

PRELIMINARY INVESTIGATION CONCERNING DIFFERENCES BETWEEN VOICE
ONSET TIME* VALUES OF SPEAKERS OF STANDARD DUTCH AND OF ONE OF
THE DIALECTS SPOKEN IN THE PROVINCE OF GRONINGEN

- SECOND VERSION -

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1. INTRODUCTION

A second version of the paper read in Leeds at the Eighth International Congress of Phonetic Sciences (1975) seemed called for in these Proceedings for a number of reasons.

Some additional data - VOT values for [k], and measurements carried out within the section designated B - C, will be introduced.

The values given in Leeds and those produced here will be seen to differ slightly. This is due to a number of reasons. The first being the fact that for one of the informants from Groningen a different series of items was used. After some hesitation his first series of items was judged to conform more closely to his (recorded) normal rate of speech, whereas in the Leeds version the second series has been used. Also measuring this time was carried out with the aid of a new gating device developed at this institute by A.C. Wempe. This gave the possibility of greater precision.

* Voice onset time (VOT) as defined by L. Lisker and A.S. Abramson, 1964, Word 20: "We have adopted the convention of assigning zero-time to our reference point, the instant of release, thus, measurements of voice onset time before the release are stated as negative numbers and called voicing lead, while measurements of voice onset time after the release are stated as positive numbers and called voicing lag."

1.1 The reason for an investigation of plosives produced by speakers of "Gronings".

In 1971 J.W. Meyers carried out an investigation on plosives in Dutch and in English (Proceedings no. 2) in which the differences along the time continuum employed by these two groups were found to be in accordance with those given by Lisker and Abramson (1964). Speakers from the province of Groningen, often even after having lost their local dialect, can be heard to do "something different" with their plosives, especially [t], when compared to speakers of e.g. Standard Dutch. The difference, it was thought, would come to light in VOT values. The [t] produced by speakers of this dialect is sometimes referred to as a 'wet' t. Traditionally the province of Groningen is inhabited with people of Saxon stock. VOT values more or less conforming to those of English speakers were expected.

2. SPEAKERS

Three speakers out of a group of fifteen male speakers were chosen at random. All fifteen were born and bred in Garnwerd and had parents from Garnwerd or its immediate vicinity and thus belonged to the same dialect group. Garnwerd is a small agricultural village situated just north of the city of Groningen. All had gone through the recording procedure and were kept ignorant as to the precise purpose of the recording.

Three speakers of Standard Dutch were selected by five members of this institute. These testees did not know the purpose of this experiment either.

3. ITEMS

In order to limit the material to reasonable proportions the items in which the plosives occurred were made up as follows: CV items, VC items, and VCV items, of which there were two types, one series with stress on the first vowel ('VCV) and one with stress on the second vowel (VC'V).

The consonants consisted of the oppositions |b-p| and |d-t| and of |k|. As Dutch has no |g| in its consonant system except in loanwords and in cases of assimilation there were no g-items. Final plosives are always devoiced in Dutch so there were no items ending in |b| or |d|.

The vowels used represented the extreme points of the Dutch vowel triangle and consisted of |u-i-a|.

The combination of vowels and consonants resulted in mainly nonsense items. A further limitation of the material made by combining these vowels and consonants was imposed by keeping first and second vowel alike in the VCV items. The result for |d| and |t| was therefore:

du	'udu	ud'u		tu	'utu	ut'u	ut
di	'idi	id'i	and	ti	'iti	it'i	it
da	'ada	ad'a		ta	'ata	at'a	at

The same configurations were used for |b| and |p|. The series for |k| resembled those of |t| and |p|.

4. MEASUREMENTS

The measurements were done directly from the sound curve shown on an oscilloscope and although basic frequency and first and second formants were measured at points A and E (Fig. 1) only

data pertaining to aspects of duration, expressed in msec., will be discussed here.

