The Effect Of Noise On Foreign-Accented Speech: An Acoustic Analysis

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1. INTRODUCTION

Etienne Lombard in 1911 reported that in the presence of noise, people with normal hearing increase their vocal intensity in order that their speech can be better heard by themselves or others [2]. This phenomenon is known as the Lombard reflex. It is well documented that speech produced in a noisy environment exhibits increases in vowel duration, fundamental frequency, and amplitude. The extent to which the Lombard reflex varies may be associated with the language, the type of noise, and the gender of speaker. Previous studies of the Lombard effect have been carried out mostly with native speakers. However, there has been limited research in accented speech under noisy condition. In addition, it has been noted that there is little research in investigating the influence of speaker-specific factor, like gender of speakers, on speaking rate [1]. Native Mandarin speakers of English have been found to speak at a slower rate in ideal (laboratory) environment than native English speakers do [6,7], but little is known about the speaking rates of native Cantonese speakers of English. The goal of this exploratory project was to investigate and compare the effect of noise on speaking rates of native Cantonese speakers with those of native English speakers in producing English sentences. Gender difference, if any, exhibited in speaking rate for the groups under the two conditions would also be examined.

2. METHOD AND EXPERIMENT

Speakers. Individual recordings were made of four adult native speakers of Hong Kong Cantonese (two male, two female). All had been born and raised in Hong Kong, and had moved to Canada after completing at least part of Form Five (secondary) in Hong Kong. Their mean age was 21.3 years. They had been living in Canada for a mean of 27 months. A comparison group of native speakers of Canadian English was also recruited. They were all born and raised in western Canada. Their mean age was 24 years. All participants had passed a hearing screen before recordings.

Recordings. A list of 12 true and 12 false statements was created as stimulus. Similar sets of statements had been used in other earlier studies [4,5,7]. Each item was a single-clause sentence of four to eight high-frequency words. The number of syllables ranged from five to 12. Having been instructed to try to produce the sentences in a conversational manner, participants read aloud to the researcher, who sat in front of the speakers at a fixed distance of two meters, the list of sentences once under each of the two conditions: quiet and noise. Participants wore a pair of headphones with an attached microphone throughout the experiment. Under the noise condition, cafeteria-like masking noise of 70 dB SPL(A), measured with a B&K sound level meter, was fed through the headphones to the speakers. No noise was presented to the speakers in the quiet condition. Participants were randomly assigned into two groups with balanced first language and gender. One of the groups read the list first under quiet and then under noise condition, while the other group read all the sentences in reverse order of condition. All the sentences had been randomized and no participant read the same version in the two conditions. Fluent utterance without noticeable pause or hesitation was elicited; otherwise, participants were asked to repeat the sentences. All recorded speech samples were digitized, and syllable rate (syll/s), obtained by dividing the syllables in each utterance by the duration, was computed.

3. RESULTS AND DISCUSSION

Mean speaking rates (syll/s) for utterances spoken in quiet and noisy conditions are shown for the two groups of speakers in Figure 1. An ANOVA was conducted to determine if first language (Cantonese and English) and condition (quiet and noise) had any effect on speaking rates. Results revealed significant effects of first language and condition on speaking rates, $Fs(1, 6) = 8.216$, and 28.912, $ps < 0.05$, respectively. No significant interaction between first language and condition was found. All these confirmed one of the manifestations of the Lombard effect that speakers generally have a tendency to speak slower in a noisy condition [3]. Moreover, the results indicated that Cantonese speakers in this experiment, like Mandarin speakers in earlier studies, speak reliably more slowly than their English counterparts. This may be due in part to the fact that a reduced speaking rate may sometimes lead to an increase in intelligibility, because nonnative speakers of English have more time to execute good articulations [6].

