

Emergent knowledge of a universal phonological principle in the L2 acquisition of vowel harmony in Turkish: A ‘four’-fold poverty of the stimulus in L2 acquisition

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Abstract

A significant body of theoretically motivated research has addressed the role of Universal Grammar (UG) in the nonnative acquisition of morphosyntax and properties of the syntax–semantics interface, but very little research has addressed the role of phonological principles of UG in nonnative language acquisition. Turkish has a regular and pervasive system of vowel harmony for which classroom second language (L2) learners receive explicit instruction and abundant input; however, there are also cases of non-canonical vowel harmony in Turkish, for which classroom learners receive no instruction and rather little input. In this study, we show that English–Turkish L2ers come to exhibit sensitivity to the ‘No Crossing Constraint’ of UG (Goldsmith, 1976; Hammond, 1988) when calculating non-canonical vowel harmony in the context of underlyingly pre-specified non-velarized laterals (i.e. ‘light’ [l]), despite the poverty of the stimulus and potentially misleading effects of classroom instruction and standard Turkish orthography. We argue that this supports the view that nonnative phonological development is guided by (at least one principle of) UG.

Keywords

autosegmental phonology, learnability, phonology, second language acquisition, Turkish, UG, vowel harmony

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I Introduction

There is a significant published literature documenting a range of effects of principles of Universal Grammar (UG) in the domains of morphosyntax and semantics on (adult) non-native language (L2) acquisition (for a representative list, see note 2), and there continues to be lively scholarly debate over the question of whether adult L2 acquisition is guided by UG in its entirety or only selectively. The relevant positions range from Schwartz and Sprouse's (1996) Full Transfer/Full Access Model (L2 development is fully constrained by UG) to Tsimpli and Dimitrakopoulou's (2007) Interpretability Hypothesis (UG principles fully apply in L2 acquisition, but L2ers have no access to those uninterpretable features that are not instantiated in their first language (L1)) to Meisel's (1997) position that interlanguage systems are restricted to linear sequencing strategies and lack hierarchical structure or distinctions such as finite/non-finite. Given the pervasive phenomenon of misperception and foreign accent in nonnative listening and speech, it would not be unreasonable to wonder whether this phenomenon could be traced (at least, in part) to deficits in nonnative phonological representations, arising from the failure of some or all of the phonological principles of UG to operate in (adult) L2 acquisition. However, there has been rather little research on the role (or the absence of one) that UG principles might play in the L2 acquisition of phonology globally, and almost no scholarly debate concerning the role of specific UG-based phonological principles in L2 acquisition.¹

This article seeks to contribute to the initiation of such a scholarly debate by reporting on an empirical study showing that despite a strong poverty of the stimulus, English-speaking learners of Turkish exhibit an emerging sensitivity to the 'No Crossing Constraint' (Goldsmith, 1976; Hammond, 1988) in their calculation of (non-canonical) Turkish vowel harmony. This effect is mysterious if phonological acquisition is purely based on frequency effects and/or instruction, but receives a natural explanation if adult L2 phonological acquisition is guided by the principles of UG.

II Theoretical motivation

There is a rich literature showing that principles of UG constrain (adult) L2 morphosyntactic and syntactico-semantic development.² While these studies (and others like them) examine a range of native languages (L1s) and target languages (TLs) and employ various tasks, they all rely on a three-fold poverty of the stimulus to make the argument that UG restricts, guides, or informs (adult) L2 acquisition: (1) the crucial TL generalization is underdetermined by primary linguistic data; (2) the generalization is not instantiated in the learner's L1³; and (3) the generalization is not the object of explicit instruction (For detailed discussion of the poverty of the stimulus in L2 acquisition studies and how this relates to the issue of UG involvement in L2 acquisition, see Schwartz and Sprouse, 2000; Slabakova, 2008; White, 2003.)

By way of illustration, let us review Kanno's (1997) study of effects of the Overt Pronoun Constraint in English-Japanese interlanguage. Following Montalbetti (1984), Kanno assumes that (some version of) the Overt Pronoun Constraint is a principle of UG. Montalbetti (1984: 94) states the Overt Pronoun Constraint as in (1a), while Kanno (1997: 267) offers the alternative statement in (1b):

- (1) a. Overt pronouns cannot link to formal variables iff the alternation overt/empty obtains.
 b. In languages that permit null arguments, an overt pronominal must not have a quantified NP as antecedent.

We note that while these two formulations are not intensionally isomorphic, either one suffices to account for the specific phenomenon of Japanese Kanno investigates.

Kanno points to the following interpretive contrast between (2a) and (2b) and between (2b) and (2c) in Japanese.

- (2) a. Dare_i ga [Ø_i sore o mita to] itta no.
 who_{NOM} that_{ACC} saw that said Q
 ‘Who_i said that he_i saw that?’
 (Kanno, 1997: 266, ex. 3a)
- b. * Dare_i ga [kare_i ga sore o mita to] itta no.
 who_{NOM} he_{NOM} that_{ACC} saw that said Q
 ‘Who_i said that he_i saw that?’
 (Kanno, 1997: 266, ex. 3b)
- c. Tanaka-san_i wa [kare_i ga sore o mita to] itta no.
 Tanaka-Mr._{TOP} he_{NOM} that_{ACC} saw that said Q
 ‘Mr. Tanaka_i said that he_i saw that.’
 (Kanno, 1997: 267, ex. 5)

The alternation between \emptyset and *kare* in (2a) and (2b) shows that Japanese is a language that permits null arguments. As predicted by the Overt Pronoun Constraint, the embedded null subject in (2a) can be interpreted as a bound variable, but the corresponding overt pronominal subject in (2b) cannot receive this kind of interpretation. However, as illustrated in (2c), an embedded overt pronominal subject can take a non-quantificational matrix clause subjects as its antecedent. The Overt Pronoun Constraint has no direct force for a non-null-argument language such as English, as illustrated in (3).

- (3) Who_i wishes he_i could be a millionaire?
 (Kanno, 1997: 267, ex. 4b)

Overt pronouns in English can be interpreted as bound variables.

Consider now the learnability challenge that the Overt Pronoun Constraint poses for an English-speaking learner of Japanese, particularly the possible sources of evidence for the generalization. First, the crucial generalization is underdetermined by primary linguistic data. Japanese input may well include instances where a null pronoun is to be interpreted deictically, instances where a null pronoun is as a bound variable, and instances where an overt pronoun is to be interpreted deictically. Natural analogical extension would lead to the conclusion that an overt pronoun could also be interpreted as a bound variable. However, the crucial datum showing that this interpretation is illicit is not available to the learner in Japanese input, because such negative evidence is, virtually by definition, missing from the primary linguistic data. This places the English–Japanese

learner in the same position as a native acquirer of Japanese, i.e. in need of a UG principle for this information. We might ask whether L2ers might be able to avail themselves of other sources, namely their L1 grammar or explicit instruction. In this case, neither of those sources will be helpful. Since English is not a null-argument language, the Overt Pronoun Constraint is irrelevant to the grammar of English. Furthermore, as verified by Kanno, the classroom learners of Japanese she studied had received no explicit instruction relevant to the non-availability of bound variable interpretations for overt pronouns. Kanno showed experimentally that (adult) English–Japanese L2ers exhibit sensitivity to the Overt Pronoun Constraint in their interpretation of Japanese sentences. In the absence of (1) relevant evidence for the constraint in the primary linguistic data, (2) non-trivial instantiation of the constraint in the L1, and (3) explicit instruction about the constraint, we are left with the conclusion that the Overt Pronoun Constraint guides (adult) L2 acquisition.

The argumentation in studies such as Kanno's does not require that learners' performance on specific experimental tasks be statistically indistinguishable from the performance of native speakers. There are distinct reasons for this for L2ers in earlier stages and later stages of acquisition. UG principles restrict the analogical extension of basic generalizations to certain particular cases, and there is no reason to suppose that one would find meaningful evidence for such restrictions before the basic generalization has been acquired. Consider, for example, learners whose L1 lacks *wh*-Movement but whose TL exhibits it. It is pointless to look for restrictions on *wh*-Movement (e.g. that *wh*-phrases cannot be extracted from relative clauses) until the learner has acquired the basic generalization that *wh*-phrases can be extracted from ordinary argument clauses. Furthermore, we cannot reasonably expect that acquisition of a new basic generalization of this sort will occur instantaneously upon first exposure to TL input. It is also naive to suppose that L2ers will perform 'perfectly' (indistinguishably from native speakers of the TL), even once the relevant generalization has been acquired. For a host of reasons related to the difference in the cognitive demands associated with performing tasks in one's native language versus a nonnative language (at least in part because of the extra cognitive resources required for access to nonnative vocabulary), we generally expect higher accuracy from native speakers. What is crucial is that there is evidence of the restrictive effect of the relevant principle of UG, and this evidence emerges once learners have received a significant exposure to TL input and appear to have acquired the new basic generalization.

