Opacity in Tiberian Hebrew: Morphology, not phonology*

Antony D. Green

The phenomenon of phonological opacity has been the subject of much debate in recent years, with scholars opposed to the Optimality Theory (OT) research program arguing that opacity proves OT must be false, while the solutions proposed within OT, such as sympathy theory and stratal OT , have proved to be unsatisfying to many OT proponents, who have found these proposals to be inconsistent with the parallelist approach to phonological processes otherwise characteristic of OT. In this paper I reexamine one of the best known cases of opacity, that found in three processes of Tiberian Hebrew (TH), and argue that these processes only appear to be opaque, because previous analyses have treated them as pure phonology, rather than as an interaction between phonology and morphology. Once it is recognized that certain words of TH are lexically marked to end with a syllabic trochee, and that the goal of paradigm uniformity exerts grammatical pressure on phonology, the three processes no longer present a problem to parallelist OT. The results suggest the possibility that *all* crosslinguistic instances of apparent opacity can be explained in terms of the phonology-morphology interface and that purely phonological opacity does not exist. If this claim is true, then parallelist OT can be defended against its detractors without the need for additional mechanisms like sympathy theory and stratal OT.

1 Introduction

Phonological opacity is the phenomenon of a process applying even though its environment is not present on the surface (overapplication), or of a process failing to apply even though its environment is present on the surface (underapplication). In rule-based frameworks, opacity is frequently accounted for by allowing rules to apply in counterbleeding order (for overapplication) or counterfeeding order (for underapplication) (Kiparsky 1968, Iverson 1995), although not all

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instances of counterbleeding and counterfeeding result in opacity.[1]

Spencer (1996: 169) gives an example of counterbleeding with resultant opacity from Bulgarian. In this language, the rules of velar palatalization (1) and yer deletion (2) apply in counterbleeding order (i.e. the second destroys the environment of the first after the first has already applied), resulting in apparent overapplication of velar palatalization: the velar /k/ has palatalized to [č] without the motivation for the change present on the surface, as shown in the derivation of [mračna] 'dark (fem.)' in (3).

(1) Velar palatalization
/k/ → [č] / __ [−cons, −back]
/k/ goes to [č] before a front vowel.

(2) Yer deletion
/ĭ/ → ∅ / __ C_0 V_{full}
/ĭ/ (a so-called "yer vowel") is deleted before a syllable containing a full vowel.

(3) Derivation of [mračna] 'dark (fem.)

Underlying representation	/mrakĭna/
Velar palatalization	č
Yer deletion	∅
Surface representation	[mračna]

An example of opacity due to counterfeeding is taken from German (Hall 2000: 142). Here, the rules of dorsal assimilation (4) and r-vocalization (5) apply in counterfeeding order, with apparent underapplication of dorsal assimilation: the front dorsal [ç] appears on the surface after the back vocoid [ɐ̯], as shown in the derivation of *durch* [dʊɐ̯ç] 'through' in (6).

(4) Dorsal assimilation
/ç/ → [+back] / [−cons, +back] __
/ç/ goes to [x] after a back vocoid.

(5) R-vocalization
/ʀ/ → [ɐ̯] / [−cons] __ $C_0]_\sigma$
Coda /ʀ/ is vocalized to [ɐ̯].

[1] Two rules are said to apply in counterbleeding order if the second rule destroys the environment of the first rule (after the first has already applied), and in counterfeeding order if the second rule creates the environment of the first rule (after the first has already failed to apply).

(6) Derivation of *durch* [dʊ̯ɐ̯ç] 'through'

UR	/dʊʀç/
Dorsal assimilation	—
R-vocalization	ɐ̯
SR	[dʊ̯ɐ̯ç]

The normal application of dorsal assimilation is seen in forms like *Buch* /bu:ç/ → [bu:x] 'book' and *Bach* /baç/ → [bax] 'creek'.

Although derivational phonology thus allowed opaque interactions to be expressed, it was acknowledged that they are less natural than transparent interactions, and it was often argued that rule orderings tend to switch from opaque to transparent over time (Kenstowicz and Kisseberth 1971, 1977, Kiparsky 1971, 1973).

