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PHONETIC EVIDENCE FOR A PHONOLOGICAL RULE:

G-DELETION IN TURKISH

Catherine Rudin

Department of Linguistics
Indiana University
Bloomington, IN 47405

Abstract

A pilot experimental study of the duration, pitch, and intensity pattern of derived and underlying long vowels in Turkish was carried out, seeking phonetic evidence bearing on the validity of the controversial phonological rule of intervocalic /g/-deletion. The results showed that while derived and underlying long vowels do not differ in pitch or intensity curves, they do differ significantly in duration. The long vowels derived by /g/-deletion are longer by about 13% and are similar in duration to surface VCV sequences. This phonetic evidence combined with distributional and other phonological considerations strongly supports the proposed /g/-deletion rule, and suggests that phonetic evidence can sometimes be used in testing phonological hypotheses.

Introduction

The phonology of standard Turkish has been claimed (by Lees, 1961) to include a rule of intervocalic g-deletion: $g \rightarrow \emptyset$ / V__V. The phonological evidence for the existence of this rule is of two types:

(1) Distribution of [g]. Surface (phonetic) VgV sequences do not occur except in a small handful of borrowed words: sıgara 'cigarette' is one of the very few in common use. All other consonants do occur intervocalically. Conversely, VV sequences do not occur except in words which are spelled with a ğ (so called 'soft g') and which are pronounced with a velar fricative or glide in some dialects, e.g.: soğan (standard [soan], dialectal [soɣan], [sowan]) 'onion', ağız ([aɯz], dialectal [aɣɯz]) 'mouth'. These two sets of facts suggests that VV sequences contain an underlying /g/ which deletes or fricativizes depending on the dialect; the underlying distribution of /g/ would then be the same as that of other consonants.

(2) Alternation k ~ Ø. A second kind of evidence for a rule of g-deletion is that some words have an alternation between final [k] and Ø when vowel-initial suffixes are added to the root.

ayak	ayağı	[ayaɯ]	'foot/his foot'
balık	balığı	[balɯɯ]	'fish/his fish'

This is paralleled by a voicing alternation in the non-velar stops, produced by the very general rule that devoices final non-continuants:

dip	dibi	'bottom/its bottom'
şerit	şeridi	'tape/his tape'
aç ([ač])	acı ([aǰɯ])	'hungry/his hunger'

If a rule of g-deletion is necessary in the non-alternating VV sequences discussed above to account for the distributional facts, then the k ~ Ø alternation falls out as an automatic consequence of two independently motivated processes: word-final stop devoicing and intervocalic g-deletion, operating on underlying forms such as /ayag, ayag + V / ('foot, his foot'). If [+high]
however, g-deletion is <u>not</u> independently required, that is, if the underlying form of a word such as <u>soğan</u> ([soan]) is identical to its surface form, then it is equally plausible (and perhaps even simpler) to derive the alternating k ~ Ø words from underlying forms with a /k/, by a rule of morpheme-final k-deletion (under specified conditions having to do with syllable structure). Such a solution has in fact been proposed by Zimmer (1975). The key to the argument is thus the existence of independent evidence for the rule of g-deletion.

The present experiment, then, was designed to explore the possibility that phonetic evidence might be found for the process of g-deletion in the non-alternating context. This in turn would provide some support for a

g-deletion analysis of the k ~ Ø alternation as well. Two separate tests were carried out, one on vowel and consonant durations, and the other on pitch and intensity.

Experiment I: Vowel Duration

The vowel duration experiment was designed to ascertain whether those long vowels which according to the g-deletion hypothesis are derived from an underlying VgV sequence differ in duration from underlying long vowels. That is, is there a difference in duration between the long vowels produced by the rule /VgV/ → [V:] and underlying /V:/? Specifically, the experiment was intended to test the hypothesis that the derived long vowels would show evidence of compensatory lengthening from the deletion of the medial consonant. The theoretical importance of such evidence is that it would imply that certain aspects of the assignment of speech timing "precede" (in some sense) the phonological or phonetic rule that deleted the /g/ segment.