In light of the body of research on morphosyntax and semantics discussed above, it is striking that there has been very little research on whether principles of UG constrain (adult) L2 phonological development. Although a large body of recent interlanguage research focuses on issues of category formation, perception, and production, including factors that render specific TL categories relatively easy or difficult for L2ers to acquire, the issue of whether adults bring the same innate knowledge to bear on the acquisition of new phonological systems as children acquiring their L1 has received extremely little attention. Typically, the issue has been investigated only indirectly (see, for example, Young-Scholten, 1995, 1996), and mostly by L2 phonologists before 1996 (see, for example, Broselow, 1987; Broselow and Finer, 1991; Eckman, 1981; Klove, 1992; Trof, 1987). Most of this research was on L2 syllabification (and more specifically on

the Sonority Hierarchy; e.g. Selkirk, 1984), perhaps because syllabification involves suprasegmental phenomena and is, as such, more informative as to the abstract generalizations learners make than segmental phenomena. One recent return to the issue of the role of UG-based principles of phonology in L2 acquisition is Özçelik's (2011, 2016) investigation of L2 acquisition of stress/prosody, another phenomenon that involves suprasegmentals. Özçelik's study looked at the presence or absence of knowledge of the UG ban on weight-insensitive iambic languages (see, amongst others, Hayes, 1985, 1995; McCarthy and Prince, 1986, 1993, 1995; Prince, 1991) in English–Turkish and French–Turkish interlanguage development.

In contrast to the relatively little L2 research on UG phonological principles, phonological parameters of UG have received greater attention, which could also be informative as to the issue of access to UG. In fact, comparing previous research on UG principles in L2 phonology vs. L2 syntax, and pointing out the relatively little work in this area by L2 phonologists, Young-Scholten (1995, 1996) argued that there is, nevertheless, reason to believe that interlanguage phonologies do not violate the principles of UG, because they often correspond to natural languages (a point first made by Eckman, 1981), and because learners can often reset phonological parameters, instead of being stuck with the L1 values. Most of the findings on successful parameter resetting in L2 phonologies also came from syllabification (see, for example, Broselow and Finer, 1991; Young-Scholten, 1992, 1994), and, not surprisingly, some from stress and prosody (Archibald, 1992, 1993a, 1993b, 1998; Goad and White, 2004, 2006, 2009; Pater, 1993, 1997), both suprasegmental phenomena, as mentioned above. The question of this latter body of research was, of course, whether L2 learners can successfully reset phonological parameters, and not whether their interlanguages are constrained by the 'principles' of UG.

Vowel harmony is certainly one suprasegmental phenomenon that could be particularly informative about the abstract generalizations made by L2 learners. Nevertheless, very little research has been devoted to L2 acquisition of vowel harmony, even for purely descriptive purposes, let alone for the purpose of investigating whether L2 phonologies are constrained by UG. Of the few L2 studies that have looked at vowel harmony, some have done so indirectly in investigating another phenomenon, such as Goad and White's (2009) use of vowel harmony data in making conclusions about L2 prosodic representations, while others have done so in the context of artificial languages, such as Finley's (2012a, 2012b) creation of an artificial grammar with rounding vowel harmony and her related attempt to answer whether positive or negative evidence is more effective in the acquisition of such a system (see also Altan, 2011; Pycha et al., 2003). To our knowledge, only Altan (2012) has so far investigated the L2 acquisition of (Turkish) vowel harmony with actual language learners; see also McLaughlin et al. (2010), who discuss some L2 acquisition of Finnish data, with event-related potentials (ERPs) comparing learners' brain responses to vowel harmonic and nonharmonic stimuli, although the article they ascribe their data to (Pitkänen et al. 2010) appears to be unpublished. Altan analysed voice recordings of learners of Turkish whose L1s did not have vowel harmony (e.g. English, French, Italian, and Spanish), and concluded that, irrespective of level of proficiency, these learners rarely made any errors indicating lack of knowledge of vowel harmony. In fact, she found that the few errors that did exist in their productions were errors of overgeneralization, i.e. a suffix that does not normally conform to vowel

harmony in native Turkish would be represented as vowel harmonic by learners of Turkish, a finding that is similar to the findings of research with L1 child learners of Turkish (Altan, 2007, 2009). Of course, it should be noted that these were instructed learners (at all levels of proficiency), and that canonical vowel harmony is taught very early on in the Turkish language classroom, as Altan notes herself. This is because the correct choice among allomorphs of some very common Turkish suffixes requires knowledge of vowel harmony. For example, the choice between *-ler* and *-lar*, the allomorphs of the plural suffix for nouns is conditioned by whether the immediately preceding vowel is [-back] or [+back].

One reason why vowel harmony has received relatively little attention in the L2 acquisition research literature as a whole is certainly because languages with full-fledged vowel harmony systems (such as Finnish, Hungarian, Kazakh, Mongolian, and Uyghur) range from less commonly taught languages to rarely taught languages. Therefore, the issue of whether UG principles guide L2 acquisition of vowel harmony has not thus far been investigated, despite the fact that, as mentioned above, vowel harmony would offer unique perspectives into this type of research, especially an analysis of atypical cases of vowel harmony, which we will refer to in this article as non-canonical vowel harmony.

III LI-TL background

I Turkish vowel inventory

Turkish has the symmetrical eight-vowel system sketched in (4):

(4) Turkish vowel system⁴

	[-back]		[+back]	
	[-round]	[+round]	[-round]	[+round]
[+high]	i	y	ɯ	u
[-high]	e	ø	a	o

As shown in (4), the eight phonemic vowels of Turkish readily lend themselves to cross-classification by three (3) binary features: [±back], [±round], and [±high], making it a perfectly symmetric vowel inventory, with an equal number of [±back], [±round], and [±high] vowels. Abstracting away from details that do not directly concern us here, vowels in uninflected words ('roots') in Turkish can exhibit any of the 8 logically possible combinations of the features [±high], [±back], [±round]. Although vowels in non-initial syllables of polysyllabic uninflected Turkic words typically conform to the rules of vowel harmony outlined below, a significant portion of the contemporary Turkish lexicon is not subject to the same restriction, particularly words borrowed from languages such as Arabic, English, French, and Persian. Thus, an uninflected borrowed noun such as *rezervasyon* 'reservation' mixes front vowels in the first two syllables with back vowels in the final two syllables.

2 Canonical vowel harmony in Turkish

In contrast to vowels in uninflected words, most vowels in Turkish suffixes are not fully specified; rather, they are specified only for [\pm high]. The underspecified features ([\pm back] and [\pm round]) are filled in through a process of vowel harmony. Canonical vowel harmony in Turkish can be captured by the three statements in (5).

- (5) For underspecified vowels,
- the value of [\pm back] spreads from the immediately preceding vowel.
 - the value of [\pm round] spreads from the immediately preceding vowel, if the suffix vowel is [+high].
 - Spreading of the value of [\pm round] is blocked if the suffix vowel is [-high], i.e. [-high] suffix vowels are always also [-round].⁵

In non-initial syllables (hence, in all suffixes), the generalization in (5a) holds.

The generalization in (5b) applies to vowels underlyingly specified as [+high], as with the 3rd person singular possessive suffix, illustrated in (6) below, for all possible combinations of root vowel + a suffix vowel specified as [+high].

