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Contextual Neutralization of Vowel Length: Evidence from Dutch

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Abstract. Based on recent experimental studies of word-final devoicing in languages like German and Catalan which show production differences between the neutralized and nonneutralized consonants, it has been claimed that phonological neutralization is 'incomplete'. It seems, however, that this claim is quite premature given that most studies have considered only the neutralizing phenomenon of word-final devoicing. In this paper, we examine a qualitatively different neutralizing phenomenon – the neutralization of vowel length in open syllables. We compared the duration of Dutch long vowels which are derived by an open-syllable lenghtening rule to those that are underlyingly long (cf. [da:len] < /dal+en/ vs. [ba:len] < /ba:l+en/). Our study shows that there is no difference in the duration between these vowels and that, at least, in this instance, contextual neutralization does lead to identical surface realization of distinct phonological segments.

The identical realization of distinct phonological segments in a specific environment is termed contextual neutralization. This is the situation in which underlying feature distinctions are lost in a given environment while being retained elsewhere. One of the most familiar examples of neutralization is the loss of voicing distinctions in syllable-final position in languages like German, Dutch, and Polish. In German, for example, the feature [voice] is distinctive such that both [+voice] and [–voice] obstruents occur in underlying representations; in word-final position however, [+voice] consonants become [–voice]. Thus, we find alternations in the nominative and genitive forms of nouns: [ra:t] – [ra:des] *Rad* 'bicycle' as against [ra:t] – [ra:tes] *Rat* 'advice', where the noun *Rad* has two surface allomorphs (rat) and (rad) as a result of the neutralization of word-final voiced consonants. Contextual neutralizations of this sort occur frequently in natural languages. In Russian, /a/ and /o/ are neutralized to [a] in unstressed position; compare the nominative singular and plural forms [mál] – [malí] 'small', but [stól] – [stalí] 'table'. Turkish geminates and single consonants are neutralized word-finally; compare the possessive and nominative forms for

'soil', [hakI] – [hak], with the respective forms for 'truth', [hakkI] – [hak].

On the one hand, neutralization processes cause the loss of surface contrasts of phonemes, and on the other, lead to surface alternations of the same underlying morpheme. But although neutralization is a well-accepted *phonological* fact, recent work in phonetics has given rise to a controversy as to whether phonological neutralization is a 'complete' *phonetic* neutralization. The contextual neutralization rule which has been referred to most in this controversy is the rule of final devoicing which is phonologically motivated in a number of languages.

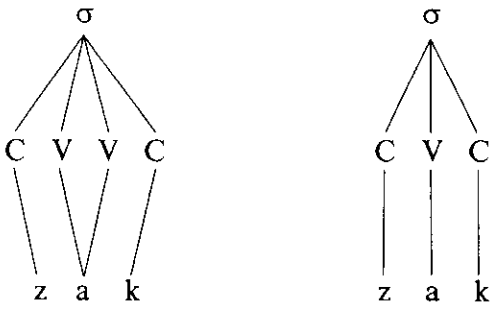
Several studies [O'Dell and Port, 1983; Port and O'Dell, 1985; Dinnsen and Charles-Luce, 1984] have suggested that final devoicing in German and Catalan may not be complete, so that voiceless obstruents which are derived by the final devoicing rule are phonetically different from underived (and therefore underlying) voiceless obstruents either in terms of closure durations, vowel length or aspiration. This evidence, however, has not been unchallenged. Fourakis and Iverson [1984] argue that the differences obtained in the studies of O'Dell and Port [1983] may be an artifact of the task and that in natural linguistic contexts voicing is completely neutralized in German. The results of Fourakis and Iverson [1984, p. 149] support the hypothesis that production differences in German final obstruents observable from data elicited by a reading task are 'hypercorrect manifestations of linguistic insecurity' due to the fact that spelling reflects the underlying distinction between the voiced and voiceless consonants (cf. *Rat* and *Rad*). Their experiments show that eliciting the relevant articulations without orthographic cues pointing to the underlying distinction can lead to a complete neutralization of the voicing of word-final consonants. In reply to Fourakis and Iverson, Port and O'Dell [1985] argue that hypercorrection should actually increase the tendency of stops to be completely neutralized since it is a widely known fact that German has final stop devoicing. However, they acknowledge that, given the 'very small differences observed' [Port and O'Dell, 1985, p. 470] in their production experiments based on reading isolated words, and given the absence of such a difference in 'casual unattended speech' in Fourakis and Iverson's [1984] study, the differences cannot play a significant role in normal speech.

Based primarily on Port and O'Dell [1985] and other similar studies, Dinnsen [1985] questions whether there is *any* actual occurrence of neutralization. Most empirical work on neutralization has centered around word-final devoicing. Even if one takes the existing results as an indication that word-final devoicing is 'incomplete', it remains an open question whether this holds for other cases of neutralization. It seems quite premature for Dinnsen [1985, p. 275] to claim that the 'standard view of neutralization...is unfortunately without empirical support' before other qualitatively different neutralizing phenomena have been examined. Therefore in this paper we examine such a phenomenon: the neutralization of vowel length in Dutch open syllables. This instance of neutralization is different from final devoicing since it involves a different class of sounds, vowels rather than consonants. However, it is similar to devoicing because the context of neutralization involves a boundary – in this case an open syllable.