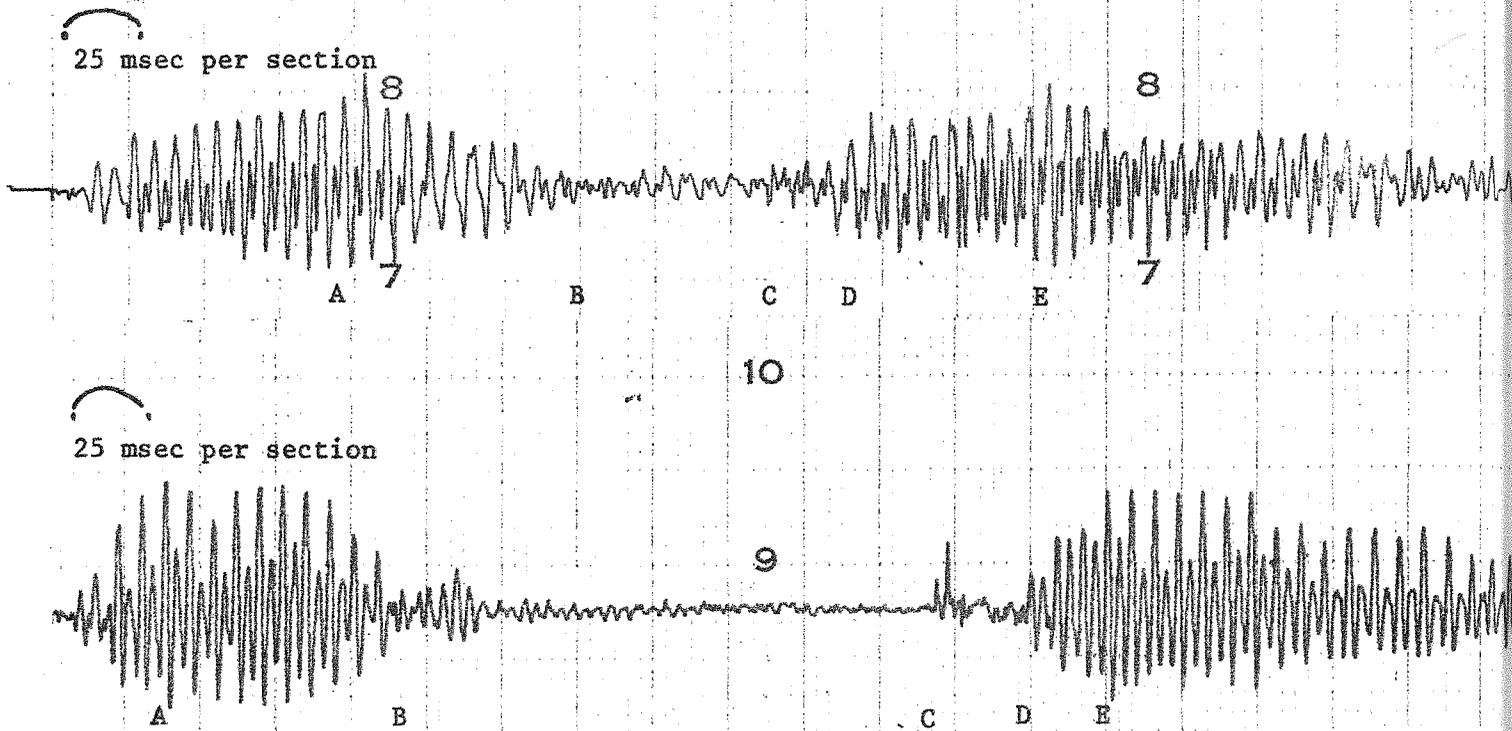


Figure 1

Items |id'i:l| above and |'iti:l| below. Speaker of Standard Dutch.

- A: damped oscillation with maximum amplitude of first vowel for VCV items and of vowel in case of VC items.
- B: end of vowel pattern proper*. F₁ and/or F₂ are no longer clearly measurable, in case of voiced CV item point B marks the beginning of glottal pulsing, and section B - C marks the VOT period for voiced plosives (voicing lead).
- C: beginning of plosive.
- D: end of plosive. 'C - D' marks the VOT period for voiceless plosives (voicing lag).
- E: damped oscillation with maximum amplitude of second vowel VCV items, and of vowel for CV items.

* see (5), last paragraph.

5. RECORDING AND DISPLAY APPARATUS

The dialect recordings in Garnwerd were made with a Tandberg portable tape recorder, and a Sennheiser microphone. The recordings were made in a livingroom, where conditions were quite adequate.

The recording of the Standard Dutch speakers took place in the recording studio at this institute by means of an Ampex recorder and Philips tulip model microphone (EL 6031).

The display of the recorded items was carried out by means of Revox taperecorders, Transient Recorder (with 1024 memory words), oscilloscope and gating apparatus. The procedure is described in the article published in these Proceedings by A.G. Wempe. Perhaps it is as well to mention here that for the display of signals of 500 msec full sweep or more the number of memory words available in the Transient Recorder is insufficient to give a precise indication where, for instance, a maximum amplitude is situated. Sampling of shorter intervals, e.g. 200 msec. or less, allows for sufficient samples per time unit to produce an almost undistorted signal.

6. VOT VALUES COMPARED

We wanted to know whether the audible difference between the dialect speakers from the province of Groningen were realized in values comparable to those found for English speakers and therefore in different parts along the time continuum than those found for (Standard) Dutch speakers. Data collected for Dutch and English speakers by Lisker and Abramson, those of Meyers and those for Standard Dutch and Gronings of the investigation under discussion can be compared at a glance. They are given on the next page.

en dan hebben
jullie nog een
Uher ook!

		b	d	p	t	
L + A 1964	1 Dutch	-85 (22)	-80 (32)	10 (46)	15 (32)	() number of samples. Items embedded in sentences.
	3 Eng.	1 (51)	5 (63)	58 (102)	70 (116)	
	1 Eng.	-101 (17)	-102 (13)			
Meyers 1971	3 Dutch	-88	-92	18	26	4 samples per initial cons. per speaker. Items consisted of loose words.
	2 Eng.*	-5	12	36	53	
	1 Eng.*	-71	-61			
H.D. 1975/76	3 St. Dutch	-95	-110	18	26	3 samples per initial cons. per speaker: loose words.
	3 Gron.	-111	-101	20	37	

* British English.

TABLE 1 Values represent milliseconds.

It will be clear that mean voicing lead values for Standard Dutch speakers are closely in agreement in all three experiments. Also that speakers from 'Groningen', the name is used loosely here to denote dialect speakers from Garnwerd, make use of the same acoustic space for their voiced plosives as do speakers of Standard Dutch. Now as regards the mean VOT value of the voiceless labial plosive |p|, we see close agreement between Gronings and Dutch. But the |t| values differ slightly. Gronings makes use of a space in the direction of aspirated English dental plosives, but the mean value for Gronings (37 msec.) remains very much smaller than those found for English (53 - 70 msec.).

The mean VOT values for |k| are identical for Gronings (47 msec) and for Standard Dutch (50 msec). Here again the same acoustic space is made use of. This result, which, after all, showed only a slight difference in values for |t|, did not look very promising at first. However, closer scrutiny of the items visible on the oscilloscope showed that there were differences, visible as well as audible, between the voiceless plosives produced by the two groups of speakers. The sections |-pi|, taken from the identical item |'ipi| and produced by a speaker of Standard Dutch (above) and of Gronings (below) will help to make the situation clear (Fig. 2). As it happens both speakers produced a |p| of identical duration (20 msec) and the amplitudes of the following |i| are well-matched.

