Hemispheric Lateralization:
Vietnamese Lexical Tone Processing in Mandarin Chinese Speakers

I. Purpose

Learning a new language can be extremely difficult for many people who are trying to learn a tonal language, a language in which specific changes in pitch are used as a part of speech to change the meaning of a word. Research has shown that speakers of a tonal language process the tones of their language in the left hemisphere, the hemisphere which is associated with language processing, while non-tonal language speakers process those same tones bilaterally. This experiment will test the lateralization of tone perception when a speaker of a tonal language, Mandarin Chinese, is processing tones in Vietnamese, a tonal language they do not speak. The purpose is to examine the plausibility of a generalized tonal language skill as compared to a language-specific tonal language skill.

II. Literature Review

Dichotic listening is a behavioral technique where a subject listens simultaneously to two different stimuli, one in each ear, via headphones. This procedure can be used to test the auditory system for selective attention. Dichotic listening tasks of this nature have been used to test hemispheric asymmetry by observing which ear produces more errors for a particular task. It has been shown that phonemes, which are the smallest units of sound in a language, are predominantly processed in the left hemisphere. This was observed by an advantage for perceiving phonemes with the right ear, which is connected contra-laterally (Kimura, 1961). Phonemic structures, while they can be devoid of any salient meaning on their own, are integral to the interpretation of language and therefore this lateralization has been used to solidify the theory that the left hemisphere is the language hemisphere (Studdert-Kennedy & Shankweiler, 1970).

This lateralization is relativity simple when it is studied in the English language because tones do not play a significant role in lexical meaning. However when a language like Vietnamese derives meaning of a word from its tonal qualities, an interesting question arises about whether or not the same lateralization will occur. An early study looking into lateralization of lexical tones by VanLancker and Fromkin (1973) compared native Thai speakers to native English speakers. Subjects were tested on three different dichotic trials: one set where words differed only in tone; one set where they had the same tone but different consonants; and a final set that was non-linguistical humming of the tones found in Thai words. Analysis of the data showed that English speakers had a right ear advantage (REA) for the words that differed by consonants and no advantage for either of the other trials. This meant that for the consonant trial the English speakers perceived what they heard in their right ear more clearly than what they heard in their left. Thai speakers, by contrast, showed a significant REA for the words that differed by tone as well as the words that differed by consonants, and no advantage on either side for humming. VanLancker and Fromkin (1973) claimed that this showed that Thai speakers were using the tone of the word as part of its linguistic quality. In a follow-up study, VanLancker and Fromkin (1978) looked into the possibility that the REA in Thai speakers for tonal words is due to their familiarity with pitch contrasts. The study broke up the groups into musically trained and untrained English speakers, as well as musically trained and untrained Thai speakers. The results were similar to the previous study and showed that in this case the left hemisphere only interprets tones when they are parts of a speaker’s linguistic knowledge base.

The Norwegian language has a simple word tone system called pitch accent and has also been used to explore lateralization of lexical tones. In a study by Moen (1993) subjects were asked to listen to dichotic pairs of words that differed only in tone and then point to a drawing that represented the word that they heard. In the first experiment of the study, subjects were not told about the dichotic portion of

the task. This resulted in 21 out of the 32 subjects pointing to the drawing correlated to the word from the right ear. In the second experiment of the study, subjects were explicitly told that they would be getting a different word in each ear and were directed to focus on only one particular side at a time. This resulted in a bias towards the right ear which was consistent with findings of the first experiment.

The present study will extend this line of research in a new direction by examining the lateralization of tone perception when a speaker of a tonal language, Mandarin Chinese, is processing tones in Vietnamese, a tonal language they do not speak. According to Wang, Jongman, & Sereno (2001) dichotic listening studies done on Mandarin Chinese speakers show that they are typical for tonal language speakers in that they interpret their own language's lexical tones in their left hemisphere. Wang et al. also discovered that lexical tone production and perception was affected by lesions in the left hemisphere only in aphasic speakers of tonal languages. Some of their participants were Mandarin Chinese speakers, so this further suggests that, as in other tonal language speakers, lexical processing of tones occurs in the left hemisphere for Mandarin Chinese speakers. It is predicted that Mandarin Chinese speakers will have no REA for the Vietnamese lexical tones because the tones that they normally interpret in the left hemisphere are only the ones that are already in their own language.

