Vowel and Consonant Disharmony in Turkish

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1. INTRODUCTION

The present study examines a range of phenomena related to the topic of vowel and consonant harmony in Turkish. Its purpose is both descriptive and theoretical. We aim first to bring new empirical data to bear upon the question of the formal treatment of vowel and consonant harmony, and second to show that autosegmental phonology provides an internally consistent account of not only the regularities but also the irregularities and apparent exceptions within the particular system of Turkish.

Turkish is normally thought of as offering a paradigm case of vowel and consonant harmony at its simplest and most transparent. According to textbook descriptions, all vowels and consonants in Turkish words agree in their specification for backness, and all high vowels agree with preceding vowels in their specification for roundness. Moreover, the velar and lateral consonants are described as having back variants in back vowel words and front variants in front vowel words. Closer examination, however, reveals a host of exceptions to these statements. While these exceptions — or cases of disharmony — have not gone unnoticed in the literature, they have not received the attention that their interest for phonological theory merits.

The existence of large numbers of exceptions to proposed rules or principles is often a sign that a system has not been well understood. We believe that this is the case with most recent studies of vowel and consonant harmony, which have been carried out within phonological theories that postulate a principle of linearity in phonological representation. We will show in this study that the apparent exceptions to otherwise general principles of vowel and consonant harmony in Turkish are predictable consequences of the structure of phonological representations, and follow from the independently-motivated assumptions of autosegmental phonology given the optimal set of underlying representations selected by the evaluation metric of the theory. It is both unnecessary and misleading to treat such apparent exceptions in terms of the theoretical devices (rule features and other diacritic symbols) that have been proposed elsewhere for the expression of true exceptionality in phonological rule systems.

More specifically, we will propose that the apparent exceptions to Turkish vowel and consonant harmony are due to the presence of *opaque vowels and consonants* in underlying representations. The notion of "opaque segment," which will be formally characterized below, is well-motivated in autosegmental theory on both theory-internal and empirical grounds. Its theoretical justification derives from the conceptual organization of the theory itself. The primitive units of autosegmental phonology — segments, tiers, association lines — permit the expression of a richer variety of arrangements of distinctive features than is possible under linear theories of phonology. In particular, the units of related autosegmental tiers may be only partially related by association lines. "Opaque" segments can be characterized as consonants and vowels that are underlyingly associated with autosegmentally-represented features. It will be shown that such segments have certain characteristics that are reflected, in surface forms, as apparent exceptions to regular "spreading" processes. A theory that provides natural means for expressing such notions as "opaque segments" embodies the hypothesis that such segments may exist, and creates a strong presumption that they should be instantiated in particular linguistic systems.

The empirical justification for the notion of opaque segment derives from the fact that the recognition of this segment type allows for simple, straightforward descriptions of commonly recurring phenomena that require complicated or ad hoc accounts under alternative theories. Thus, in tone systems it has been found that certain types of consonants ("depressor consonants") function as opaque elements with respect to processes of tone spreading (Laughren, in press; Kisseberth, in press). Opaque segments play an essential role in the description of nasal prosodies (Poser (1981b), Hyman (1982), van der Hulst and Smith (this volume)). Opaque segments have elsewhere proven to be fundamental to an understanding of the vowel harmony system of Akan (Clements (1981)).

The notion of opaque segment cannot, however, be reconstructed within the representational system of standard generative phonology (see e.g. Chomsky and Halle 1968). Under this theory, phonological representations have the characteristics of *linearity, complete feature specification*, and *segmental integrity*. According to the first of these properties, phonological representations are exhaustively analyzable into sequences of segments having no ordered subparts: the phonemes of traditional linguistic analysis. "Suprasegmental" properties such as pitch, stress or length are treated as features of phonemes. Secondly, the criterion of complete feature specification requires that all segments be fully specified for all distinctive features; this condition rules out the possibility of archiphonemes. The third characteristic is related to, but logically independent of the second, and requires that phonological rules may operate only upon

phonemes as wholes, and not upon their subparts. Thus, assimilation processes are formally characterized as properties which substitute phonemes, rather than features (see Chomsky and Halle (1968): "Appendix on Formalism").

Many structuralist and generative approaches to the description of vowel and consonant harmony have proposed to eliminate the second of these three criteria, by admitting archiphonemes into the theory (for treatments of Turkish along such lines, see Lees (1961), Crothers and Shibatani (1980)). Advocates of this approach have not so far succeeded in responding to familiar criticism of archisegmental representation such as that of Stanley (1967). In the framework of autosegmental phonology, it has been shown that the rejection of linearity does not entail the rejection of complete feature specification or segmental integrity. Given multilinear representations, it is possible to maintain that all segments on each tier are fully specified for all features, and to disallow rules that operate upon subparts of such autosegmentally-arrayed segments. Now since the assumption of linearity must be abandoned for entirely independent reasons (e.g. the treatment of floating tones, complex segments and the like), the adoption of an autosegmental approach to the analysis of vowel and consonant harmony is the most conservative move one can make. Given the independent need for nonlinear representations, an autosegmental treatment of harmony phenomena need exploit only those principles of phonological theory that are motivated in the treatment of other domains.

The present study focuses on the role of opaque segments in explaining apparent irregularities in the system of vowel and consonant harmony in Turkish. The discussion is organized as follows. Section 2 presents an introduction to the main features of Turkish vowel harmony and to the theoretical framework assumed in this work. Section 3 examines the main cases of disharmony: polysyllabic roots (3.1), exceptional suffixes (3.2), consonant harmony and disharmony (3.3), consonant-conditioned suffix harmony (3.4), and epenthetic vowels (3.5); further problems are discussed in 3.6. In section 4 we summarize our theoretical results.

2. VOWEL HARMONY

By vowel harmony we mean a system of phonological organization according to which all vowels are drawn from one or the other of two (possibly overlapping) sets within harmonic spans in the word. There are two well-defined types of word harmony systems. In *symmetrical* systems, roots do not alternate, and alternating affixes agree with the category of the nearest nonalternating vowel. In *asymmetrical* systems, both roots and affixes

alternate; moreover, alternating forms assimilate to a single ("dominant") value of the harmony category if and only if a ncnalternating morpheme of that value appears in the word. Examples of symmetrical systems include Turkish, Finnish, Hungarian, Mongolian, Manchu, and Akan. Examples of asymmetrical systems include Nez Perce, Chukchee, Somali, Diola-Fogny, and Kalenjin.

The following forms illustrate regular harmonic alternations in Turkish:

(1)

		nom.sg.	gen.sg.	nom.pl.	gen.pl.
'rope'	ip	ip-in	ip-ler	ip-ler-in
'girl'	kɨz	kɨz-ɨn	kɨz-lar	kɨz-lar-ɨn
'face'	yüz	yüz-ün	yüz-ler	yüz-ler-in
'stamp'	pul	pul-un	pul-lar	pul-lar-ɨn
'hand'	el	el-in	el-ler	el-ler-in
'stalk'	sap	sap-ɨn	sap-lar	sap-lar-ɨn
'village'	köy	köy-ün	köy-ler	köy-ler-in
'end'	son	son-un	son-lar	son-lar-ɨn

(*k̯ l̯* are palatal; see section 3.3). These forms illustrate two intersecting vowel harmony systems, one involving the feature of backness and the other involving the feature of roundness. All the vowel phonemes of Turkish are represented in (1). The system of backness harmony opposes the front vowels /i, ü, e, ö/ to the back vowels /ɨ, u, a, o/, and the system of roundness harmony opposes the rounded vowels /u, ü, o, ö/ to the unrounded vowels /i, ɨ, e, a/. It will be seen that all vowels in the word agree in backness. Suffix vowels alternate according to the category of the root vowel. Moreover, all high vowels agree in rounding with the preceding vowel, whether high or not; nonhigh vowels show no alternation in rounding. Finally, the back consonants /k, l/ appear in back vowel words while the front consonants /k̯, l̯/ appear in front vowel words.

It will be seen from the forms in (1) that Turkish displays the characteristics of a symmetrical vowel harmony system. No roots in Turkish alternate, and alternating suffix vowels agree with the nearest (in this case, the only) root vowel.

Previous studies of vowel harmony have shown that an autosegmental analysis permits an explanation for various recurrent properties of vowel harmony systems in the languages of the world (Clements (1977a)). These properties include the fact that vowel harmony is *phonetically motivated* in terms of universal distinctive feature theory; its *bidirectionality* (the fact that roots control the harmony of both prefixes and suffixes); its *obligatory* character (while vowel assimilation rules are optional in many languages, vowel harmony rules are not); and its *unboundedness* within the domain of the word, applying across maximal sequences of harmonic

vowels. These properties follow from the formal structure of the theory. Phonetic motivatedness is a consequence of the fact that autosegmental representations are arrangements of distinctive features, rather than arrangements of arbitrarily selected "prosodies" or the like. Bidirectionality, obligatoriness, and unboundedness follow as a consequence of the fact that vowel harmony is characterized as an effect of the universal Well-formedness Conditions of the theory, which have these three properties. It will be noted that none of these properties follow from traditional accounts of vowel harmony, which describe vowel harmony systems in terms of language-particular rules.[1]

It has further been shown that the autosegmental framework allows a substantial reduction in the abstractness and arbitrariness of conventional descriptions, by reducing the emphasis on the role of rules in favor of the specification of a small number of parameters along which individual languages make a selection (Clements (1981)). These parameters appear to include the following:

(2)   a.   The class of *P-segments* (melody units) which constitute the autosegmentally-represented harmony features;

        b.   The class of *P-bearing units* (melody-bearing units) defined as the class of units to which P-segments are associated under the universal Well-formedness Conditions;

        c.   The (possibly null) class of *opaque segments*, defined as those which are underlyingly associated with a P-segment;

        d.   The (possibly null) class of *transparent segments* which must be formally excluded from the class of P-bearing units;

        e.   The *domain* within which the Well-formedness Conditions initially apply.

It seems that several of these parameters can be "set" on a language-independent basis. In all known vowel harmony systems, the class of P-bearing units stipulated under (2b) is the class of vowels. Similarly, the domain identified under (2e) is the (phonological) word, as this is independently defined in each language.[2] Thus these values can be supplied by the theory, and what remains to be specified on a language-particular basis are the classes of P-segments, opaque segments, and transparent segments. As noted above, the P-segments characterizing any vowel harmony system are drawn from the universal set of vowel features, including such features as back, round, advanced tongue root (ATR), high, and perhaps certain others.[3] Opaque segments, insofar as they are predictable, must be specified in the grammar of each language; note that opaque segments may include segment types other than those included in the class of P-bearing units (thus, consonants, in the case of vowel harmony).

Transparent segments are a subset of the segments characterized under (2b) which are "neutral" to the system in the sense that they do not associate with P-segments under the Well-formedness Conditions, but receive their feature values by independent specification. These include the familiar neutral vowels of many Uralic and Altaic languages.[4]

Turkish vowel harmony may be provisionally stated as follows. Each system is stated separately.