- (6) Suffix vowel underlyingly specified as [+high]: 3rd person singular possessive suffix /-I/⁶

			root vowel	suffix vowel
a.	iş-i	[iʃi]	‘(his) work’	{[+high] [-back] [-round]} { [+high] [-back] [-round]}
b.	kız-ı	[kuzɯ]	‘(his) girl’	{[+high] [+back] [-round]} { [+high] [+back] [-round]}
c.	ün-ü	[yny]	‘(his) fame’	{[+high] [-back] [+round]} { [+high] [-back] [+round]}
d.	kuş-u	[kuʃu]	‘(his) bird’	{[+high] [+back] [+round]} { [+high] [+back] [+round]}
e.	ders-i	[dersi]	‘(his) lesson’	{[-high] [-back] [-round]} { [+high] [-back] [-round]}
f.	at-ı	[atu]	‘(his) horse’	{[-high] [+back] [-round]} { [+high] [+back] [-round]}
g.	göz-ü	[gøzy]	‘(his) eye’	{[-high] [-back] [+round]} { [+high] [-back] [+round]}
h.	dost-u	[dostu]	‘(his) friend’	{[-high] [+back] [+round]} { [+high] [+back] [+round]}

Because the values of both [\pm back] and [\pm round] in the vowel of the suffix are copied from the immediately preceding vowel, this suffix displays four (4) allomorphs: /-i/, /-u/, /-y/, and /-u/, that is /-i/ after /i/ and /e/ (6a and 6e), /-u/ after /u/ and /a/ (6b and 6f), /-y/ after /y/ and /ø/ (6c and 6g), and finally /-u/ after /u/ and /o/ (6d and 6h).

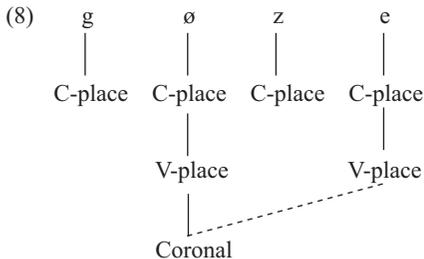
The generalizations in (5a) and (5c) are illustrated in the vowel underlyingly specified as [-high] in the dative suffix, shown in (7). As explained in (5), because the vowel of the suffix is underlyingly [-high], only [\pm back] spreads, and spreading of [\pm round] is blocked:

- (7) Suffix vowel underlyingly specified as [-high] ([-round]): dative suffix /-E/⁷

			root vowel	suffix vowel
a.	iş-e	[iʃe]	‘(to the) work’	{[+high] [-back] [-round]} { [-high] [-back] [-round]}
b.	kız-a	[kuza]	‘(to the) girl’	{[+high] [+back] [-round]} { [-high] [+back] [-round]}

c. ün-e	[yne]	‘(to the) fame’	{[+high] [-back] [+round]}	{[-high] [-back] [-round]}
d. kuş-a	[kuʃa]	‘(to the) bird’	{[+high] [+back] [+round]}	{[-high] [+back] [-round]}
e. ders-e	[derse]	‘(to the) class’	{[-high] [-back] [-round]}	{[-high] [-back] [-round]}
f. at-a	[ata]	‘(to the) horse’	{[-high] [+back] [-round]}	{[-high] [+back] [-round]}
g. göz-e	[gøze]	‘(to the) eye’	{[-high] [-back] [+round]}	{[-high] [-back] [-round]}
h. dost-a	[dosta]	‘(to the) friend’	{[-high] [+back] [+round]}	{[-high] [+back] [-round]}

Here there are only two (2) allomorphs: /-e/ and /-a/, because only the feature [\pm back] is copied from the immediately preceding vowel. That is, /-e/ is used after front vowels /i/, /y/, /e/, and /ø/, and /-a/ is used after their back counterparts /u/, /u/, /a/ and /o/. As stated in (5c), with underlyingly underspecified suffix vowels, if the suffix is pre-specified as [-high], as with the dative suffix illustrated in (7), then it must always surface as [-round], i.e. rounding features do not transfer in this case. Canonical vowel harmony is illustrated in (8) below in a Feature Geometric representation (Coronal represents [-back] for vowels). Notice that only vowels have V-Place, although both consonants and vowels have C-Place. Note also that the feature [Coronal] can be directly under either C-Place or V-Place. When under C-Place, it handles Coronal consonants, whereas [Coronal] under V-Place handles Coronal vowels (corresponding to [-back]) and secondary articulations of consonants. The same is true for the placement of the feature [Dorsal] under C-Place or V-Place, which handles Dorsal consonants and vowels, respectively. The separation of vowel and consonant tiers ensures that spreading of vowel features, even when the two vowels are not string adjacent is ‘local’ (see, for example, Clements and Sezer, 1982; Nevins, 2010); that is, locality is maintained at the V-Place node level:



3 Distribution of laterals in Turkish

Having illustrated canonical vowel harmony in Turkish, and before we demonstrate its less common non-canonical counterpart, a few words are necessary on the distribution of the laterals [l] and [ɭ] in Turkish. As we will illustrate below, these sounds exhibit both a canonical and a non-canonical distribution, and their non-canonical distribution leads to non-canonical vowel harmony.

We start with the canonical distribution of the phoneme /l/ in Turkish. This phoneme has two allophones: non-velarized (‘light’) [l], which generally occurs in the context of

[–back] vowels, and velarized (‘dark’) [ɟ], which occurs in the context of [+back] vowels.⁸ Consider root-final /l/ in inflected words, that is, the configuration sketched in (9).

(9) ... V /l/ + C* V ... (+ denotes a morpheme boundary)

It follows from canonical vowel harmony that both Vs in (9) will be either [–back] or [+back].⁹ If the final V of the word is [–back], /l/ is realized as ‘light’ [l]. If the final V is [+back] V, /l/ is realized as ‘dark’ [ɟ]. This is indeed the pattern found in native Turkic words, as illustrated in (10).

(10) Canonical distribution of /l/

			V realization of /l/	
a.	il-e	[ile] ‘city.DAT’	[–back]	‘light’ [l]
b.	kıl-a	[kuɾa] ‘hair.DAT’	[+back]	‘dark’ [ɟ]
c.	kül-e	[kyle] ‘ash.DAT’	[–back]	‘light’ [l]
d.	kul-a	[kuɾa] ‘servant.DAT’	[+back]	‘dark’ [ɟ]
e.	bel-e	[bele] ‘back.DAT’	[–back]	‘light’ [l]
f.	bal-a	[baɾa] ‘honey.DAT’	[+back]	‘dark’ [ɟ]
g.	göl-e	[gøle] ‘lake.DAT’	[–back]	‘light’ [l]
h.	kol-a	[koɾa] ‘arm.DAT’	[+back]	‘dark’ [ɟ]

That is, ‘light’ [l] appears in the environment of front vowels (i.e. 10a, c, e, g), and ‘dark’ [ɟ] in the environment of back vowels (i.e. 10b, d, f, h). At first glance, this appears to be a straightforward case of allophones of a phoneme in (phonetically natural) complementary distribution, and it is thus hardly surprising that the standard system of Turkish orthography employs a single grapheme to represent both allophones.

However, the modern Turkish lexicon includes a set of exceptions to the canonical distribution of /l/, such that (in certain loanwords) ‘light’ [l] occurs in the environment of a [+back] vowel, contra (10), indicating that the two are not simply allophones of the same phoneme, despite the apparent generalization presented in (10). Some examples are given in (11).

(11) Non-canonical distribution of /l/

			V realization of /l/	
a.	rol	[rol] ‘role’	[+back] V	‘light’ [l]
b.	petrol	[petrol] ‘petroleum’	[+back] V	‘light’ [l]
c.	hal	[hal] ‘situation’	[+back] V	‘light’ [l]

The ‘light’ [l] in these examples follows a [+back] vowel, i.e. [o] and [a], where one would normally expect to see a ‘dark’ [ɟ], given (10) above. Since this represents a

relatively small class of exceptional words, we assume, following Levi (2001), that in just such cases, the lateral is underlyingly specified as non-velarized ('light') [l]. Of course, this also suggests that the two laterals are, in fact, phonemic in Turkish, not just allophones of the same phoneme, perhaps a contrast that has recently emerged through borrowings, although this contrast appears in only a proper sub-part of the lexicon. Example (12) below demonstrates that there are, in fact, minimal pairs involving the two laterals, although very few:

- (12) a. sol [soɫ] 'left'
 b. sol [sol] 'sol' (musical note)

The formal reason behind the appearance of an allophonic variation despite the contrast given in (12) is, we believe, because laterals are normally placeless, as is argued by Canalis (2009), meaning that they will normally adjust to the place features of the neighboring vowels, that is that they will be either velarized or non-velarized based on the environment, as with the data in (10) above. They can, nevertheless, be (underlyingly) specified for place features, which, in the case of Turkish, results in the emergence of the non-velarized /l/ in the context of [+back] vowels, i.e. the data in (11).

4 Non-canonical vowel harmony

The non-canonical distribution of [l] illustrated above in (11) gives rise to non-canonical vowel harmony.¹⁰ Consider the environment root-final /l/ in inflected words in the configuration in (13).