But in a surface-based theory like OT, it is very difficult to explain why faithfulness should be violated excessively when it does not result in improved markedness, which is usually the problem in cases of opacity. Both supporters and opponents of optimality theory point to opacity as a serious flaw in the theory. René Kager, a prominent OT phonologist, says in his textbook on OT (1999: 377):

> Opacity appears to be a direct empirical refutation of the *surface-based* evaluation of well-formedness constraints in OT. Since opacity is OT's Achilles heel, researchers have attempted to find solutions for it which maximally preserve the theory's advantages.

But in his subsequent discussion he finds that each attempted solution has certain advantages and disadvantages and none of them seems to truly solve the opacity problem.

Perhaps the best known proposal for solving the opacity problem in OT is sympathy theory (McCarthy 1999, 2003), which extends the domain of faithfulness constraints beyond input/output and output/output relations to include relations between competing candidates. As we shall see below, sympathy theory enables opaque candidates to be selected as optimal by proposing constraints enforcing some degree of faithfulness between one candidate and another, so-called "sympathetic," candidate, which would have been optimal if a specific constraint had been ranked high rather than low.

Another approach to opacity is provided by stratal OT (McCarthy and Prince 1993 (appendix); Kenstowicz 1995; Booij 1996, 1997; Noyer 1997; Paradis 1997; Rubach 1997; Kiparsky 2003), which allows evaluation to proceed in more than one stage, with the possibility of constraint reranking between stages; the input for each stage after the first is the output of the previous stage,

rather than the "underlying" input. This approach also enables the selection of opaque candidates, because faithfulness constraints consider only the relationship of the surface form to an intermediate input rather than the underlying input. I will argue against both sympathy theory and stratal OT below, and show that both approaches are not only too powerful but also unnecessary for an analysis of apparent opacity.

Idsardi (1997, 1998, 2000), an opponent of OT, argues that traditional OT cannot handle the opacity found in the alternations between stops and fricatives in Tiberian and Modern Hebrew at all, and that even sympathy theory, which may be able to handle opacity, predicts that historical language change should decrease opacity (a hypothesis made also by derivational phonologists, as mentioned above), contrary to the facts, since Modern Hebrew has more opaque interactions than Tiberian Hebrew had. He considers opacity to be "*the* single most important issue in current phonological theory" (Idsardi 2000: 337). Other opponents of OT (e.g. Chomsky 1995 and McMahon 2000) concur, arguing that opacity proves that OT is false and that phonology *must* be derivational.

In this paper I will argue that the apparent opaque relationships of Tiberian Hebrew (henceforth TH) can be analyzed in a fully parallel, monostratal version of OT without recourse to mechanisms like sympathy theory and stratal OT. In particular, I contend that there is no phonologically productive opacity in TH; rather, opaque interactions are almost always limited to certain morphological classes or environments.[2] In TH at least, and perhaps more generally, problems of opacity are never purely phonological in character but are always dependent on morphological/lexical information in some way. If this assertion turns out to be true crosslinguistically, then opacity is a red herring in OT phonology, because truly phonological processes are always transparent. Opacity becomes a question of the interaction of morphology and phonology, rather than a question of the interaction between markedness and faithfulness, which previous accounts have made it out to be.

The paper is organized as follows: in §2 we are introduced to the phonology of TH, and in the following sections we examine in turn three cases of opacity found in TH: the interaction between epenthesis and stress placement in §3, that between epenthesis and ʔ-deletion in §4, and that between spirantization and syncope in §5. In §6 we see how opacity has been handled up to now in OT,

[2] See Sanders (2003) for a similar claim about opacity in Polish. I make the qualification "almost" to the statement because some cases of apparent opacity, such as that of German *durch* 'through' mentioned above, do seem to be purely phonological. However, even such cases may turn out to have other explanations: in the case of *durch*, my own impression is that the nonsyllabic vocoid corresponding to underlying /ʀ/ is actually rather more front before [ç] than the transcription [ʁ̞] would indicate. Perhaps a spectrographic analysis will reveal that a transcription like [dʊe̯̞ç] or [dʊi̯̞ç] would be more accurate.

namely by discarding parallelism either covertly (as in sympathy theory) or overtly (as in stratal OT). In §7 we reexamine the TH data and find that an analysis taking morphological constraints into consideration allows for a fully parallel interpretation of OT: no additional machinery is necessary to account for opacity. §8 sums up with conclusions.