(3)   backness harmony:
       P-segments: [+back], [−back]

(4)   roundness harmony:
       P-segments: [+round], [−round]
       opaque segments: [+syllabic, −high]

(3) and (4) may be taken as the rules of vowel harmony in Turkish. Note that the fact that nonhigh vowels do not participate in the roundness system as P-bearing units is not treated by excluding them as transparent segments under (2d), but rather by identifying them as opaque segments under (2c). We shall see shortly how this treatment accounts for the phonological behavior of these vowels.
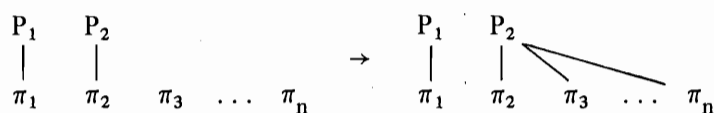
The present theory further assumes a set of universal Association Conventions which implement the Well-formedness Conditions. These conventions have the effect of requiring all P-bearing units (vowels) to be associated with one P-segment (harmony feature). The following informal statement is based upon that given in Clements (1981):

(5)   Association Conventions

       a.   Associate free (i.e. as yet unassociated) P-segments with free P-bearing segments from left to right across the mapping domain, until no further such associations can be made. For example (P = P-segment, π = P-bearing segment):

$$P_1 \quad P_2 \quad P_3 \quad \ldots \qquad \rightarrow \qquad \begin{array}{ccc} P_1 & P_2 & P_3 \\ | & | & | \\ \pi_1 & \pi_2 & \pi_3 \end{array} \quad \ldots$$

       b.   Associate any remaining free P-bearing units with a P-segment, giving precedence (in case of indeterminacy) to the P-segment on the left:

$$
\begin{array}{ccccc}
P_1 & P_2 & & & \\
| & | & & & \\
\pi_1 & \pi_2 & \pi_3 & \ldots & \pi_n
\end{array}
\quad \rightarrow \quad
\begin{array}{ccccc}
P_1 & P_2 & & & \\
| & | & & & \\
\pi_1 & \pi_2 & \pi_3 & \ldots & \pi_n
\end{array}
$$

(mirror image)

Convention (5a) provides for a left-to-right, one-to-one mapping between free (unassociated) P-segments and free P-bearing segments. (5b) insures that all P-bearing units will be associated with a P-segment, though not the converse. (5b) incorporates the following priority clause proposed in Clements (1976):

(6)   Given configurations in which one or more free P-bearing units are flanked on both sides by bound P-bearing units, associate from the left. E.g.:

$$
\begin{array}{ccc}
P & & P \\
| & & | \\
\pi & \pi & \pi
\end{array}
$$
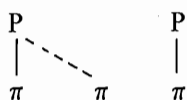
(5a) and (5b) together express the commonly-observed bias toward spreading from left to right. We finally assume the general constraint on autosegmental representations that prohibits the crossing of association lines (Goldsmith (1976)). These conventions act as "monitoring" devices in phonological derivations to preserve well-formed patterns of association between P-segments and P-bearing units. At the phonetic level, these associations are interpreted as patterns of coarticulation. Language-particular association rules, such as are commonly met with in tone languages, may take precedence over these conventions. Thus, the Association Conventions may be regarded as constituting the unmarked basis for mapping between autosegmental tiers. Language-particular rules may override any of these conventions, but only at the cost of adding extra complexity to the grammar.

Given these principles, we may return to the forms given in (1) above. The simplest set of underlying representations required to account for the representative forms *ip* 'rope' and *son* 'end' are the following:

(7)   *nom. singular:*   *nom. plural:*

    a. −R   −R   −R
                                            |

        Ip In   Ip   1 E r

        −B   −B

    b. +R   +R   −R
                                            |

   sEn In   s En 1 E r

        +B   +B

Here, in accordance with (4), nonhigh vowels are represented as opaque on the roundness tier. Otherwise, suffixes have no P-segments in their representation.[5] Each root, on the other hand, has a P-segment in its representation for each autosegmental tier. Since root vowels have not been defined as opaque,[6] there are no underlying associations between root vowels and root P-segments. Association Conventions (5a) and (5b) apply in succession to create the following output forms:

(8)   a.

    b.

Notice that no rule has applied in deriving the surface forms of (8) from the underlying forms of (7). The rules defining Turkish vowel harmony, as stated in (3) and (4), are structure-building rules rather than feature-changing rules.

The special properties of opaque vowels become apparent if we consider the derivation of the genitive plural of these two forms. The underlying forms are as follows:
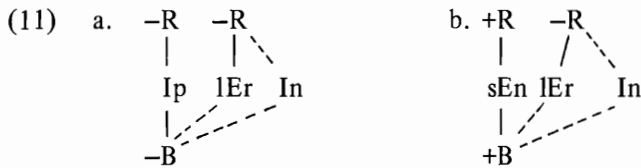
(9)   a.   −R −R   b. +R −R
                  | |
                I p l Er In   s En l Er In

                −B   +B
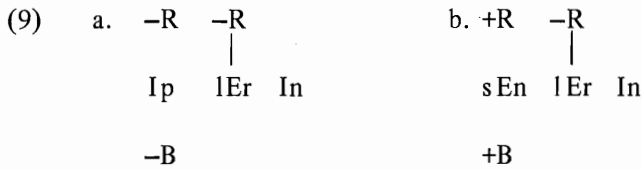
Association Convention (5a) applies first to link the single free P-segment on each tier to the first free P-bearing segment:

(10)   a.   −R −R   b. +R −R
                 ⋮ | ⋮ /
                I p l Er In   s En lEr In
                 ⋮   ⋮
                −B   +B
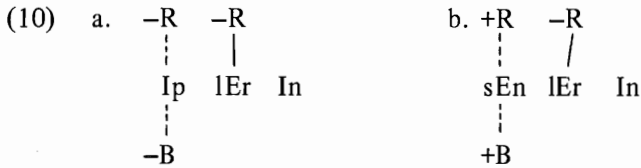
Association Convention (5b) then applies to link remaining free vowels to the first P-segment to their left:

(11)   a.   −R −R   b. +R   −R
                 | | \ | / \
                I p l Er In   s En lEr   In
                | ⁄ | ⁄
                −B   +B

If we observe the roundness tier, we note that the opaque vowel of the plural suffix has three characteristics: (i) it fails to associate with the P-segment of the root to its left, (ii) it prevents the P-segment on its left from associating with any vowel to its right, and (iii) it determines the roundness value of the vowel to its right. These properties are formal consequences of the Association Conventions (5). We may therefore say that opaque segments are "nonundergoers," "blockers," and "spreaders" with respect to the Association Conventions, differing in this respect from true neutral segments (such as consonants[7]) which are nonundergoers but neither blockers nor spreaders. We shall take these three properties as criterial for the identification of opaque segments in our subsequent discussion.

3. A TYPOLOGY OF VOWEL AND CONSONANT DISHARMONY IN TURKISH

In this section we examine various types of exceptions to the principles of vowel and consonant harmony suggested by our preliminary examination of the forms in (1), and show that these follow from the existence of "opaque" vowels and consonants in phonological representations.

3.1.   Vowel Disharmony in Roots

Many polysyllabic roots conform to the principles of vowel harmony stated earlier. However there is a large number of exceptions to these principles which any adequate analysis of Turkish must take account of. Representative examples, involving exceptions to backness harmony, are given below.

(12)   a.   cooccurrence of /a/ and /i/:

vāli	'governor'	kitap	'book'
hamsi	'anchovies'	izmarit	'sea-bream'
dakīka	'minute'	fiat	'price'
vaziyet	'position'	infilak·	'explosion'
takvim	'calender'	istakoz	'lobster'
hani	'where is'	silah·	'weapon'

b.   cooccurrence of /a/ and /e/:

hareket·	'movement'	hesap	'bank account'
anne	'mother'	general	'general'
adet	'item, piece'	jevap	'answer'
haber	'news'	jezā	'punishment'
kardeš	'sibling'	mezat	'auction'
katmer	'fold, layer'	selam	'salute'

c.   cooccurrence of /o/ and /i/:

bobin	'spool'	pilot	'pilot'
polis	'police'	činko	'zinc'
orkinos	'tunny fish'	čiroz	'dried mackerel'
torik·	'blue fish'	limon	'lemon'
politika	'politics'	sifon	'toilet flush'
komite	'committee'	kilo	'kilo'

d.   cooccurrence of /o/ and /e/:

otel	'hotel'	petrol	'petrol'
kolye	'necklace'	peron	'railway platform'
rozet	'collar pin'	teleskop	'telescope'
model	'model'	depo	'warehouse'
noter	'notary public'	metot	'method'
dočent	'associate professor'	dekor	'stage scenery'

e.   cooccurrence of /u/ and /i/:

billur	'crystal'	hūri	'beautiful girl'
zigurat	'ziggurat'	muzip	'mischievous'
(gap)		kulis·	'stage wing'
		mūnis	'easy-going'
		muhit	'neighbourhood'
		zarūri	'necessary'

f. cooccurrence of /u/ and /e/:

sūret	'copy'	ĵesur	'brave'
buket	'bouquet'	mebus	'member of parliament'
kubbe	'dome'	mektup	'letter'
kudret	'power'	mevzū	'topic'
sūre	'chapter of the Koran'	nemrut	'unsociable'
		resul	'messenger of God'
muhterem	'respected'		

We note that while /u...i/ in that order is a common sequence, /i...u/ is very rare. With this exception, we find that exceptions to backness harmony involving vowels from the set /i, e, a, o, u/ are common in Turkish, involving many items of the everyday as well as the learned vocabulary. On the other hand, exceptions involving the vowels /ü, ö, i/ are very rare. Furthermore, these, unlike the previous class of exceptions, are highly unstable and tend to regularize to various extents in different dialects. For example, we find the following examples of disharmonic sequences containing /ü, ö/ in the standard dialect:

(13)

komünizim	∿ kominizim	'communism'
komünist	∿ kominist	'communist'
mersörize	∿ merserize	'mercerized'
püro	∿ puro	'cigar'
nüzul	∿ nüzül	'paralysis'
motör	∿ motor	'engine, motorboat'
kupür	∿ küpür	'denomination, clipping'
šoför	∿ šöför	'driver'
külot	∿ kilot	'panties'
küsur	∿ küsür	'fractions'
fütur	∿ fütür	'langour'
nüfus	∿ nufus	'population'
mürur	∿ mürür	'lapse'
zulüm	∿ zulum	'oppression'
nüfuz	∿ nufuz	'authority'
bülū	∿ bulū	'adolescence'
bisküvit	∿ büsküvüt	'biscuit'
šövalye	∿ šovalye	'knight'

Examples such as *külot*∿*kilot* show that regularization need not make an item regular with respect to backness harmony, but may only replace one vowel of the set /ü, ö, i/ with a vowel of the set /i, e, a, o, u/ agreeing with it in backness.

Let us now consider exceptions to the system of roundness harmony.

We may first note that just as in the case of backness harmony, exceptions involving vowels from the set /ü,ö, ɨ/ are rare and subject to regularization; indeed, exceptions consisting of /ɨ/ cooccurring with a rounded vowel are virtually nonoccurrent. As a subregularity, however, we find that /ü/ and /i/ cooccur in several words, in either order:

(14)   ümit   'hope'   tifüs   'typhus'
        düzine   'dozen'   virüs   'virus'
        ümmī   'illiterate'   virgül   'comma'
        mümbit   'fertile'   nīlüfer   'water lily'
        ünsiyet   'familiarity'   bitüm   'bitumen'

With this set of exceptions, we conclude that /ü, ö, ɨ/ are extremely infrequent in words violating roundness harmony.

