Some acoustic characteristics and perceptual consequences of foreign accent in Dutch spoken by Turkish immigrant workers

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SOME ACOUSTIC CHARACTERISTICS AND PERCEPTUAL CONSEQUENCES OF FOREIGN ACCENT IN DUTCH SPOKEN BY TURKISH IMMIGRANT WORKERS*

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1. Introduction

From around 1960 onwards there has been a steady migration of mostly poorly educated workers from the Mediterranean area to the industrialized countries in Northern Europe. Thousands came to The Netherlands to take on menial jobs, and were later followed by their families. It is now deemed unlikely that they will ever repatriate. The largest contingent of immigrant workers in The Netherlands are Turks (156,000 or just over 1% of the total population).

As can be expected, these immigrants, who are faced with a host of socioeconomic problems, also have problems with language. Turks, and other groups of immigrant workers, have severe difficulties in making themselves understood. This has sparked off extensive research programs in the Northern European countries starting around 1965 (for a literature survey, cf. Perdue 1982). The bulk of this research was aimed at a description of morphological and syntactic anomalies in the speech of immigrant workers. As a celebrated example of this line of research we mention Klein and Dittmar's (1979) Developing Grammars, a purely syntactic study, carried out largely on written protocols of speech samples.

It occurred to us that the communicative problems of, for instance, Turks in Dutch do not necessarily stem from poor syntax or improper morphology. Instead, we decided to tackle the problem from an entirely different angle: pronunciation. After all, if the words themselves are pronounced so poorly that no recognition results at all, it is hard to see how morpho-syntactical (in)correctness can improve much on this. Clearly, then, proper pronunciation functions as a condition sine qua non for (correct) morpho-syntax to enable/disable speech understanding.

In this presentation I shall review some of the experimental work we have done at the Department of Linguistics/Phonetics Laboratory at the University of Leyden on the nature and communicative effects of foreign accent in the pronunciation of Dutch by Turkish immigrant workers. In much of our research we employ experimental phonetic techniques that are typically used in the perceptual evaluation of synthetic speech, or of natural speech of degraded quality through poor transmission lines. It appeared to us that this methodology might be equally fruitful when applied to study the communicative effects of foreign accent:

from our point of view there is no essential difference between a Turk speaking accented Dutch and an incorrectly programmed speech synthesizer (except that the latter is more easily reprogrammed once the exact nature of the errors has been determined).

2. Experiment I: Communicative Importance of Pronunciation vs. Morpho-Syntax

The first experiment that I shall discuss was designed to check the validity of the assumption on which much of our work is based: is it really true that correct pronunciation is at least as important in the communication between speaker and listener as correct morpho-syntax? Or, to phrase the question in more neutral terms, what are the respective contributions of pronunciation and morpho-syntax to speech understanding?

To answer these questions, short utterances were collected in which a speaker spontaneously described simple acts that were performed by the experimenter. For each act, four versions were collected (on separate occasions):

(i) Original utterance by a Turkish speaker of Dutch, with improper pronunciation and faulty morpho-syntax;
(ii) Same utterance repeated literally by a native Dutch speaker, with correct pronunciation but imitating the incorrect morpho-syntax;
(iii) Utterance by Turkish speaker, with improper pronunciation but corrected morpho-syntax (after instruction);
(iv) Utterance by Dutch speaker, with both correct pronunciation and correct morpho-syntax.

Several precautions were taken to ensure a fair comparison of the Turkish and Dutch speaker. For instance, since foreign learners tend to speak more slowly than natives, the Dutchman repeated his utterances until they matched the Turkish counterparts in duration (within 10%). For details on this and related experiments I refer to Van Heuven, Kruyt & De Vries (1981) and Van Heuven and De Vries (1981, 1983).

Sixty-four experimental subjects, all native Dutch speakers, were then instructed to listen to the utterances, and perform the act described in each, as promptly as they could, making use of an array of objects provided them by the experimenter. Both the number of errors (failure to understand the description) and the subject's reaction time in case of correct understanding were established. To preclude learning effects, the experimental design was such that each subject heard only one version of each set of four utterances. Ceiling effects (especially in the case of the Dutch speaker) were avoided by adding electronic noise to the stimuli (such that the noise intensity was modulated by the speech signal).