- (13) ... V[+back] 'light' [l] + underspecified V ... (+ a morpheme boundary)

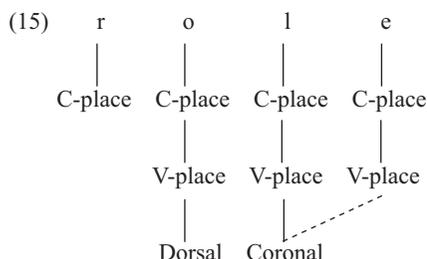
The vowel immediately preceding underspecified V is [+back], but the adjacent (light) [l] is [-back] (i.e. Coronal). In this case, the No Crossing Constraint of Universal Grammar (Goldsmith, 1976; Hammond, 1988) blocks the spreading of [+back] from the root vowel to the (underspecified) suffix vowel, because there is a closer segment specified for that feature that can provide the relevant specification, in this case the 'light' [l].¹¹ This is illustrated below by the examples in (14).

- (14) Examples of the No Crossing Constraint satisfaction

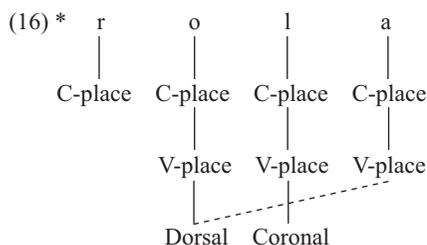
- | | | | | | |
|-------------|-----------|----------------|---------|-------------|----------------|
| a. rol-e | [role] | 'role.DAT' | [+back] | 'light' [l] | [-back] |
| b. petrol-e | [petrole] | 'gasoline.DAT | [+back] | 'light' [l] | [-back] |
| c. hal-e | [hale] | 'situation.DAT | [+back] | 'light' [l] | [-back] |

In the examples in (14), the dative suffix /-E/ is realized with the [-back] vowel /e/, instead of the [+back] vowel /a/, despite the [+back] specification of the root vowel. This, we assume, is because the intervening lateral has a V-Place node here, a proposal

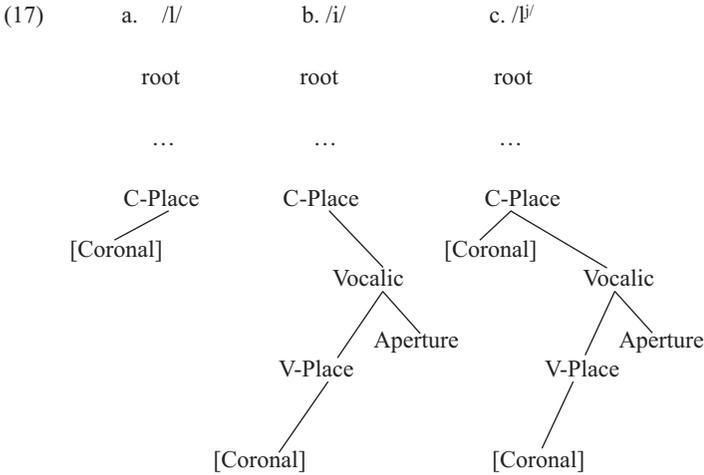
initially made by Levi (2001) for Turkish, although she does not specify the reason (see below). And since the [Coronal] feature associated with the lateral is under a V-Place node, spreading of the [Dorsal] feature from the preceding vowel is blocked; instead, the [Coronal] feature associated with the lateral spreads to the following vowel. This phenomenon is illustrated in a condensed Feature Geometric representation in (15).¹²



Normally, we would expect [\pm back] ([Dorsal] vs. [Coronal] for [+back] and [-back], respectively) to spread from one vowel to another (i.e. from [o] in this example), as it is, in the general case, only vowels that have the node Vowel-place (V-place), where spreading of vowel features occurs, ensuring that vowel harmony satisfies locality, despite intervening consonants (Clements and Sezer, 1982). The No Crossing Constraint explicitly blocks a representation in which the V-place node of the second vowel is associated with the Dorsal node of the first vowel, crossing the direct line from the V-place of the intervening /l/ associated with Coronal, as with (16):



Typically, as mentioned above, [Coronal] under C-Place handles coronal consonants while [Coronal] under V-Place handles coronal vowels. The reason why the lateral here has a [Coronal] feature that is associated with a V-Place (instead of a C-Place) node, we assume, is because this ‘light’ /l/ (also called the ‘palatal /l/’, see, for example, Levi, 2001) is palatalized, i.e. /lʲ/, and, as such, comes with a secondary articulation that has a V-Place node.¹³ This is in line with Clements (1991) and Clements and Hume (1995), according to whom a secondary articulation, including palatalization, is represented with V-Place features. Thus, the palatalized light /lʲ/ differs from both most consonants and most vowels in that it has both C-Place and V-Place nodes, as illustrated below in (17).



5 The learning scenario

An English-speaking classroom learner of Turkish is faced with a four-fold poverty of the stimulus in acquiring non-canonical vowel harmony, thereby leading to an even more serious poverty-of-the-stimulus effect than considered in previous generative research on L2 acquisition (see Section II): (1) Non-canonical vowel harmony is underdetermined by Turkish primary linguistic data. In fact, there are relatively few words of this type in the Turkish language, and most (but not all) of them are vocabulary items that only advanced learners will encounter. So the property is rather difficult to acquire based on input alone, particularly if it is to be applied productively to inflected forms of nonce roots ending in a [+back] vowel followed by a palatal [l]. (2) English does not instantiate vowel harmony, canonical or otherwise, nor does English have an underlyingly specified palatalized /i/ with an appropriate V-Place node on the lateral to block spreading of vowel features. Thus, the relevant properties cannot be acquired based on transfer from the L1. (3) Learners receive explicit instruction on canonical vowel harmony, but not on non-canonical vowel harmony. In fact, neither instructors of Turkish nor Turkish language textbooks talk about the presence of non-canonical vowel harmony or the fact that this is a pattern in itself.¹⁴ So classroom learners of Turkish do not acquire non-canonical vowel harmony on the basis of explicit instruction; in fact, instruction predicts the opposite pattern: explicit instruction on canonical vowel harmony should lead learners to make incorrect assumptions about non-canonical vowel harmony (at least at the level of metalinguistic knowledge). (4) In addition to these three poverty-of-the-stimulus factors analogous to the factors familiar from morphosyntactic and syntax–semantic L2 studies (see Section II), the L2 acquisition of non-canonical Turkish vowel harmony also involves overcoming the potentially misleading effects of Turkish orthography. Turkish orthography, which is generally a reliable representation of Turkish at the phonemic level, does not represent the difference between ‘light’ [l] and ‘dark’ [ɫ]. Given the robust nature of the canonical distribution of /l/, orthographic representations like <rol> for [rol] are misleading. If such learners nevertheless exhibit a developmental path away

from reliance on the rules of Turkish canonical vowel harmony alone and begin to exhibit knowledge of non-canonical vowel harmony as well (despite lack of sufficient input, difference from the L1, misleading instruction and misleading orthography), this would point to the conclusion that the No Crossing Constraint of UG is guiding their phonological development.

Precisely such a developmental path is confirmed by the experimental results reported in Section V.

IV Participants, methods, and materials

1 Participants

Forty-eight participants participated in the experiments, including 34 L1 English-speaking L2 learners of Turkish, as well as a comparison group of 14 native Turkish speakers. The L2ers were attending a major Midwestern university in the USA. Their mean age was 25.29 years (range 19–36 years; mode 22). Turkish native speakers were near-monolingual, living in the USA at the time of testing. The only additional language they were familiar with was English (as an L2). The mean age of native Turkish speakers was 30.07 (range 22–35; mode 32). The L2ers had acquired their knowledge of Turkish through a combination of instruction in Turkish as a foreign language at the university (ranging from 6 months to 4 years of instruction) and naturalistic exposure through study, tourism, or residence in Turkey (one month to 3 years), as well as through Turkish-speaking partners, friends, or relatives. However, none of the learners were heritage speakers of Turkish. In total, 22 out of 34 participants had some type of regular naturalistic input in Turkish, in addition to the classroom input (naturalistic or formal) from native speaking teachers and teaching assistants. On the basis of a multiple-choice cloze test,¹⁵ participants were divided into three proficiency levels: beginner ($n = 13$), intermediate ($n = 10$) and advanced ($n = 11$). These proficiency levels closely matched participants' self-reported proficiency levels and the Turkish-language classes in which they were enrolled at the university.