In contrast, violations involving vowels from the set /i, e, a, o, u/ are common. Consider first violations with /o/. Since nonhigh vowels are opaque to rounding harmony, the only true violations will involve cases of /o/ followed by either of the high vowels /i, ɨ/; as we have just seen, violations involving /ɨ/ do not exist. Examples of the remaining case, /o/ followed by /i/, were given in (12c).

Let us consider, finally, violations of rounding harmony involving /u/. Since, once again, nonhigh vowels are opaque to the roundness system, violations are of one of two sorts: /u/ followed by /i/, already illustrated in (12e), and /u/ following one of the vowels /i, e, a/. Words with /u/ following /i/ are rare, as shown by the near-total gap in (12e) (two examples were found). Words with /u/ following /e/ are on the other hand not uncommon, as shown in (12f). Our final case is /u/ following /a/, and this deserves special comment.

The /a...u/ type of exception pattern is common in Turkish, and a special status is usually assigned to this sequence. In the traditional analysis, /u/ is found to the exclusion of /ɨ/ after /a/ if the intervening consonant is one of the labials /p, b, m, f, v/ (or if the intervening consonant cluster contains a labial). In generative analysis, this statement is usually formulated as a morpheme structure condition of Labial Attraction (see, for example, Zimmer (1969)), since the rule does not hold across morpheme boundaries, as already illustrated by the form *sap-ɨn* in (1).

Now while many Turkish roots conform to the proposed rule of Labial Attraction, many more do not. Lees (1966) and Zimmer (1969) were able to find 61 roots of the form /...aCu../ where C is a labial consonant or a cluster containing a labial, and 13 which had /ɨ/ in place of the expected /u/. Further examination shows that exceptions of the latter sort are more numerous than Lees and Zimmer believed. We have found the following, all of which are quite common words:[8]

(15) apɨš (arasɨ) 'crotch'   čapkɨn   'womanizer'
      čarmɨh   'cross'   kapɨ   'door'
      kaplɨja   'thermal spring' sābɨk   'ex' (prefix and noun)
      hāfɨza   'memory'   sarmɨsak   'garlic'
      sabɨr   'patience'   yapɨšmak   'to stick to'
      kabɨz   'constipated'   kamčɨ   'whip'
      hāfɨz   'Koran reciter'   apɨšmak   'to be shocked'
      damɨz (lɨk)   'stag'   kamɨš   'reed'
      rābɨta   'connection'   yapɨnjak   'kind of grape'
      damɨtmak   'to distill'   sapɨk   'psychotic, pervert'
      mutābɨk   'in agreement'   münāfɨk   'heretic'
      muhāfɨz   'sentry'   kɨzamɨk   'measles'

Even more decisive evidence against a rule of Labial Attraction is the existence of a further, much larger set of roots containing /...aCu.../ sequences in which the intervening consonant or consonant cluster does not contain a labial; we have found 61 such roots, of which a representative sample is given below:

(16) marul   'lettuce'   barut   'gunpowder'
      mālup   'defeated'   žaluzi   'Venetian blind'
      hātun   'lady'   fatura   'invoice'
      sardunya   'geranium'   mādur   'oppressed'
      fasulya   'beans'   māsum   'innocent'
      arzu   'desire'   kazūrat   'feces'
      anut   'sulky'   kānun   'law'
      ajūze   'ugly'   ajur   'type of cucumber'
      panžur   'shutter'   asūre   'kind of dessert'
      vakur   'grave'   yakut   'emerald'
      āguš   'bosom'   mahkum   'convict'
      yahudi   'Jew'   sahur   'meal before dawn'

We conclude that there is no systematic restriction on the set of consonants that may occur medially in roots of the form /...aCu.../.

Our conclusion is supported by the results of psycholinguistic experimentation carried out by Zimmer (1969). Zimmer found that subjects' reactions to nonsense-word preference tests fell into two categories. One set of speakers consistently preferred nonsense words of the shape /...aCu.../ to nonsense words of the shape /...aCɨ.../, while the other set consistently made the opposite choice. In both cases, the nature of the intervening consonant was found to have no bearing upon the choice. These results support our view that there is no rule of Labial Attraction

in the synchronic grammar of modern standard Turkish. The fact that /...aCu.../ sequences were regularly preferred by one group of subjects reflects the fact that this sequence is well-formed in roots, in spite of its apparent violation of roundness harmony.

Let us consider now how our results are to be interpreted. The standard approach to disharmonic roots has been to treat them as exceptions to the otherwise general rules of vowel harmony. Their exceptional status is reflected in the grammar by assigning them diacritic features indicating that they are exceptions to backness harmony, roundness harmony, or both. Yet our results suggest that the burden of proof is on the linguist who wishes to demonstrate that roots are governed by vowel harmony at all.

The traditional analysis has been defended on the basis of the claim that disharmonic roots are loanwords, and thus not subject to the otherwise general and productive rules of Turkish (Lightner (1972)). This account is problematic on two counts. In the first place, no support can be found for this claim in the synchronic grammar of Turkish. Lightner enumerates a number of features that distinguish nonnative words from native words in the Turkish lexicon: (i) occurrence of /ž/, /ä/ as phonemes; (ii) stem-internal ablaut (*kitap* 'book', *kütüp* 'books'); (iii) occurrence of glottal stop; (iv) root-initial consonant clusters; (v) nonfinal stress in morphemes other than adverbs and place names; and (vi) occurrence of palatal /l̡/ in back-vowel words. He suggests that roots having these characteristics are marked [-native], and that nonnative roots are redundantly marked as exceptions to vowel harmony. The fact is, however, that the vast majority of exceptional roots, including most of those cited above, show none of the characteristics listed by Lightner nor other characteristics that would mark them as nonnative. Whatever their historical source (many, though not all[9] disharmonic roots are historical borrowings), there is no basis for the claim that most disharmonic roots involving the vowels /i, e, a, o, u/ show any exceptionality other than their disharmony.

Secondly, even if disharmonic roots were loanwords, there is no reason to suppose that they would not undergo the productive rules of Turkish phonology. Yavash (1980a) cites examples such as the following in support of the claim that loanwords regularly undergo Turkish phonological rules:

(17)   Final k-deletion[10]

biftek	'steak'	biftei	'his steak'	(Fr. *bifteck*)
tɨrafik	'traffic'	tɨrafii	'its traffic'	(Fr. *trafic*)

(18)   Final obstruent devoicing

|		
kitap	'book'	(Ar. *kitāb*)
istibdat	'despotism'	(Ar. *istibdād*)

Yet these and similar roots do not undergo vowel harmony. We conclude that one cannot isolate disharmonic roots as somehow marginal to the regular system of Turkish phonology.

To summarize, we see that the vowels /i, e, a, o, u/ freely cooccur with each other in Turkish roots. The large number of disharmonic roots created by the combination of these vowels is readily attestable in any dictionary of modern Turkish. There appear to be no grounds for treating these sequences as in any way exceptional. Such roots are common in the everyday vocabulary, fail to become "regularized" (as do disharmonic roots involving the vowels /ü, ö, ɨ/), undergo the productive rules of Turkish phonology, and are accepted by native speakers as "well-formed" in psycholinguistic testing. Further evidence for the latter observation has been adduced by Yavash (1980b), who reports on the results of an experiment similar in nature to that carried out by Zimmer. Yavash found the following hierarchy of disharmonic vowel sequences, those at the top of the list being most acceptable to his subjects. The figure in parentheses indicates the number of times the sequence in question was selected in preference to a corresponding harmonic sequence, out of a total of 26 trials.

(19)   i...a   (13)
       e...a   (13)
       a...e   (11)
       a...i   (10)
       e...u   (9)
       ü...a   (7)
       u...e   (6)
       o...e   (5)
       ɨ...e   (5)
       a...ü   (1)
       e...ɨ   (1)
       ö...a   (0)

Yavash's results are consistent with our claim that disharmonic combinations involving /i, e, a, o, u/ are well-formed, but those involving /ü, ö, ɨ/ are not. Indeed, the first two disharmonic sequences were selected as frequently as the corresponding harmonic sequences. Only the sequence /ü...a/ occurs higher on the list than expected.

We therefore conclude that within single morphemes, the vowels /i, e, a, o, u/ freely cooccur, while the vowels /ü, ö, ɨ/ may occur only harmonically. In order to state this constraint formally we will assume that all root vowels are opaque. We therefore add the following statement to (3) and (4):

(24)   if αR   then αR

          |

        V C_0 V   V C_0 V

      [–low]   [–low]

        | |

      –αB   –αB

(mirror image)
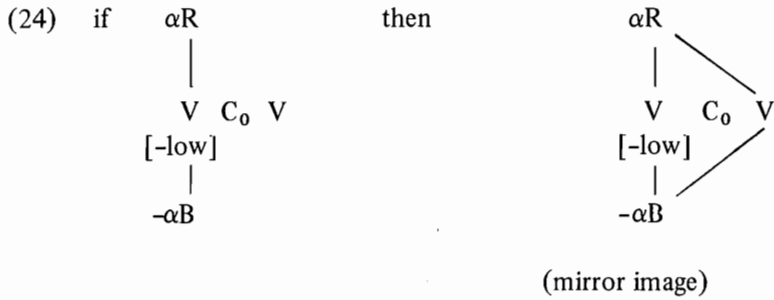
Or, using the abbreviatory conventions of autosegmental phonology,

(25) αR

         |

        V C_0 V   (mirror image)

     [–low]

        |

    –αB
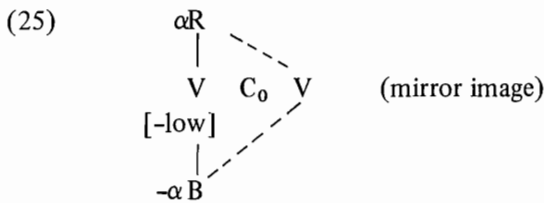
The exceptional, well-formed subsequences involving /i, ü/ are subsumed under the following further condition:[11]

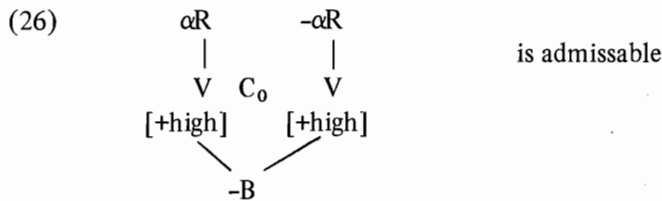(26) αR   –αR

        | | is admissable

       V C_0 V

    [+high]   [+high]

           –B

3.1.1. The Status of non-initial /o/

In connection with the distribution of /o/ we would like to comment briefly on a claim that has gained wide currency in the literature, to the effect that /o/ is restricted to initial syllables of roots. Whatever its historical status, this claim is not true of modern standard Turkish, which offers many examples of non-initial /o/; see (12c, d) for a few examples, which can easily be multiplied. Surface exceptions to this alleged regularity arise through two regular processes: (i) partial reduplication of certain adjectives, (ii) a rule of vowel assimilation whereby a high vowel optionally assimilates to an immediately preceding nonhigh vowel with which it agrees in backness and rounding:

(20)   opaque segments: [+syllabic, +root]

This ensures underlying representations like the following (cf. (12)):

(21)
```
     -R   +R          +R -R +R              -R
      \   /            |  |  /             /  \
      IstEkEz          ErkInEs            IzmErIt
      |   \/            |  |  \            |  |  \
     -B   +B           +B -B +B           -B +B -B

   'lobster'        'funny fish'        'sea-bream'
```

This treatment is consistent with the analysis of opaque vowels given earlier. Recall that opaque vowels were characterized as "nonundergoers," "blockers," and "spreaders". Root vowels are nonundergoers; thus a root vowel does not harmonize with the preceding vowel. Root vowels are blockers; thus a suffix vowel cannot harmonize with a nonfinal root vowel, except coincidentally. Root vowels are spreaders; thus a final root vowel determines the harmonic category of the immediately following harmonic suffix vowel. The last two points are illustrated in (22) for the genitive singular of *orkinos* 'tunny fish':

(22)
```
      +R -R +R
       |  |  /\
      ErkInEs In        [orkinosun]
       |  |  \ ./
      +B --B +B
```

It can be deduced from (3), (4), and (20) together with the universal Well-formedness Conditions that harmonic suffix vowels following a root will harmonize with the last root vowel, a claim which is correct for Turkish.