The results were completely straightforward:

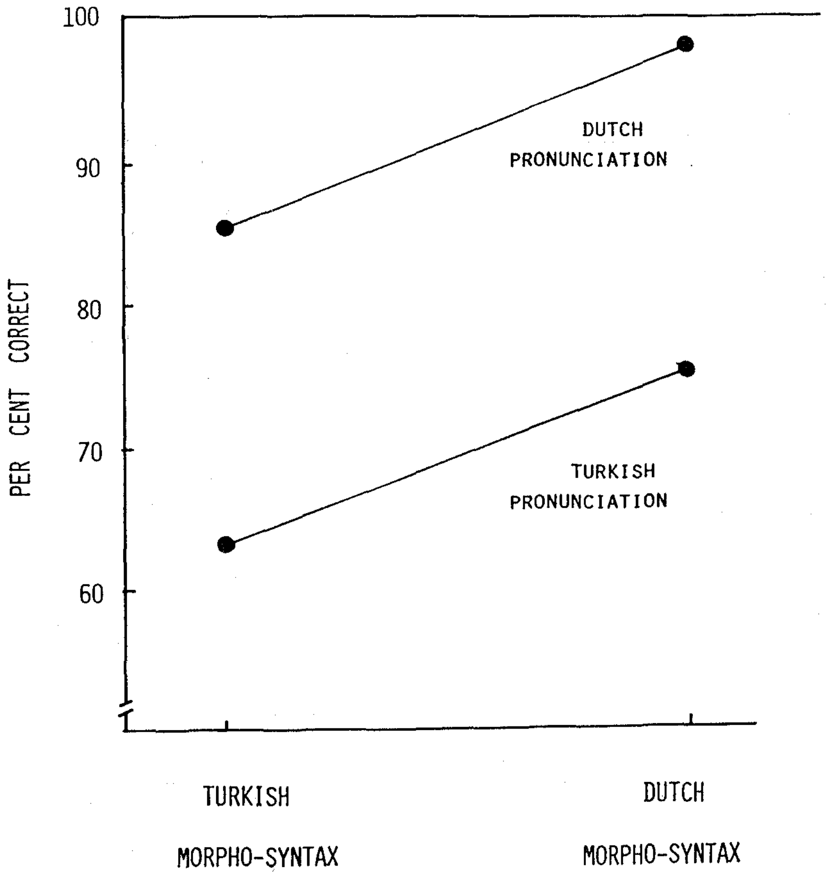

FIGURE 1. Percentage of descriptions correctly simulated as a function of presence versus absence of phonetic interference from Turkish (pronunciation factor) and presence versus absence of morpho-syntactic interference (morpho-syntactic factor). Each mean in the figure is based on nominally 128 measurements. $F(1,510) = 48.5$, $p < .001$, for pronunciation; $F(1,510) = 13.4$, $p < .001$, for morpho-syntax; $F(1,508) < 1$ for interaction.

Versions with both pronunciation and morpho-syntax correct score highest (98% correct), those with neither correct score least (63% correct). When pronunciation and morpho-syntax are pitted against each other, in the hybrid versions, pronunciation clearly exerts the stronger effect: correct pronunciation by itself scores 11% better than correct morpho-syntax by itself. This result is closely paralleled in the reaction times:

