Ann. Bull. RILP, No. 15, 1 - 8 (1981)

RELATIVE TIMING OF THE CONSONANT AND VOWEL ARTICULATIONS IN SELECTED VCV UTTERANCES IN AMERICAN ENGLISH

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It is generally believed that, in the production of a V_1CV_2 sequence, the consonantal gesture and the diphthongal gesture from the preconsonantal vowel to the postconsonantal vowel occur simultaneously and the consonantal movement is temporally superimposed on to the diphthongal movement. It is also believed that the relative timing between the consonantal movement and the diphthongal movement may vary according to the presence or absence of the word boundary or other kinds of boundaries. In order to investigate such an effect of the word boundary, the articulatory movement for the production of V_1C (or consonant cluster)V_2 sequences in American English was observed by means of the X-ray microbeam system using test utterances having the word boundary located at various positions in the same sets of VCV sequences.

In the present paper, preliminary data for the following test utterances will be presented as a part of a larger set of VCV sequences.

Miss Pa pede it.	Miss Pop eats it.	Miss pop pede it.
Miss Pee pots it.	Miss Peep otts it.	Miss peep pots it.
Miss Pa pooed it.	Miss Pop ooed it.	Miss Pop pooed it.
Miss Pee pooed it.	Miss Pop ooed it.	Miss Pop pooed it.
Miss Pa sots it.	Miss Poss otts it.	
Miss pa seeds it.	Miss Poss eats it.	
Miss Pee sots it.	Miss Piece otts it.	
Miss pa lots it.	Miss pa plots it.	Miss pop plots it.

Data Assessment

The subject was a native speaker of American English who was born and raised in the city of New York. As shown in Fig. 1, three pellets were attached to the surface of the tongue and one pellet each was attached to the lower lip and the lower incisor.

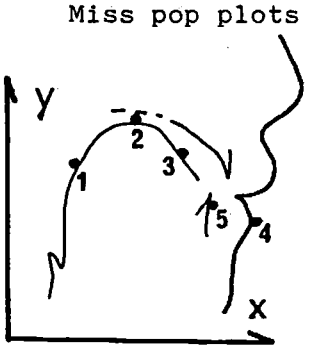


Fig. 1 Schematic illustration of the locations of the pellets

Movements of the five pellets were recorded by means of the X-ray microbeam system at a rate of 130 frames per second.

Results

$V_1\#pV_2$ vs. $V_1p\#V_2$

Figure 2 illustrates superposed displays of the time functions of the pellet coordinate and the speech envelope for the pairs of utterances of the $V_1\#pV_2$ and the $V_1p\#V_2$ type, in which the X-coordinate of pellet 1 roughly representing the front-back movement of the tongue is shown. Time curves for the pair of utterances are temporally aligned with reference to the moment of implosion of /p/. It can be seen that, except for the utterance pair /Pa pede/ - /Pop eats/, the temporal pattern of the pellet movement is quite similar for each pair of the uuterances. Namely, there is no apparent difference in the timing of the start of the front-back movement of the tongue with reference to the implosion of /p/ and in the speed of its movement between each pair of the uuterances. In these utterance pairs, the temporal pattern of the pellet movement is quite similar regardless of whether the word boundary precedes or follows the consonant /p/.

$V_1\#pV_2$ vs. $V_1p\#pV_2$

Figure 3 compares the pairs of utterances containing a single consonant /p/ and a geminate consonant /pp/. Naturally, the closure pariod of the consonant is longer for the geminate consonant. It is noted that for the utterances containing the geminate consonant the speed of the transitional movement during the closure period is slower than for the utterances with the single consonant. This tendency can be seen for three pairs of utterances shown in Figure 3. There is no difference in the speed of transitional movement between the utterance pair /Pee pooed/ - /Peep pooed/.

$V_1\#sV_2$ vs. $V_1s\#V_2$

In Figure 4, time curves for the pairs of utterances are aligned with reference to the moment of the voice onset of V_2. In this case there is a clear difference in the temporal pattern of the pellet movement between each pair of the utterances. The result is apparently different from that for the $V_1\#pV_2$ and the

V_1p#V_2 pairs presented above. In the case of the utterance V_1s#V_2, movement from /s/ to the following vowel starts during the period of frication of /s/, while for the utterances V_1#sV_2, the timing of the start of the transitional movement is closer to the moment of voice onset of the following vowel.

V_1#spV_2 vs. V_1s#pV_2

The timing and speed of the transitional movement from /s/ to the following vowel during the closure period of /p/ is almost the same in these two utterance types. It appears that the difference in the position of the word boundary has little effect on the temporal pattern of the transitional movement.