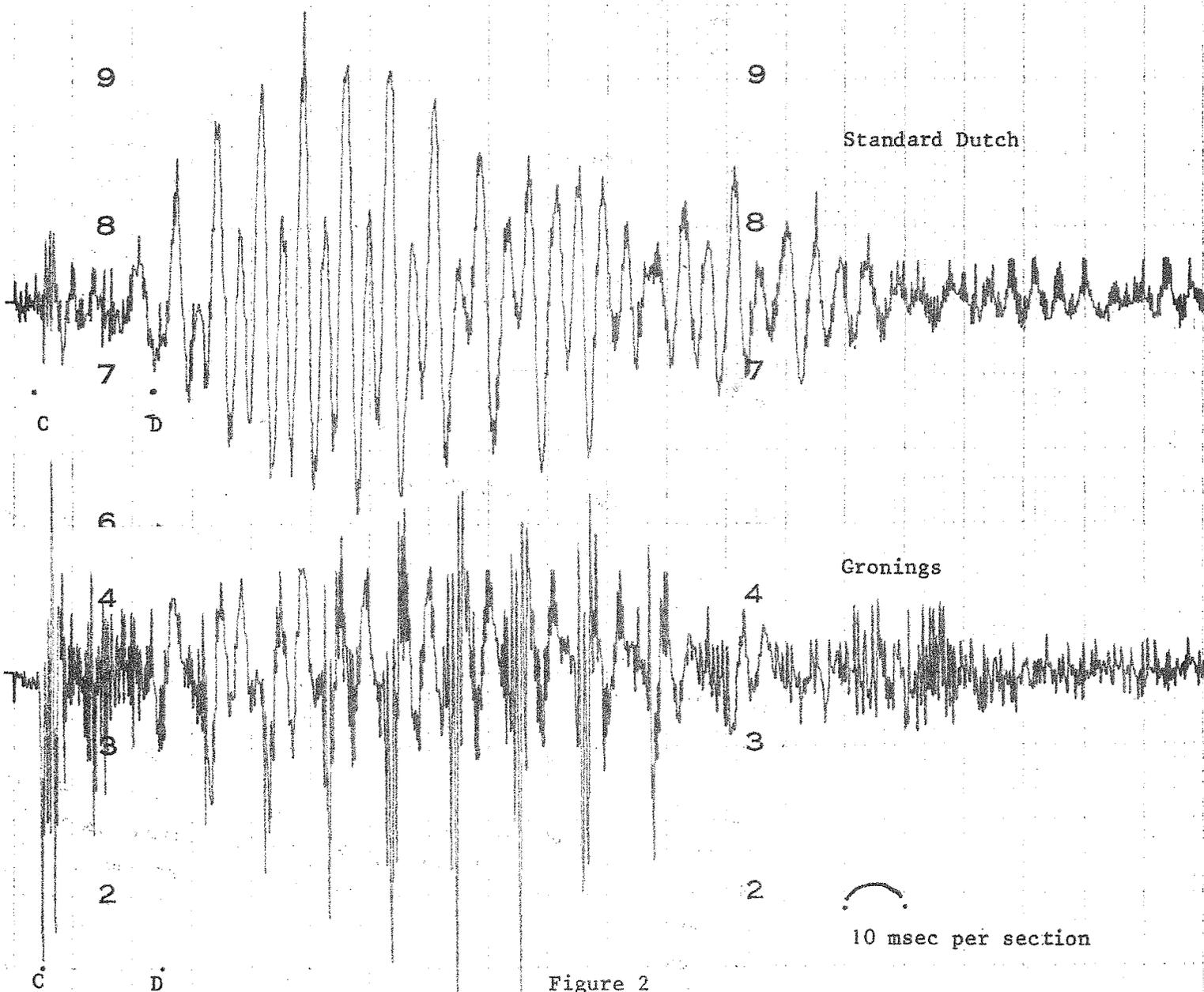


Figure 2

Duration of |p| is 20 msec. for both items.

Although durations are well-matched we can see clearly, when comparing the items, that duration need not be the only factor distinguishing two types of voiceless plosives. Amplitude ratios between consonant and following vowel need to be investigated for a possible solution. Before submitting the problem for a mathematical solution, however, it had occurred to me to look at the stretch between the point where the vowel proper ends (called point B here) and the point where the plosive starts (point C), to see if this part of the signal might not yield some simple duration clue which could be investigated without much trouble. The idea was supported by a letter received from John Westbury, University of Texas, suggesting that 'a point where glottal pulsing ceases' might give some further useful information.

7. DEFINING THE MEASURING POINTS (Fig. 1)*

A definition of the points referred to in this investigation has yet to be given in detail.

As regards points A and E the beginning of the maximum damped oscillation was taken as a reference point, i.e. the point where its first zero crossing occurs. These points do not present any problems.

Point B, the end of the vowel proper, presented more difficulties. The oscillogram below (Fig. 3) will clarify this. The same item 'iti was used in Fig. 1 (page 4), but now the signal is rendered in two 200 msec. sweeps, while part of the first vowel has been omitted.

* Point C', referred to in the Leeds hand-out has been omitted here.

