

# /p/ and /pp/ in Finnish: Durations of the Voiceless Phase in Intervocalic Contexts

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/p/ and /pp/ in Finnish are not used to distinguish between lexical entries except in a very small number of (loan) cases. They do, however, at some stage in the phonology have to be represented distinctly for much the same reasons as palatal and velar /l/ in English, and appear at the systematic phonetic level as extrinsic allophones. The data presented below indicates that there is an articulatory difference between the two that could not be the result of a coarticulatory, or context sensitive involuntary effect.

Six pairs of Finnish words were selected. The two pairs: *hippi/hipi* and *nappa/napa* having the pseudo-phonemic distinction on the /pp/ and /p/ segments; *kippi/kipin*, *pappa/papan*, where the morphemic distinction is carried by the final /n/; and *lappaa/lapa*, *tappaa/tapa*, where the morphemic distinction is carried by the final vowel. Aspiration is slight phonetically and non-distinctive phonologically in Finnish and it was considered that a suitable parameter for articulatory investigation was the period of non-vocal cord activity between the vowel sounds adjacent to the consonants /pp/ and /p/.

Three native speakers of Finnish (male in their mid-twenties) recorded each of the twelve items fifteen times in the frame: 'Toista sana — kerran' ['Repeat the word — once']. The twelve items were randomised, but the repetitions of each formed a block. An audio recording was taken for monitoring purposes and an electroglottograph — the Fourcin Laryngograph — was used to detect vocal cord activity. Signals were recorded on two channels of an Ampex SP300 FM tape recorder at 15 ips (frequency range 0-2.5 kHz within 3 dB) and played back for measuring purposes on to an Elema-Schönander Mingograf [an ink-jet chart recorder of the period - MT 1997] running at 100 mm/sec (frequency response: 0-700 Hz +3 dB; chart speed accuracy: 5%). The stopping and starting of vocal cord vibration was sufficiently abrupt in the tracings from all three subjects for accurate measurements of the voiceless period to be taken to the nearest millimetre (1 csec) (Fig. 1). Measurements were taken of 12 tokens for each item, beginning in each case with the second in each block.

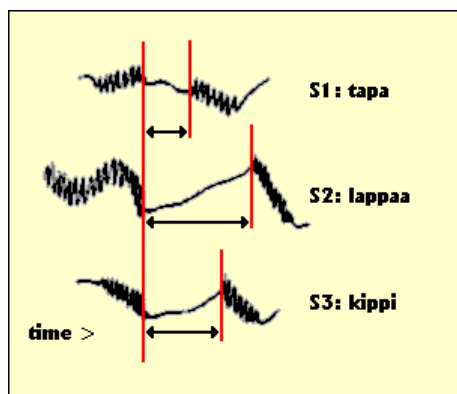


Fig. 1 Three typical tracings: Speaker 1, *tapa*; Speaker 3, *lappaa*; Speaker 2, *kippi*. Variations in baseline position are due to vertical larynx movement between the electrodes of the electroglottograph; the should not affect the measurements made for this experiment.

## RESULTS

For each speaker:

Column 1 = mean duration of 12 repetitions

Column 2 = standard deviation

Column 3 = Pearson coefficient of variation

Speaker 1				Speaker 2			
hippi	14.5	1.2	8.2	hippi	16.5	2.1	12.7
hipi	9.5	1.3	13.9	hipi	8.1	1.4	17
nappa	15.5	1.4	9.3	nappa	16.8	2.1	12.2
napa	8.8	.8	9.5	napa	9.3	1.3	14.1
kippi	15.3	.9	5.9	kippi	17	2	11.5
kipin	8.7	1.6	18.8	kipin	7.5	.8	10.1
pappa	19	2	10.3	pappa	16.1	2	12.7
papan	10.3	1.2	11.4	papan	9	.6	6.3
lappaa	20.1	1.5	7.5	lappaa	22.9	3.8	16.7
lapa	9.8	1.3	13.3	lapa	10.6	1.4	12.8
tappaa	18.4	1.8	9.5	tappaa	22.5	2.7	12
tapa	9.3	.6	6.8	tapa	9.4	.7	7.5

Speaker 3			
hippi	17.8	2	11.1
hipi	9.3	.7	7.1
nappa	16.7	.9	5.3
napa	9	1.2	13.6
kippi	16.3	1.1	6.7
kipin	9.7	.4	4.1
pappa	20.4	2.1	10.1
papan	8.9	.6	6.6
lappaa	21.6	1.2	5.4
lapa	9.1	.8	8.7
tappaa	21	1.5	7
tapa	8.9	.7	8

It is immediately obvious that there is a durational distinction in all cases between /pp/ and /p/. In fact for all three speakers with all six pairs there was absolute durational discrimination — i.e. in no case was the lowest /pp/ score lower than the highest /p/ score — the sets did not intersect at all. Furthermore the coefficient of variation is fairly small throughout, informally lending reliability to the statistical viability of a 12-token sample. Furthermore within each speaker the set of highest scores for /p/ did not overlap the set of lowest scores for /pp/ — e.g. no score for Speaker 1 for *lapa* was longer than any score for *hippi*.