2 Tiberian Hebrew

Tiberian Hebrew (Brown et al. 1906, Gesenius 1910, Hetzron 1987, Malone 1993, Khan 1997, Steiner 1997, Churchyard 1999) is the language in which almost the entire Old Testament is written.[3] The term "Tiberian" refers not the region in which the language was spoken, but the region where the scholars (called Masoretes) lived who devised the pointing system that eventually became standard. It is important to be aware that all information about vowels, stress, and spirantization is indicated by this Tiberian pointing system and that Hebrew had died out as a language of everyday communication several centuries before the pointing system was invented. Thus virtually everything that modern linguists assume about the structure of TH depends on information provided by people who were native speakers of Aramaic, not Hebrew.

The surface phone inventory of TH is as shown in (7). The sounds enclosed by boxes are allophones of a single phoneme, traditionally considered to be the stop, but by richness of the base the constraint hierarchy should be organized in such a way that the correct distribution of allophones is predicted regardless of which allophone is assumed in the input. The so-called "emphatic" coronals [ṭ ṣ] were probably originally ejective and later uvularized or pharyngealized (Churchyard 1999: 126); the uvular stop [q] also belongs to the class of "emphatic" obstruents. The sound symbolized [ś] descends from Proto-Semitic [ɬ] but had already merged with [s] five hundred years before the Masoretic period (Churchyard 1999: 126). If [ś] was ever a nonlateral sibilant distinct from [s], it is unknown what the distinction was: McCarthy (1979/85, 13) suggests [ś] may have been palatalized; Malone (1993: 28) assumes [ś] is [−distributed] (i.e. apical) while [s] is [+distributed] (i.e. laminal). Note that the pharyngeals [ḥ ʕ] and laryngeals [h ʔ] are considered glides.

[3] A few passages, namely Ezra 4:8–6:18, 7:12–26, Jeremiah 10:11, and Daniel 2:4–7:28, are written in Aramaic.

(7) Surface phones of TH

Consonants[4]

	Labial	Dental	Alveolar	Palatal	Velar	Uvular	Pharyngeal	Laryngeal
Voiceless stops	p	t			k			
Voiceless fricatives	f	θ	s, ś	š	x			
"Emphatic" obstruents		ṭ	ṣ			q		
Voiced stops	b	d			g			
Voiced fricatives	v	ð	z		ɣ			
Nasals	m	n						
Liquids			l, r					
Voiceless glides							ḥ	h, ʔ
Voiced glides	w			y			ʕ	

Vowels[5]

Long	Short	Reduced
i: u:	i u	
e: o:	e o	
ɛ: ɔ:	ɛ ɔ	ĕ ə ŏ
	a	ă

TH has at least three interesting phenomena conventionally described as opaque interactions, which we will discuss in turn in the following sections: there is an epenthesis process that interacts opaquely both with stress placement and with a process of ʔ-deletion, and a spirantization process that interacts opaquely with a syncope process.

[4] The labial fricatives may have been bilabial [ɸ β] rather than labiodental [f v].

[5] I follow Hetzron (1987), Malone (1993), Khan (1997), Rendsburg (1997), Steiner (1997), and Bye (2003) in assuming TH had seven different full vowel qualities [i, e, ɛ, a, ɔ, o, u]. This contrasts with the transcription system used by McCarthy (1979, 1999), Idsardi (1997, 1998, 2000), Benua (1998), Churchyard (1999), and Coetzee (1999), which allows only five different vowel qualities [i, e, a, o, u].

3 Epenthesis and stress placement

Among the declension classes of TH is one comprising the forms known as *segolate* nouns.[6] Segolate nouns, which are all masculine, are characterized by their penultimate stress and by the vowel [ɛ] (but [a] adjacent to pharyngeals and [i] after [y]) in the final syllable. In Proto-Semitic, the ancestors of the TH segolate nouns had the root form CVCC, and most phonologists working on TH assume this shape in the underlying forms of the segolate nouns for synchronic analyses as well. Some examples of segolate nouns are shown in (8).