V_1#1V_2, V_1#p1V_2, V_1p#1V_2

In the production of V_1#p1V_2, the speed of the pellet movement toward the target position of /1/ is slower than that in V_1#1V_2. However, in V_1p#1V_2, the speed is faster than that in V_1#p1V_2 and almost the same as that in V_1#1V_2. The closure period of /p/ is almost the same in V_1#p1V_2 and V_1p#1V_2 and the target position for /1/ is reached during the closure period of /p/ in the latter type, while it is reached after explosion of /p/ in the former. Thus, there is an apparent effect of the position of the word boundary in these cases.

Concluding remarks

In the preliminary data presented above, it is observed that there is a difference in the temporal pattern of the pellet movement between the utterance types V_1#sV_2 and V_1s#V_2 in that the transitional movement from /s/ to the following vowel with reference to the onset of the voicing starts earlier in V_1s#V_2. It can be assumed that, at the word final (and/or syllable final) position, articulatory effort to maintain the target gesture is weaker than at the word initial position and the coarticulation with the following vowel takes place more easily. In contrast, there is little difference in the pellet movement during the closure period of /p/ between the utterance types V_1#pV_2 and V_1p#V_2. In the production of /p/, there is no specific target position of the tongue and the transitional movement toward the following vowel always takes

place almost at the same time as the beginning of the /p/ gesture. Thus, the difference in the position of the word boundary has little effect on the temporal pattern of the pellet movement during the closure period of /p/.

Another effect observed in the present study is that the speed of the transitional movement is slower during the geminate consonant /pp/ than during the single consonant /p/. Presumably, the speed of movement varies depending on the duration of the closure period of /p/, during which the transition to the following vowel has to occur.

From the present data, there appears to be a word boundary effect on the speed of transitional movement in /pl/ sequences, whereas the effect is not apparent in /sp/ sequences. The difference between the two types of the consonant sequences may be due to the difference in the types of the consonants or to the different order of the /p/ and the lingual consonants examined. Further study is needed for the clarification of this problem.