Methods

The test words consisted of two minimal sets differing only in the length of the vowel (/a/ in all cases) and the presence or absence of a medial consonant:

sat	maş	short vowel /a/
saat	maaş	long vowel /a:/
sağat	mağaş	derived long vowel /aga/ ([a:])
sarat	maraş	two short V's, short C /ara/
satat	mataş	two short V's, long C /ata/

(ş is the standard Turkish spelling for [š].) Some of these are nonsense words, but all are phonologically "possible Turkish words". Words containing medial /r/ and /t/ were included to allow comparison of underlying and "derived" long vowels not only with each other, but also with VCV sequences with both long and short consonants. The Turkish /r/ is a very short flap or tap, and the /t/ is normally aspirated.

The test words were placed in stressed position at the end of the carrier sentence "Ahmede göre, bu ____" ("According to Ahmet, this is a ___"). Five native speakers of Turkish were given a list of sentences which included two tokens of each test word (twenty sentences in all) in a random order, and were asked to read the list three times through at a normal speech tempo. Speakers 1 and 2 were given an earlier version of the test list which did not include the words with /r/ and /t/.

Spectrograms were made of five tokens of each word for each speaker. Measurements were made to the nearest 5 msec of the duration of each of the vowels from the onset of the vowel formants to apparent closure in the case of a following /t/ or the onset of fricative noise in the case of a following /š/, the duration of the medial /t/ from closure to the burst and from the burst to voice onset (aspiration), and the duration of closure of the medial /r/. In approximately 40% of the tokens of medial /r/, closure was incomplete. In these cases there was still a sharp drop in intensity and usually a gap in the second formant so the duration of this gap or intensity drop was measured.

T-tests were performed on pairs of means. Two-tailed probabilities are reported below.

Results and Discussion

The pooled results of the vowel length experiment are summarized in Table 1 and presented graphically in Figure 1.

Figure 1 and Table 1 about here

The vowel or medial VCV sequence was consistently longer in the context m___š than in the context s___t, however, the relative durations of /V,V:,VğV,VrV,VtV/ remained constant across both contexts, so only the overall averages will be considered here.

As expected, the short /a/ is much shorter than either of the long vowels /V:/ ($p<.01$ by t-test) and /VğV/ ($p<.01$) or the VCV sequences ($p<.01$); /a/ is only about half as long as the non-derived long /a:/. The derived long vowel /ağa/ is significantly longer than the non-derived long /a:/ ($p<.01$), by 31 msec or approximately 13%. This appears to support the hypothesis of deletion and compensatory lengthening. However, /VğV/ is not, as might be expected, the same length as a VCV sequence with a short medial consonant (/r/ ($p<.01$)); rather, the duration of /VğV/ is intermediate between that of /VrV/ and /VtV/, while /V:/ and /VrV/ do not differ significantly in duration ($t=.48$). The situation can be summarized schematically as follows where < means "is significantly shorter than":

$$/a/ \; < \; \left\{ \begin{matrix} /a:/ \\ /ara/ \end{matrix} \right\} \; < \; /ağa/ \; < \; /ata/$$

Speakers 1 and 2 could not be included in the pool for the t-tests, since complete data for them was not available. It appears, however, that including their (partial) results would not have affected the overall result, namely, that /VğV/ is significantly longer than /V:/, and similar in

duration to sequences with phonetically manifested stops. The hypothesis of durational compensation for the loss of a (relatively long) underlying consonant in the "derived" long vowel (/VğV/) is thus supported, although not conclusively proved, by these data.

It should be noted that individual speakers show considerable variation in the degree of this effect: the difference in average duration between /V:/ and /VğV/ varies from 103 msec for Speaker 1 to 14 msec for Speaker 3. However, all five speakers show some difference in mean duration for both contexts in the expected direction. Speaker 4 consistently pronounced /ağa/ with a voiced velar fricative: [saɣat], [maɣaš]. The [ɣ] was not distinct enough to be measured on spectrograms, but the overall duration of [aɣa] for this speaker was very similar to that of the derived long vowel [a:] (=/ağa/) for the other speakers. These findings suggest that a consonant similar in length to [ɣ] has been deleted by most of the speakers, while the timing of the syllables retains evidence of the absent consonant.

Conclusions

The results of Experiment 1 demonstrate that "derived" and "underlying" long vowels are not identical. In particular, derived long [a:] is longer than underlying long [a:], and is intermediate in duration between VrV and VtV (sequences of VCV with a short and a long consonant respectively). This provides some support for the idea that the derived long vowels are underlying /VCV/ with a medium-length medial consonant. Based on the defective distribution of [g] and the presence of a velar fricative in some dialects this deleted consonant is assumed to be /g/.