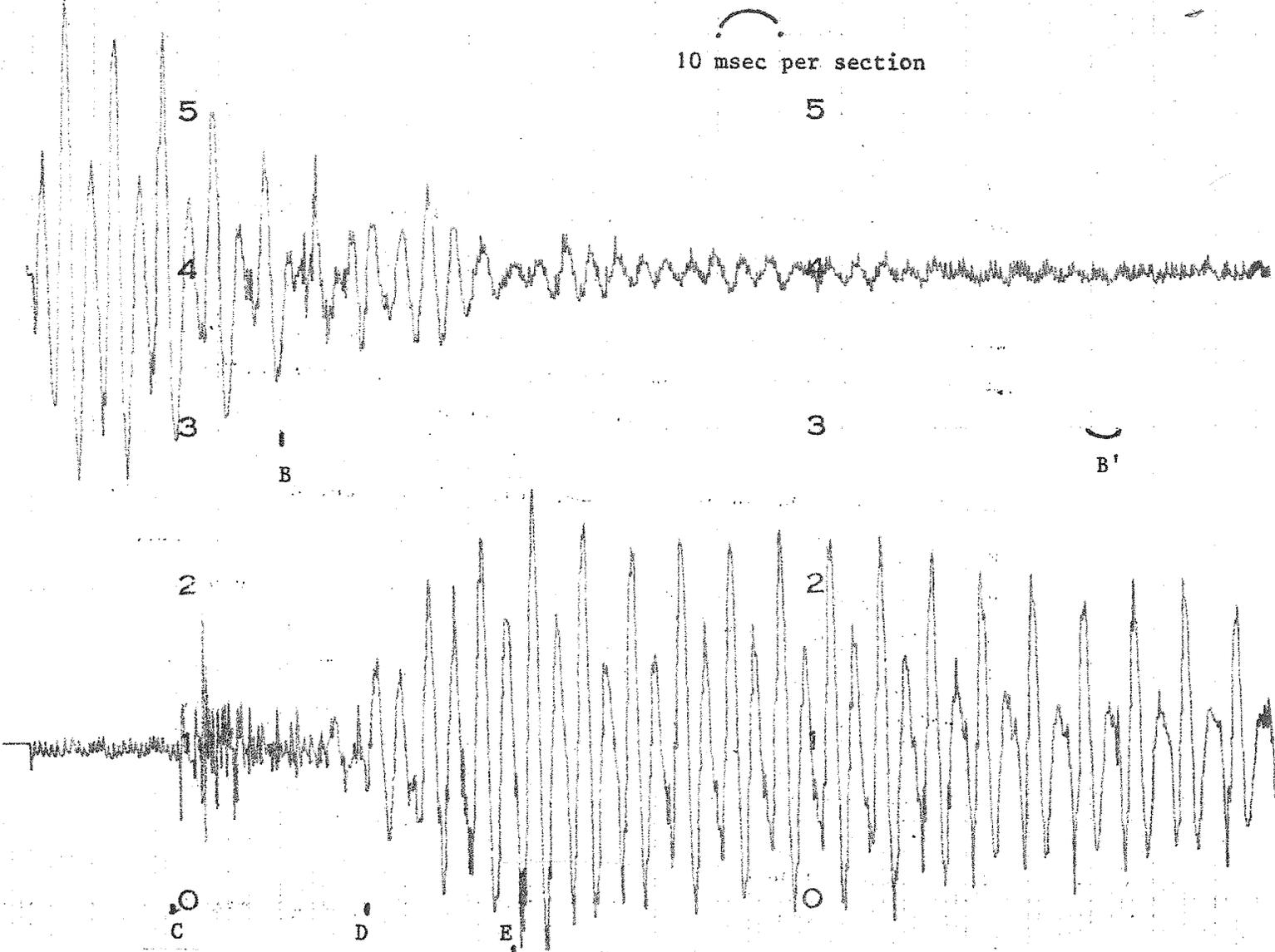


Figure 3

200 msec sweeps; item, part of |'iti|.

The point here defined as B was arrived at in the following manner. As the change in formant pattern alone did not give sufficient information the gate was used to transmit the signal at several different places consecutively, both adding or subtracting from the signal till the point was found after which the signal became ~~o~~-like. One whole damped oscillation before this point was ~~i~~-like, the next oscillation sounded

like |ɔ|. Of course great care was taken while listening to the signal emitted to keep transients at a minimum. As this procedure was rather time-consuming it was impossible to ask other people to give their judgement independently except incidentally. Point B had to be established in this round about way a number of times, but as a rule pattern changes and change in quality to |ɔ̃|-like sounds coincided so that eye- and earjudgements could be got without too much trouble.

The next point on the oscillogram, point B', was defined as follows:

For a vowel followed by a voiceless plosive, B' is the point where glottal pulsing ceases and the voiceless period before the plosive can be seen to begin. It stands to reason that this point is always an approximation, depending among other things on the signal to noise ratio. For a vowel followed by a voiced plosive, B' is the point where glottal pulsing starts and the period commenced which can be compared, in a manner of speaking, with the voicing lead found in the initial voiced plosives of a great many languages.

Point B' is given for an item with voiced labial, |ubu|, (Fig. 4 A) and with voiceless labial, |upu|, (Fig. 4 B).

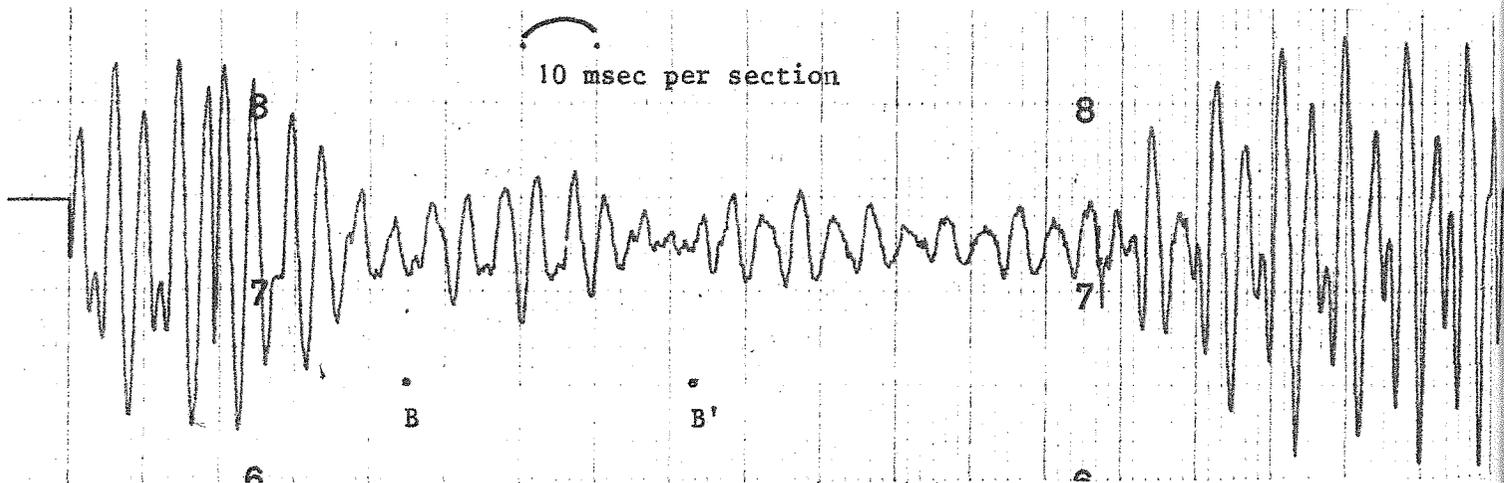


Figure 4 A
Sections of |ub'u|. Speaker of Standard Dutch.