2 Methods and task

On the experimental task, participants were presented with an uninflected Turkish noun or pseudo-noun, and asked to choose the correct variant of a nominal suffix from among four or two options depending on whether the suffix contained a [+high] vowel (four allomorphs) (half of the items) or a [-high] vowel (two allomorphs) (the other half of the items). In all test items, one of the answers was straightforwardly the correct suffix and all or both the incorrect options were the remaining allomorphs of the correct suffix. The task consisted of 256 semi-randomized items, half of which (i.e. 128) were experimental (i.e. ending in a lateral) and the other half fillers (i.e. ending in a variety of consonants other than a lateral), all presented on a computer screen. Both real Turkish nouns and pseudowords were used as experimental items, with approximately equal numbers (more on this below). All items involved an auditory presentation of the uninflected noun or pseudo-noun. For half of the stimuli (both experimental and fillers),

words were presented auditorily only, and participants had to choose the correct suffix to be attached from among those presented on a computer screen by clicking on the correct option. For the other half, the words were presented both auditorily and visually; for these items, participants were instructed to also read the stimuli, in addition to listening to them, before choosing the correct option. Hence, of both experimental items and fillers (128 each), 64 of them were presented only auditorily and 64 both auditorily and visually.

The following suffixes were used:

- (18) a. Suffixes with an underlying high vowel (128 in total; 64 experimental, 64 filler):
- i. {/im/, /üm/, /ım/, /um/} ‘1ST PERSON SINGULAR POSSESSIVE’
 - ii. {/siz/, /süz/, /sız/, /suz/} ‘without’
- b. Suffixes with an underlying low vowel (128 in total; 64 experimental, 64 filler):
- i. {/ler/, /lar/} ‘PLURAL’
 - ii. {/de/, /da/} ‘LOCATIVE’

3 Stimuli

We tested every logically possible combination of stem vowel + suffix vowel. This is illustrated in Figure 1. For example, the sequences $\ddot{u}-\ddot{u}$ and $\ddot{o}-\ddot{u}$ under \ddot{u} means that the suffix vowel is expected to have \ddot{u} , following a word whose final vowel is \ddot{u} and following a word whose final vowel is \ddot{o} respectively, as in *kül-üm* and *çöl-üm*.¹⁶ There were 16 stimuli in each of the 16 conditions (e.g. $i-i$, $o-u$, $\ddot{o}-\ddot{u}$) presented in Figure 1, of which 8 are experimental (words that ended in /l/) and 8 are fillers. Again, half of these were presented auditorily only and half both auditorily and visually. The syllable structure of the words was either monosyllabic (C)VC or bisyllabic (C)V.CVC. All of the pseudonouns were hand-created by the experimenters and the researchers in order to ensure the relevant distribution and conformity with phonological rules of Turkish.

Half of the experimental items in each condition (i.e. 4 out of 8) had a non-contrasting /l/, which means that the /l/ surfaced as a non-velarized (‘light’) [l] in the environment of front vowels and a dark (velarized) [ɫ] in the environment of back vowels, e.g. [baɫ] ‘honey’ vs. [bɛɫ] ‘back’ as in (8). For the other half, the quality of the lateral was underlyingly specified, as with the forms in (9) above, such as [rol] ‘role’, where a ‘light’ [l] appears in the environment of back vowels. Because of this, back harmony is affected by the presence of this [l] in that the vowel of the following suffix needs to be front, not back, even though the last vowel in this word is a back vowel, i.e. as in [rol-de] and not *[rol-da]. In addition to these forms which have a lateral underlyingly specified as [-back], we also created stimuli that were the mirror image of these cases, words with a lateral underlyingly specified for [+back], i.e. cases leading to a dark [ɫ] on the surface immediately following a front vowel, e.g. [tøɫ] and [reɫ], even though this particular pattern does not occur in Turkish at all.¹⁷ The focus of this article is on the former type of underlyingly specified laterals, i.e. those that actually (can) occur in Turkish; the latter are not analysed here. In sum, whereas half of the experimental items (i.e. 64) had a non-contrasting /l/ (not pre-specified for [±back]), the other half had a contrasting /l/ (i.e. pre-specified for [±back]), half of which (i.e. 32) were pre-specified for (i.e. underlyingly had) a light /l/, and the other half (i.e. 32) were pre-specified for a dark /ɫ/, the form

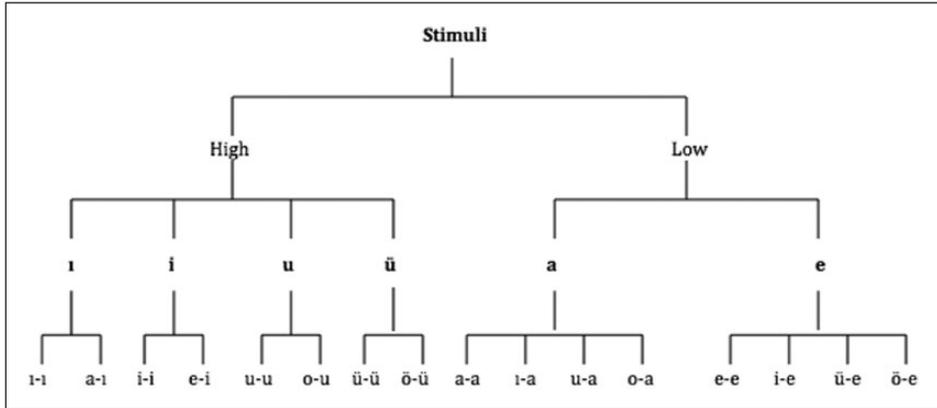


Figure 1. Expected stem+suffix vowel sequences in stimuli.

Note. The tokens represented in this figure are more representative of the distribution of vowel sequences expected under canonical vowel harmony and do not necessarily reflect non-canonical vowel harmony.

What matters here is that every possible sequence of vowels has been symmetrically represented among the stimuli selected for the study.

that does not exist in Turkish. These were equally distributed between the two different modalities of presentation. The main focus of this article, as mentioned above, is cases where there is an underlying light /l/.

There were also 128 fillers, which ended in a variety of Turkish consonants. The fillers, unlike experimental stimuli, did not contain consonants affecting vowel harmony or any other type of exceptionality. Their inclusion helped us to ascertain if participants knew several linguistic structures involved in the experimental stimuli, such as vowel harmony rules most importantly, including both back and rounding harmonies. Perhaps more importantly, they also ensured that the number of words ending in [l] and [ɫ] vs. other consonants was somewhat balanced, helping us avoid a situation where all test stimuli ended in a lateral. Table 1 below provides examples of stimuli used, including pseudowords and real words.

4 Procedure

Participants were tested individually, using the Powerpoint software, on a computer screen, where one word appeared at a time. The order of testing was as follows: (1) a language background questionnaire, (2) vowel harmony experiment, and (3) cloze test. Responses were recorded and subsequently downloaded into Excel for analysis. For all the results reported below, we conducted a two-way ANOVA, followed by a post-hoc test, i.e. a Tukey HSD (honest significant difference) test.

V Results

We used the proportion of participants' correct suffix choices as our dependent variable. Our independent variables were (1) modality of presentation, i.e. whether the stimulus

Table 1. Example stimuli.

	Canonical vowel harmony (excluding /l/)		Canonical vowel harmony with canonical /l/		Non-canonical vowel harmony, i.e. [+back] V + light l	
Real	/taʃ/	/øküz/	/akuʃ/	/el/	/hal/	/rol/
	taş 'stone'	öküz 'ox'	akıl 'mind'	el 'hand'	hal 'situati.'	rol 'role'
Nonce	/tarkuʃ/	/pør/	/kasaʃ/	/føl/	/ral/	/adul/
	tarkıt	pör	kasal	föl	ral	adul

was presented auditorily only or both auditorily and visually, as well as (2) proficiency level, which were compared using factorial ANOVAs. Table 2 summarizes these results, in terms of percentage of correct responses, for (1) canonical vowel harmony, words that end in consonants other than a lateral (rows 1a–1b), (2) canonical vowel harmony that involves laterals that are underlyingly unspecified and thus appear as light-l in the environment of front vowels and dark-ɫ in the environment of back vowels (rows 2a–2b), and (3) stimuli ending in laterals underlyingly specified as Coronal (i.e. [-back]) following a [+back] vowel) (rows 3a–3b).