We now introduce the following constraint on vowel cooccurrence within single morphemes:

(23)   The vowels /ü, ö, ɨ/ do not occur disharmonically in VC_0V sequences, except that /i, ü/ may occur in either order.

This statement admits roots of the type /CuCaCɨ/ while excluding roots of the type /CuCɨCa/ and /CaCɨCu/, since only the latter involve harmony violations involving /ü, ö, ɨ/ in disyllabic subsequences. This formulation seems intuitively correct, although we have not found examples of disharmonic roots of the first type. This statement also provides for the subregularities involving /i, ü/ (see (14)). The first part of (23) may be restated formally as an if-then condition holding of single morphemes:

(27)   a.   Adjective reduplication:

bok	'ordure'	bombok	'utterly useless'
dolu	'full'	dopdolu	'full to the brim'
mor	'purple'	mosmor	'bright or dark purple'

       b.   Vowel assimilation:

aɨr	∿	aar	'heavy'
böür	∿	böör	'bellow'
yourt	∿	yoort	'yogurt'

Underlying exceptions have a variety of historical sources. The earliest loans introducing noninitial /o/ include loans from the 14th and 15th centuries (28a), and later loans from Byzantine Greek (28b) and Italian (chiefly Venetian) (28c):

(28)   a.

abanoz	'ebony'	<	Gr. ebenos
horoz	'rooster'	<	Gr. horus
afyon	'opium'	<	Pers. afyon (cf. Gr. opion)
orospu	'whore'	<	Pers. ruspī
anadolu	'Asia Minor'	<	Lat. Anatolia

       b.

anafor	'whirlpool'	<	anafori
lodos	'southwest wind'	<	lotos
istavros	'cross'	<	stavros
takoz	'wooden wedge'	<	takos

       c.

kalyon	'gallion'	<	galión
moloz	'debris'	<	molo (<Lat. moles)
marangoz	'carpenter'	<	marangón
alabora	'capsize'	<	albora

Examples of more recent loans, coming primarily from French and Italian, are numerous. The following are minimal pairs in which the first member has noninitial /o/:

(29)

tablo	'painting'	tabla	'tray'
komplo	'plot'	komple	'complete'
limon	'lemon'	liman	'harbor'
balkon	'balcony'	balkan	'Balkans'
balo	'ball'	bale	'ballet'
filo	'fleet'	file	'shopping net'

That noninitial /o/ is well-entrenched in modern Turkish is further shown by the fact that many loans have introduced noninitial /o/ in place of an original /u/, a fact which would be surprising if there were a constraint

against noninitial /o/. See the examples *horoz* and *orospu* in (28a), as well as the following, which now have /o/ in free or dialectal variation with the original /u/:

(30) mool   ∿   moɣol ∿   mogol ∿ mogul 'Mongolian'
      soot   ∿   soɣot ∿   sogot   ∿ sogut 'Sogdian'
      feyl̥esof   ∿   feyl̥esuf   'philosopher'

3.2.   *Vowel disharmony in suffixes*

We may draw a distinction between *harmonic* and *disharmonic* suffixes as follows: harmonic suffixes are those whose vowels show regular alternation involving at least one of the two harmonic features [back] and [round], while disharmonic suffixes contain at least one vowel which fails to alternate under any circumstances. The following examples illustrate words formed with the disharmonic suffixes /-Iyor/ 'progressive', /-gen/ 'noun-forming', /-istan/ 'noun-forming', and /-Edur/ 'verb-forming'. Note that in the first and fourth of these the first vowel alternates regularly while the second vowel does not:

(31) a.   gel-iyor-um   'I am coming'
           koš-uyor-um   'I am running'
           gül-üyor-um   'I am laughing'
           bak-ïyor-um   'I am looking'
      b.   üč   'three'   üč-gen-ler   'triangles'
           altï   'six'   altï-gen-ler   'hexagonals'
           sekiz   'eight'   sekiz-gen-ler 'octagonals'
           čok   'many'   čok-gen-ler   'polygonals'
      c.   arab-istan-ï   'Arabia'   (acc.)
           ermeni-stan-ï   'Armenia'   "
           mool-istan-ï   'Mongolia'   "
           türk-istan-ï   'Turkestan'   "
      d.   gid-edur-sun   'let him keep going'
           koš-adur-sun   'let him keep running'
           gül-edur-sun   'let him keep laughing'
           bak-adur-sun   'let him keep looking'

It will be noticed that the nonalternating vowels exhibit the characteristics of opaque segments: they are nonundergoers, blockers, and spreaders. Accordingly, we will postulate underlying representations such as the following, for *geliyorum*:

(32)   -R   +R
        | |
        gEl   IyEr   Im
        | |
        -B   +B

Association Convention (5b) is applicable. Notice that the condition of precedence (6), incorporated into the statement of (5b), uniquely determines the pattern of association shown below:

(33)   -R   +R
       / ⟍   / ⟍
      gEl   IyEr   Im   = [geliyorum]
       | ⟋ | ⟋
      -B   +B
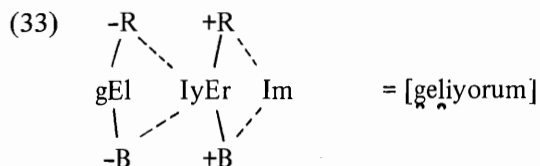
More generally, we find that (6) is always correct for Turkish: opaque segments, whether vowels or (as we shall see) consonants, always govern the harmonic category of a harmonic vowel to their right. We might call (6) the Principle of Inertia, according to which an articulatory state determined by a particular feature configuration is maintained until a new specification (or set of specifications) is encountered. This principle need not be stated as a condition on rule application. As noted earlier, this principle, together with the left-to-right mapping convention (5a), explains the common phonological bias toward spreading from the left. As a convention (rather than a language-particular rule condition), it expresses the "unmarked" case of spreading which can only be overruled by a language-particular statement taking precedence over it.[12]

The constraint ruling out disharmonic sequences with /ü, ö, ɨ/ in roots holds of polysyllabic suffixes as well. A small number of such suffixes contain two opaque vowels. The suffix /-istan/, illustrated in (31c), is one, and the others are:

(34)   -āne   denominal, adjective-forming
        -vāri   denominal, adverb-forming
        -leyin   denominal, adverb-forming
        -iyet   denominal, noun-forming

In these suffixes the disharmonic vowels are drawn exclusively from the set /i, e, a/. More generally, opaque vowels in suffixes are always one of the following: /i, e, a, o, u/; the vowels /ü, ö, ɨ/ do not occur as opaque segments outside roots. We thus have the following condition holding of suffixes in underlying representation:

(35)   /ü, ö, ɨ/ are prohibited in suffixes.

3.3. Consonant harmony and disharmony

The following chart gives a partial distinctive feature specification of Turkish surface consonants:

(36)	p	b	f	t	d	s	z	č	ǰ	š	ž	k	g	m	n	v	l	r	y	h
coronal	−	−	−	+	+	+	+	+	+	+	+	−	−	−	+	−	+	+	+	−
anterior	+	+	+	+	+	+	+	−	−	−	−	−	−	+	+	+	+	−	−	−
labial	+	+	+	−	−	−	−	−	−	−	−	−	−	+	−	+	−	−	−	−
high	−	−	−	−	−	−	−	+	+	+	+	+	+	−	−	−	+	−	+	−
sonorant	−	−	−	−	−	−	−	−	−	−	−	−	−	+	+	+	+	+	+	+
voiced	−	+	−	−	+	−	+	−	+	−	+	−	+	+	+	+	+	+	+	−
strident	−	−	−	−	−	+	+	+	+	+	+	−	−	−	−	−	−	−	−	−

The high nonstrident consonants k, g, l have two major forms, front (palatal) and back (velar), which occur under conditions which we state below. While the choice between these forms is, as we shall see, partly conditioned by context, it is partly unpredictable, as the following examples show:

(37)	velar /k g l/:		palatal /k̭ g̭ ḽ/:	
	bol	'abundant'	boḽ	'cocktail, drink'
	kalp	'counterfeit'	kaḽp	'heart'
	kar	'snow'	k̭ar	'profit'
	gaz	'gas'	g̭avur	'infidel'

In addition to these, an unpredictable palatal /r̭/ has a marginal occurrence in stem-final clusters, and some dialects of modern standard Turkish retain a very restricted occurrence of palatal /ṱ/ in absolute stem-final position. We shall see examples of all of these below. Apart from these cases, the feature of backness is not distinctive in consonants.[13]

The selection between /k g l/ and /k̭ g̭ ḽ/ is partly determined by the harmonic structure of the word in which they occur. In general — and we shall shortly see that this is an oversimplification — /k g l/ appear in back vowel words and /k̭ g̭ ḽ/ appear in front vowel words. This so-called "consonant harmony" cannot be considered a redundant effect of vowel harmony since disharmonic consonants may appear in regular harmonic words while harmonic consonants may appear in disharmonic words.

3.3.1. The velar consonants

The following forms illustrate harmonic velar consonants in monosyllables. The words in (38a) show that syllable-initial velars assimilate to

the value of the following vowel, and those in (38b) show that syllable-final velars assimilate to the value of the preceding vowel.