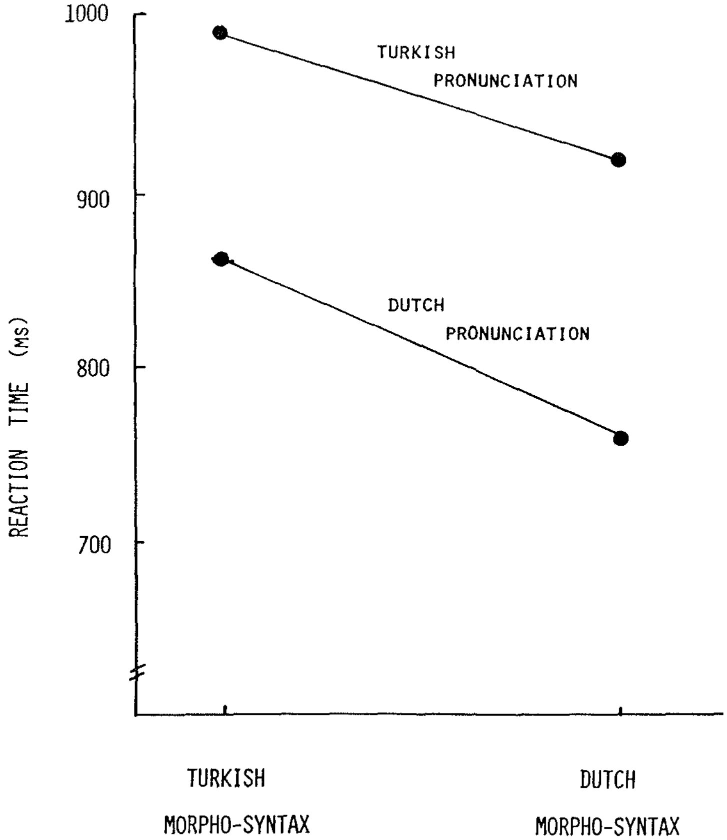

FIGURE 2. Reaction times measured for correctly simulated descriptions (as explained in Figure 1). $F(1,411) = 5.6$, $p = .019$, for pronunciation; $F(1,411) = 2.4$, $p = .120$, for morpho-syntax; $F(1,409) < 1$ for interaction.

The extreme conditions differ by some 250 ms; correct pronunciation alone accelerates understanding by about 50 ms relative to correct morpho-syntax.

It seemed to us that these results adequately support our position that priority should be given to the study and subsequent remedy of pronunciation over the correction of morpho-syntactic errors.

3. Experiment II: Error Analysis of Dutch Vowels Spoken by Turks

Subsequently we attempted to tease out exactly what errors in the pronunciation of Dutch by Turks are most detrimental to their intelligibility. As a first approximation we decided to concentrate on segmental errors, i.e., incorrect pronunciation of vowels and consonants, leaving aside for the moment such matters as rhythm and intonation. Moreover, to get a clear focus we limited our scope to the intelligibility of isolated words, and left the possible interaction of contextual redundancy and segmental recognition for the future (but cf. Van Boeschoten, in prep.). Results of a preliminary examination of both vocalic and consonantal errors, using the so-called "gating" technique (cf. Grosjean 1980, Nooteboom and Doodeman 1984) have been reported by Van Boeschoten (1984,1985). Here I shall summarize a different set of experiments carried out to establish the nature and perceptual consequences of errors in vowel pronunciation. For details on these experiments I refer to Van Heuven and Van Houten (1985).

Vowel errors constitute an obvious potential source of unintelligibility. Turkish has a rather simple eight-member vowel inventory, traditionally described with the aid of three binary features (Swift 1963, DiPietro 1972):

VOWEL HEIGHT DIMENSION		FRONT / BACK DIMENSION	
		FRONT	BACK
	HIGH	i/y	ɨ/u
	LOW	ɛ/ø	ɑ/ɔ

FIGURE 3. Phonological inventory of the Turkish vowel system. The slash separates unrounded from rounded vowels (after DiPietro 1971:147-148).

Notice that Turkish -- by implication -- has neither diphthongs nor a length contrast. Dutch, on the other hand, has a richer vowel inventory, as exemplified in Figure 4:

VOWEL HEIGHT DIMENSION		FRONT / BACK DIMENSION		
		FRONT	CENTRAL	BACK
	HIGH	IE	UU	OE
	MID	I / EE	U / EU	O / OO
	LOW	E (EI)	(UI)	A / AA (AU)

FIGURE 4. Phonological inventory of the Dutch full vowel system. Slashes separate short from long vowels; diphthongs are in parentheses. Vowels are indicated in orthographic form, spelled as in a closed syllable.

We use four features to capture this system, two of which are ternary, and two are binary. Notice a number of discrepancies between the two systems:

	Turkish	# values	Dutch	# values
length	no contrast	1	short-long (non-high vowels only)	2
height	high-low	2	high-mid-low	3
diphthong	no contrast	1	monophthong-diphthong (*mid* vowels only)	2
backness/ rounding	all combinations	4	[+back, -round] lacking	3

FIGURE 5. Phonological comparison of Dutch and Turkish vowel systems

Three Turkish and three Dutch speakers read out the set of Dutch pure vowels (excluding the diphthongs ei, ui, au, and, due to an oversight, the back vowel oe) three times in CVC monosyllables embedded in a short fixed carrier phrase. The monosyllables were existing words with constant consonant frames in which the vowels could be freely commuted.