The results suggest that on test items, i.e. words that end in a palatal [l] after a back vowel as in [rol] (row 3), hearing stimuli only auditorily led to a higher percentage of correct responses than being presented with stimuli both auditorily and visually; that is, 'modality of presentation' mattered. As seen, all learner groups, irrespective of their level of proficiency performed more accurately in the 'auditory only' condition than in the 'auditory+visual' condition. The results of a two-way ANOVA showed that these differences are statistically significant, $F(1, 62) = 24.517, p < .001$. In addition, there was a significant main effect for the 'proficiency' factor, $F(2, 62) = 8.557, p < .001$. However, the interaction between 'modality of presentation' and 'proficiency' was not significant, $F(2, 62) = 1.203, p = .307$. Finally, the results of a Tukey HSD test demonstrate that the significant effect of 'proficiency' was due to the significant difference between the 'Beginner' and 'Advanced' groups ($p < .001$); there was no statistical difference between the 'Intermediate' and 'Advanced' groups ($p < .254$), nor was the difference between the 'Beginner' and 'Intermediate' groups significant, although it approached significance ($p < .059$). Notice that L2 learners in all proficiency groups performed well above 0% correct on non-canonical vowel harmony, although their knowledge of canonical vowel harmony should normally point them to make decisions that would lead them to have 0% correct on non-canonical vowel harmony. That is, the percentages of about 48% to 67% we observe here are well beyond the chance level. Further, as the high standard deviations indicate, there was great individual variation among the learners, with some learners achieving correct representations nearly all the time.

In contrast to the non-canonical vowel harmony, for all other stimuli, such as (regular) /l/ that is underlyingly not specified as coronal or dorsal (rows 2a–2b), as well as all the fillers (rows 1a–1b), presenting stimuli visually in addition to auditorily increased the percentage of correct responses, as opposed to what happened in the case of experimental stimuli. First, for stimuli ending in a regular /l/, the two factor analysis of variance

Table 2. Results (percentages; standard deviations are given in parentheses).

	Beginner (n = 13)	Intermediate (n = 10)	Advanced (n = 11)	Native (n = 14)
<i>1. Canonical vowel harmony (excluding /l/):</i>				
(1a) Auditory only	82.26 (5.62)	93.75 (5.80)	97.02 (2.83)	98.99 (1.69)
(1b) Auditory + visual	97.07 (3.29)	99.06 (1.09)	97.16 (3.19)	98.44 (2.12)
<i>2. Canonical vowel harmony with canonical /l/:</i>				
(2a) Auditory only	74.04 (5.62)	88.44 (8.97)	95.87 (2.80)	99.33 (1.81)
(2b) Auditory + visual	96.31 (3.82)	98.00 (2.11)	98.55 (2.70)	98.86 (1.88)
<i>3. Non-canonical vowel harmony: [+back] V + light /l/:</i>				
(3a) Auditory only	47.69 (9.92)	61.00 (27.26)	66.81 (30.52)	83.21* (18.77)
(3b) Auditory + visual	5.59 (4.96)	28.18 (37.71)	47.93 (33.54)	75.32 (16.02)

Notes. * One reason why natives speakers' scores were so low was due to the fact that one native speaker, C.A., skewed the results by having 30% and 36.36% correct on audiovisual and auditory stimuli only conditions respectively. If this speaker is excluded, performance on these words increases to 87.3% and 78.3% respectively.

showed a significant main effect for the 'modality of presentation', $F(1, 62) = 93.906$, $p < .001$ and a significant main effect for 'proficiency' level, $F(2, 62) = 38.343$, $p < .001$. In addition, unlike the test items, the interaction between 'modality of presentation' and 'proficiency' was also significant, $F(2, 26) = 25.177$, $p < .001$. Further, the results of a Tukey HSD test show that the significant effect of 'proficiency' was due mostly to the difference between the 'Beginner' and 'Advanced' ($p < .001$) and 'Beginner' and 'Intermediate' ($p < .001$) groups, although the difference between the pair 'Intermediate and Advanced' were also statistically significant ($p = .027$).

Finally, on fillers, as with cases with regular (non-contrasting) /l/, 'modality of presentation' (auditory only or auditory + visual) made a difference, with stimuli presented both auditorily and visually leading to higher rates of correct responses than stimuli presented auditorily only. Accordingly, the results of a two factor analysis of variance demonstrated a significant main effect for 'modality of presentation', $F(1, 62) = 52.503$, $p < .001$; and a significant main effect for the 'proficiency' factor, $F(2, 62) = 27.896$, $p < .001$. The interaction between 'modality of presentation' and 'proficiency' was also significant, $F(2, 62) = 22.884$, $p < .001$. Further, the results of a Tukey HSD test show that the significant effect of 'proficiency' was due to the difference of the 'Beginner' group from both 'Intermediate' and 'Advanced' groups ($p < .001$ for both). There was no significant difference between the pair 'Intermediate' and 'Advanced' ($p = .833$), meaning that, for regular cases of vowel harmony, proficiency level mattered only to the extent that it distinguished beginners from intermediate learners; at higher levels, intermediates and advanced learners did similarly.

The contrast in Table 2 between row 1, on one hand, and rows 2 and 3, on the other, is striking: Whereas presenting stimuli visually (in addition to auditorily) negatively influences participants' correct responses in cases where a palatal (light) [l] immediately follows a back vowel (where orthography is opaque), the same presentation modality (auditory + visual) positively influenced participants' proportion of correct answers in

the two other types of stimuli, cases with regular /l/ (where the underlying place of /l/ is not specified) and fillers (i.e. the types of stimuli where word-final vowels only determine the quality of the suffix vowel). It should be noted, however, that in cases with canonical /l/ and fillers (forms with regular vowel harmony), almost none of the participants had any noteworthy difficulties to begin with (and those who did were beginners), suggesting that canonical vowel harmony itself is not difficult for learners of Turkish, irrespective of level of proficiency and regardless of whether it involves back harmony or rounding harmony.

One might wonder whether success on non-canonical vowel harmony is the result of memorization of individual lexical items occasionally presented in the input. The results of a one-way ANOVA indicate that there was no statistically significant difference between performance on real vs. nonce words; this was true of both the auditory-only condition ($F(1, 66) = 0.698, p = 0.406$), and the auditory+visual condition ($F(1, 66) = 0.287, p = 0.594$). This means that the participants' knowledge of non-canonical vowel harmony cannot be attributed to memorization of the (extremely rare) exceptional forms in the input. For native Turkish speakers, on the other hand, performance differences on real vs. nonce words were statistically significant, $F(1, 26) = 3.882, p = 0.060$ in the auditory-only condition and $F(1, 26) = 22.855, p < 0.001$ in the auditory+visual condition, meaning that new forms with non-canonical vowel harmony were challenging even for native speakers, probably due to the influence of metalinguistic knowledge of vowel harmony patterns.

Furthermore, in order to determine a potential interaction between target words being real vs. nonce (type) and proficiency level and mode of presentation, we have conducted a factorial ANOVA. The results indicated that neither type ($F(1, 124) = 0.005, p = 0.945$) nor its interaction with proficiency ($F(2, 124) = 0.343, p = 0.710$) nor mode of presentation ($F(1, 124) = 1.051, p = 0.307$) were significant factors in determining participants' performance on non-canonical vowel harmony. This means that the effect of type (nonce vs. real) does not depend on the level of proficiency one is at or the mode of presentation, i.e. that type is not significant no matter what. In other words, whether a stimulus item is a real word or nonce word has no effect whatsoever on the participants' performance on non-canonical vowel harmony. Their performance is due solely to knowledge of the underlying representations regarding vowel harmony patterns.

VI Discussion and conclusions

First and foremost, the results indicate that L2 learners learned that the lateral can be a harmony trigger in Turkish, knowledge that could not have come from instruction, input, or L1 transfer (the three-fold poverty-of-the-stimulus argument used in previous literature). Further, this knowledge was acquired despite orthography and instruction leading learners to an alternative analysis, one in which the lateral should not be a harmony trigger, thereby adding a fourth aspect to the poverty of the stimulus. The English-speaking learners of Turkish studied in this article thus appear to be on a developmental path in the direction of phonological representations of Turkish that are congruent with Turkish as an L1, despite a four-fold poverty of the stimulus. In light of these findings, we conclude that the source of L2 learners' performance was most likely their innate knowledge of the

universal principles that govern vowel harmony and other autosegmental spreading processes, such as blocking effects that are observed when an intervening segment is exceptionally pre-specified with a feature value typically spread from another segment. Although particular formal approaches to this kind of subtly complex vowel harmony system may differ in their details, this finding, by itself, is crucial and is one that presents strong evidence for the involvement of UG in L2 phonology.