Vowel Length in Dutch

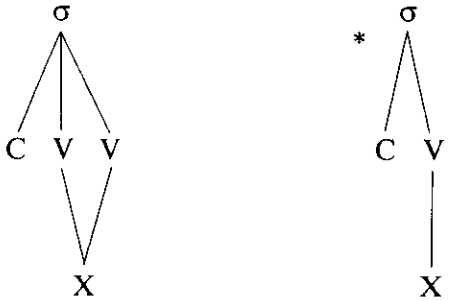
Dutch has both underlying short and long vowels. Their distributional properties have been studied in great detail by phonologists and will not be discussed here [Booij, 1981; Trommelen, 1983; van der Hulst, 1985]. Suffice it to say that short vowels (not including schwa) do not occur syllable-finally and therefore not word-finally, whereas long vowels can [van der Hulst, 1985]. Thus it is possible to get contrasts of the type

(1)



(thing) (bag)

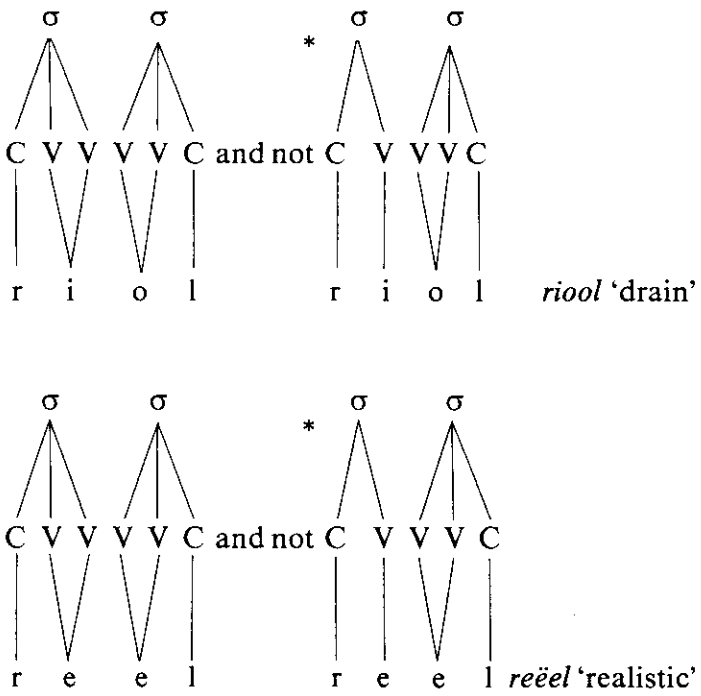
but not



The fact that, in syllable-final position, Dutch only allows long vowels is also manifested in bisyllabic words, where the first syllable is open and the second syllable begins with a vowel [van der Hulst, 1985].

Examples:

(2)



The singular form of nouns shows contrasts between underlying long and short vowels:

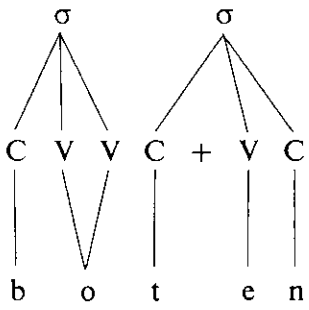
Examples:

(3) vlaag 'squall' vs. vlag 'flag'
mees 'titmouse' vs. mes 'knife'
boot 'boat' vs. bot 'bone'

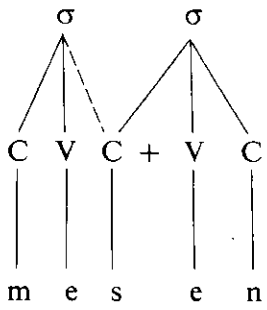
However, the addition of the plural affix [ən] (written *en*) can potentially create an open first syllable. Therefore one would expect the short vowels in a word like *mes* to be lengthened in the plural. This, however, does not happen because of the ambisyllabicity of the following stem consonant [Booij, 1981; van der Hulst, 1985]. It is not relevant here which theory of ambisyllabicity one follows. What is important is that the underlying phonological length of the singular is preserved in the plurals of these nouns.

The structure of the corresponding plurals is as follows:

(4)



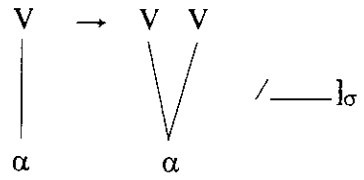
(boats)



(knives)

Ambisyllabicity is, however, blocked in certain specific morphological classes [including certain nouns, adjectives and strong verbs; van der Hulst, 1985]. These words can then undergo a rule of vowel lengthening in open syllables which can be stated as

(5)



The application of this rule leads to long and short vowel contrasts for certain nouns on the surface:

Examples:

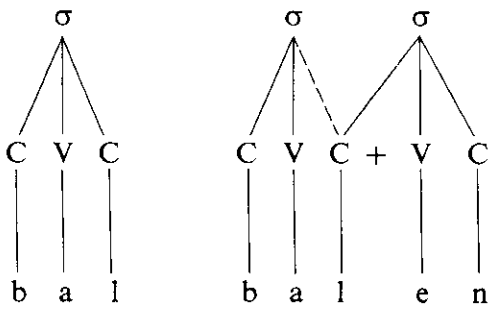
(6) dag – dagen 'day'
dal – dalen 'valley'
gat – gaten 'hole'