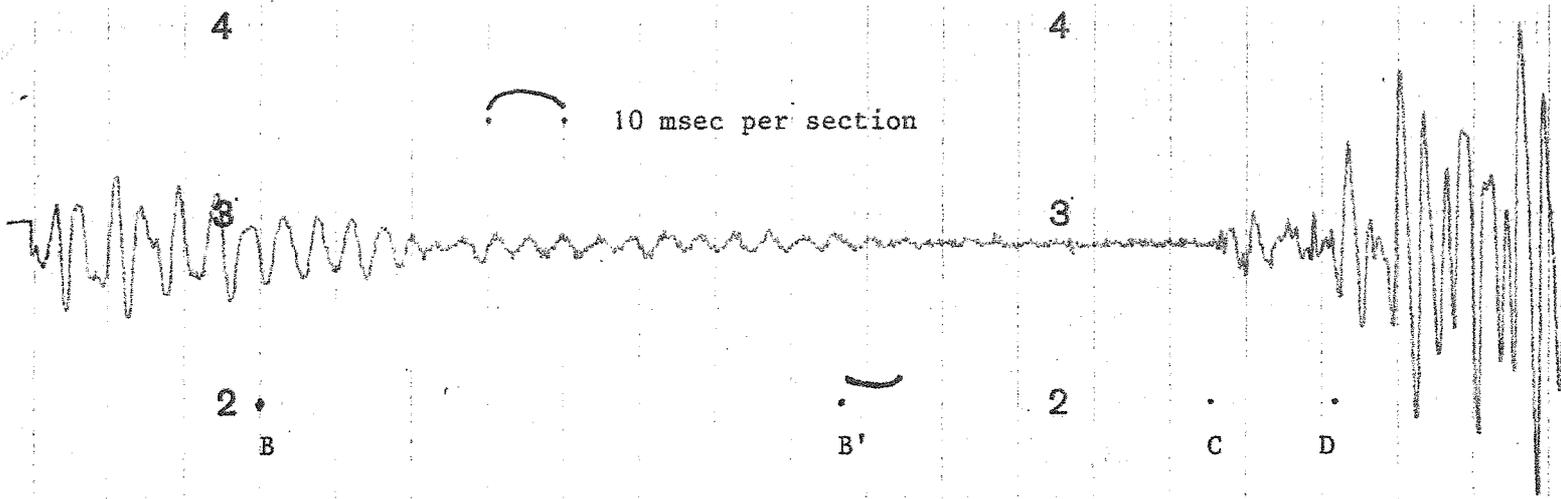


Figure 4 B
Sections of |up'u|. Speaker of Standard Dutch.

The next point to be defined is point C, which shows the beginning of the plosive and is, as a rule, clearly definable on the oscillogram, except in some of the VC combinations where a number of labial plosives were barely noticeable.

Point C can be regarded as the pivot point for all the (duration) measurements, except for the section B-B'.

If this point, demarcating the beginning of the plosive, was simple enough to find, the end of the plosive, point D, was not so easy to locate where voiced plosives were involved. Here coarticulation phenomena occur where vowel patterns can be clearly defined visually and yet audibly the signal still carries 'plosive information' even after the (visually) apparent signal is cut out by the gate (See fig. 5). A 100 msec sweep taken from the item |'udu| shows what is meant. If the signal is transmitted after the point shown by the arrow the plosive |d| is still audible. At first steps of 5 to 10 msec were used to try and gain some insight about the duration of these coarticulation phenomena, afterwards steps of one whole damped oscillation were used. Again transients were kept at a minimum to avoid transient clicks. For a possible 108 items for Standard Dutch and for Gronings 68 inci-

dences occurred with these coarticulation phenomena, with 34 incidences each for Standard Dutch and Gronings.

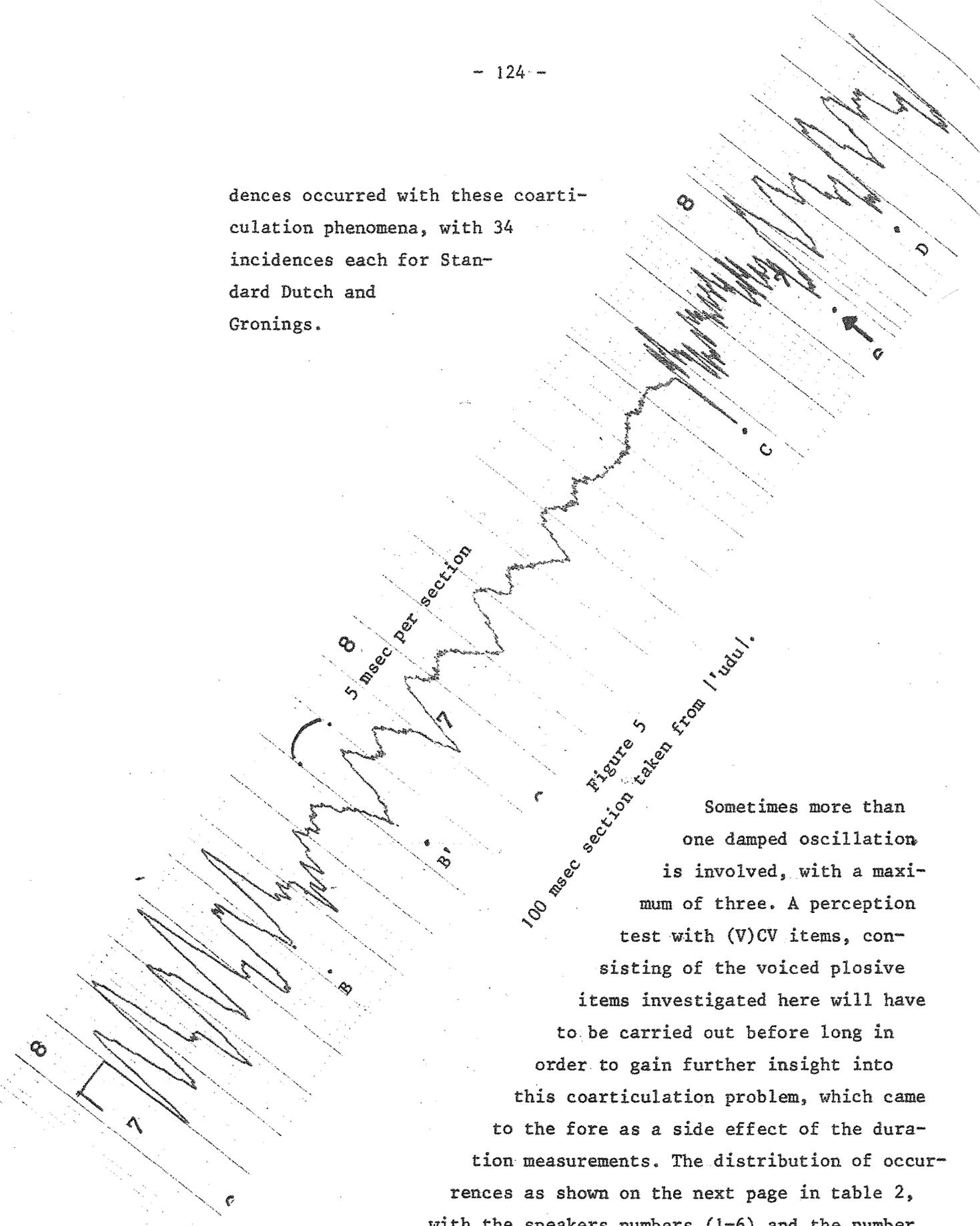


Figure 5
100 msec section taken from |'udu|.