Experiment 2: Stress and Pitch

This experiment was intended to determine whether underlying and derived long vowels can be differentiated by characteristics of either their pitch curves or their intensity pattern. Evidence of this type might indicate a different syllabic structure for the two kinds of long vowels: /V:/ = one syllable, while /VğV/ = two syllables.

Methods

The following set of test words was chosen to include minimal pairs for underlying and derived long /a,i,u/ and one example each of derived long /ɯ,ü/ (underlying long /ɯ,ü/ do not exist; any underlying long vowels other than /a,i,u/ are extremely rare, since almost all underlying long vowels are in words borrowed from Arabic or Persian).

saat	maaş	şiir	şuur	süğüt
sağat	mağaş	şiğir	şuğur	sığış

These words were embedded in the carrier sentence "Arkadaşı____anladı" ("His friend understood (heard)___"). Speakers were instructed to read a list of twenty sentences, which included two tokens of each test word, three times through at a normal speaking rate. The same five native speakers were used as for Experiment 1. Two of them did a preliminary version of the experiment which did not include the words şiir, şiğir, şuur, şuğur. Narrow-band linearly expanded spectrograms (Voice Identification, Series 700) with superimposed average intensity curve (20 msec integration time) were made of five tokens of each word for each speaker. Pitch curves were determined by tracing the tenth harmonic of the vowels, and tracings were also taken of the intensity curves. Intensity curves were made for one

speaker's productions of sarat, satat, maraş, mataş from Experiment 1 as well, to allow comparison with two-syllable words.

Results and Discussion

The results of this experiment show no consistent difference in either pitch or intensity patterns between /V:/ and /VğV/. From the averaged intensity curves for two representative speakers presented in Figure 2, it

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Figure 2 about here

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appears that each vowel has a characteristic intensity pattern for each speaker, but these patterns are not constant across speakers, nor do they generalize to a characteristic pattern for derived as opposed to underlying long vowels (see also Figure 3). If /VğV/ were two syllables, it might be

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Figure 3 about here

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expected to have an intensity curve with two peaks and with greater intensity near the end (stress is always on the final syllable of a word in Turkish). This was not found for any of the speakers. In two-syllable words with a medial consonant the stress does fall on the end; the last vowel is longer (see Table 1) and has greater intensity (see Figure 3). Both /V:/ and /VğV/ also tend to be more intense at the end, but there is no evident difference between the two types of long vowels in this respect. The lack of evidence for a syllabic structure (stress) difference between derived and underlying long vowels does not, of course, constitute an

argument against the rule of g-deletion. For example, it is possible that syllabification could take place after the deletion has already occurred.

The intonation curve results indicate that pitch also is not a significant distinguishing factor for /V:/ versus /VğV/. All vowels rose in pitch from beginning to end. The amount and steepness of the pitch rise varied from speaker to speaker but showed no discernable effect of either particular vowels or the distinction of derived versus underlying long vowels.

Conclusions

In summary, underlying and derived long vowels differ significantly and consistently in duration, but not, apparently, in intensity or pitch patterns. This difference in duration suggests that an underlying stop is taken into account in the timing of speech even though the stop gesture is never performed. The durational difference is fairly small (about 30 msec or 13%, on the average), but is quite possibly large enough to be perceived in ideal circumstances. The question of whether speakers can actually make use of this difference to distinguish minimal pairs such as şiir/şiğir remains open, but could be answered with a perception study.

The basic phonological question is why I view the extra length of some long vowels as evidence for a deleted underlying consonant. Why not simply posit three underlying vowel lengths for Turkish: short, long, and over-long, the last of which just happens to be spelled with a g? There are at least two possible replies to this on non-phonetic grounds: first, the presence of [ɣ] in dialects which are in close contact with standard Turkish, and, second, the distributional facts about [g] and sequences of vowels

discussed in the introduction to this paper. A third argument could be advanced if it could be shown that "overlong" vowels also occur in the k ~ Ø alternation. That is, if the long [a:] in uçağa [uča:], the dative case form of uçak 'airplane' is the same in duration as non-alternating derived long vowels and longer than underlying long vowels in a similar context, it would strongly suggest that overlong vowels are derived by deletion. This hypothesis is testable, although near-minimal pairs of polysyllabic test words would be difficult to find.

