Pre-speech Postures of Second-Language versus First-Language Speakers

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1. Introduction

In an x-ray study of the vocal tract, Perkell (1969) was one of the first to document the existence of a pre-speech posture of the articulators—a position that the tongue, lips, jaw, and velum assume immediately before speech. Pre-speech posture is different from absolute rest position (Ramanarayanan, Byrd, Goldstein and Narayanan 2010) in that the former is assumed to be language-specific—determined by the segmental inventory and/or the token frequency of sounds in a language, whereas the latter is assumed to be unrelated to a particular language. Like pre-speech posture, inter-speech posture (ISP), the position that the articulators return to between utterances, is language-specific and gives us a way to measure the underlying articulatory setting of a language (Wilson and Gick 2014).

Gick, Wilson, Koch and Cook (2004), using previously collected x-ray data, showed that English and French have different ISPs. Wilson (2013) confirmed this finding by using newly collected ultrasound and Optotrak data. Going one step further, Wilson and Gick (2014, p. 371) studied the ISPs of bilingual French/English speakers and found results that “support the stance that articulatory setting is a necessary component for a bilingual to be perceived as a native speaker of two languages.” It remains to be seen, however, the nature of the underlying articulatory settings of second-language (L2) speakers, especially those of a lower proficiency. It should also be noted that in all of the studies mentioned above, only a midsagittal view of the vocal tract was examined. The vocal tract is three-dimensional, though, and what happens off the midsagittal plane certainly affects the sound produced. For this reason, we examine the coronal plane, looking at the articulatory setting of the tongue for both L1 and L2 speakers of English.

2. Method

2.1 Participants

A total of 7 people participated in the experiment—three male L1 speakers of North American English and four L2 speakers of English. Their details are listed in Table 1. Among the L2 speakers, J1 and J3 were lower proficiency English speakers with no phonetics knowledge, while J2 and S1 were near native. None of the participants were aware of the focus of our research (i.e., articulatory setting of the tongue in the coronal plane).

2.2 Apparatus and Stimuli

In this experiment, we used a Carstens AG500 electromagnetic articulometer (EMA) to track the three-dimensional position of a marker placed near the side of the tongue (see Figure 1). Participants were asked to read the following English nursery rhyme:

Mary had a little lamb, little lamb, little lamb.
Mary had a little lamb. Its fleece was white as snow.
Everywhere that Mary went, Mary went, Mary went, Everywhere that Mary went, the lamb was sure to go.
Table 1 Participants

<table>
<thead>
<tr>
<th>Code</th>
<th>L1</th>
<th>Gender</th>
<th>Phonetics knowledge</th>
<th>English proficiency</th>
</tr>
</thead>
<tbody>
<tr>
<td>E1</td>
<td>Canadian English</td>
<td>male</td>
<td>Phonetics professor</td>
<td>native</td>
</tr>
<tr>
<td>E2</td>
<td>General US English</td>
<td>male</td>
<td>Phonetics professor</td>
<td>native</td>
</tr>
<tr>
<td>E3</td>
<td>General US English</td>
<td>male</td>
<td>Phonetics grad student</td>
<td>native</td>
</tr>
<tr>
<td>S1</td>
<td>Spanish</td>
<td>female</td>
<td>Phonetics researcher</td>
<td>near-native</td>
</tr>
<tr>
<td>J1</td>
<td>Japanese</td>
<td>female</td>
<td>none</td>
<td>intermediate</td>
</tr>
<tr>
<td>J2</td>
<td>Japanese</td>
<td>male</td>
<td>Phonetics professor</td>
<td>near-native</td>
</tr>
<tr>
<td>J3</td>
<td>Japanese</td>
<td>female</td>
<td>none</td>
<td>beginner</td>
</tr>
</tbody>
</table>

That nursery rhyme was chosen because of its abundance of /l/ and /r/ sounds. Since /l/ requires the tongue to narrow in the coronal plane, while /r/ requires the sides of the tongue to be braced against the side teeth, a wide range of movement should be visible in the coronal plane.

2.3 Procedure

Data were collected at the Japan Advanced Institute of Science and Technology (JAIST). We used a total of 12 EMA markers: 4 on the tongue (3 midsagittal and 1 on the side), 2 on the incisors, 2 on the lips, 1 on the chin, 1 on the nose, and 2 near the mastoid processes of the skull behind the ears, but our results in this paper focus on only the tongue side marker. Each participant’s bite plane was measured relative to the 12 markers, so that the 3-D position of each marker could be expressed in a coordinate space relative to the bite plane. A dental arch sweep and also a palate sweep were done using the tongue tip marker, so that anatomical differences across participants could be accounted for.

Participants were asked to read the stimulus paragraph from 5 to 7 times and they were allowed a short break of from 10 to 15 seconds between each trial. After post-processing of the data to express positions in terms of the bite plane, we analyzed the tracked data using mview, a MATLAB m-file written by Dr. Mark Tiede (Haskins Laboratories).

Data were normalized based on the maximum width of the dental arch (i.e., the straight-line distance from the back molar on one side of the mouth to the back molar on the other side).

3. Results and Discussion

Results of tongue side marker tracking for four of the participants can be seen in Figures 2 to 5. Note that the figures show the positions of the side tongue marker in the coronal plane (i.e., the vertical axis is “up and down” in the mouth, and the horizontal axis is “side to side”). Figures 2 and 3 show the position of the tongue side marker for two of the native English speakers; measurements were plotted every 100 ms and data for all trials are plotted. Grey circles indicate positions during speech, while black squares indicate positions during pre-speech posture. In Figure 2, one cluster of black squares off to the left corresponds to the pre-speech posture during only one of the trials, and this cluster is probably an outlier. In Figure 3, the black squares tend to be more to the right (i.e., more lateral—away from the midsagittal plane), but this is simply due to a number of grey dots off to the left (i.e., more medial), which required a wider plotting area for this figure. It is possible that this speaker narrows his tongue more than usual for some sounds in English. Figure 4 shows the same plot for the English speech of participant J1, a Japanese female speaker with intermediate-level English proficiency. Finally, Figure 5 shows the same plot for a near-native proficiency Japanese phonetics professor (participant J2).

Two interesting observations can be noted, and provide motivation for future research using more
participants and more languages. First, it is interesting to note the movement trajectories of the tongue side marker for native English speakers: the marker tends to move upwards as it moves toward the midsagittal line (i.e., as the tongue narrows) or downwards away from the midsagittal (as the tongue widens); for pre-speech, though, we mostly see a concentration in the middle of the graph, as if the speaker is optimizing the ability to narrow or widen the tongue.

A second observation is that the pre-speech posture for native and near-native speakers tends to be close to the median of the positions for speech. This is a more energy-efficient position for the side tongue marker before speech, as it minimizes the distance it must travel to get to the average speech sound. On the other hand, the pre-speech posture for the tongue side marker
of participant J1 is much more medial than the median position of her (L2) speech sounds. This indicates that just before speech, her tongue is much more narrow than it should be for the sounds she is about to speak. It is possible that the native Japanese articulatory setting has the tongue more narrow than the native English setting, and that participant J1’s pre-speech posture is being influenced by her L1 pre-speech posture, something to be confirmed by future research. This supports the view that pre-speech posture and articulatory setting in general are things that L2 learners need to learn or that L2 learners naturally acquire as they develop proficiency over time.

4. Acknowledgements

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References


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