Sometimes more than one damped oscillation is involved, with a maximum of three. A perception test with (V)CV items, consisting of the voiced plosive items investigated here will have to be carried out before long in order to gain further insight into this coarticulation problem, which came to the fore as a side effect of the duration measurements. The distribution of occurrences as shown on the next page in table 2, with the speakers numbers (1-6) and the number of damped oscillations involved (0-3).

	(Gr.)			(St.D.)				(Gr.)			(St.D.)		
	Speaker no.			Speaker no.				Speaker no.			Speaker no.		
	1	2	3	4	5	6		1	2	3	4	5	6
bu	0	0	1	1	1	1	du	1	0	2	1	2	1
bi	1	1	1	1	0	1	di	0	0	0	0	0	1
ba	0	0	2	2	0	1	da	1	1	2	0	1	0
'ubu	0	2	1	2	0	1	'udu	1	1	0	0	0	0
'ibi	0	1	1	1	1	1	'idi	1	0	0	1	1	1
'aba	1	1	2	0	2	1	'ada	1	0	3	1	3	0
ub'u	1	2	0	0	1	2	ud'u	1	1	2	0	0	1
ib'i	0	0	1	1	1	2	id'i	0	0	1	0	0	1
ab'a	1	0	1	0	2	1	ad'a	1	1	1	0	1	0

Table 2.

Of course, before the perception experiment has been carried out these results must be regarded as preliminary. For the voiceless plosives, verifying point D presented no problem.

8. RESULTS

The measurements carried out in the time continuum for speakers of Gronings and of Standard Dutch are compared below. All figures refer to values in milliseconds.

Arrows point from smaller to larger values. Each figure represents the mean value of three items. Figures which are underlined show a comparative difference of 20% or more.*

* In a pilot investigation such as this was, it was considered premature to give a statistical interpretation of the results. The rough arrow pointing indication was therefore used instead.

Voiceless plosives:

Section:	A - C		B - C		B - B'		C - D		C - E	
	Gr.	St.D.	Gr.	St.D.	Gr.	St.D.	Gr.	St.D.	Gr.	St.D.
pu	-	-	-	-	-	-	<u>30</u> ←	23	68	← 62
pi	-	-	-	-	-	-	16	← 14	46	← 35
pa	-	-	-	-	-	-	13	→ 17	<u>85</u>	← 38
'upu	232	→ 245	151	← 147	70	→ 118	<u>27</u>	← 21	66	← 60
'ipi	187	← 182	115	→ 120	50	→ 112	18	→ 24	58	← 55
'apa	235	→ 240	128	→ 138	19	→ 97	14	→ 15	36	- 36
up'u	203	→ 228	130	→ 158	32	→ 117	28	← 26	<u>84</u>	← 55
ip'i	210	→ 258	133	→ 203	29	→ 127	22	← 19	<u>73</u>	← 51
ap'a	163	→ 223	150	→ 152	30	→ 62	15	← 13	<u>89</u>	← 41
up	213	← 207	153	- 153	65	→ 113	<u>80</u>	← 67	-	-
ip	162	→ 220	130	→ 140	39	→ 132	52	→ 77	-	-
ap	170	→ 200	122	→ 132	18	→ 112	62	→ 65	-	-
tu	-	-	-	-	-	-	<u>33</u>	← 23	52	← 50
ti	-	-	-	-	-	-	40	- 40	61	← 56
ta	-	-	-	-	-	-	<u>37</u>	← 15	<u>92</u>	← 39

Voiceless plosives continued:

Section:	A - C		B - C		B - B'		C - D		C - E	
	Gr.	St.D.	Gr.	St.D.	Gr.	St.D.	Gr.	St.D.	Gr.	St.D.
'utu	223	→ 235	150	→ 157	61	→ 130	29	← 25	62	← 49
'iti	245	← 222	172	← 128	45	→ 118	38	→ 44	54	→ 67
'ata	213	→ 252	102	→ 122	21	→ 73	46	← 25	105	← 52
ut'u	202	→ 233	125	→ 173	36	→ 125	26	← 25	69	← 55
it'i	188	→ 222	123	→ 152	29	→ 108	42	← 38	80	← 71
at'a	180	→ 220	172	← 168	21	→ 73	26	← 21	71	← 53
ut	133	→ 183	102	→ 122	40	→ 122	98	← 82	-	-
it	172	→ 198	97	→ 130	47	→ 115	98	→ 112	-	-
at	200	→ 208	113	← 112	19	→ 85	108	← 72	-	-
ku	-	-	-	-	-	-	43	→ 58	109	← 90
ki	-	-	-	-	-	-	61	← 56	122	← 118
ka	-	-	-	-	-	-	38	← 37	98	← 95
'uku	247	← 203	173	← 123	57	→ 118	44	→ 50	92	← 90
'iki	160	→ 217	100	→ 128	33	→ 100	68	← 54	105	← 95
'aka	213	← 203	95	→ 115	24	→ 107	58	← 35	95	← 80

Voiceless plosives continued:

Section:	A - C		B - C		B - B'		C - D		C - E	
	Gr.	St.D.	Gr.	St.D.	Gr.	St.D.	Gr.	St.D.	Gr.	St.D.
uk'u	207	→ 232	128	→ <u>165</u>	43	→ <u>138</u>	53	← 45	<u>134</u>	← 95
ik'i	192	→ 213	138	→ 157	26	→ <u>120</u>	62	← 52	<u>119</u>	← 99
ak'a	192	→ 215	128	→ 146	16	→ <u>47</u>	33	← 32	<u>116</u>	← 72
uk	163	→ <u>195</u>	113	→ <u>138</u>	54	→ <u>97</u>	108	- 108	-	-
ik	156	→ 185	102	→ <u>135</u>	56	→ <u>127</u>	98	→ 113	-	-
ak	232	← 225	124	→ 145	11	→ <u>85</u>	53	→ <u>65</u>	-	-