(38) a. kir   'dirt'   gür·   'abundant'
          kel   'bald'   kör·   'blind'
          kɨr   'meadows'   kul   'slave'
          gaz   'gas'   kol   'arm'
      b. dik   'upright'   yük   'load'
          tek   'single'   dök   'pour'
          sɨk   'often'   ak   'white'
          ok   'arrow'

(Note that /g, g/ do not occur syllable-finally.[14]) As a preliminary hypothesis, we might suppose that it is the position of the consonant with respect to the vowel in the linear string of phonemes that determines whether the palatal or the velar is selected, and propose the following rule (cf. Anderson (1974), 211):

(39) $[+\text{cons}] \rightarrow [\alpha\text{back}] / \left[\begin{array}{c} \underline{} \\ +\text{high} \\ -\text{strident} \end{array}\right] \left[\begin{array}{c} +\text{syllabic} \\ \alpha\text{back} \end{array}\right]$ (mirror image)

Due to the convention related to mirror image rules according to which the given order of elements takes precedence over the mirror image order, this rule also extends correctly to the following data:

(40)   sākin·   'calm'   raket·   'racket'
        vakit·   'time'   fakir·   'poor'
        īkaz   'warning'   mika   'mica'
        ikon   'icon'   patika   'path'
        sigara   'cigarette'   istigal   'occupation'
        hakīkat   'truth'   dikkat   'attention'

In *sākin*, for example, the velar assimilates to the following vowel by the first case of the rule, and since this case takes precedence over the second, the rule cannot reapply. Consider now, however, the following data:

(41)   fark   'difference'   kɨrk   'forty'
        zamk   'glue'   burk   'sprain'
        sirk   'circus'   ilk   'first'
        kürk   'fur'   denk   'equal'

Here the backness of the final consonant is determined by the value of the preceding (and only) vowel. But since rule (39), as stated, does not provide for an intervening consonant it will not account for any of these forms. We must therefore modify the rule to allow for the presence of an intervening consonant:

(42) $[+cons] \rightarrow [\alpha back] / \underline{\hspace{1cm}} \begin{bmatrix} +high \\ -strident \end{bmatrix} (C) \begin{bmatrix} +syllabic \\ \alpha back \end{bmatrix}$

(mirror image)

A serious problem now arises, however, with forms such as the following, which are also perfectly regular:

(43) nektar   'nectar'   reklam   'advertisement'
      ikram   'offer'   šükran   'gratitude'
      boksit   'bauxite'   akrep   'scorpion'
      daktilo   'typist'   ukte   'ganglion'

Our revised rule will apply incorrectly to these forms due to the principle (required for the forms of (40)) that the first case of a mirror image rule applies disjunctively with respect to the second case. Thus, there appears to be no way of accounting for velar consonant harmony in terms of a rule formulated in terms of the linear string of segments alone.

Let us propose, instead, that the backness value of a harmonizing velar consonant is determined by the *tautosyllabic* vowel – the vowel with which it shares a syllable. We may account for consonant harmony by defining the following autosegmental system, which spreads the backness value of a vowel onto any tautosyllabic high non-strident consonant:[15]

(44) Consonant Harmony
          P-segments: [+back], [−back]
          P-bearing units: [−syl, +high, −strident]
          domain: σ

This rule, in effect, generalizes the rule of backness harmony (3) to the set of harmonic consonants within the domain of the syllable. The bidirectional and obligatory character of this rule, as well as the irrelevance of intervening consonants, are an automatic consequence of this analysis. (44), defining an autosegmental system, will apply in a derivation whenever its structural description is met. (44) will apply correctly to the following examples, as indicated by the broken lines:

(45)

+B	+B−B+B	−B +B
/l\	l ʌ ʌ	ʌ ʌ
kIrk	hEkIkEt	dIkkEt
∀	∀ ∀ ∀	∀ ∀
σ	σ σ σ	σ σ
[kɨrk]	[haḵɑ̄kat]	[dikkat]
'forty'	'truth'	'attention'

There are some occurrences of velar stops in stem-initial and stem-medial position whose values cannot be predicted on the basis of rule (44). Some representative examples follow:

(46) bekar   'bachelor'   kātip   'clerk'
       ahḵam   'judgements'   zekat   'alms'

In traditional analyses within linear frameworks, such consonants must be marked with a diacritic feature indicating that they are exceptions to rule (44). No such diacritic marking is necessary in the present treatment, which regards these forms as regular, though somewhat more complex in structure than forms with harmonizing velars. We need only treat the consonants in question as opaque segments. This will give us underlying representations such as the following, to which no further rules apply:

(47)

−B +B	−B +B −B	+B −B+B	−B +B
ʌ		\	/	/ //	ʌ /
bEkEr	kEtIp	EhkEm	zEkEt
∨ ∨	∨ ∨	∨ ∨	∨ ∨
σ σ	σ σ	σ σ	σ σ
[bekar]	[kātip]	[ahḵam]	[zekat]

3.3.2. The lateral

We now consider the harmonic behavior of the lateral. This consonant has generally been treated in parallel to the velars. However, its harmonic behavior is considerably more complex.

First of all, in the Istanbul dialect the lateral is predictably palatal in word-initial position:

(48) laf   'expression'   lutuf   'favor'
       lodos   'south wind'   lɨkɨrda−   'gurgle'

In word-final position after back vowels, however, the value of this consonant is unpredictable:

(49) a. front 1:

sol	'sol' (musical note)	kalp	'heart'
bol	'cocktail, drink'	ihlal	'violation'
usul	'system'	sual	'question'

 b. back 1:

sol	'left'	kalp	'counterfeit'
bol	'abundant'	okul	'school'
bavul	'suitcase'	hamal	'porter'

The lateral is invariably palatal when the first preceding or following vowel is [−back]:

(50)

čelo	'cello'	melun	'cruel'
ilač	'drug'	selam	'hello'
kalem	'pen'	polis	'policeman'
albüm	'album'	islam	'Islam'

Otherwise, word-internal laterals may be front or back, with the front variant strongly favored if either flanking vowel is long (51a) and the nonpalatal favored in all other cases (51b):

(51) a.

mālum	'known'	ālā	'fine'
ulūfe	'soldier's pay'	ukalā	'pedantic'

 b.

| ɨlɨk	'warm'	balɨk	'fish'
yala	'lick'	balo	'ball'

There is evidence that the predictable occurrence of front /l/ in (50) is lexically determined by a morpheme structure condition, rather than assigned by rule. While predictable occurrences of back laterals are fronted before invariant front vowel suffixes (52a), predictable occurrences of front laterals remain front before invariant back vowel suffixes (52b):

(52) a.

asɨl	'original'	aslī	'basic'	aslen	'basically'
mool	'Mongolian'	moolistan	'Mongolian'		

 b.

ādil	'just'	ādilāne	'justly'
sefil	'miserable'	sefilāne	'miserably'

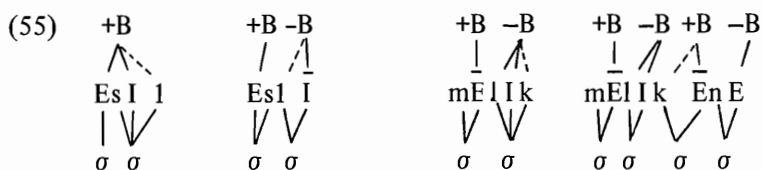The velar consonants, in contrast, assimilate to a following back vowel across morpheme boundaries:

(53) mālik 'owner' mālikāne 'residence'

These facts are easily accounted for on the assumption that the palatal laterals in (50) and (52b) are determined by a morpheme structure condition having the following form (this statement is to be interpreted as a conditional, as in (25) earlier):

(54)   −B
          ╱- - - - ~   (mirror image)
       V   (C)   [+lateral]
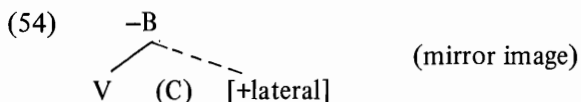
In other words, laterals are lexically associated with any −B harmony segment associated with the first vowel to their left or right.

Laterals which are not opaque are subject to rule (44) given earlier. (44) will therefore not apply to the forms in (50) and (52b), but it will apply to the forms in (52a), just as it does to those in (53):

(55)   +B   +B −B   +B −B   +B −B +B −B
        Λ·.   │ ╱Ι   │ Λ,   │ ╱ ╱Λ ╱
       Es I 1   Es1 Ι   mEl Ι k   mEl I k En E
        │ V   V V   V V   V V V V
        σ σ   σ σ   σ σ   σ σ σ σ

This analysis is confirmed by the fact that the lateral is not palatal before the invariant front-vowel suffix /-gil/ in examples like (56b), in apparent violation of (54); the latter, as a morpheme structure condition, will not apply across morpheme boundaries.

(56)   a.   tombul   (a name)
       b.   tombulgiller 'the Tombuls'

To summarize, we have proposed an analysis of the "harmonizing" consonants of Turkish which parallels the treatment we have given of harmonizing vowels. We have suggested that harmonizing occurrences of the velars and the lateral are underlyingly transparent, while nonharmonizing occurrences are underlyingly opaque. In the next section we turn to some consequences of this analysis.

3.4.   Consonant-conditioned vowel harmony

In the preceding section we showed that certain properties of "nonharmonic" consonants could be accounted for in a straightforward way by treating them as opaque segments. Recall that opaque segments are non-undergoers, blockers, and spreaders. Examples such as those of (46) and

(48) show that opaque consonants do not undergo the Consonant Harmony rule (44), and are thus "nonundergoers". In this section we turn to evidence confirming our prediction that nonharmonic consonants are also blockers and spreaders.

Consider first the velars. We have seen examples of disharmonically palatal /k̞/ in initial and medial position in the word, but no examples of this consonant word-finally. Indeed, this is a genuine gap in the surface distribution of this form in the dialects we have examined which remains to be accounted for.

There is a further idiosyncracy regarding roots with opaque palatal /k̞/. We find a small number of Turkish words whose final syllables have back vowels and which govern front vowel harmony, and whose final consonant is [k] word-finally, or before a consonant-initial suffix, and [k̞] before a vowel-initial suffix. A partial list includes the following:

(57)

	nom. sg.	*acc. sg.*
'explosion'	infilak	infilāki
'perception'	idrak	idrāki
'alliance'	ittifak	ittifāki
'participation'	ištirak	ištirāki
'fasting'	imsak	imsāki
'expropriation'	istimlak·	istimlāki
'real estate'	emlak·	emlāki
'exhaustion'	helak·	helāki
'addiction'	inhimak	inhimāki
'consumption'	istihlak·	istihlāki ·

Most of these words are ultimately of Arabic origin, and originally ended in nonemphatic velars. In most examples, the penultimate vowel is front and the final vowel is long back /ā/.

Now it will easily be seen that if we permit opaque palatal velars to occur freely in underlying representations – and in particular, to occur finally in the underlying representations of the stems in (57) – the front vowel quality of the suffixes will be instantly accounted for. Thus, assuming the final consonant of *idrak* to be opaque, we have the following representations of the nominative and accusative singulars, respectively:

(58)   −B +B −B   −B +B −B
          | | /   \ | /\
         IdrEk   IdrEk   I

By Association Convention (5b), the P-segment associated with the final consonant of the accusative singular becomes associated with the suffix

vowel, as indicated by the broken line. In order to account for the back quality of the final consonant in the nominative singular, where it occurs syllable-finally, we introduce a rule disassociating the P-segment in syllable-final position: [16]

(59) $-B$

       [$-$son] $]_\sigma$

This rule will not apply to syllable-final sonorants, which retain their palatal quality on the surface (see (62) below). Consonant Harmony (44) then applies to spread the backness value of the preceding vowel to the now-transparent consonant:

(60) $-B +B -B$ $-B +B$ $-B +B$
        $\mid \ \mid \ /$ $\rightarrow$ $\mid \ \mid$ $\rightarrow$ $\mid \ \ \backslash$
        I dr E k   I dr E k   I dr E k
                                   (by (59))   (by (44))

We here assume that a (nontonal) P-segment left afloat after the operation of a phonological rule is automatically deleted by convention. If it is not left afloat, it is of course retained in the representation, as in the nominative plural:

(61) $-B +B \ \ -B$ $-B +B \ \ -B$ $-B +B \ \ \ -B$
        $\mid \ \mid \ /$ $\rightarrow$ $\mid \ \mid \ \ \backslash$ $\rightarrow$ $\mid \ \ \backslash \ \ /$
        I dr E k 1 Er   I dr E k 1 Er   I dr E k   1 Er
                                   (by (59))   (by (44))

It will be noticed that rule (59) is in no way an artifact of the present analysis; the absence of syllable-final palatal velars after back vowels is a surface gap that must be accounted for in any analysis. Nor can the recognition of underlying word-final palatal velars be considered unnecessarily "abstract", since such representations are justified by alternations (57).