Dutch nouns therefore show different kinds of vowel alternations on the surface. They can be divided into the following three classes:

(7)

Singular Plural

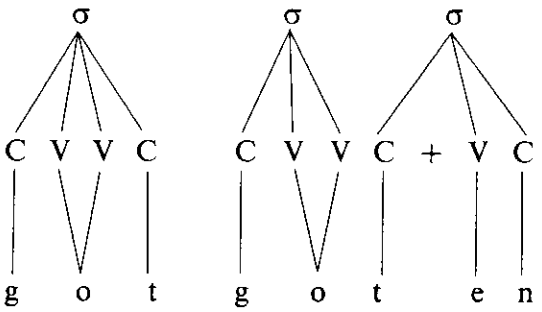
(I) Underlying short



'ball'

bal *ballen*

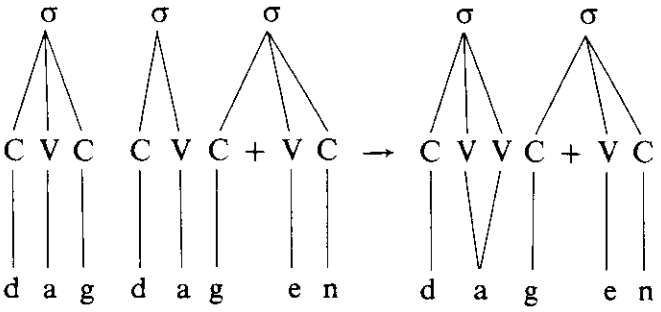
(II) Underlying long



'drain'

goot *goten*

(III) Underlying short – derived long



dag *dagen* 'day'

In class I the underlying short vowel of the singular does not change in the plural because of the ambisyllabicity of the stem-final consonant. In class II, the underlying long vowel remains unchanged. And in class III, the underlying short vowel of the

singular becomes long in the plural because of the vowel lengthening rule in open syllables.

Length distinction in Dutch in thus neutralized in open syllables since long vowels can also be derived from underlying short vowels by the application of the lengthening rule. In this paper, our main interest is focussed on comparing the surface realization of the underlying long vowel in the plural forms of class II nouns with the derived long vowels of the corresponding class III plurals. Notice that the long vowels in the class III plural forms (cf. *dagen*) are derived by rule from underlying short vowels which are *phonologically* identical to the short vowels of the class I nouns. The necessary precondition for the comparison between the underlying and derived long vowels (i.e. plurals of class II and III) to be valid is that the short vowels in the class III singular nouns do not differ in length from the corresponding vowels of the class I singular nouns.

Method

The purpose of this study was to examine the duration of the Dutch vowels [a], [e] and [o] and their long counterparts as they are produced by native speakers in pairs of nouns of classes I, II, and III. The stimuli consisted of 42 Dutch nouns and their plurals and were organized as follows: There were 14 sets of 6 words. Each set consisted of 3 singular nouns (monosyllabic) and their corresponding plural forms such that each of the three classes was realized once in each set. Although it was not possible to get complete minimal pairs, within each set the vowel and the postvocalic consonant were kept constant. The consonant immediately preceding the vowel was kept as minimally distinct within each set as the language would permit. In all, we had 4 sets with the vowel [e], 4 with [o] and 6 sets with [a]. The complete list of the test stimuli, which were chosen from the CELEX data base, is given in the Appendix. An example of a complete set would be as follows:[1]

		Singular	Plural	
(I)	Short/short	bal	ballen	'ball'
(II)	Long/long	baal	balen	'bag'
(III)	Short/long	dal	dalen	'valley'

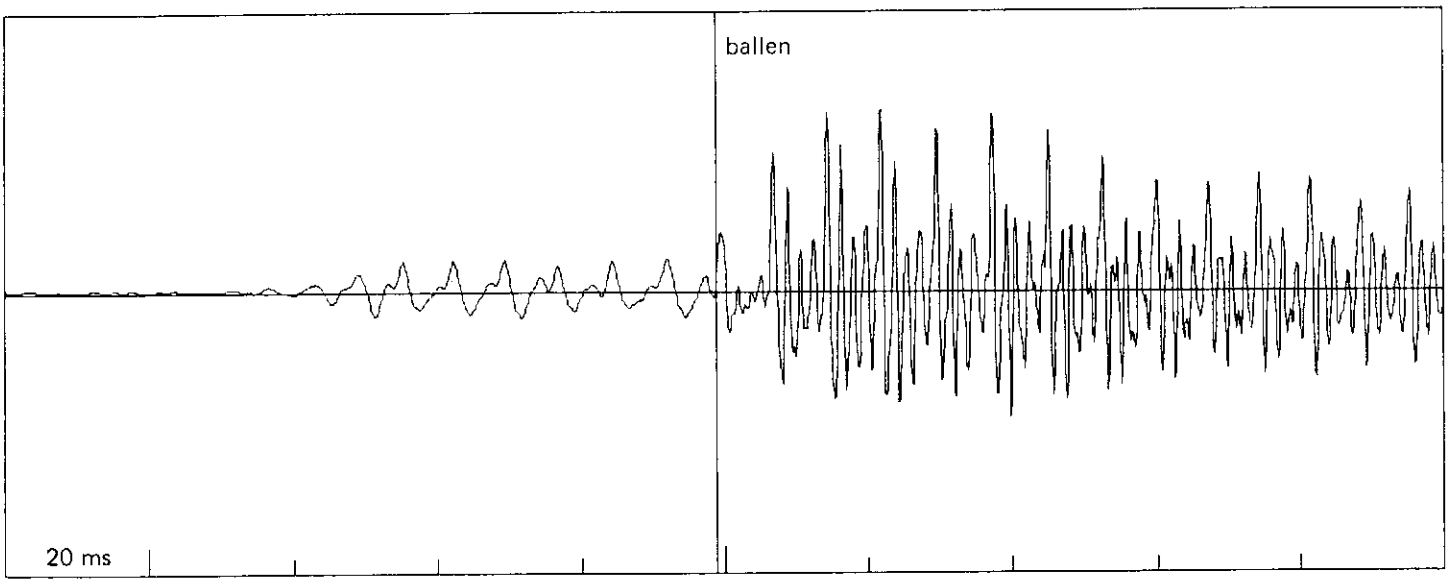
Three paid male subjects read the 84 words three times in a different randomized sequence. In order to prevent subjects from interpreting some of the plurals as verbs (which is possible in some instances) they were told that the words that they had to read were singular and plural Dutch nouns. Each word was written out on a separate index card and the subject was instructed to read a word, place the card face down and then continue. After each sequence of 84 words there was a short pause.