128 +

Voiced plosives:

	Perceptive part of voiced plosive	
	Gr.	St.D.
bu	-	-
bi	-	-
ba	-	-
'ubu	<u>247</u>	← 198
'ibi	<u>195</u>	← 140
'aba	208	← 182
	17	← 14
	<u>20</u>	← 13
	21	← 20
	<u>26</u>	← 20
	16	→ 19
	20	← 19
	45	→ 47
	<u>61</u>	← 47
	<u>108</u>	← 59
	48	→ 49
	34	← 32
	<u>73</u>	← 25

Perceptive part of
voiced plosive

Voiced plosive continued:

Section:	A - C		B - C		B - B'		C - D		C - E	
	Gr.	St.D.	Gr.	St.D.	Gr.	St.D.	Gr.	St.D.	Gr.	St.D.
ub'u	145	→ 168	97	→ 118	7	→ 36	16	← 14	47	→ 63
ib'i	183	→ 210	103	→ 123	0	→ 25	10	→ 18	47	← 34
ab'i	162	← 157	102	← 100	23	→ 39	19	→ 24	107	← 61
du	-	-	132	← 107	-	-	19	← 16	52	- 52
di	-	-	102	→ 107	-	-	13	→ 22	51	→ 60
da	-	-	68	→ 116	-	-	29	← 18	97	← 75
'udu	203	→ 207	73	→ 90	15	→ 36	19	← 12	49	← 34
'idi	152	← 142	89	← 62	16	← 10	16	← 15	41	→ 50
'ada	172	→ 190	73	→ 77	28	→ 32	27	→ 28	50	→ 57
ud'u	207	← 175	108	← 95	11	→ 40	19	← 16	64	← 40
id'i	182	← 173	100	← 88	9	→ 27	16	← 15	53	- 53
ad'a	168	→ 192	92	→ 105	26	→ 33	18	← 16	117	← 67

8.1 Summary of the results.

Voiceless plosives:

Section A - C. From the maximum of the 1st vowel to the start of the plosive, the tendency emerges for larger duration values for St.D. than for Gronings.

Section B - C shows almost the same distribution pattern as section A - C.

Section B - B' shows a remarkable difference between the two types of speakers. Figure 6 has been inserted to show the item |ap| for two types of speakers, which makes abundantly clear that glottal pulsing continues much longer for speakers of Standard Dutch, often up to the moment of the plosion, which, in turn, is often found to be 'feeble', even almost imperceptible for |p| in final position.

Section C - D, which includes VOT values for CV-items, shows a tendency for larger values for plosives of Gronings. It may be as well to state here that duration values for final plosives are difficult to ascertain as these plosives tend to end in a friction-like noise, petering out to the level of the noise of the tape.

The amplitude ratios of consonant and following vowel in (V)CV-items were clearly different for the two types of speech (see 6, fig. 2).

Section C - E shows larger values again for speakers of Gronings.

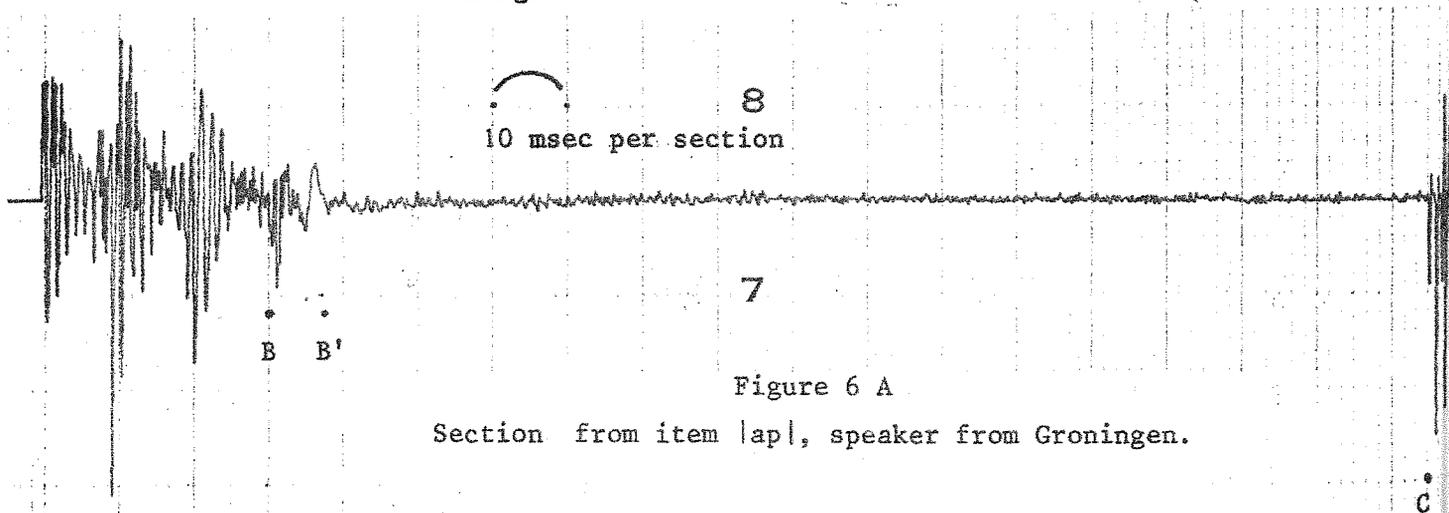


Figure 6 A

Section from item |ap|, speaker from Groningen.