Consider now the behavior of words ending in a back vowel followed by a palatal *l*. These words invariably take front suffixes, as the following examples show:

(62)   *nom. sg.*   *acc. sg.*
           'system'   usul   usūlü
           'petrol'   petrol   petrolü
           'role'   rol   rolü
           'question'   sual   suāli
           'crescent'   hilal   hilāli
           'independence'   istiklal   istiklāli

To this group may be added words ending in back vowels followed by consonant clusters whose first member is palatal *l*:

(63)   'heart'   kalp   kalbi
           'golf'   golf   golfü
           'waltz'   vals   valsi

All such words contrast in their behavior with back vowel words ending in nonpalatal *l*, which invariably take back vowel suffixes:

(64)   'fork'   čatal   čatalɨ
           'school'   okul   okulu
           'police station'   karakol   karakolu

The harmonic behavior of a word ending in a lateral is therefore fully predictable: front vowel suffixes are required if the final lateral is palatal, otherwise back vowel suffixes are required. As before, we may represent stem-final palatal *l* as an opaque segment underlyingly associated with the autosegment [−back]. This unit spreads onto any suffix vowel or vowels that follow:

(65)   +B −B   +B −B
                               \ /\   /\/\
                              kElb I   IsIl I
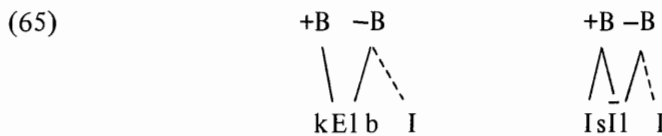
We have now succeeded in verifying our prediction concerning opaque consonants: as the forms in (57), (62) and (63) show, they are not only nonundergoers, but also blockers and spreaders.

In addition to the forms we have examined so far, there is a fairly large set of back vowel stems ending in either a cluster containing /r̥/, or in one of the consonants /t, d, b/, which require front vowel suffixes. Their Arabic or Persian sources have plain (nonemphatic) consonants in this position. A few examples are given below:

(66)

	nom. sg.	acc. sg.
'war'	harp	harbi
'letter'	harf	harfi
'west'	garp	garbi
'coinage'	darp	darbi
'watch; hour'	saat	saati
'limit'	hat	haddi
'acquittal'	beraat	beraati
'congregation'	ǰemaat	ǰemaati
'attention'	dikkat	dikkati
'reading'	kɨraat	kɨraati
'interest'	menfaat	menfaati
'God'	rab	rabbi

It appears that for some speakers, words such as *saat* end in a phonetically palatal *t* in the unsuffixed form (Waterson (1970)). For these speakers, an analysis parallel to that given for palatal *l*-stems is called for. For speakers who do not have palatal *t* in word-final position, we may generalize the solution given earlier for palatal *k*-stems. That is, the final consonant of these stems will be represented as opaque. If a vowel-initial suffix follows, the P-segment attached to the *t* will associate to it; otherwise it will be disassociated by rule (59).

Finally, we turn to a small class of stems which in some idiolects exceptionally take back vowel suffixes although their final syllable contains a front vowel. These stems include the following:

(67)

	nom. sg.	acc. sg.
'desire'	ševk	ševkɨ
'drive'	sevk	sevkɨ
'top'	fevk	fevkɨ
'creator'	hālik	hālikɨ
'confirmation'	tasdik	tasdikɨ
'Mercury' (planet)	utarit	utaridɨ[17]

For those (mostly older) speakers who still retain these forms, the nominative singular ends in a back velar rather than the expected front velar, as our transcriptions indicate. This behavior reflects the historical fact that the Arabic sources of these words ended in a uvular. The behavior of these forms suggests that the final consonant is underlyingly associated with a +B P-segment:

(68)

$$
\begin{array}{cc}
-B \ +B & -B \ +B \\
\vert \ \ \vert & \vert \ \ \vert \backslash \\
\text{š}E\text{vk} & \text{š}E\text{vk} \ \ \text{I}
\end{array}
$$

For speakers who do not have final opaque consonants in these words, the suffix vowels are front.

In sum, we have seen that the following generalizations hold of the class of exceptions discussed in this section: (i) no roots governing disharmonic suffix values end in a vowel; (ii) all roots ending in disharmonic consonants govern disharmonic suffix values. These generalizations, which do not follow from "diacritic" treatments of exceptions to vowel and consonant harmony, are consequences of a theory treating disharmonic consonants as opaque.[18]

3.5. Disharmonic epenthetic vowels

There are some 200 bisyllabic forms in Turkish in which a high vowel in the second syllable alternates with $\emptyset$. Some ten of these forms go back to old Turkic. These refer to body parts except for *oul* 'son', 3. poss. *ōlu* from the older *ogul*. The remaining forms are almost exclusively of Arabic origin. These include many common, everyday words that are heard with great frequency in the present-day language. Some examples follow:

(69)

	nom. sg.	*3. poss.*	*abl.*
'bosom'	koyun	koynu	koyundan
'idea'	fikir	fikri	fikirden
'judgement'	hüküm	hükmü	hükümden
'part'	kɨsɨm	kɨsmɨ	kɨsɨmdan
'patience'	sabɨr	sabrɨ	sabɨrdan
'text'	metin	metni	metinden

We see that the vowel in question agrees in backness and rounding with the preceding root vowel.

There are in addition bisyllabic forms that are similar to those in (69), but in which the alternating vowel does not show the expected backness harmony with the root vowel. All these words are of Arabic origin. The following is a representative list.

(70)

	nom. sg.	*3. poss.*	*abl.*
'time'	vakit	vakti	vakitten
'womb'	rahim	rahmi	rahimden
'resolution'	azim	azmi	azimden
'volume'	hajim	hajmi	hajimden
'tomb'	kabir	kabri	kabirden
'tribe'	kavim	kavmi	kavimden

Let us consider the question whether the alternating vowels in (69) and
(70) are to be treated in terms of epenthesis or deletion. It would appear,
on the face of things, that an epenthesis analysis would be difficult to
maintain. Under such an analysis, we could not predict whether the
epenthetic vowel is back /ɨ/ or front /i/. We could not predict whether
an epenthesizing stem governs back vowel suffixes or front vowel suffixes.
And finally, there would be no way of capturing the generalization that
all and only the stems that take epenthetic front vowels also require front
vowel suffixes.

A deletion analysis, on the other hand, can account for all three facts
at once. By setting up underlying /sabɨr/ 'patience' and /kabir/ 'tomb',
for example, we directly relate the quality of the suffix vowel in the 3.
possessive to the quality of the second stem vowel in the nominative
singular and ablative. Thus the derivation of *sabɨr, sabrɨ, kabir*, and *ka-bri* proceeds as follows:[19]

(71)   ./sabɨr/   /sabɨr-I/   /kabir/   /kabir-I/
       –   sabɨr-ɨ   –   kabir-i   Vowel Harmony
       –   sabr-ɨ   –   kabr-i   Vowel Deletion

In spite of the apparent attractiveness of this solution, it is quite clearly
incorrect. The first problem is that there is a host of exceptions to the
proposed rule of vowel deletion which cannot be predicted on phonolo-
gical grounds. Some representative examples include the following:

(72)

		nom. sg.	*3. poss.*	*abl.*
'copper'		bakɨr	bakɨrɨ	bakɨrdan
'food'		azɨk	azɨɨ	azɨktan
'poor'		fakir	fakiri	fakirden
'baby's shoe'	patik	patii	patikten	
'coal'		kömür	kömürü	kömürden
'sheep'		koyun	koyunu	koyundan

Thus, vowel deletion would have to be a lexically conditioned rule that
will fail to apply to a majority of eligible forms.

Secondly, and more significantly, there is a large class of exceptions
to the vowel deletion rule that *can* be predicted on phonological grounds.
This consists of the set of stems of the form $C_1VC_2VC_3$ where C_2C_3
elsewhere form a permissable syllable-final cluster. Examples are the fol-
lowing:

(73) 'gunpowder' barut   barutu   baruttan
      'strange'   garip   garibi   garipten
      'ambitious'   haris   harisi   haristen
      'outfit'   kɨlɨk   kɨlɨɨ   kɨlɨktan
      'lifebuoy'   simit   simidi   simitten

Permissable syllable-final clusters in Turkish are of the following types:[20]

(74) a. sonorant + obstruent: *türk* 'Turk', *genč* 'young'
      b. voiceless fricative + oral stop: *čift* 'double', *ašk* 'love'
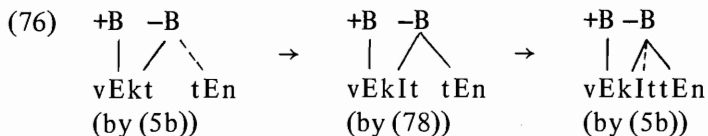   c. k + s: *raks* 'dance', *boks* 'boxing'

Under the deletion analysis there is no way to capture the relationship between the forms of (73) and the generalizations expressed in (74) short of postulating some sort of transderivational constraint on the deletion rule that would prohibit its operation just in case it would give rise to a cluster that, if syllable final, would be well-formed. Such a solution is clearly unacceptable.

In sum, traditional approaches place us in a dilemma. The epenthesis analysis forces us to introduce independent diacritic features to describe forms that are exceptional both in regard to epenthesis and to suffix harmony, and fails to explain why forms that are exceptional with regard to one are also exceptions with regard to the other. The deletion analysis is unable to relate a phonologically-motivated class of exceptions to deletion to independently-needed constraints on syllable structure.
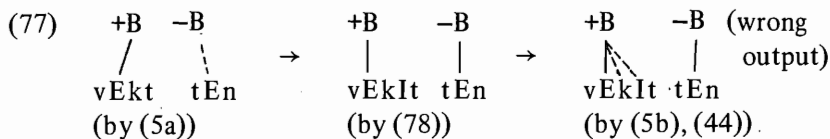
Under an autosegmental analysis, two solutions are potentially available in the face of data such as this. One solution is to postulate root-final floating P-segments in the case of the forms in (70); the other is to treat the second consonant of each root of (70) as opaque. Both solutions assume the epenthesis rule. Thus, the alternative analyses can be represented as follows:

(75) a. +B −B   b +B −B
           | | /
          vEkt   vEkt

If all else were equal, the evaluation metric would select (75a) over (75b) as the simpler of the two representations. As it happens, however, all else is not equal. A consideration of the ablative forms shows us that only the second solution, positing an opaque consonant in C_2 position, accounts for the surface form:

(76)   +B −B   +B −B   +B −B
        | ∕ ＼   → | ∕＼   → | ∕＼
       vEkt   tEn   vEkIt tEn   vEkIttEn
       (by (5b))   (by (78))   (by (5b))

The first solution, positing a floating P-segment, fails:

(77)   +B   −B   +B   −B   +B   −B (wrong
         ∕   ＼   → | | →   ｜＼ | output)
        vEkt   tEn   vEkIt tEn   vEkIt ·tEn
       (by (5a))   (by (78))   (by (5b), (44))

The Epenthesis rule involved in the above derivations is the following:

(78)   Vowel Epenthesis

$$\emptyset \;\to\; I \;/\; C \underline{\quad} C' \qquad (C' = \text{an extrasyllabic consonant})$$

(78) inserts an epenthetic high vowel, unassociated with any features on the autosegmental tiers involved in harmony, between two consonants if the second can form neither a syllable onset nor a syllable coda by the syllable structure rules of Turkish.[21] The inserted vowel then undergoes the normal operation of the Association Conventions (5).[22]

Given this analysis, then, we see that a further class of monosyllabic noun roots of the structure CVCC must be recognized, where the second C is opaque. But it will be recalled that this is not in fact a new structural type of Turkish root, since such roots have already been motivated: see (63), and in particular (66), where we find a unique set of occurrences of palatal /r�/. Thus, roots of the type (75b) come cost-free in our analysis, and indeed fill in an otherwise unexplained gap in the distribution of opaque segments.