The words were recorded on tape in a soundproof room using a Nagra 4.2 tape recorder and an AKG microphone. All stimuli were then digitized using a 10-kHz sampling rate and a 5-kHz low pass filter setting. Vowel duration measurements were made using a waveform editing program.

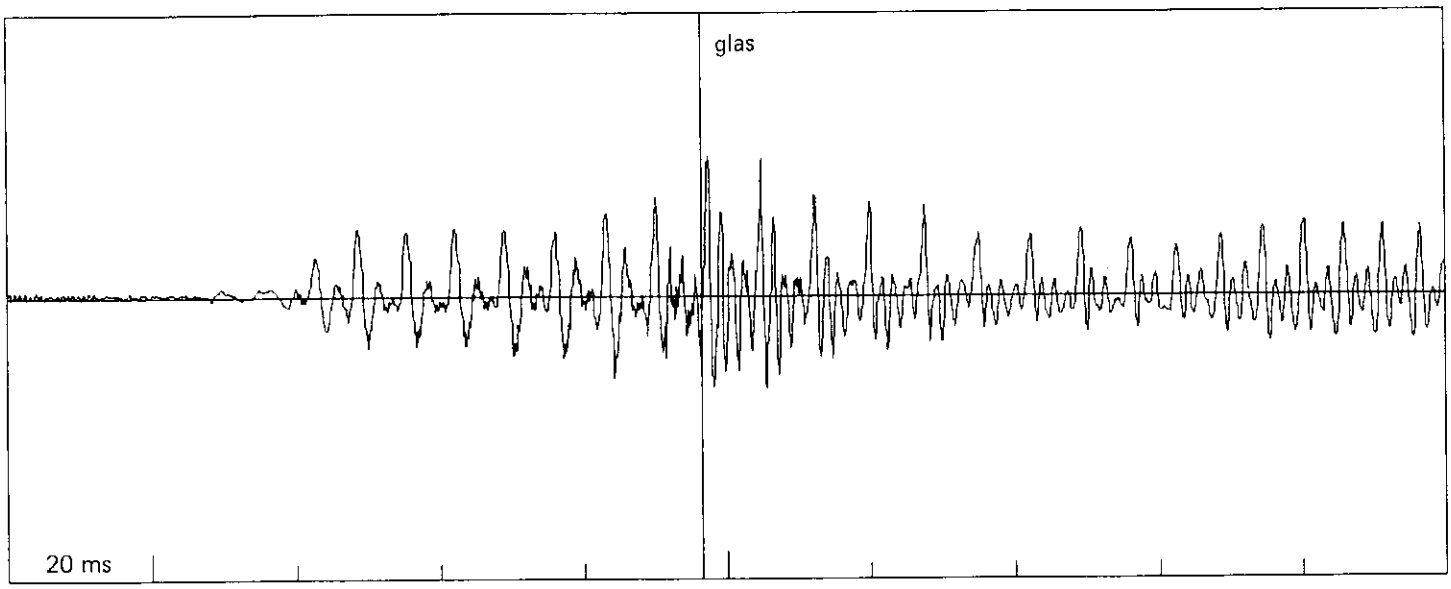
Sample waveforms with marks indicating the beginning and end of the vowels are given in figure 1.

Vowel onset was considered to be the onset of periodicity in the waveform. The postvocalic consonants were [t,d,s,z,x,f,v,n,l], and the end of the vowel was taken to be the point at which there was a sudden drop in amplitude along with the disappearance of higher harmonics in the waveform.