In our experiment, modality of presentation was a very significant factor. When compared with auditory presentation alone, bimodal presentation (including both auditory and orthographic stimuli) led learners at all three proficiency levels to a higher rate of correct responses on canonical vowel harmony but to a lower rate of correct responses on non-canonical vowel harmony. Bimodal presentation led even native speakers of Turkish to a depressed rate of accuracy on non-canonical vowel harmony, when compared with auditory presentation alone. One reason why the effect of modality of presentation was different across canonical vs. non-canonical vowel harmony is, of course, due to the level of transparency that Turkish orthography offers with regard to the two types of vowel harmony, and how this plays a role on perception: Turkish orthography is very transparent when it comes to backness/rounding of Turkish vowels. Since only a knowledge of vowels is sufficient for canonical vowel harmony, and the correct perception of the vowel's backness and rounding is strengthened by orthography, bimodal presentation leads to better performance. With regard to non-canonical vowel harmony, on the other hand, since Turkish orthography does not make a distinction between dark and light /l/, if beginning level learners cannot clearly hear the difference between the two types, they may rely solely on orthography, which will lead them to the incorrect analysis, one that is based on vowels only, although the quality of the lateral is the determining factor in non-canonical vowel harmony.

The basic outline of development reported here suggests an important role for orthography in the phonological development of instructed learners acquiring a language such as Turkish. It would appear that the (many) facets of Turkish orthography that more or less transparently encode the phonological system of Turkish (of course, paired with abundant auditory input) can be highly facilitative of phonological acquisition, particularly in early stages of acquisition; however, the less transparent or even obfuscating aspect of the orthographic system (which in our case are relevant for relatively low-frequency phenomena) can (partially) inhibit such acquisition in early learners. As development unfolds, our English-speaking learners of Turkish have come to rely less on potentially misleading orthographic stimuli, performing at a significantly higher rate of accuracy, even when potentially misleading orthographic presentation was included in the stimulus. Likewise, looking across the three learner groups, one can see that the difference in accuracy on non-canonical vowel harmony between auditory only and bimodal presentation conditions decreases over the course of development. This also suggests that participants at higher levels of proficiency development have come to be decreasingly misled by (phonologically unhelpful) written stimuli in performing this task.

This finding has significant implications for general L2 acquisition research and theories of L2 acquisition, as well as for language pedagogy. Crucially, it presents strong evidence that the dimensions along which L2ers' performance differs from L1ers should be evaluated not just in the context of L1 influence (and its extent) and access to UG (and

its extent), but also in the context of the presentation of orthography at the onset of language acquisition (or later). After all, previous acquisition of another language is not the only factor distinguishing L2 acquisition from L1 acquisition in literate societies. Except for L2 acquisition in early childhood, typical L2 acquisition in literate societies also involves early encounter with the written form and the orthography of the target language. This is in striking contrast to L1 acquisition, where literacy development begins much later in the acquisition process. In other words, we believe that L2ers share with L1ers full access to UG, but L2ers differ from L1ers not only in that they are prone to L1 transfer (e.g. Schwartz and Sprouse, 1994, 1996; White, 1989, 2003), but also in that their acquisitional path is significantly affected by their early encounter with orthography, an issue that has not received sufficient attention in previous research aiming to determine the fundamental differences between L1 and L2 acquisition.

Some readers might wonder the extent to which the results presented here could be explained as the result of frequency effects or memorized exceptions. We believe that frequency effects or memorization cannot explain these results, first of all because there was no statistically significant difference between learners' performance on real vs. nonce words. Second, and perhaps more crucially, even the beginners, who have likely not been exposed to a single form with non-canonical vowel harmony (or even a word ending with non-canonical /l/, which are a handful and tend to be advanced words) performed significantly better on non-canonical vowel harmony than their performance on canonical vowel harmony or instruction on canonical vowel harmony would predict. For example, beginners displayed an 82.26% accuracy rate on canonical vowel harmony and intermediates displayed a 93.75% accuracy rate. If they used the same strategies they employ for canonical vowel harmony for non-canonical vowel harmony, performance on non-canonical vowel harmony should be the mirror image of performance on canonical vowel harmony, i.e. about 17.74% for beginners and 6.25% for intermediates. The results indicate however that they do far better than this, i.e. 47.69% for beginners and 61.00% for intermediates. This is despite the fact that instruction leads them to the alternative analysis.

The developmental path displayed by the three learner groups points to the acquisition of abstract phonological representations that distinguish between the canonical and non-canonical distributions of Turkish /l/ and recognize the need for pre-specification of non-canonical /l/, as well as the palatalized /l/ having an associated V-Place node. Only on the assumption that an innate locality principle such as the No Crossing Constraint is (still) active in adult L2ers does it follow that this underlying specification results in the TL-like computation of non-canonical vowel harmony in both (a small set of) actually occurring and nonce forms. It is important here not to be misled by the still far from native-like performance of the Advanced group on non-canonical vowel harmony. Recall that on the basis of classroom instruction on both canonical vowel harmony and the interpretation of Turkish orthography, we would expect accuracy on non-canonical vowel harmony to be the mirror image of accuracy on canonical vowel harmony, i.e. close to 0%. This is far from the case, and it suggests that the difference between the Advanced group and the Native group is quantitative, not qualitative: The performance of both groups is impacted by a UG-based locality principle such as the No Crossing Constraint. Further, the fact that neither advanced learners nor L1 speakers performed close to about 90%–100% on average can be explained by the possibility that both

instruction and metalinguistic knowledge of vowel harmony rules prevent them from making naturalistic judgments at all times. For example, one native speaker, C.A. had 30% and 36.36% correct on audiovisual and auditory stimuli, skewing the results (see note 22), likely because she was mostly guided by rules of vowel harmony taught in Turkish language classes (rules of canonical vowel harmony – but not non-canonical vowel harmony – are taught as early as elementary school in Turkey). The same could be stated for L2 learners who are taught canonical vowel harmony as early as the first week of classes in Turkish, with non-canonical vowel harmony never taught (even at advanced-superior levels of proficiency).

A few words must be made on the nature of the learning algorithm that is needed for L2 learners to have set up the correct representation for a pre-specified palatalized /l/ for successful acquisition of non-canonical vowel harmony. We believe that upon hearing words like /rol-e/, where a suffix with a front vowel follows a word ending in a back vowel, the phonological parser fails, as the current grammar has led the learner to expect a back vowel in this context. Since the incoming input is no longer compatible with the initial analysis, grammar restructuring must take place. Faced with the task of accommodating this input, and armed with the universal knowledge that association lines cannot cross (the No Crossing Constraint), the parser realizes that there must be something between the two vowels which blocks the spreading. Since such blocking effects can only be caused by pre-specification of the opposite value of the spreading feature (i.e. [-back]) and the same node through which spreading occurs (i.e. a V-Place node), the parser realizes that a V-Place node must be associated with the intervening lateral. Seeing that this accounts for the input (i.e. /rol-e/) and the associated blocking effects observed, and having encountered with additional words of this type (e.g. /hayal-e/, /petrol-de/, etc.), the parser sticks with this representation.

We conclude with some comments about the general paucity of research studies addressing the question of whether adult L2 phonological acquisition is constrained by principles of UG (but, for studies examining sources of L2 phonological knowledge other than input, see Archibald, 2000; Broselow, 1987; Cardoso, 2007; Eckman, 1981; Tropic, 1987). We doubt that this state of affairs can be attributed to a general consensus among (generative) L2 acquisition scholars about the answer to this question or to a trivially obvious answer.

Of course, it is trivially obvious that most nonnative speakers exhibit at least some vestiges of a foreign accent and highly likely that even highly proficient nonnative listeners lag behind native listeners on most naturalistic and experimental comprehension tasks. However, it is far from clear that these differences between natives and nonnatives can be explained on the basis of limited ‘access’ to UG. An obvious analogy from L2 morphosyntax is the Missing Surface Inflection Hypothesis (Haznedar and Schwartz, 1997; Prévost and White, 2000), which offers a plausible account of L2ers’ use of default verbal forms in production without appeal to a lack of finiteness in their interlanguage grammars. TL-divergence in L2ers’ behavior per se does not imply UG-divergent underlying interlanguage representations.