All the recordings were presented (in random order across words, repetitions and speakers) to a panel of Dutch listeners who had to identify the vowels with forced choice from the complete set of 15 full vowels (i.e. including oe and the diphthongs, but excluding schwa). Skipping a number of intermediate stages, the following structure emerged from the data obtained for our Turkish speakers:

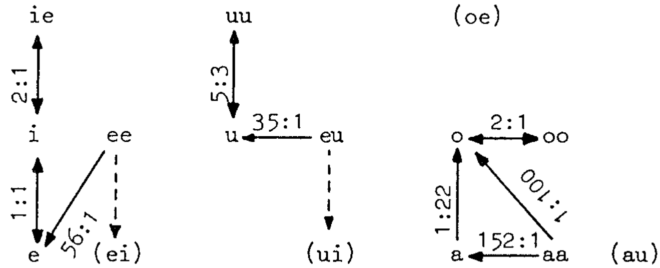

FIGURE 6. Symmetry (bidirectional arrows) and asymmetry (unidirectional arrows) in confusions of Dutch vowels spoken by Turks, as perceived by native Dutch listeners. Confusions with a probability below 10% have been omitted. The numbers indicate the skew of the confusion: "152:1" for the /a-aa/ pair means "/aa/ is heard as /a/ 152 times more often than /a/ as /aa/."

The following facts emerge:

(i) The front-back dimension (including roundness) is correctly preserved in the identifications, and hence must have been correctly produced by the Turkish speakers;

(ii) Vowel height is often incorrectly identified ("confused"); apparently Turks produce vowels intermediate between Dutch ie and i, between i and e, and between o and a;

(iii) The length contrast is largely lost in the identifications: long vowels are typically identified as their short counterparts, but not vice versa; apparently the natural Turkish vowel duration comes close(r) to the Dutch short vowel than to the Dutch long vowel.

This pattern clearly results from the Turkish mother-tongue interference: Dutch vowels are approximated by substituting the nearest available vowel in Turkish. The confusion pattern is readily understood when we compare the acoustic characteristics of the Dutch vowels as pronounced by Turks and by native Dutch speakers. In view of the results of the perceptual identification test, the measurements were restricted to vowel quality parameters (the center frequencies of the two lowest resonances in the vowel spectra, F1 and F2, corresponding closely to vowel height and backness, respectively, cf. Ladefoged 1975) and vowel duration (as an obvious correlate of the length contrast).

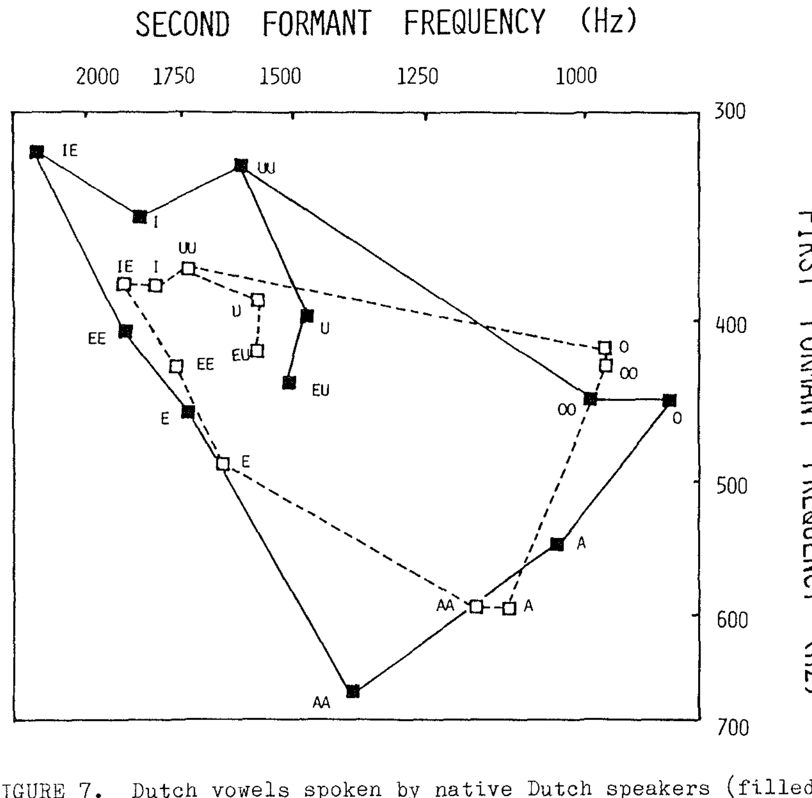

FIGURE 7. Dutch vowels spoken by native Dutch speakers (filled symbols) and by Turkish learners (open symbols) plotted in the vowel plane with F1 (acoustic correlate of vowel height and F2 (acoustic correlate of vowel backness) as dimensions. The frequencies are given in Hertz along logarithmic axes.