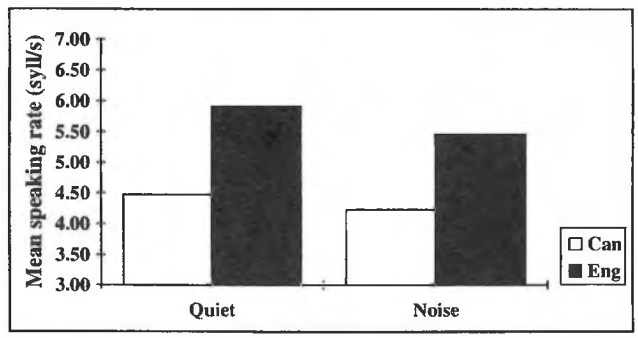

Figure 1. Mean speaking rates for Cantonese and English speakers in quiet and noise conditions

Figure 2 shows the mean speaking rates for statements spoken by females and males under the quiet and noise conditions in each of the two speaker groups. For the group of Cantonese speakers, no significant differences were found between female speakers in both quiet and noise conditions ($M = 4.52$ and 4.25 syll/s) and male Cantonese speakers ($M = 4.41$ and 4.20 syll/s), $ts(1, 94) = 0.582$ and 0.247, $ps > 0.05$. In contrast, female English speakers in both quiet and noise conditions ($M = 6.23$ and 5.91 syll/s) speak significantly faster than male English speakers ($M = 5.59$ and 5.00 syll/s), $ts(1, 94) = 3.088$ and 4.629, $ps < 0.05$. The latter findings might appear contradictory to results of some research where adult female English speakers are found to speak at a slower rate than male English speakers [1].

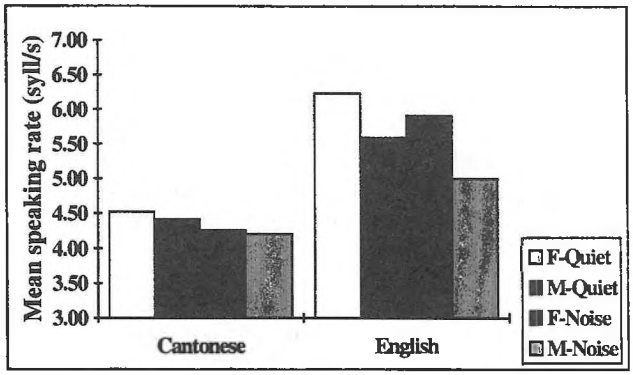

Figure 2. Mean speaking rates for females and males in the two speaker groups in quiet and noise conditions

4. CONCLUSIONS

In this experiment, the masking noise and the first language were found to have strong effects on speaking rates for the set of simple true and false English statements spoken by the native Hong Kong Cantonese and the native English speakers. The results suggest that under the influence of cafeteria-like noise, speakers with normal hearing probably slow down their speaking rates. One of the reasons may be that while speaking in such an adverse condition, the speakers modify their vocal output in order to maintain intelligible communication. Moreover, it is not surprising to find that native speakers of Cantonese speak more slowly than the English speakers in both the quiet and noise conditions. Further, although no gender difference in speaking rates was observed among the Cantonese speakers, female English speakers spoke faster than male English speakers in both conditions. No conclusive statement at this stage can be drawn, as it has been suggested that an account of such a sex-dependent difference needs further research [1]. Because of the limited number of participants and above all, the highly speaker-dependent and inter-speaker variability nature of the Lombard reflex, the results reported here cannot be extended too far. It is hoped that future research can involve more nonnative speakers of English and other types of noise to have a better understanding of the effect of noise on foreign-accented speech.

5. REFERENCES

[1] Byrd, D. (1992). Preliminary results on speaker-dependent variation in the TIMIT database. Journal of the Acoustical Society of America, 92(1), 593-596.

[2] Egan, J. (1971). The Lombard reflex: Historical perspective. Archives of Otolaryngology, 94, 310-312.

[3] Hanley, T., & Steer, M. (1949). Effect of level of distracting noise upon speaking rate, duration and intensity. Journal of Speech and Hearing Disorders, 14(4), 363-368.

[4] Munro, M. (1998). The effects of noise on the intelligibility of foreign-accented speech. Studies in Second Language Acquisition, 20, 139-154.

[5] Munro, M., & Derwing, T. (1995). Processing time, accent, and comprehensibility in the perception of native and foreign-accented speech. Language and Speech, 38(3), 289-306.

[6] Munro, M., & Derwing, T. (1998). The effects of speaking rate on listener evaluations of native and foreign-accented speech. Language Learning, 48(2), 159-182.

[7] Munro, M., & Derwing, T. (1999). The effects of speaking rate on the comprehensibility and accentedness of L2 speech. Manuscript submitted for publication.

6. ACKNOWLEDGEMENT

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