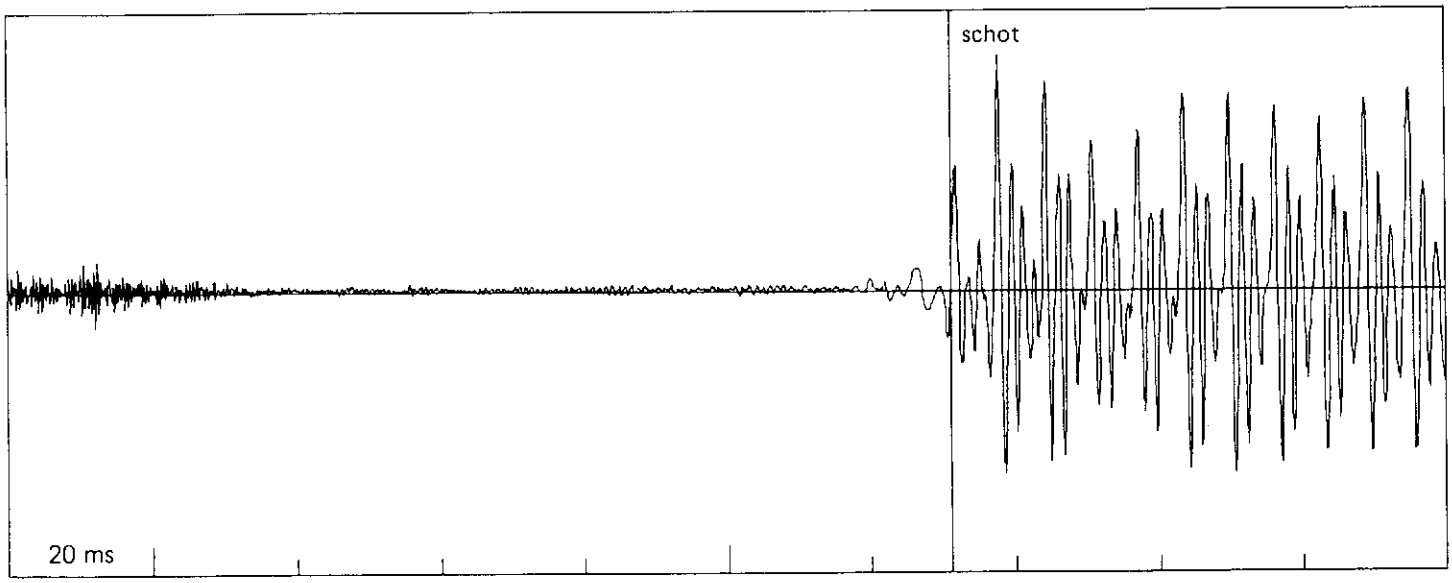
[1] Dutch spelling consistently reflects the length of the vowels. Long vowels are marked by digraphs in closed syllables. In bisyllabic words, short vowels are always followed by two consonants to indicate closed syllables and long vowels are indicated only by a single letter in open syllables.