We have so far examined cases of disharmonic epenthetic ˙vowels inserted into root-final clusters. There is another source of epenthetic vowels in Turkish consisting of root-initial clusters, as the representative forms in (79) illustrate. It will be noted that each word (consisting of un-inflected roots) shows two or more variants. The first variant, containing the cluster, generally reflects a careful or learned pronunciation. The second and subsequent forms represent normal or colloquial pronunciations. In the latter forms, which are the more usual, we observe a short epenthetic vowel between the two members of the cluster. Under contrastive emphasis, these short vowels may receive the full value of normal (short) vowels.[23]

(79)		*careful form*	*colloquial form(s)*
a.	'fetters'	pranga	pɨranga
	'prince'	prens	pirens
	'test'	prova	purova
	'Prussia'	prusya	purusya
	'protest'	protesto	purotesto
	'premium'	prim	pirim
	'canvas'	branda	bɨranda
	'bridge' (card game)	bričʼ	birič
	'brooch'	broš	bɨroš
	'blue jeans'	blujin	bulujin, bülüjin
	'bromide'	brom	bɨrom, burom
	'brake'	fren	firen
	'France'	fransa	fɨransa
	'frenchified'	frenk	firenk
b.	'banister'	trabzan	tɨrabzan
	'trichinosis'	trišin	tirišin
	'Tripoli'	trablus	tɨrablus
	'transit'	transit	tɨransit
	'direct'	drek	direk
	'Dracula'	drakula	dɨrakula
	'announcer'	spiker	sipiker
	'probation'	staž	sɨtaž, ?sitaž
	'dinner jacket'	smokin	sɨmokin, simokin
	'sports'	spor	sɨpor, sipor
c.	'king'	kral	kɨral
	'credit'	kredi	kɨredi
	'necktie'	kravat	kɨravat
	'crèche'	kreš	kɨreš
	'sketch'	kroki	kɨroki
	'jack'	kriko	kɨriko
	'cruiser'	kruvazör	kuruvazör
	'group'	grup	gurup
	'grippe'	grip	gɨrip
	'strike'	grev	gɨrev

We have divided our examples into three groups. (79a) illustrates the behavior of labial-initial clusters, (79b) that of dental-initial clusters, and (79c) that of velar-initial clusters.

We note first that with a few sporadic exceptions, the epenthetic vowel consistently harmonizes in backness with the following root vowel after labials and dentals, but is invariably back after velars, whatever the category of the following root vowel. There is, however, a second pecu-

liarity of velar-initial clusters: namely, that when these clusters are not broken up by an epenthetic vowel, the velar is invariably back in quality, regardless of the harmonic category of the following root vowel. These two facts can be related if we assume that word-initial velar consonants are assigned the feature [+back] before a following consonant. If epenthesis applies, the inserted vowel will then automatically receive the feature [+back] from the preceding consonant:

(80)   +B −B   +B −B
         | /   → |\ | (by (5b))
        grEv   gIrEv

A further set of exceptions to backness harmony consists of *s*-initial clusters, which allow front-vowel epenthesis in the four forms we have found. We assume that an analogous solution positing opaque occurrences of /s/ is possible here, although auditory judgements are more subtle in this case than with the velars. Note that the linking of the acoustically "grave" velars with the feature [+back], and of the acoustically "acute" /s/ with the feature [−back], is a phonetically motivated pairing: it seems quite appropriate to attribute the exceptional quality of the epenthetic vowel in these cases to intrinsic features of the initial consonant.[24]

Apart from these cases, epenthetic vowels are regular with respect to backness harmony. Turning to roundness harmony, there is a single regular pattern of exceptions: the epenthetic vowel may be unrounded before /o/ (though not, in our data, before /ö/). Examples are *brošˇ, brom, smokin, spor,* and *kroki*; compare the expected behavior of *prova, protesto*. In the case of at least the *s*-initial forms, we can observe that the initial consonant is unrounded even in the nonepenthetic variant. Thus compare [sp^{w}or] (not [s^{w}p^{w}or]) with regular words like [s^{w}om^{w}un] 'loaf', where /s/ assimilates in rounding to the following vowel. Apparently, therefore, some consonants occur with an opaque specification for the feature [−round] in word-initial clusters if the root vowel is /o/.

Otherwise, all forms are regular with respect to roundness harmony. In particular, we have found no cases of an epenthetic rounded vowel before an unrounded root vowel. The phonetic value of the epenthetic vowel in regular forms is accounted for by the mirror image case of Association Convention (5b):

(81)   −B   −B
             | →   /|
        p r E n s   p I r E n s
             | \|
            −R   −R

What is particularly instructive about examples like (81) is the fact that it shows that autosegmentally-represented features may spread leftward, if the opportunity arises. Thus epenthesis in initial clusters confirms the prediction of autosegmental phonology that vowel harmony is a bidirectional process. The apparent unidirectional nature of Turkish vowel harmony is a consequence of the fact that Turkish lacks prefixes, and does not reflect any fundamental restriction on the directionality of this process.

3.6. *Further problems*

The discussion of the preceding sections has not exhausted the cases of disharmony in Turkish. As noted by Lees (1967), in certain varieties of the Istanbul dialect a short vowel is unrounded immediately before a palatal or palatoalveolar consonant within word boundaries if either (i) morpheme-final, or (ii) not in the first syllable of the word, and it is moreover raised if the conditioning consonant is followed immediately by a vowel. This process, as Lees elsewhere noted (1961), is confined to deverbal suffixes. Compare the deverbal suffixes of (82) with the denominal suffixes of (83):

(82) ara-mak   'to search'
      arɨ-yan   'one who searches'
      arɨ-yajak   'will search'
      arɨ-yor   'is searching'

(83) ara   'interval'
      ara-ya   'to the interval'
      ara-yɨ   'the interval'

If the unrounded vowel follows a rounded vowel, surface exceptions to roundness harmony are created: thus [üšümiyiš] 'not feeling chilly' from /üšü-me-yiš/, and [okɨyɨp] from /oku-yIp/ 'having read'.

What is particularly problematical about the latter forms is that the unrounding of the vowel preceding the palatal or palatoalveolar consonant induces the unrounding of all subsequent vowels. As Anderson ((1974): 216) points out, this fact offers an apparently insoluble challenge to standard theories of rule interaction. If unrounding precedes roundness harmony, the latter rule should cancel the effects of the former rule: oku-yIp → okɨ-yIp → oku-yup. If roundness harmony precedes unrounding, the final vowel should remain rounded: oku-yIp → oku-yup → okɨyup. There is no solution to this problem within the context of the standard theory that does not introduce unwarranted or ad hoc assumptions about the nature of rule ordering or rule interaction.

Within autosegmental phonology, on the other hand, a straightforward solution is available. It will be noted that the vowel preceding the palatal consonant has the properties of an opaque segment: it does not undergo rounding harmony, it blocks the spread of rounding harmony, and it spreads its own value onto the following vowel(s). Since the ultimate source of the opacity is the palatal consonant, it is reasonable to suppose that it is this element that is opaque in underlying representations. We thus have:

(84)   +R −R   +R −R
                          →   (leftward spreading)
        E k I y I p   E k I y I p

A local readjustment rule spreads the [−round] value of the opaque consonant onto the preceding vowel, as shown above.[25]

While this analysis seems attractive, there remain certain questions concerning the extensiveness and exact nature of the phonological processes involved. In the dialect spoken by one of the authors (Sezer), the two processes of unrounding and raising are optional and independent of each other. Either, both, or neither may apply, with application in both cases favored in casual speech styles. Furthermore, the raising rule itself appears to have a stylistically marked variant which not only raises, but also rounds the vowel in question if the preceding vowel is round. It seems likely then, that the vowel alternations associated with palatal and palato-alveolar consonants are not yet fully understood.

4. CONCLUSIONS

In this study we have offered evidence that apparent exceptions to vowel and consonant harmony in Turkish should be treated in terms of opaque segments, a category provided by autosegmental representation, rather than in terms of the diacritic (rule exception) features provided by the standard theory. We have shown that in each case where alternative solutions present themselves, the autosegmental solution can be motivated over the diacritic solution on purely empirical grounds.

It has been shown, moreover, that opaque segments are consistently characterized in Turkish by the following three properties: they are non-undergoers, blockers, and spreaders with respect to vowel and consonant harmony processes. These properties follow from the formal structure of the theory itself, and in particular from the formulation of the Association Conventions stated in (5). We offer these results as a contribution to the

current discussion concerning the nature and formal characterization of vowel harmony systems (see, for example, Halle and Vergnaud (1981), as well as several contributions to the present volume).

The theory of autosegmental phonology, first formulated in response to a number of problems as diverse as the treatment of tone, accent, and nasalization in a variety of languages unrelated to Turkish, has proven capable of explaining a relatively complex and intricate set of forms in Turkish with no essential modification. This result supports the interest of pursuing a research strategy which seeks a simple and unified account of the deep-seated structural regularities underlying apparently distinct phonological processes, which – taken from the phonetic point of view alone – would appear superficially to have no properties in common across diverse languages.

NOTES

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1. Certain of these claims have been challenged by Anderson (1980). In particular, Anderson questions the validity of the claim that vowel harmony systems are phonetically motivated, citing Nez Perce and certain dialects of Mongolian as examples of phonetically arbitrary systems. As Anderson points out, the "asymmetrical" system of Nez Perce is not a strict counterexample to the claims of Clements (1977a) which were there formulated to hold of the "symmetrical" type of system. Nevertheless, even "asymmetrical" systems are elsewhere known to be phonetically motivated, and Nez Perce would continue to constitute a puzzling phonological anomaly were it not for the convincing recent demonstration that Nez Perce harmony is based on the feature ATR (Hall and Hall (1980)). The Mongolian dialects cited by Anderson have yet to receive satisfactory descriptions within modern phonological frameworks, and phonetic information regarding them is still sparse. Assuming, however, that Anderson's sources are correct in essential respects, it would be incorrect to consider these systems as phonetically arbitrary; they are quite clearly based on the feature category "back" as demonstrated by regular suffix alternations. The problem raised for phonological analysis by these systems derives from the fact that certain nonalternating vowels belong phonologically to the category of back vowels but (due to regular processes of historical change) phonetically to the category of front vowels. Eventual analyses of these systems will have to select between the options of treating these vowels "abstractly" by deriving them from underlying back vowels, or "concretely" by deriving them from underlying front vowels. Either type of analysis will, in spite of this additional complexity, treat these systems as based on the feature "back", and thus as phonetically motivated.