As is apparent from this figure, the Turkish speakers exploit only part of the available vowel space. Although their range of variability is quite comparable to the Dutch group along the horizontal (backness) dimension, it has shrunk considerably along the vertical (height) axis. Due to this height compression no three vowel heights can be adequately distinguished. Moreover, the Dutch speakers maintain a considerable spectral distance between the members of the various short-long oppositions. In the pronunciation of the Turks this spectral difference virtually disappears, so that the burden of the contrast is shifted entirely onto the duration parameter. However, as Figure 8 shows, the duration difference itself is not properly observed either:

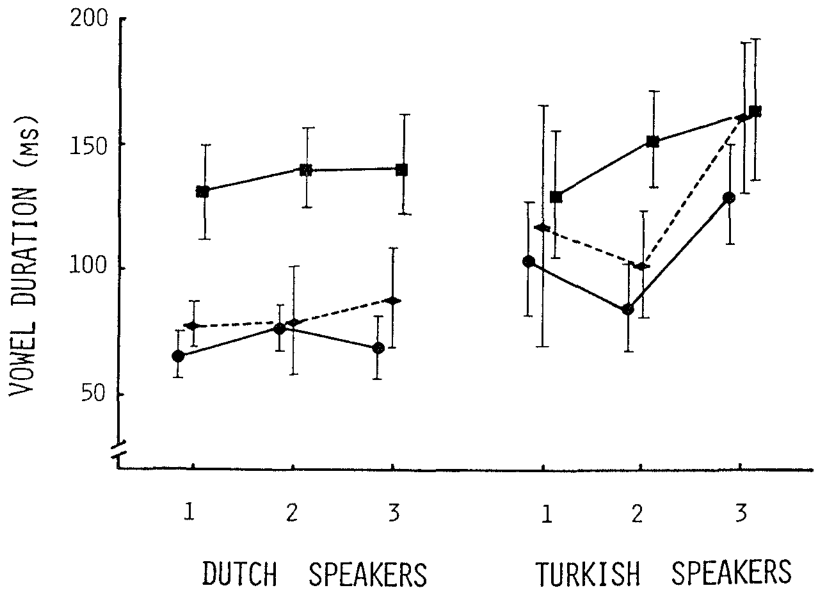

FIGURE 8. Mean duration and standard deviations of short (circles), half-long (/ie, uu, oe/, diamonds), and long (squares) Dutch vowels, as pronounced by Dutch (left-hand panel) and Turkish (right-hand panel) speakers.

The difference between short and long vowels is much smaller on average for the Turkish speakers than for the Dutch speakers; also, in the native pronunciation there is no overlap (in terms of standard deviation around the means) between the length categories, whereas substantial overlap is seen in the foreign pronunciation.

4. Experiment III: Foreign and Native Perceptual Norms for Dutch Pure Vowels

The last experiment I shall deal with here (for a full report see Van Heuven, Van Houten and De Vries 1986) was carried out to clarify the possible causes of the flawed pronunciation of Dutch vowels spoken by Turks. Logically, there are two possibilities (for a more elaborate discussion of this issue cf. Schouten 1975, Van Dommelen 1980):

(i) Turks have no inkling of what Dutch vowels should really sound like, i.e. they have incorrect internalized norms, probably those of their substrate native language. This we would call a cognitive cause for the pronunciation defect.

(ii) Turks do know what Dutch vowels should sound like, but for some reason cannot put this knowledge into practice when <u>producing</u> Dutch utterances. This would be a motor defect.

To distinguish between these possibilities we must tap the speaker's intuitions without involving the speaker in speech motor activity. Therefore we presented both Dutch and Turkish subjects with a large number of vowel tokens (embedded in words), some optimally conforming to the Dutch norm, others deviating from it in systematically varied degrees. The need for accurate control of the relevant parameters of the vowel stimuli necessitated the use of a speech synthesizer. For the stimuli we synthesized vowels in isolated monosyllables of the type <u>biet</u>, <u>baat</u>, <u>boet</u>, <u>fuut</u>, <u>fut</u>, etc., and covered intermediate vowel qualities in 34 approximately equidistant steps, each with 6 different vowel durations. The subject's task was (i) to label the target sound as one of the 15 full vowels of Dutch and (ii) to rate the token for acceptability (good/poor/unacceptable). Responses that rated a given token 'unacceptable' were discarded and 'good' responses were counted twice[1].