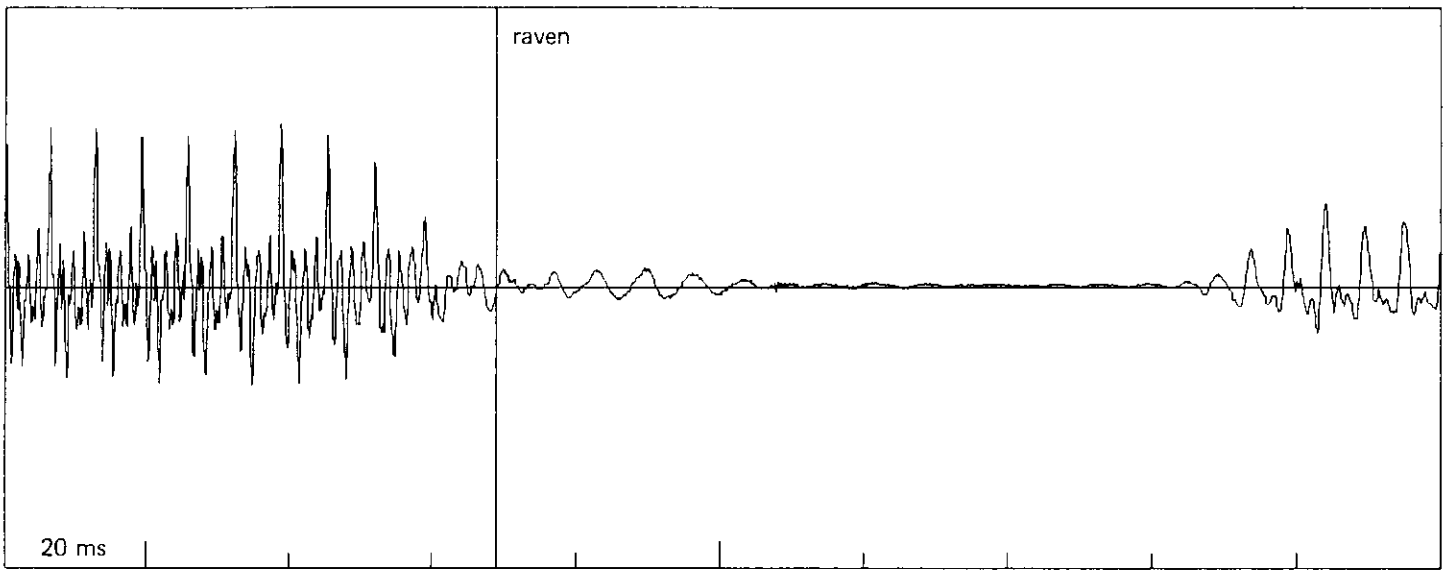
a



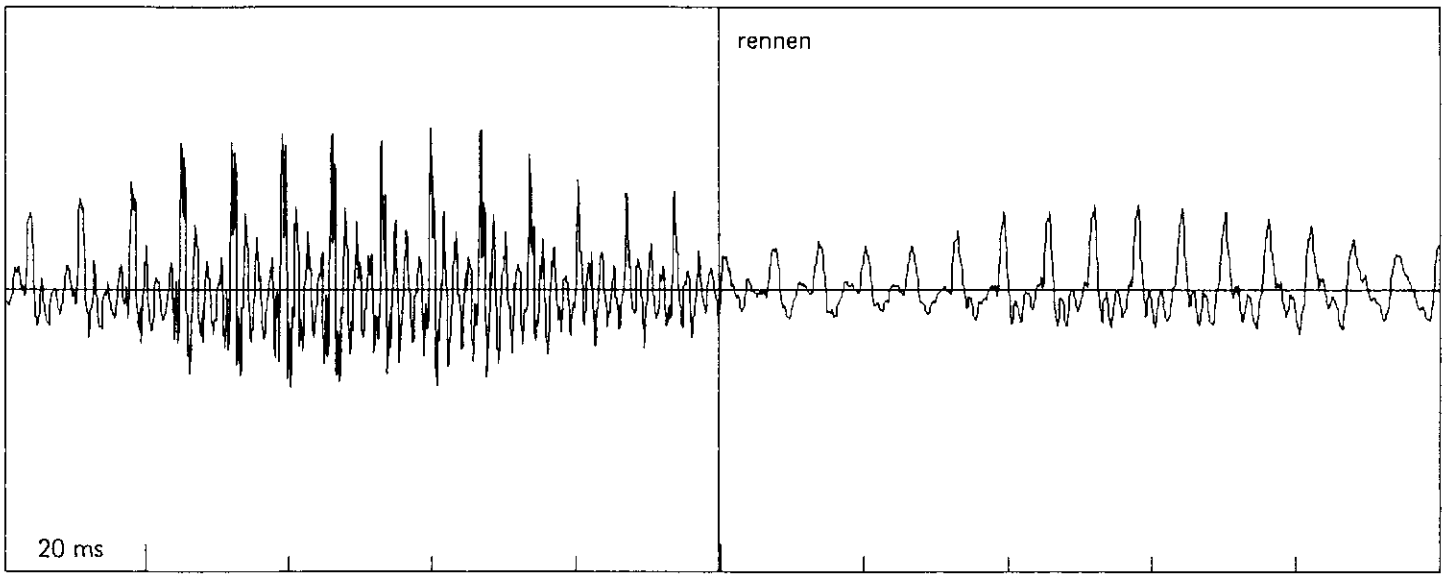
b



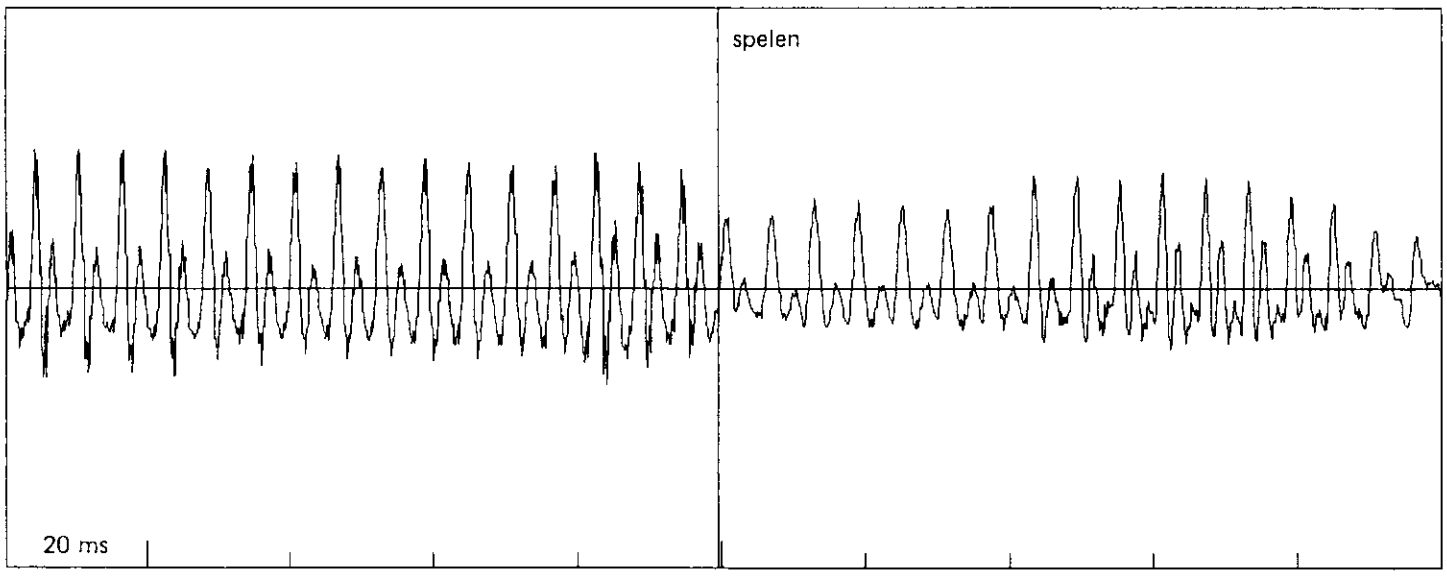
c



d



e



f

Fig. 1. Sample waveforms with the measurement points marking beginnings **(a–c)** and ends **(d–f)** of vowels.