Anderson's second objection concerns the claim that vowel harmony is bidirectional. The claim here, of course, is not that vowel harmony is always both progressive and regressive in all languages, but rather that it is progressive in suffixing systems, regressive in prefixing systems, and bidirectional in systems that employ both prefixing and suffixing. Anderson has offered no counterevidence to this claim. Rather, he cites examples from Turkish and other languages showing that (to adopt our ter-

feature characterization of (36), since /y/ is the only nonanterior high sonorant. Unlike the velars and the lateral, backness is always predictable in /y/.
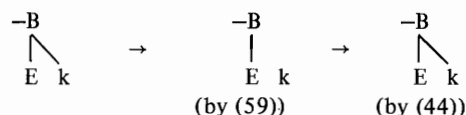
14. The only genuine exception to this that we know of is *lig* 'sports conference'. In most cases the orthography has *g* where the pronunciation has [k]:

ürolog	'urologist'
katalog	'catalogue'
vantrilog	'ventriloquist'

15. The treatment of consonant harmony proposed here is based on a suggestion by Toni Borovsky (personal communication). Note that rule (44), as formulated, will apply to laterals as well as to velars; this treatment is motivated in section 3.3.2.

It would be phonetically plausible to suppose that not only laterals and velars, but all consonants undergo Consonant Harmony (44). Presumably, the phonetic effects of this rule are less salient in the case of labials and dentals than in the case of laterals and velars. Rule (44) can be extended to the remaining consonants simply by eliminating the features [+high, −strident].

16. This rule, as formulated, will disassociate the feature [−back] in front vowel syllables as well as back vowel syllables. This instance of overapplication is harmless, since Consonant Harmony (44) will subsequently apply, restoring the original configuration which is subject to no further rules:

$$
\begin{array}{ccccc}
\overset{-B}{\diagdown} & & \overset{-B}{\mid} & & \overset{-B}{\diagdown} \\
\text{E} \quad \text{k} & \rightarrow & \text{E} \quad \text{k} & \rightarrow & \text{E} \quad \text{k} \\
& & \text{(by (59))} & & \text{(by (44))}
\end{array}
$$

17. This form is highly suspect, since dictionaries old and new cite *Utarid* as a perfectly regular root Devellioğlu and Kiliçkan (1975), Redhouse (1890), Hony (1972)). This word, which is now obsolete, was borrowed from Arabic and originally ended in a non-emphatic consonant.

18. As a check on the validity of the descriptive generalizations summarized in this section, based upon standard dictionaries and grammars, the authors conducted a survey of university-aged Turkish speakers resident in Cambridge, Massachusetts. Five subjects were presented with a randomized list of unsuffixed Turkish nouns. They were asked first to eliminate from the list any words unfamiliar to them, and then to read the remaining items on the list, first in the uninflected form and then in the accusative plural form (X-1ER-I). Nouns of three types were included:

A: palatal-*l* stems (*usul*)
B: other consonant-final stems reported as taking exceptional front-vowel harmony (*ištirak*)
C: consonant-final stems reported as taking exceptional back-vowel harmony (*ševk*)

In addition, regular nouns were included as distractors. Each subject was tested separately.

The results of this survey were as follows. All subjects invariably assigned front vowel suffixes to all ten test words of class A (*usul, petrol, rol, mahsul, alkol, sual, hal, hilal, general, istiklal*). Of the ten test words of class B (*kalp, garp, harp, harf, infilak, idrak, ištirak, saat, kabahat, hat*), only the latter received front vowels suffixes

minology) opaque segments control harmony domains to their right. Such a bias toward spreading from the left is characteristic not only of vowel harmony systems but also of tone systems, and is expressed in the theory assumed here in the formulation of the Association Conventions (5).

2.   Some vowel harmony systems appear to show spreading of the harmony feature beyond the domain of the word. However, it seems that such spreading should be treated in terms of independent mechanisms. In Akan, such spreading involves a phonetic "cline:: effect rather than the assignment of a simple plus- or minus-value of the harmony feature (Clements (1981)). In Somali, whose vowel harmony system is of the "asymmetrical" type, spreading beyond the domain of the word is a variable phenomenon, depending on phrasing and rate of speech, while word-internal vowel harmony is obligatory (Farnetani (1981), 55-8).

3.   The phonetic basis of certain Nilotic vowel harmony systems remain to be identified. See e.g. Jacobson (1980).

4.   The treatment of neutral vowels assumed here is different from that of Clements (1977b), in which neutral vowels were treated as P-bearing units.

5.   Except, of course, in the case of non-alternating vowels, which we will discuss in 3.2., below.

6.   We shall find reason to revise this treatment in the next section. For the moment, the forms in (8) will serve to illustrate the usual operation of the Association Conventions.

7.   Except in the case of opaque consonants. See 3.4., below.

8.   The last four examples could be removed from this list if Labial Attraction were formulated to apply to the first two syllables of a root only. This formulation, however, would predict that we should find /...aCɨ.../ to the exclusion of /...aCu.../ in the second and third syllables of trisyllabic roots. This claim is inconsistent with examples such as the following:

kɨlavuz	'guide'
palamut	'type of fish'
salamura	'brine for pickling'
salapurya	'large boat; small lighter'
arnavut	'Albanian'
firavun	'pharaoh'
telaffuz	'pronunciation'

9.   Examples like *hani* 'where', *hangi* 'which', *kardeš* 'sibling', and *elma* 'apple' are native Turkish words often cited in traditional grammars.

10.   See Sezer (1981) for discussion of this rule.

11.   This rule, stated as an admissability condition (Akers (1981)), takes precedence over (25) under the Elsewhere Condition (Clements (in press)).

12.   For an example in Shona, see Odden (in press)). A further example, cited from Guaraní by Poser (1981b), seems susceptible to reanalysis (Van der Hulst and Smith (this volume)). It should be noted that (6), as a condition on the operation of the Association Conventions, is not inconsistent with the existence of rules of regressive (right-to-left) assimilation, which do not directly involve the operation of the Association Conventions but rather of rules operating on autosegmentally-specified features.

13.   This feature is not needed to distinguish /y/ from other consonants, given the

23. See Yavash (1980a,c) for further examples. The variety of Turkish reported on in this study appears to be similar to that of Yavash in respect to the quality of the epenthetic vowels.

24. Less understandable from this point of view is the possible, though generally dispreferred occurrence of disharmonic front vowels in /fl/ clusters:

| 'banner' | flama | fɨlama, ?fil ama |
| 'flush' (poker) | floš̌ | fɨloš̌, ?fil̰ oš̌ |

In contrast, only back epenthetic vowels are found in /fr/ clusters: *fransa* 'France', *frak* 'frock', *frank* 'French currency', *franǰala* 'type of bread'. Apparently, /l̥/ may optionally replace /l/ in /fl/ clusters. A further, isolated occurrence of palatal /l̥/ is in *bluz* 'blouse'; palatal /r̥/ occurs exceptionally in *traž* 'circulation'.

25. We could alternatively suppose that it is the preceding vowel, rather than the consonant, that is opaque. Under this analysis, a context-sensitive rule would assign opacity to any vowel preceding a palatal or palatoalveolar consonant. The treatment given in the text, however, seems preferable, for two reasons. First, it seems that opaque segments can elsewhere be characterized entirely in terms of context-free rules; the recognition of context-sensitive rules of opacity assignment would allow a degree of latitude into the theory that seems at present unwarranted. Second, rules similar to the raising and unrounding rule given here are not infrequent in Altaic languages (see Johnson (1980) for further examples). In all such cases of "preemptive" harmony, the feature value associated with the class of opaque consonants represents the unmarked value of the feature category for that class of consonants. In the present case, for example, the unmarked value of the feature category *round* for palatal consonants is [−round]. This relationship can be most naturally explained if we regard the consonant, rather than the vowel as the opaque element.

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uniformly; the others showed variation among subjects with *infilak* and *idrak* show-ing the greatest tendency toward back vowel behavior (four out of five subjects). Six words of class C were included (*ševk, sevk, fevk, tasdik, halik, Utarit*), and all were assigned front vowel suffixes by all speakers, except for four cases which had to be eliminated due to their unfamiliarity (*halik* twice, *fevk* and *Utarit* once).

These results may be taken to reflect the different degrees of integration of opaque consonants in contemporary Turkish. The palatal *l*'s of the class A words are the most fully integrated into the Turkish system, occurring initially, medially, and finally. In the latter environment they offer phonemic contrasts with non-opaque (harmonic) *l*'s (see (49)). The opaque consonants of the class B words are less well integrated, since none occur freely as surface disharmonic consonants in all positions in the word. Indeed, *t* never occurs disharmonically anywhere in the word except for marginal occurrences in final position in the dialect reported by Waterson (1970). Finally, not only do the opaque consonants of class C words never occur as surface disharmonic consonants anywhere in the word, but more signifi-cantly, most varieties of modern standard Turkish have *no* surface back-velar conso-nants in front-vowel words at all; hence one would expect this class to be the most unstable, and the first to undergo regularization, in conformity with our results.

19. Such an analysis is proposed in Foster (1969). See, in contrast, Pyle (1974) and Yavash (1980c), whose arguments for an epenthesis analysis are incorporated into the following discussion.

20. In the learned dialect, we also find *alarm* 'alarm', *titr* 'academic title', etc.

21. There are a few forms in which the epenthetic vowel breaks up clusters which are otherwise permissible in Turkish. These include the following:

ufuk	/ufk/	'horizon'
akis	/aks/	'echo'
kayɨt	/kayt/	'record'
lahit	/laht/	'sarcophagus'
ahit	/aht/	'testament'

Compare the well-formed *čift* 'double', *raks* 'dance', *taht* 'throne'. Some of the words in this class have regularized in some dialects: thus *beyit* 'line of a poem' may appear in the 3. possessive as either *beyti* or *beyiti*. We assume that the excep-tionally epenthetic words are distinguished from normal words in the lexicon in that their final consonants are (unpredictably) extrasyllabic, that is, unaffiliated to the syl-lable:

$$\overset{\sigma}{\underset{\text{laht}}{\wedge}} \quad \text{vs.} \quad \overset{\sigma}{\underset{\text{taht}}{\wedge}}$$
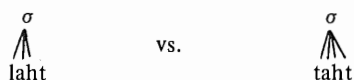
The extrasyllabic consonant of the first form triggers Vowel Epenthesis (78).

22. Notice that in forms to which Vowel Epenthesis (78) cannot apply, such as the 3. possessive, rule (59) is applicable:

$$\begin{array}{ccc} \text{+B} \quad \text{−B} & \text{+B} \quad \text{−B} & \text{+B} \quad \text{−B} \\ \underset{\text{vEkt} \quad \text{I}}{/\;\nearrow\backslash} \rightarrow & \underset{\text{vEkt} \quad \text{I}}{/\quad\mid} \rightarrow & \underset{\text{vEkt} \quad \text{I}}{\wedge \quad\mid} \\ \text{(by (5b))} & \text{(by (59))} & \text{(by (44))} \end{array}$$