was calculated for each utterance.

- Pitch variability was calculated as the coefficient of variation (SD/µ) for each utterance.

Data analysis

- Group means and 95% confidence intervals (CI) of the coefficient of variations were calculated for on- and off-stimulation conditions for the STN and cZi groups at 6 and 12 months Post-op, under four measurement conditions:
  - Short (≤ 10 words) utterances from (1) read and (2) spontaneous speech
  - Long (11-25 words) utterances from (3) read and (4) spontaneous speech.

- Differences in pitch variability between off- and on-stimulation conditions were considered robust if there were non-overlapping CIs.

Results and discussion

Figure 2 demonstrates that changes in pitch variability on- compared with off-stimulation, as measured by the coefficient of variability of fo, differ according to speech task and utterance length measurement conditions in both STN-DBS and cZi-DBS patient groups.

STN-DBS group

Observable changes in pitch variability at both 6m and 12m Post-op.

- Robust increase on- versus off-stimulation for both long and short utterances, but only in read speech.

- Similar trends for short utterances in spontaneous speech, but there was some overlap of CIs. This lack of statistical strength was most likely due to the considerably lower number of utterances that were available for analysis for spontaneous speech.

- No meaningful results for long utterances in spontaneous speech because of the extremely small number of utterances available for analysis.

CZi-DBS group

Observable changes in pitch variability only at 12m Post-op.

- Robust increase on- versus off-stimulation for both long and short utterances, but only in spontaneous speech.

- No clear trends in read speech, despite larger number of analysed utterances.

Figure 2. Mean coefficient of variation in pitch (with CI) compared for off and on stimulation conditions, for utterances grouped according to DBS treatment, recording session, speech task, and utterance length.

Conclusion

The results suggest that measurement of changes in pitch variability in DBS patients are sensitive to speech task, more so than utterance length.

However, the results for the two different patient groups are inconsistent, with read speech giving robust results in one group, and spontaneous speech in the other.

More than one type of speech task should be carefully considered when measuring and comparing pitch variability in studies of the speech outcomes of DBS in patients with PD.

References


jan.vandoorn@logopedi.umu.se
fredrik.karlsson@ling.umu.se