With respect to the relations between phonetics and phonology, these results suggest that segmental processes like stop deletion need not always be at a highly abstract level. It seems that deletion may sometimes be so close to the "surface" of articulatory gestures that the timing patterns are already determined.

Perhaps the most important methodological implication of this study is that it illustrates the possibility of profitably combining experimental phonetic investigation with phonological argumentation (see also Garnes, 1973, on this point), even when dealing with such abstract questions as what the underlying forms of words are, or how to analyze a (morpho)-phonological alternation.

References

Garnes, Sara. 1973. "Phonetic Evidence Supporting a Phonological Analysis." Journal of Phonetics 1.273-84.

Lees, Robert B. 1961. The Phonology of Modern Standard Turkish. Indiana University Uralic and Altaic Series Vol 6. Bloomington: Indiana University Press.

Zimmer, Karl E. 1975. "Some Thoughts on Likely Phonologies for Non-Ideal Speakers," Papers from the Parasession on Functionalism, 556-67. Chicago: Chicago Linguistic Society.

context ___t

speaker	sat	saat	saǧat	sarat = (V - r - V)			satat = (V - t* - V)			
1	224	242	368							
2	168	278	248							
3	176	258	276	248			292			
4	90	240	264	226			266			
5	86	166	222	210			246			
average:	104	232	272	228	88	26	115	268	59	110	99

context s___ʂ

speaker	maʂ	saaʂ	maǧaʂ	maraʂ = (V - r - V)			matas = (V - t* - V)			
1		358	368							
2		260	280							
3	182	304	314	312			352			
4	132	278	322	274			308			
5	130	246	280	252			288			
average:	148	289	311	279	101	24	154	316	72	109	135

	/V/	/V:/	/VǦV/	/VrV/ = (V - r - V)			/VtV/ = (V - t* - V)			
average for both contexts:	126	261	292	254	95	25	135	292	66	110	117

TABLE 1: Duration of vowel or VCV in msec. (five tokens per speaker for each word)

*t duration includes an average 30 msec. of aspiration.

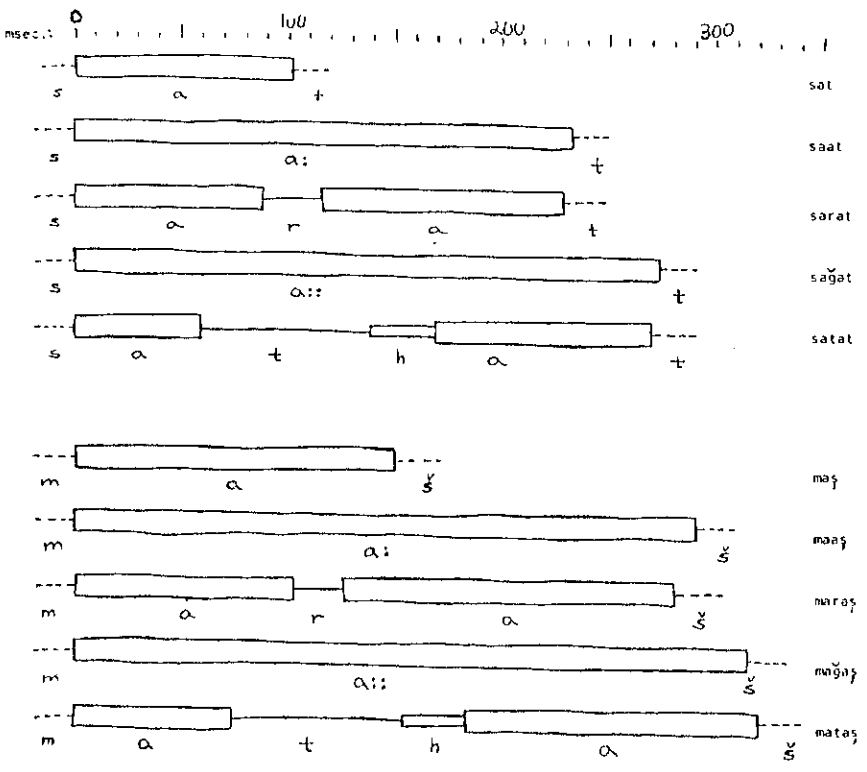

Figure 1: Duration of vowel(s) and medial consonant.