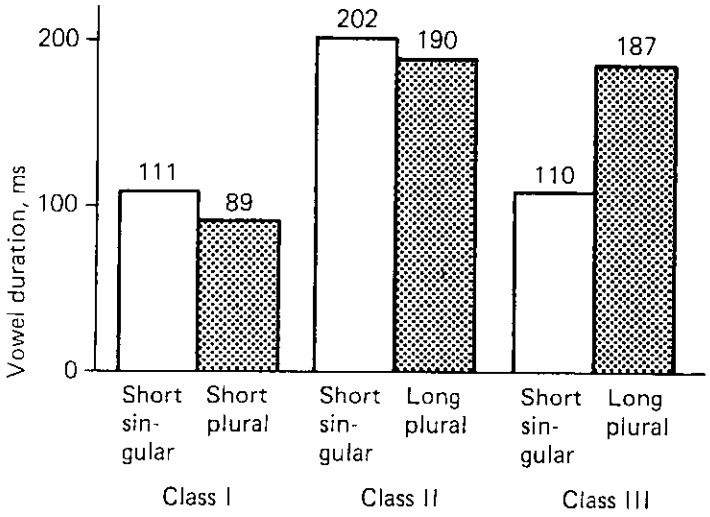


Fig. 2. Mean vowel durations across speakers and vowels for three classes of singular-plural pairs.

Results

The mean vowel duration for the three types of singular-plural pairs (class I, II, and III) across subjects and across all vowels is shown in figure 2. The overall pattern shows that underlying and derived long vowels are phonetically identical.

Analysis of variance of vowel duration with subjects as units of analysis shows a significant effect of the six conditions (singular vs. plural of class I, II, and III) plotted in figure 2 [$F(5, 10) = 156.1$, $MSe = 2{,}014$, $p < 0.0005$]. The short vowels of the

Table I. Mean vowel duration and standard deviations (SD) for each subject and each vowel in plural forms of class II (underlying long) and class III (derived long)

Vowel		Subject 1			Subject 2			Subject 3		
		mean	SD	t	mean	SD	t	mean	SD	t
[a:]	Underlying long	219	24		197	14		211	19	
				t(17)=–3.7 $p<0.002$			t(11)=–0.38 NS			t(11)=–1.1 NS
	Derived long	207	18		192	27		210	22	
[e:]	Underlying long	177	35		168	16		180	22	
				t(17)=–0.91 NS			t(11)=0.23 NS			t(11)=–0.41 NS
	Derived long	175	29		169	9		181	21	
[o:]	Underlying long	181	19		172	28		186	28	
				t(17)=–0.21 NS			t(11)=0.15 NS			t(11)=–0.3 NS
	Derived long	177	19		170	20		184	26	

In addition, the t values for the nine critical comparisons of the duration of underlying vs. derived long vowels are given.

singular nouns of both class I and class III (i.e. *bal* and *dal*) are almost identical. Moreover, the long vowels in the plural nouns, underlying long for class II and derived long for class III, show a mean difference of only 3 ms. Neither differences approach significance in a Newman-Keuls test. We conclude from this that, across subjects and vowels, the phonetic realization of underlying long vowels and those that are derived by rule do not differ. We then checked to see whether this pattern holds for each subject and each word.

Table I shows the mean vowel duration of underlying long vowels (i.e. long vowels from the plural of class II nouns) and derived long vowels (i.e. long vowels from the plural of class III nouns) for each of the 3 subjects and each of the three vowels. In addition, table I gives the standard deviations of these means and the t values for pairwise t tests for correlated samples. For vowel [a], each mean is based on 18 observations, for vowel [e] and [o] on 12 observations.

Only one of the nine comparisons yields a statistically significant difference between underlying long and derived long vowels. For the other eight, the differences are non-significant. Taken as a whole, the results of the overall analysis as well as the pairwise comparisons within subjects and within vowels support the view that neutralization in the case of vowel length is complete.

In addition to the results on neutralization, the Newman-Keuls test carried out on the six condition means reveals the following pattern: The short vowel of plurals from class I nouns is significantly shorter than its counterpart in the singular ($p < 0.05$). This result fits in well with other findings [e.g., Nooteboom, 1972; Klatt, 1973], which show

Table II. F_1 and F_2 measures for 1 subject and each vowel in plural forms of class II (underlying long) and class III (derived long).

	Underlying long	Derived long	t	p
[a:]				
F_1	605	595	$t(5) = 1.14$	$p = 0.304$
F_2	1,445	1,448	$t(5) = -0.213$	$p = 0.839$
[e:]				
F_1	445	444	$t(3) = 0.055$	$p = 0.960$
F_2	2,146	2,218	$t(3) = -0.926$	$p = 0.423$
[o:]				
F_1	506	511	$t(3) = -0.191$	$p = 0.861$
F_2	876	860	$t(3) = 0.437$	$p = 0.692$

In addition, the t values for the six critical comparisons of the F_1 and F_2 measures of underlying vs. derived long vowels are given.

that monosyllabic words (in our case singular forms) have longer vowels than the corresponding bisyllabic words (in our case plural forms). In contrast to Nooteboom's results, although the same pattern holds descriptively for long vowels, it cannot be confirmed statistically. This may be due to the fact that phonologically Dutch has a strong tendency to lengthen vowels in open syllables (cf. the examples in 2). The short vowels of class I nouns occur in closed syllables both in singular and plural forms due to ambisyllabicity. For the class II nouns, the vowel in the singular is in a closed syllable, but it is in an open syllable in the plural (cf. example 7). Therefore, it is not surprising that the 'phonetic shortening' as a function of the number of syllables is less

pronounced for the underlying long vowels (class II) than for the underlying short vowels (class I).