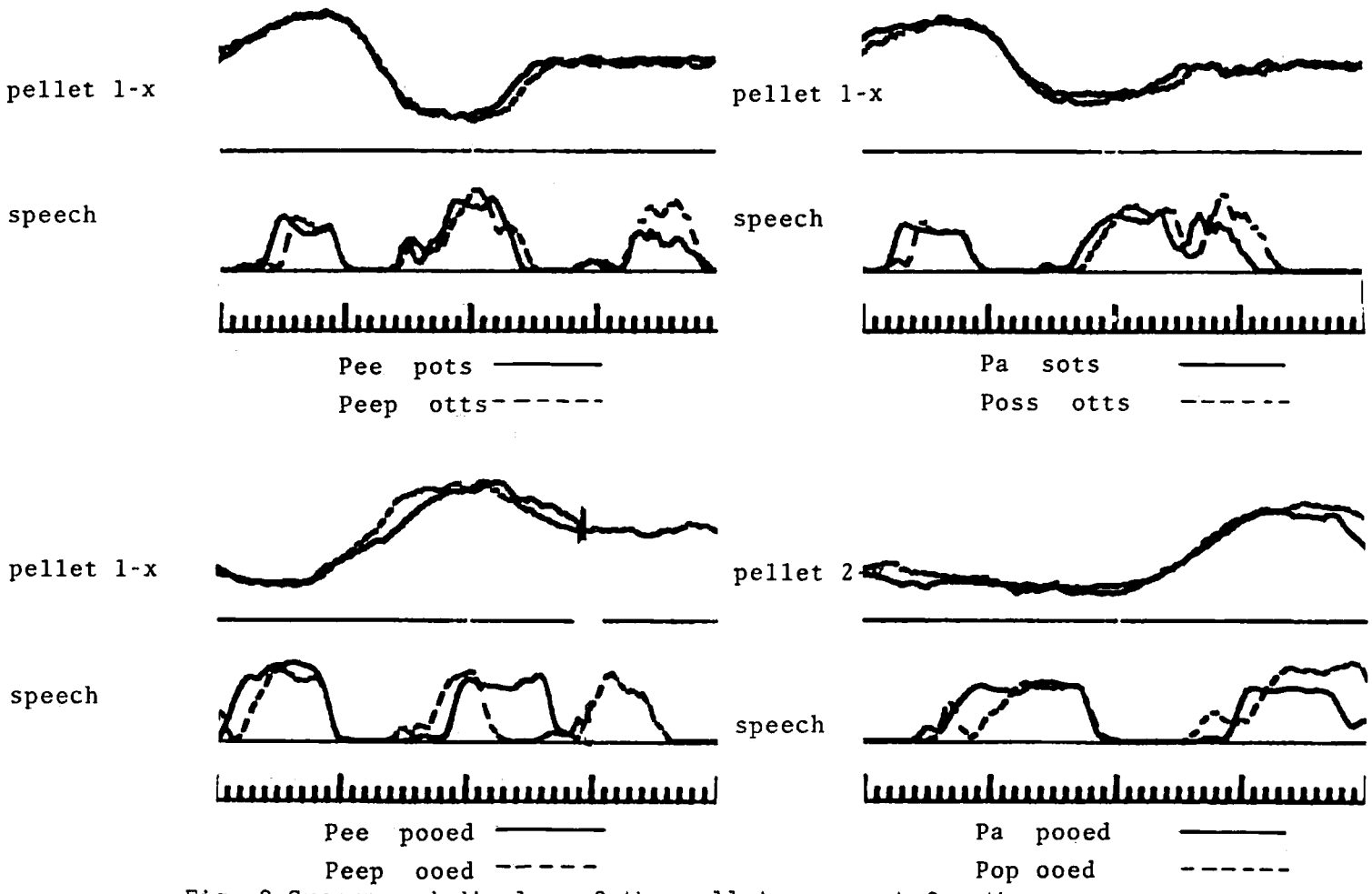


Fig. 2 Sueprposed display of the pellet movement for the pairs of utterances $V_1\#pV_2$ and $V_1p\#V_2$ (25msec/div)