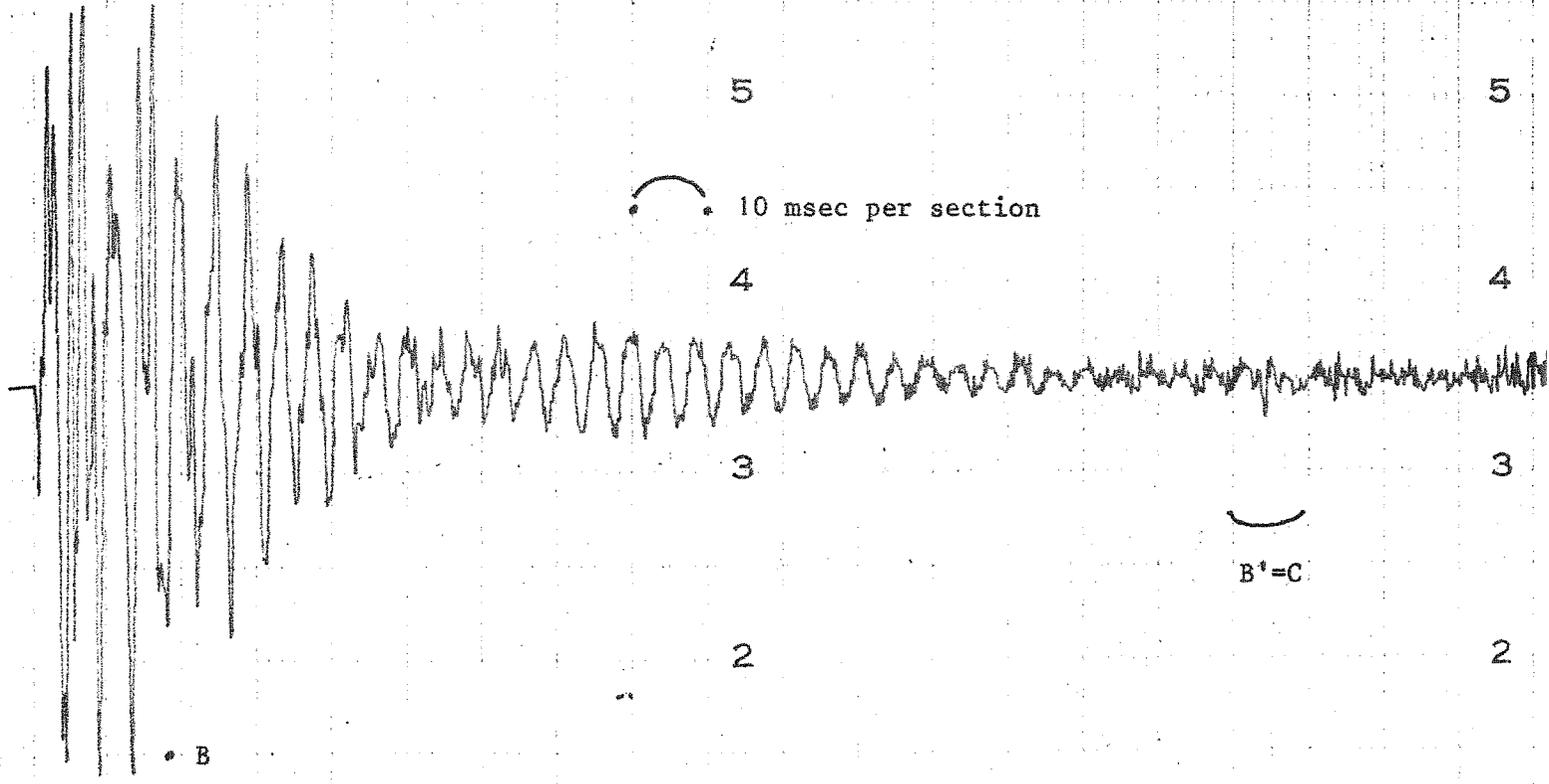


Figure 6 B
Section from item |ap|, speaker of Standard Dutch

Voiced plosives:

Section A - C shows a fairly even distribution between the two types of speakers.

Section B - C, which for CV-items includes VOT-values, again shows a fairly even distribution.

Section B - B'. Where the vowel proper ends and the voicing lead starts which precedes the voiced plosive gives larger values for Standard Dutch than for Gronings.

Section C - D. The (perceptive) plosive gives the larger values for Gronings, even if the number of times one or more damped oscillations are involved remained the same for the two types of speech (see Table 2).

Section C - E also gives larger values on the whole for Gronings, with |a|-items tending to be extremely long.

9. CONCLUSION

This experiment was carried out in order to find out what temporal pattern would emerge when plosives produced by speakers of Standard Dutch were compared to those produced by speakers from the province of Groningen. The dialects spoken in this province are audibly different to Standard Dutch as regards, among other things, the way some plosives are realized. It was thought that VOT values for speakers of "Gronings" would be comparable to values found for speakers of English.

This proved not to be the case. Values for |t| have slightly greater voicing lag for speakers of "Gronings" - mean value 37 msec, Standard Dutch 26 msec - but they cannot be compared to values found for English - between 50 - 73 msec.

The other plosives have comparable temporal aspects as far as VOT values are concerned.

However, it looks as if amplitude ratios C/V are quite unlike in the two types of speech.

As this was intended to be an investigation of duration phenomena only, a closer scrutiny was carried out in order to find out if any other difference than the one concerned with VOT could be found, which might account for the audibly distinct difference between the two types of speech.

The items, which were combinations of CV, 'VCV, VC'V, and VC, were measured so that a number of points were related to the moment where the pertaining plosive commences.

Combinations of VCV and of VC, where C is a voiceless plosive show distinct differences between Standard Dutch and "Gronings", which shows that for speakers of "Gronings" glottal pulsing ceases appreciably faster than for speakers of Standard Dutch, whatever the physiological cause of this might be. Speakers of Standard Dutch are shown to continue glottal pulsing to a point quite close to the release of the voiceless plosive.

The differences in glottal pulsing are such that the supposition seems justified that they contribute to the perceptive differences between the two types of speech. Since items with voiceless plosives are also the ones that show differences in amplitude ratios C/V when we compare the two types of speech, this aspect combined with the difference in glottal pulsing should be investigated further.

It is not too early to state that here lies, among others, a dialect clue.

There were no temporal differences between 'VCV and VC'V items, this was not entirely contrary to expectation, but both types were included in this investigation because of further research on similar lines.

Investigation concerning the perception of the 'coarticulation' phenomenon mentioned on pages 11 and 12 will be carried out shortly.

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