(average for 5 speakers; five tokens per speaker for each word.)

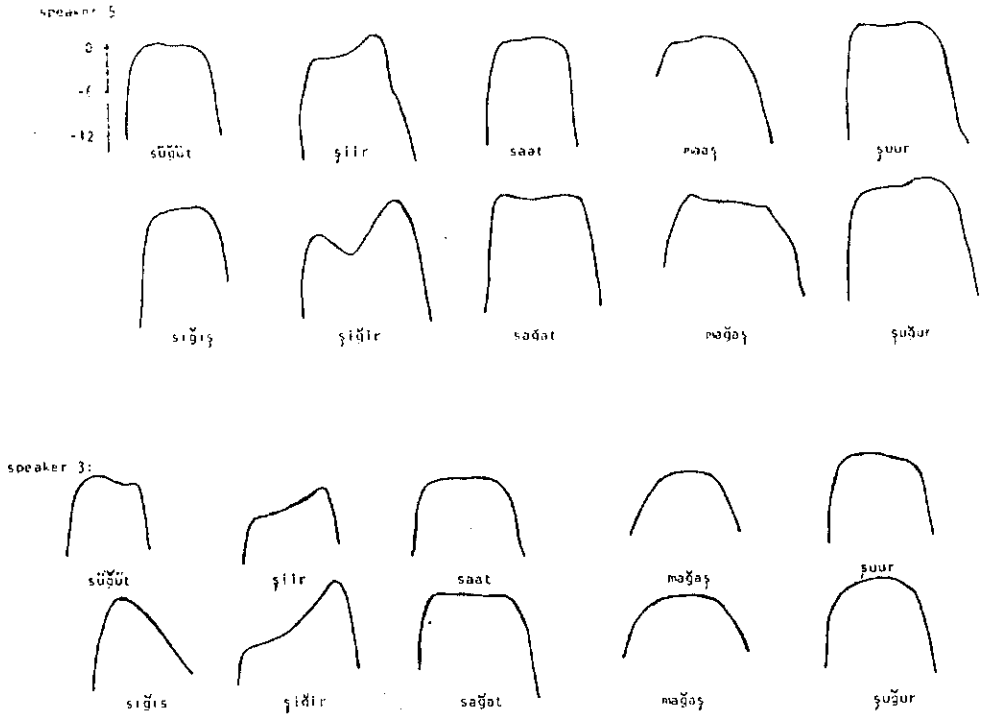

Figure 2: Intensity curves for two speakers. (averaged over five tokens)

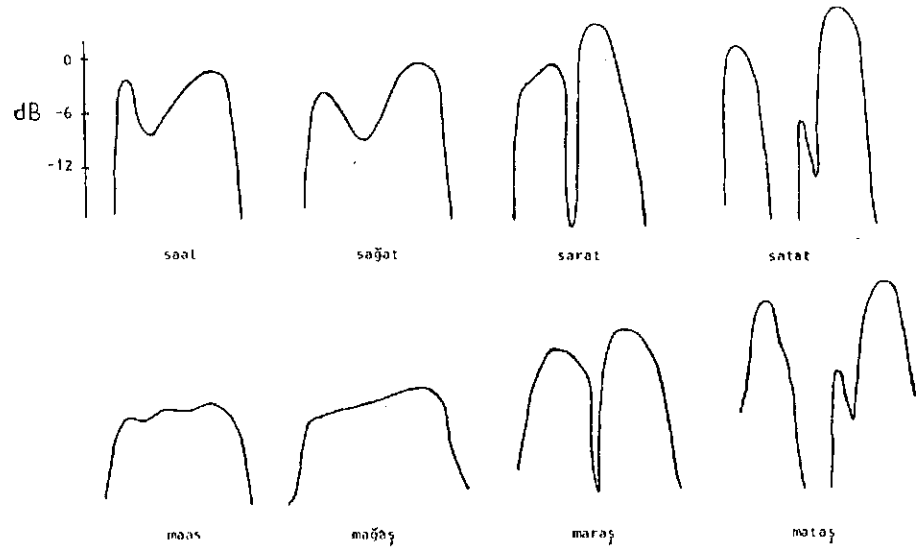

Figure 3: Comparison of intensity curves for /V:/, /VğV/, /VrV/, /VtV/.