III. Methods

Participants

Twenty-four adult native listeners of Vietnamese and twenty-four adult native listeners of Mandarin Chinese from the University of California, Irvine (UCI) will be used as participants. Students will be recruited from Experimetrix. Informed consent will be provided in English, Chinese, and Vietnamese. Compensation will be given in the form of 1 point of extra credit in the course of the student's choice.

Design

This study can be considered a 2 x 3 between-subject factorial design, because there are two independent variables. The native language of the speaker has two levels, Vietnamese or Mandarin Chinese, and there will be three different attention conditions given to each subject: a base trial (in which no instruction as to ear of attention is given), right ear focus, and left ear focus. The dependent measure is what percentage they respond to the right ear stimuli.

Stimuli

The stimuli will be six commonly used monosyllabic Vietnamese words that differ only in tone: *ba* (three), *bà* (grandmother), *bá* (king), *bả* (bane), *bã* (waste), *bạ* (any). The stimuli will be produced in a similar manner to those in Wang, Jongman, & Sereno (2001). A native Vietnamese speaker will produce the stimuli in a soundproof room in the Social Science Laboratory using a microphone to record them on a computer. The six target words will be produced and recorded in isolation. Twenty repetitions of the words will be recorded at varying speeds, and tokens will be chosen such that each of the 36 dichotic pairs will be matched for duration and intensity. The stimuli will be presented in 36 randomized dichotic pairs given twice for each of the three conditions, resulting in a total of 216 pairs for the test.

Procedure

The experiment will be conducted in the Social Science Laboratory at UCI where the listeners will be tested individually over headphones. For cross-language consistency, subjects will be trained before the session on a stimulus-response association, in which each of the 6 tones will be assigned a number from 1 to 6. The corresponding number assigned to each tone will be balanced by a Latin square, and four Vietnamese listeners and four Mandarin Chinese listeners will be assigned to each level of the

Latin square. Subjects will be tested for tone-response accuracy and, once they have reached the desired accuracy level (100% for Vietnamese speakers and 75% for Mandarin speakers, who are less familiar with the tones), they can continue.

The experiment will follow the Hugdahl (1988) paradigm for dichotic listening task research. There will be three conditions that will each be repeated twice. The first condition is a baseline trial where the subject will be given no instruction on which ear to attend to. They will respond to the set of 36 randomized dichotic pairs, rest briefly, then run another set. Next, using complete counterbalancing to compensate for any progressive effect, subjects will be instructed to listen to either their right or left ear two times each for the next 4 sets of 36 dichotic pairs. A MATLAB program will be run to present the stimuli and collect data on responses and response time. Trials where the stimulus is the same in both ears and trials where participants do not correctly identify one of the presented stimuli will be discarded from the final results.

IV. Budget

UROP Poster Presentation Materials: $100
Sound Canceling Headphones: $110
Total: $210

V. Time Line

Fall Quarter:

Turn in proposal to UROP for review and grant approval
Begin to write formal literature review and methods for final thesis
Begin recruiting participants through Experimetrix
Begin running participants

Winter Quarter:

Finish running participants
Begin to analyze collected data

Spring Quarter:

Finish analysis of data
Begin to write up formal results and discussion
Finalize thesis
Prepare presentation for UCI Undergraduate Research Symposium

IRB Review

IRB approved under Dr. Hickok.

References

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Sidtis, J. J. (1981). “The complex tone test: Implications for the assessment of auditory laterality effects.” *Neuropsychologia* 19, pp. 103–112.

Studdert-Kennedy, M., & Shankweiler, D. P. (1970). “Hemispheric specialization for speech

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