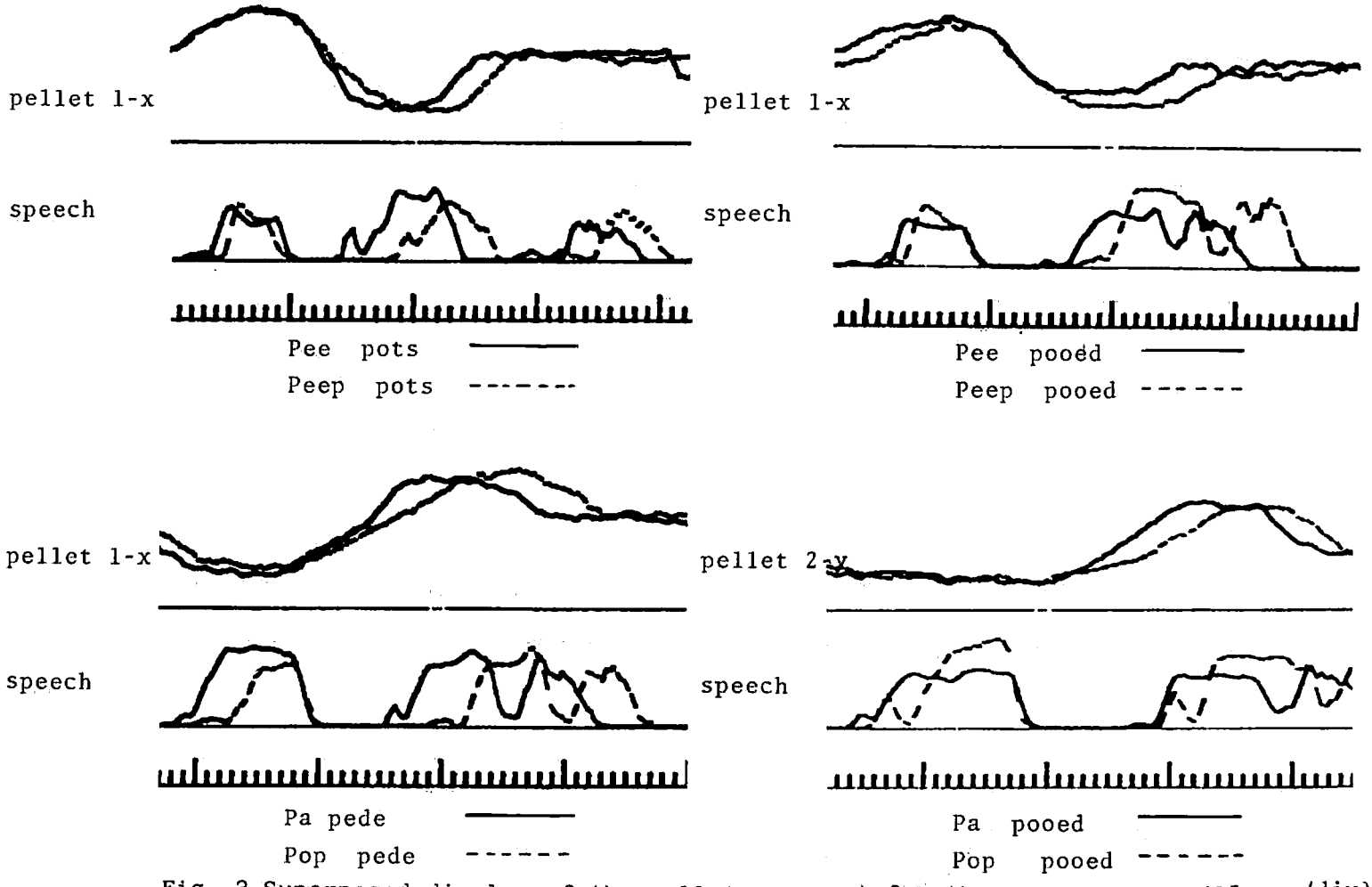
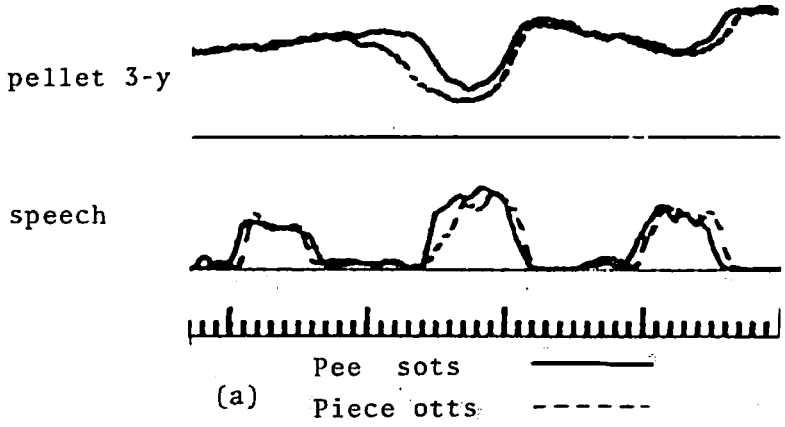
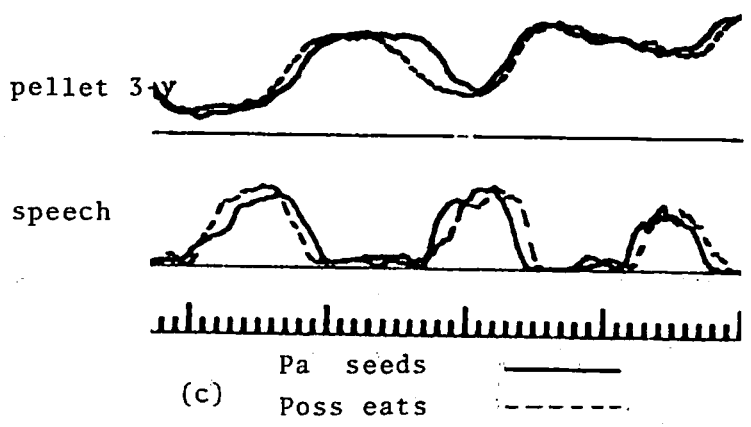


Fig. 3 Superposed display of the pellet movement for the pairs of utterances $V_1\#pV_2$ and $V_1p\#pV_2$ (25msec/div)





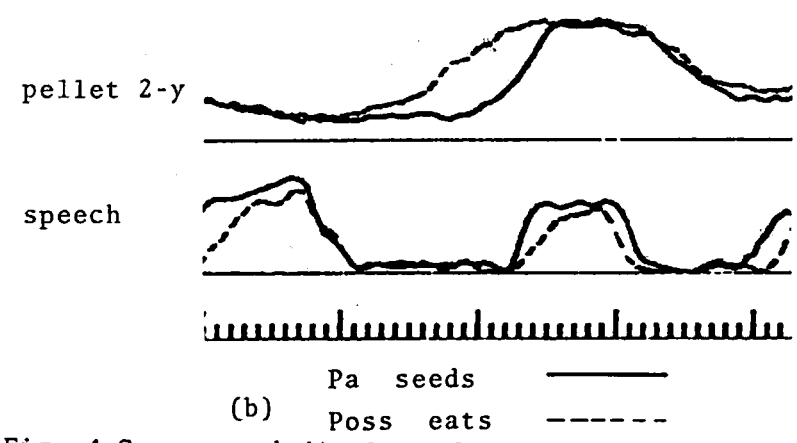


Fig. 4 Superposed display of the pellet movement for the pairs of utterances $V_1\#sV_2$ and $V_1s\#V_2$