The results are given on the following two pages. In Figure 9A are given the perceptual tolerances for six native Dutch speakers and in Figure 9B those for five Turkish learners. Here stimulus types represented by upper-case letters were labeled with at least 50% agreement among the subjects, and lower-case letters stand for labeling with 25-50% agreement. When less than 25% of the responses were convergent, the stimulus type is merely indicated with a dot.

The distribution of the native speakers' responses is rather straightforward: there are clearly preferred areas for 9 of the 12 pure vowels. The remaining three are long <u>ee</u>, <u>eu</u>, and <u>oo</u>, which in our synthesized stimuli were not given the -- apparently --

TIMBRE step #	FRONT VOWELS Duration (ms) 80	104	128	152	176	200	BACK VOWELS Duration (ms) 80	104	128	152	176	200
1	IE	IE	IE	IE	IE	IE	OE	OE	OE	OE	oe	OE
2	IE	IE	IE	IE	ie	ie	OE	OE	OE	OE	OE	oe
3	i	i	.	.	.	.	OE	OE	OE	oe	oe	oe
4	I	i	i	.	.	.	oe	oe	oe	oe	.	.
5	E	e	e	e	.	.	oe	o	.	.	.	.
6	E	E	e	e	e	e	o	o	o	o	.	.
7	E	E	e	e	e	.	o	o	o	.	.	.
8	e	e	.	aa	.	.	.	o	o	o	o	.
9	.	aa	AA	AA	AA	.	a	A	A	A	a	a
10	aa	aa	AA	AA	AA	.	A	A	A	A	A	A
11	aa	AA	AA	AA	AA	AA	A	A	A	A	A	a/au

TIMBRE step #	CENTRAL VOWELS Duration (ms) 80	104	128	152	176	200	OPEN VOWELS Duration (ms) 80	104	128	152	176	200
1	.	uu	uu	uu	uu	uu/ie	A	A	A	A	A	a/au
2	uu	uu	uu	uu	uu	uu	A	A	A	A	a	a
3	uu	.	uu	uu	uu	uu	A	A	A	A	a	a
4	.	u	u	u	.	.	A	A	A	.	aa	aa
5	U	U	U	U	u	u	a	a	AA	AA	AA	AA
6	U	U	U	U	U	U	a	AA	aa	AA	AA	AA
7	U	U	U	U	u	u	aa	AA	AA	AA	AA	AA

FIGURE 9A. Summary of perceptual labeling of 104 synthesized vowel stimuli by Dutch listeners, broken down by vowel timbre (F1 and F2 combined) and by vowel duration. Front vowels, central vowels, back vowels and open vowels are plotted in separate panels. Upper-case symbols represent labelings with 50% or more agreement among the subjects; lower-case symbols represent 25-50% agreement. When less than 25% agreement was found among the subjects, only a dot is plotted. See Figure 9B (next page) for the results for Turkish listeners.

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necessary diphthongal element, so that our Dutch subjects rejected them as acceptable tokens. With regard to the front vowels, three vowel heights are distinguished; duration is used only to discriminate between short i and long ee.

The Turkish responses show a completely different patterning. In the category of front vowels, for instance, only two vowel heights are distinguished: i/ie versus e/ee; duration is

TIMBRE step #	FRONT VOWELS Duration (ms)						BACK VOWELS Duration (ms)					
	80	104	128	152	176	200	80	104	128	152	176	200
1	ie/i	ie/i	ie	ie	ie/i	ie	oe	oe	oe	oe	oe	oe
2	ie/i	ie/i	ie/i	i	.	ie	oe	oe	oe	oe	oo	.
3	I	ie/i	i	.	ie	ie	oe	oe/oo	.	oe	oe	oe
4	i	ie/i	.	ee/ie	ie	ee	.	oe	oe	.	.	oo
5	E	e	e	e	ee/e	ee	oe	.	.	.	o	.
6	E	E	e/ee	e/ee	e/ee	EE	o/oo	.	o	.	o	oo
7	E	E	E	e	e/ee	EE	o	o	oo	.	o	.
8	E	E	E	e/ee	EE	EE	O	o	o	.	.	o
9	E	e	E	e	ee	ee	a	a	a	.	a	.
10	e/a	e/a	a	e/a	ee/aa	ee/aa	a	a	a	a	a	a/au
11	A	A	A	a/aa	AA	AA	A	a	a	A	.	.