In order to address the issue of no access, limited access, or full access to UG in (adult) L2 phonological acquisition, it is necessary first to identify plausible phonological principles of UG and then to identify L1–TL constellations where the relevant

principle operates in a manner in the TL such that it could not be inferred (by the learner) from any relevance it has for the L1 grammar. Furthermore, it must be the case that there are crucial facets of the phenomenon that are neither explicitly presented in classroom instruction nor readily apparent from TL input. If adult L2ers still come to exhibit (productive) knowledge of the relevant phenomenon, the only plausible source of this knowledge is the relevant phonological principle of UG. We have attempted to carry out such a study here, with the added poverty-of-the-stimulus 'bonus' that the standard orthography of the TL presents learners with potentially misleading data. In addition, the relevant pattern, non-canonical vowel harmony, is not only instructed, but classroom instruction (on canonical vowel harmony) leads the learners to make incorrect generalizations for non-canonical vowel harmony, adding to the poverty of the stimulus, and rendering the relevant generalizations essentially impossible to acquire in the absence of access to UG. Additional research on this and associated questions about the role of UG in L2 phonological research will have to rely on the availability of well motivated phonological principles of UG that are designed to explain poverty-of-the-stimulus problems.¹⁸

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Notes

1. This is not to suggest that there has been no discussion whatsoever about the role of UG in L2 phonological acquisition. In Section II, we return to some of the relatively few studies of which we are aware.
2. Some examples include studies on the interpretation of overt vs. null pronouns in null-subject languages (Kanno, 1997; Pérez-Leroux and Glass, 1997), the acceptability of remnant scrambling vs. remnant topicalization (Hopp, 2005; Schreiber and Sprouse, 1998), process vs. result interpretation of double genitives (Dekydspotter et al., 1997), the multiple event requirement with certain floated quantifiers (Dekydspotter et al., 1999/2000), scope asymmetries with pied piping vs. in situ restrictions on interrogative quantifiers (Dekydspotter and Sprouse, 2001; Dekydspotter et al., 2001), weak vs. strong movement violations (Martohardjono, 1993), and distributive interpretation of quantifiers and target landing sites (Marsden, 2009).
3. It is important to make the distinction between generalizations and putative UG principles here. The more general and wider the coverage of proposed UG principles, the more difficult it becomes to claim that a given principle plays no role in any given L1. Thus, the classic

question about the involvement of UG in L2 acquisition might be reasonably reformulated as the extent to which L2ers extend such principles to new domains of phenomena arising in the TL, but not instantiated in the L1. We return to this question in Section VI.

4. In this diagram and throughout this article, we employ a very broad transcription for Turkish vowels, abstracting away from all allophonic variation. It should be noted that Turkish vowels tend to be somewhat more centralized ('lax') than this transcription might suggest. For example, /e/ is often realized as [ɛ] in closed syllables with sonorant codas; /u/ is often realized as [ɨ] in some environments, etc. We adopt this practice in the interest of maximal simplicity and transparency, in particular in the interest of abstracting away from phonetic details that are irrelevant to the points at hand. For a more detailed treatment of the phonetics of Turkish vowels, see Göksel and Kerslake, 2005; Kornfilt, 1997; Lees, 1961.
5. The blocking effects here are due to an independent constraint of Turkish phonology, which bans rounded non-high vowels (i.e. /o/ and /ø/) in non-word-initial syllables of polysyllabic Turkish words.
6. We follow the standard Turkological practice of representing the underlying [+high] vowel of such suffixes as /I/. The gloss 'his' should be understood as 'his or her.'
7. Again, we follow standard Turkological practice by representing the underlying [-high] vowel of such suffixes as /E/.
8. In word-initial position, many speakers tend to use non-velarized ('light') [I] exclusively. This fact has no bearing on the alternations investigated in this study.
9. In these contexts, the preceding and the following vowel will be either both [+back] or both [-back]; hence, it might seem difficult to state whether /I/ becomes velarized (or non-velarized) immediately before or immediately after a [+/-back] vowel. For this reason, we simply use the terminology 'in the environment of'. However, three factors suggest that the preceding vowel is the trigger: (1) Vowel harmony spreads from left to right in Turkish; (2) in native Turkic words, a word-final /I/ (followed by no other vowels) will be light after front vowels and dark after back vowels; and (3) many speakers use exclusively non-velarized ('light') /I/ in word-initial position, even when the immediately following vowel is [+back].
10. For reasons of experimental feasibility, we restrict the focus of this study to non-canonical vowel harmony associated with non-canonical laterals. There are additional cases in Turkish where non-Turkic words exhibit non-canonical vowel harmony, such as *harf-i* [harfi] 'his letter (of the alphabet)' where, following the front vowel /a/ in the (only syllable of the) root, the allomorph of the 3rd person singular possessive suffix is the front vowel /-i/, rather than the expected back vowel /-u/ (compare *at-ı* [atu] '(his) horse' (= 6f)). For a more detailed coverage of additional cases of non-canonical vowel harmony, we refer the reader to Clements and Sezer, 1982; Kabak, 2011.
11. Here we adopt the No Crossing Constraint (Goldsmith, 1976; Hammond, 1988) within a Feature Geometric framework for the sake of concreteness. In alternative approaches, such as that of Nevins (2010), there are analogs to the No Crossing Constraint of traditional Autosegmental Phonology. What is crucial is that UG includes a locality condition that applies to vowel harmony. It is unclear to us whether the facts of Turkish vowel harmony provide a probative test case to distinguish between competing versions of that locality condition. It should also be noted, however, that as one reviewer correctly points out, the No Crossing Constraint is not an assumption held by all accounts of vowel harmony (for a critical evaluation, see also Coleman and Local, 1991). It is, however, still assumed to hold by many practicing autosegmentalists (Hyman, 2014), such that spreading cannot produce representations whereby a feature [+F] under tier X_1 spreads across a feature with the opposite value [-F] under the same tier, i.e. X_2 , in order to reach X_3 . There are, of course, alternative ways of capturing such blocking effects, such as Nevins (2010), which, as the same reviewer points out, also assumes Universal Grammar.

Here, for the sake of reaching the most general L2 acquisition audience, we explain this phenomenon through the No Crossing Constraint. Ultimately, other approaches would also work; see, for example, Nevins (2010) for a formulation of locality conditions in vowel harmony systems that seeks to assimilate such locality in phonological computation to locality in syntactic computation, in the spirit of Chomsky's (1995) Minimalist Program (for a similar account and for arguments against the No Crossing Constraint, see also Samuels, 2011).

12. Note that this effect does not depend on strict adjacency between the pre-specified /l/ and the following vowel; indeed the two need not even be tautosyllabic, as seen in examples with the locative *-de*, like *rol-de* [rol.de] 'role-LOC', *petrol-de* [pet.rol.de] 'petroleum-LOC', *hal-de* [hal.de] 'situation-LOC' (compare examples without pre-specified /l/ like *bal-da* [baɫ.da] 'honey-LOC' or *kolda* [koɫ.da] 'arm-LOC').
13. We are indebted to an anonymous *Second Language Research* reviewer for this insight.
14. Anecdotaly, we can report that in the rare case where an inflected form with non-canonical vowel harmony arises in Turkish language courses, the teacher labels the example an 'exception' to be memorized. No mention is made of a generalization involving (certain types of) laterals.
15. We used the same cloze test as the one used by Özçelik (2011), which is basically a multiple choice version of the cloze test used by Montrul (1997).
16. Of course, only the root vowel stayed constant at all times; the suffix vowel differed from the expected vowel if the participant got the relevant item incorrect (see Section IV). Again, it differed when a stimulus item tested non-canonical vowel harmony (i.e. if there was an intervening non-canonical -l).
17. These items were added in order to test whether learners (and native speakers) would attach a suffix with a back vowel after a lateral underlyingly specified as [+back], mirroring what happens with forms like [rol-de], where a suffix with a front vowel is attached after a word whose final vowel is a back vowel, because of the underlyingly specified 'light'/l/. We will return to this issue in future research.
18. Although in this article for reasons of concreteness and simplicity of exposition we have adopted a Feature Geometric formulation of locality in phonological representations, we also refer the reader to Nevins' (2010) framework, in which locality conditions for the computation of vowel harmony are largely assimilated to locality conditions for the computation of Agree in Minimalist syntax. We find this general approach not only extremely fruitful for phonological theory itself, but also very promising for future generative approaches to L2 phonological acquisition.

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