CONVERSATIONAL SPEECH INTENSITY UNDER DIFFERENT NOISE CONDITIONS IN HYPOPHONIA AND PARKINSON'S DISEASE

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1. INTRODUCTION

Low speech intensity or hypophonia is one of the most common speech symptoms in Parkinson's disease (PD). Subjects with hypophonia, often report that their conversational speech is dramatically influenced by the intensity of the surrounding background noise. In general, PD subjects report that the louder the background noise is the more difficult it is for them to communicate. Interestingly, this relationship between conversational speech intensity and background noise level has received limited attention in previous studies of PD. A preliminary report, by Adams and Lang (1992), found that 90dB SLP of white noise produced a marked increase in speech intensity in 10 PD subjects. In contrast, Ho et al. (1999), found that pink noise, presented at 10-30dB above threshold, produced minimal or no increase in speech intensity in a group of 12 PDs. More recently, Adams et al. (2005) found a systematic increase in speech intensity across increases in background noise (positive Lombard effect) during sentence reading in a group of 10 subjects with PD. This study also noted that, PD subjects showed a Lombard relationship that was parallel to control subjects. These inconsistencies may be related to a number of factors such as, the severity of hypophonia, the type background noise, the noise levels, the speech tasks, the intensity measures, and the methods of stimulus presentation. Defining the relationship between speech intensity and background noise has important implications for the understanding, assessment and treatment of hypophonia in PD. The purpose of the present study was to examine the effects of 3 types of background noise on conversational speech intensity in individuals with hypophonia and Parkinson's disease.

2. METHOD

This study included 23 idiopathic PD subjects with hypophonia and 15 age-equivalent controls. All subjects with PD were reported by a Neurologist (MJ) to demonstrate reduced speech intensity or hypophonia. All subjects with PD were stabilized on their anti-parkinsonian medication and were tested at approximately 1 hour after taking their regularly scheduled anti-parkinsonian medication. Normal and PD subjects passed a 40 dB hearing screening.

All subjects were tested in an audiometric booth. During all conditions, subjects sat in a chair facing the experimenter. A loudspeaker was placed 150 centimeters in front of the subjects. Subjects wore a headset microphone (AKG-C420) positioned a constant 15 cm distance from the mouth. The experimenter presented the background noise through the loudspeaker, adjusting the dB level of the noise via a diagnostic audiometer (GSI 61). The speech of each subject was recorded using a digital audio tape recorder (Tascam DA-01). Subjects were engaged in approximately 2 minutes of conversation for each of the 15 noise conditions (total conversation time = 30 minutes). Three types of background noise were examined. These included multi-talker noise (Audiotech – 4 talker noise), music (A taste of soul; 101Strings Orchestra), and pink noise. For each of these 3 noise types, 5 intensity levels (50, 55, 60, 65, 70 dB) were randomly presented.

The subjects' recorded test sentences were digitized using Kay Elemetrics' Visipitch program. The average intensity (dB) for each conversational utterance (minimum length = 6 words) was determined using the Visipitch intensity analysis routine. The average of at least 6 conversational utterances determined the conversational speech intensity for each noise condition. Three separate two-factor (noise level, group) repeated measures ANOVAs were used to examine the effects of each noise type on speech intensity. A series of planned comparisons (t-tests) were used to compare the 3 noise types.

3. RESULTS

The effects of each of the 3 noise types (multi-talker, music, pink) on the conversational speech intensity of the PD and control groups are shown in Figure 1. For each of the 3 noise types, both PDs and controls showed a significant increase in conversational speech intensity across increases in the level of background noise ($p=.0001$). Thus, the PD and control subjects showed a significant positive Lombard effect for each noise type. In addition, PD subjects were significantly lower (3-5 dB) than controls across all noise types and noise levels ($p<.005$).

For each of the noise types examined, the group x noise level interaction was not significant (multi-talker $p=.22$; music $p=.42$; pink $p=.82$). These interaction results

suggest that the PD subjects have a Lombard relationship that is essentially parallel to the controls. This parallel relationship is illustrated by the regression lines in Figure 1.

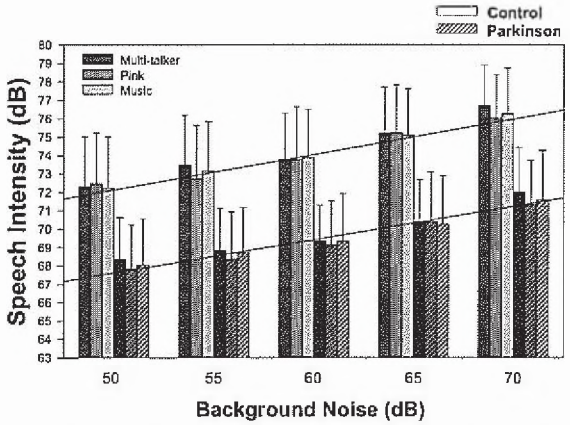

Figure 1. Average conversational speech intensity obtained from Parkinson disease and control subjects during multi-talker noise, pink noise and music presented at 5 levels (50, 55, 60, 65, 70 dB). Corresponding regression lines are a shown for each group.

The comparisons of the noise types at each noise level revealed very few significant differences. For the PD subjects, there was only one significant comparison. During the 70dB multi-talker noise the PDs used a conversational speech intensity that was 0.66dB higher than during the 70dB pink noise (p=.02). The control subjects, also had a significantly higher speech intensity (0.69dB) during the 70dB multi-talker noise than during the 70dB pink noise (p=.002). The controls also had a significantly higher speech intensity (0.74dB) during the 55dB multi-talker noise than during the 55dB pink noise (p=.034). Thus, only 3 of the 30 statistical comparisons of noise types were significant. In all three cases, these involved the multi-talker noise being associated with a higher speech intensity than the comparable pink noise.

4. DISCUSSION

The results of this study suggest that PD subjects show a systematic increase in speech intensity across increases in background noise. These findings are consistent with two previous reports on the 'Lombard effect' in PD (Adams & Lang, 1992; Adams et al., 2005). These previous reports involved the use of white noise and multi-talker noise during sentence reading. The present study extends this 'Lombard effect' in PD to conversational speech as well as pink noise and background music. Thus, the 'Lombard effect' in PD appears to be fairly consistent across speech tasks and noise conditions. The present study also showed that the positive relationship between speech intensity and background noise is approximately parallel to that of controls. Interestingly, despite this positive Lombard relationship, the PD subjects' speech intensity was consistently below that of the controls for each of the noise levels examined. Thus, relative to controls, the PD subjects showed a parallel but reduced speech versus noise intensity relationship. This suggests that individuals with PD may show a normal pattern of speech intensity regulation but with an "overall gain reduction". These results may have important implications for the development of assistive devices and new treatment procedures for hypophonia in PD.

REFERENCES

Adams, S.G. & Lang, A.E. (1992). Can the Lombard effect be used to improve low voice intensity in Parkinson's disease? European Journal of Disorders of Communication, 27, 121-127.

Adams, S.G., Haralabous, O., Dykstra, A., Abrams, K., & Jog, M. (2005). Effects of multi-talker background noise on the intensity of spoken sentences in Parkinson's disease. *Canadian Acoustics*, 33, 94-95, 2005.

Ho, A.., Bradshaw, J., Iansek, R., & Alfredson, R. (1999). Speech volume regulation in Parkinson's disease: Effects of implicit cues and explicit instructions. *Neuropsychologia, 37,* 1453-1460.

ACKNOWLEDGEMENTS

This research was funded by a grant from the University of Western Ontario's Academic Development Fund that was awarded to the first author.