TIMBRE step #	CENTRAL VOWELS Duration (ms)						OPEN VOWELS Duration (ms)					
	80	104	128	152	176	200	80	104	128	152	176	200
1	u	u	ui	.	ui	.	A	a	a	A	.	.
2	u	ui	.	ui	ui	ui	A	A	a	a	.	aa
3	u/ui	.	ui	ui	ui	.	A	A	A	.	aa	a/aa
4	u	u/ui	u	u	u	ui	A	A	A	a/aa	AA	AA
5	u	u	u	u	u	u	A	a	a/aa	a/aa	a/aa	AA
6	u	U	u	u	.	u	A	a	A	a/aa	AA	AA
7	u	u	u	u	.	eu	A	A	A	a/aa	AA	AA

FIGURE 9B. Summary of perceptual labeling of 104 synthesized vowel stimuli by Turkish listeners, broken down by vowel timbre (F1 and F2 combined) and by vowel duration. Conventions are the same as for Figure 9A (previous page), which gives the data for Dutch listeners.

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then called in to further discriminate between the members of each height class, as illustrated in Figure 10 on the next page.

The most interesting example of incorrect perceptual representation is provided by the contrast between short, back <u>a</u> and long, front <u>aa</u>. Figures 11A and B plot the percentage of <u>a</u> responses (by implication the percentage of <u>aa</u> responses equals 100 minus the percentage of <u>a</u> responses) as a joint function of vowel quality (F1, F2) and duration. A linear regression line drawn through the <u>a/aa</u> cross-over (i.e. 50%) points indicates that spectral and temporal cues contribute about equally to the contrast for Dutch natives (as has been observed in the literature, cf. Nooteboom and Cohen 1984). Our Turkish listeners,

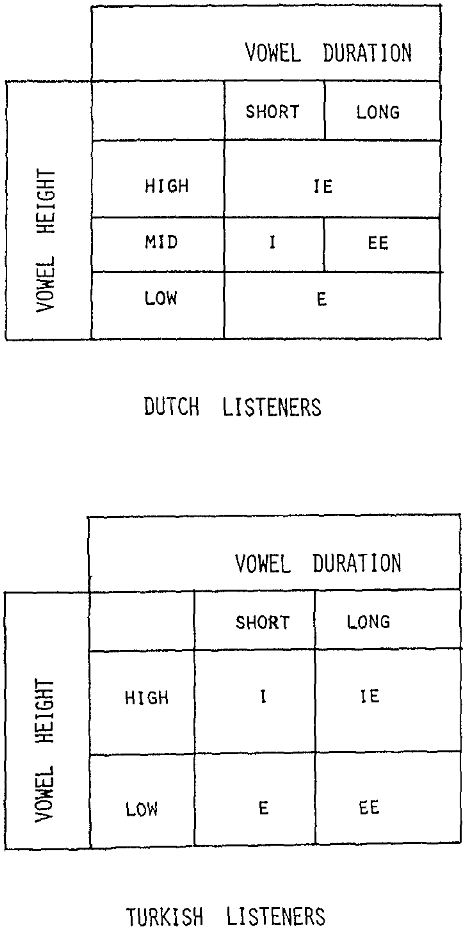

FIGURE 10. Subdivision of front-vowel continuum along vowel height and duration dimensions, for Dutch listeners (top panel) and Turkish listeners (bottom panel).

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however, show a total disregard for the spectral parameter, and rely exclusively on the durational cue, and consequently come up with the wrong labeling in half the cases.

So far we have not been able to trace the cause of this superiority of the duration cue, but at least it ties in neatly with our previous observation that the <u>a/aa</u> contrast is produced more clearly in the vowel duration than in its quality (cf. Figures 7 and 8). Several speculations come to mind:

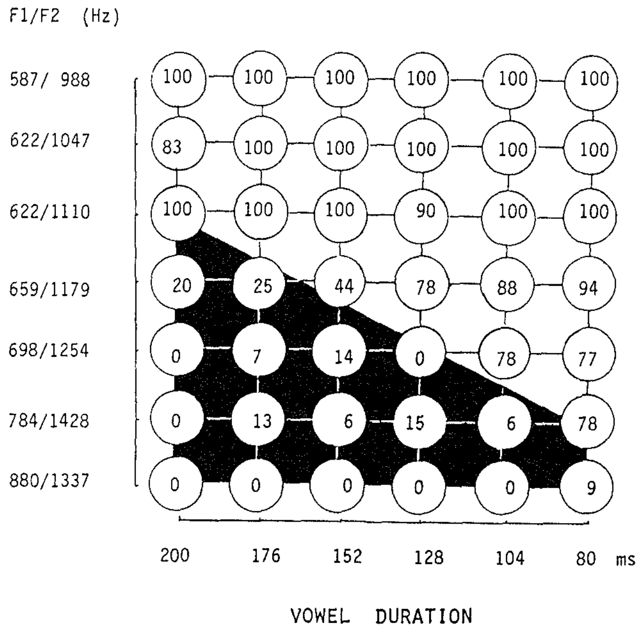

FIGURE 11A. Percentage of /a/-responses (where /aa/-responses are the complement), plotted as a function of vowel timbre (F1 and F2 combined) and of vowel duration (from long to short). Figure 11A plots the responses obtained from Dutch listeners, and Figure 11B (next page) those of the Turkish learners. The /aa/-responses lie in the dark area; /a/-responses are in the white area. The boundary separating the long and short vowel areas was drawn by fitting a linear regression line through the interpolated cross-over points in both horizontal and vertical dimensions.

(i) There may be (allophonic?) duration phenomena in Turkish that our subjects appeal to;
(ii) The duration cue may be more salient in Dutch, and is therefore picked up first by foreigners;
(iii) It may be the result of explicit teaching, based on the (often misguided) belief that Dutch vowels written with digraph symbols last longer than single-letter vowels.

The general picture that emerges from this experiment is that our Turkish listeners still classify vowel tokens by

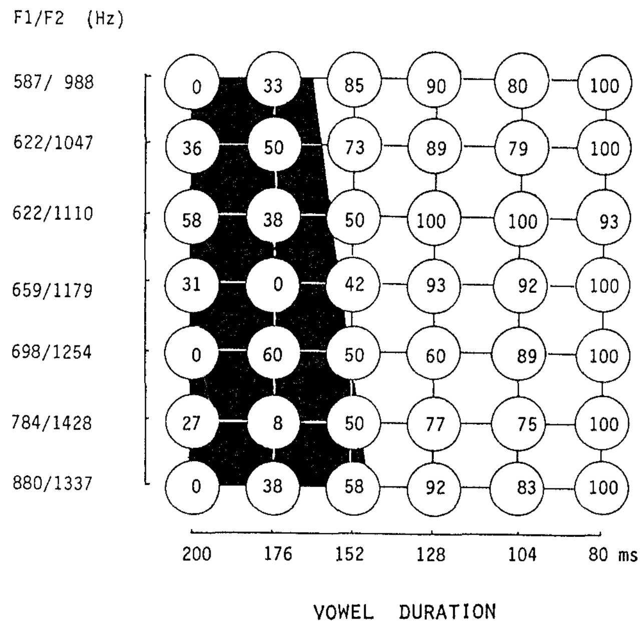

FIGURE 11B. Percentage of /a/-responses (where /aa/-responses are the complement), plotted as a function of vowel timbre (F1 and F2 combined) and of vowel duration (from long to short). This Figure (11B) plots the responses obtained from the Turkish learners; Figure 11A (previous page) those of Dutch listeners. For conventions, see Figure 11a.

reference to their native vowel system, in disregard of their instructions, and in spite of the lexical structure of the stimuli, all of which were existing Dutch words. Clearly, then, much of the erroneous vowel pronunciation in experiment II originates from an incorrect conception of what the various Dutch vowels sound like.

5. Concluding Remarks

Our experiments have uncovered a number of communicative defects in the Dutch speech of Turkish immigrant workers, that are elusive and largely escape even the trained ear of the phonetician. I would argue that only with the aid of experimental techniques, such as those used in our illustrations, can one bring out the true nature of the foreign accent.

The research that I have presented here may also be of interest to the teaching of Dutch abroad (i.e., as a foreign rather than a second language). The sound systems of Dutch and American English, for instance, differ vastly; Americans in The Netherlands are immediately spotted by their accent. It remains to be investigated how much of a communicative handicap this type of accent is: (how severely) does it interfere with the speaker's intelligibility; what deviations from the Dutch norm are the most detrimental? Once the nature of the communicative problems has been established, there is still the question of pedagogy. What teaching strategies can be devised to eliminate the defects? To what extent can technology help, e.g. through automatic feedback and error correction? Be this as it may, our second and foreign language teaching will be the more effective if we know what the errors are that we want to eliminate.

NOTES

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1 For details on this experimental technique and an application to the problem of dialect interference with the standard language I refer to Van Zanten and Van Heuven 1984a,b.

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