Long and short vowels in Dutch do not only differ in duration, but they are also qualitatively different. This qualitative difference between vowels like [a] and [a:] is manifested in their different formant values [cf. Koopmans-van Beinum, 1980; Nooteboom and Cohen, 1976]. These studies refer to qualitative differences between long vs. short vowels, and no differences in formant values have been noted between underlying and derived long vowels. Nevertheless, to be certain that there were no differences in quality between the class II and class III vowels in the plural nouns we ran a pilot study comparing the F_1 and F_2 values for one set of stimuli for 1 speaker. Using a 25.6-ms full hamming window, we took LPC measures of each of the vowels. The window was placed at the beginning of the fifth glottal pulse to ensure that we were in the steady state of the vowel. Table II gives the mean values for F_1 and F_2 of underlying and derived long vowels. The corresponding t tests do not show any significant difference between the underlying and the derived long vowels.

Discussion

The general question we addressed in this paper was whether the phonological merger of two distinct segments (contextual neutralization) leads to phonetically identical segments. Specifically, we investigated whether phonological neutralization of vowel length in Dutch is phonetically complete. We compared the durations of long vowels which are derived by rule from underlying short vowels (i.e. plurals of class III nouns) with long vowels which are not derived by rule (i.e. plurals of class II). As we also noted, a necessary precondition for this comparison to be valid is that the short vowels of the singulars of class III nouns do not differ from the short vowels of the singulars of class I nouns. The results show that this precondition holds. Given this precondition, the comparison of class II and class III plural nouns supports the claim that neutralization of vowel length in Dutch open syllables is complete.

Most of the arguments against the completeness of neutralization are based on the loss of the voicing distinction in syllable-/word-final position. A number of studies [Dinnsen 1985; Port and O'Dell, 1985; Slowiaczek and Dinnsen, 1985] have claimed that experimental examinations of neutralization phenomena have shown that there are differences in production corresponding to underlying distinctions. The present results show that this claim does not hold at least for neutralization of vowel length in Dutch. This holds for vowel duration as well as for vowel quality as expressed in the F_1 and F_2 measures.

Fourakis and Iverson's [1984] results suggest that production differences in reading tasks between regular German voiceless obstruents and those derived by word-final devoicing may be due to the fact that German spelling reflects the underlying distinction between voiced and voiceless consonants. In the case of Dutch, however, the spelling of the plurals of class II and class III nouns does not give any cue as to whether the long vowel is derived by rule or not. Thus the production of vowel length in the present study cannot have been influenced by orthographic cues.

In sum, the present results contradict Dinnsen's [1985] claim that phonologically neutralized segments are phonetically distinct. We feel that without orthographic cues indicating the underlying phoneme which may lead to hypercorrection, what is accepted as *phonological* neutralization of underlying feature distinctions can be expected to be complete. Contextual neutralization *can* lead to identical surface realization of distinct phonological segments, and for the case of neutralization of vowel length in Dutch it indeed does.

Acknowledgements

Our thanks to Hans Kerkman for providing us with an exhaustive list of Dutch nouns from the CELEX data base. We would also like to thank Ino Flores d'Arcais, Klaus Kohler, Pim Levelt, William Marslen-Wilson, Antje Meyer, Pienie Zwitserlood, and two anonymous reviewers for comments on an earlier version of the paper.

The software we used was developed by Henning Reetz at the Max Planck Institute for Psycholinguistics. We would like to thank him for making it available to us so quickly.

Appendix

List of Test Words

	Singular	Plural	Gloss
(1)	plag	plaggen	'sod'
	laag	lagen	'layer'
	slag	slagen	'blow'
(2)	krat	kratten	'crate'
	raat	raten	'honeycomb'
	gat	gaten	'hole'
(3)	klas	klassen	'class'
	blaas	blazen	'bladder'
	glas	glazen	'glass'
(4)	haf	haffen	'lagoon'
	raaf	raven	'raven'
	graf	graven	'grave'
(5)	bal	ballen	'ball'
	baal	balen	'bale'
	dal	dalen	'valley'
(6)	wad	wadden	'mud flat'
	daad	daden	'deed'
	bad	baden	'bath'
(7)	ren	rennen	'run'
	scheen	schenen	'shin'
	gen	genen	'gene'
(8)	scheg	scheggen	'wedge'
	veeg	vegen	'wipe'
	weg	wegen	'road'
(9)	wed	wedden	'ford'
	zweed	zweden	'swede'
	schred	schreden	'step'
(10)	spel	spellen	'game'
	peel	pelen	'peel'
	spel	spelen	'game'
(11)	schot	schotten	'partition'
	goot	goten	'gutter'
	schot	schoten	'shot'
(12)	vod	vodden	'rag'
	brood	broden	'loaf'
	god	goden	'god'
(13)	pof	poffen	'puff'
	stoof	stoven	'stove'
	hof	hoven	'court'
(14)	tol	tollen	'toll'
	stool	stolen	'stolle'
	hol	holen	'hole'

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