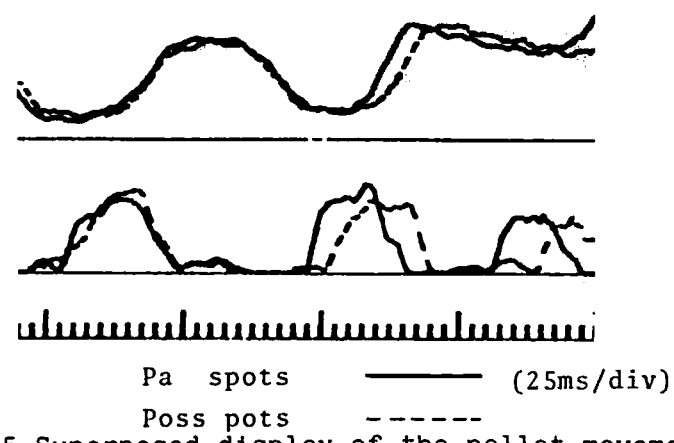


Fig. 5 Superposed display of the pellet movement for the utterances $V_1\#spV_2$ and $V_1s\#pV_2$

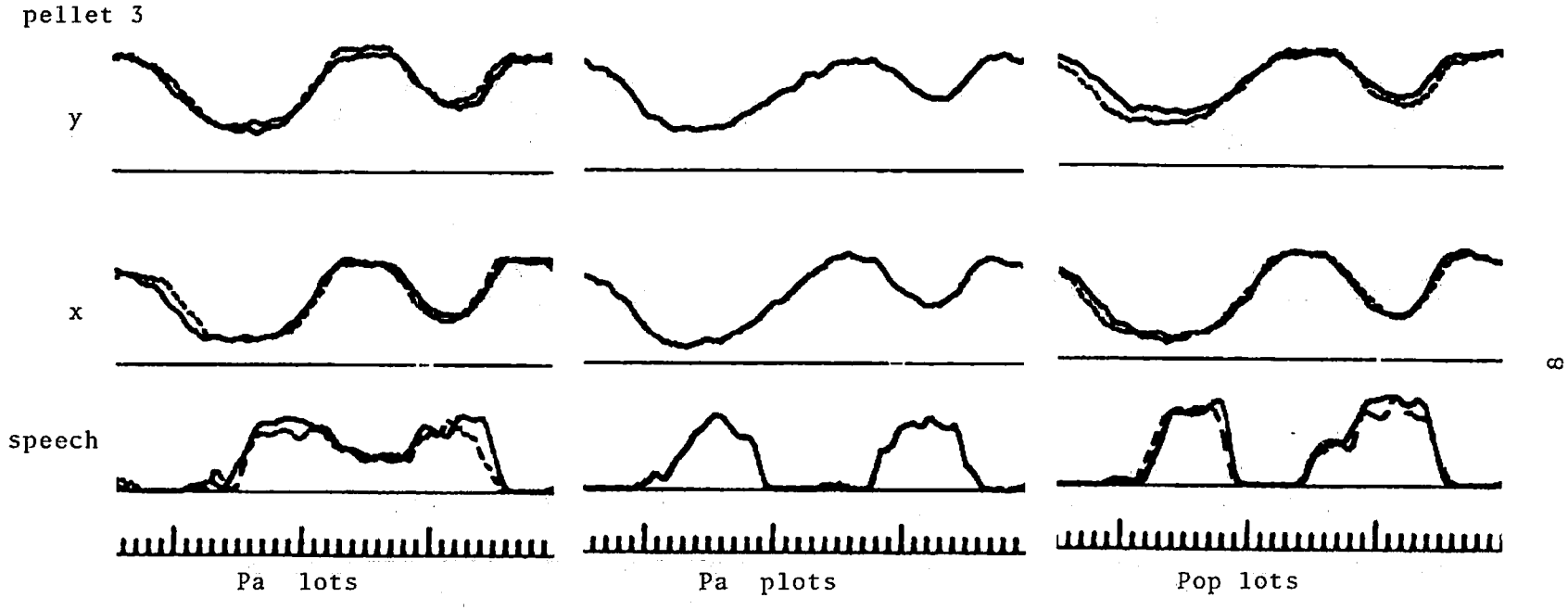


Fig. 6 Pellet movement for the utterances $V_1\#p1V_2$ and $V_1p\#1V_2$