Fig.2 plots the mean scores of the voiceless period for each item by each speaker. Notice that all three speakers tended to lengthen significantly the duration of the voiceless phase of /pp/ when followed by the vowel /aa/ and that Speakers 1 and 3 also lengthened the voiceless phase of /pp/ in *pappa* — though not in *nappa*, where the vowel context is similar.

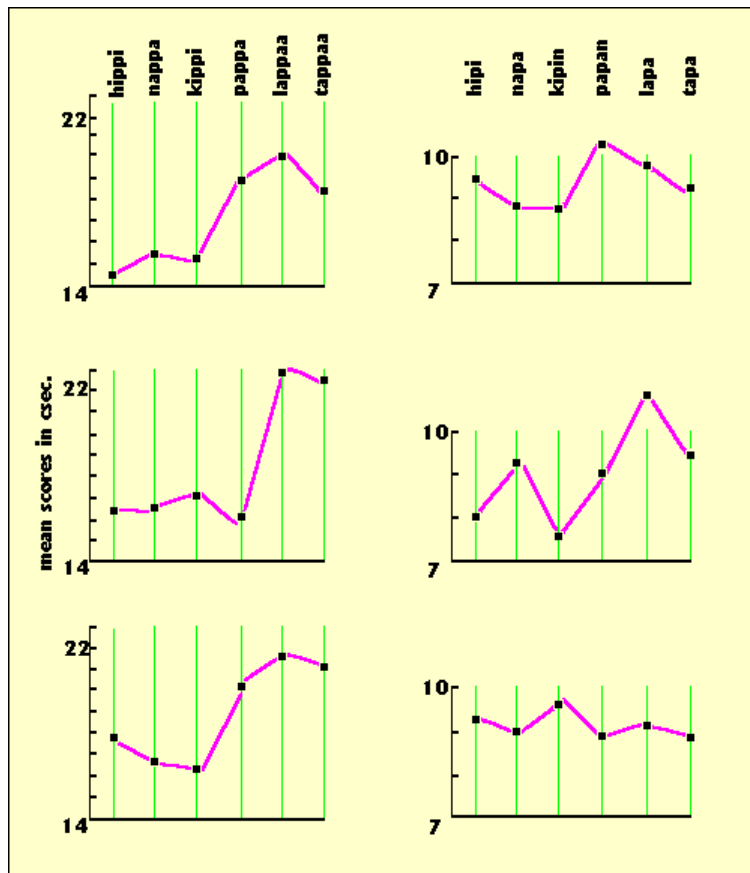


Fig. 2 Histograms indicating the mean score in csec. of voicelessness for each item for each speaker. Points have been connected to improve the visual indication of trends.

## DISCUSSION

/pp/ and /p/ operate non-phonemically in Finnish. However, in at least these three speakers each uttering twelve tokens of each of six pairs, there appears to be an extrinsic allophonic differentiation between the two segments. Unlike, for example, palatal and velar /l/ in English, the occurrence of /pp/ and /p/ does not appear to be phonologically determined by a context sensitive rule — at least not from this data, but their extrinsic allophonic status is similar to the English pair. Certainly we could postulate no phonetic context sensitive rule for deriving one or other of the pair. The difference between the period of bi-labial closure between /pp/ and /p/ is similar to the difference between the voiceless period — so at the level of articulatory features more than one feature is involved in the durational distinction. It remains to be seen whether non-durational features, like muscle tension, also show the same absolute discrimination between the members of each pair.

It is interesting that there should be a fairly consistent pattern across speakers regarding variation within the set of /pp/'s. Why, for example, did all three speakers have a mean voiceless period over 20csec for *lappaa*, yet below 17 for *nappa* and *kippi* and *hippi* (not Speaker 3)? Indeed, for Speaker 1 example, there is absolute discrimination between the voiceless periods in *lappaa* and *hippi*, and there may be a sense in which we should not regard /pp/[*lappaa*] as 'the same as' /pp/[*hippi*]. It is not within the scope of this paper or this particular experiment to determine whether such a difference is of central or peripheral origin.

We would hypothesise, though, that the length of the following vowel could bear a possible relationship to this length difference in the voiceless period — notice that all three speakers have a prolonged /pp/ in both *lappaa* and *tappaa*, but not in *nappa* (which has the same vowel before the /pp/, although two speakers did have a long /pp/ in *pappa* which has a short vowel both before and after the /pp/).

The object of this experiment has been to examine a pair of segments which phonologically do not strictly distinguish, on their own, lexical items. The distinction, however, at the phonetic level *is* present and with absolute consistency.