(8) Segolate nouns (Gesenius 1910: 264–65)

	UR	Surface form	Gloss	Citation
a.	/malk/	mélɛx	'king'	Gen. 14:7
b.	/sepr/	séfɛr	'book'	2 Sam. 11:14
c.	/qodš/	qóðɛš	'sacredness'	Exod. 3:5
d.	/mawt/	mɔ́wɛθ	'death'	Deut. 19:6
e.	/naʕr/	náʕar	'a youth'	Gen. 37:2
f.	/neṣḥ/	néṣaḥ	'perpetuity'	1 Sam. 15:29
g.	/poʕl/	póʕal	'deed'	Hab. 1:1
h.	/zayt/	záyiθ	'olive'	Gen. 8:11

Suffixed forms like those in (9) have no epenthetic vowel, indicating that the locus of epenthesis is a syllable- or word-final consonant cluster.

(9) Suffixed forms of segolate nouns

a.	/malk-i:/	malkí:	'my king'	2 Sam. 19:44
b.	/sepr-i:/	sifrí:	'my book'	Exod. 32:33
c.	/qodš-i:/	qɔðší:	'my sacredness'	Lev. 20:3
d.	/neṣḥ-i:/	niṣḥí:	'my perpetuity'	Lam. 3:18

Malone (1993: 93–94) proposes the rule of segolate epenthesis shown in (10), which inserts the vowel [ɛ] into a word-final consonant cluster.[7]

(10) Segolate epenthesis (Malone 1993: 93–94)
∅ → ɛ / C __ C #
[ɛ] is inserted into a word-final consonant cluster

[6] From *segol* [səɣó:l], the Hebrew name of the vowel point representing [ɛ].

[7] Malone's formulation is more complex, taking into account the fact that the vowel surfaces as [a] adjacent to pharyngeals and as [i] after [y]. Malone states his rules using an *SPE*-style formalism, though most phonologists working in 1993 would probably have stated the rule of segolate epenthesis in terms of syllable structure.

In contrast to the segolate nouns, most polysyllabic nouns of TH have final stress (with concomitant vowel lengthening in both the stressed and the pretonic syllable, processes that will not concern us here), as shown in (11) (list adapted from Bye 2003, example (7)).

(11) TH nouns with final stress

	UR	Surface form	Gloss	Citation
a.	/dabar/	dɔ:vɔ́:r	‘word’	Gen. 18:14
b.	/ṣaba/	ṣɔ:vɔ́:	‘army’	Num. 1:3
c.	/ḥaṣer/	ḥɔ:ṣé:r	‘court’	1 Kings 7:8
d.	/zaqen/	zɔ:qé:n	‘old man’	Gen. 43:27
e.	/lebab/	le:vɔ́:v	‘heart’	Deut. 28:28
f.	/śeʕar/	śe:ʕɔ́:r	‘hair’	Gen. 25:25
g.	/katep/	kɔ:θé:f	‘shoulder’	Zech. 7:11
h.	/raʕabo:n/	rəʕɔ:vó:n	‘hunger’	Ps. 37:19

Verbs also have a strong tendency to stress the final syllable, with the exception of some unstressed endings or suffixes, as shown in (12).

(12) Stress patterns in verbs

a. with final stress

lɔ:máð	‘he has learned’	Isa. 26:10
yilmáð	‘he learns’	Deut. 17:19
ʔɛlməðɔ́:	‘I learn’	Ps. 119:73
yilməðú:n	‘they (m.) learn’	Deut. 4:10
limðú:	‘learn! (m.pl.)’	Isa. 1:17
limmáð	‘he taught’	Eccles. 12:9
yəlammé:ð	‘he teaches’	Ps. 25:9
ʔălamməðɔ́:	‘I teach’	Ps. 51:15
yəlamme:ðú:n	‘they teach’	Deut. 4:10
lummɔ́:ð	‘he was taught’	Jer. 31:18

b. with unstressed endings or suffixes

lɔ:máð-ti:	‘I have learned’	Prov. 30:3
limmaðtá-ni:	‘you (m.sg.) have taught me’	Ps. 71:17
təlammәðén-nu:	‘you (m.sg.) teach him’	Ps. 94:12
lammәðé:-ni:	‘teach (m.sg.) me!’	Ps. 25:4

On the basis of forms like those in (11) and (12)a, we could propose a rule building an iamb at the right edge of a prosodic word (cf. Malone 1993: 53–54), shown in (13).

(13) Stress placement
Build an iamb at the right edge of the prosodic word.

This rule interacts opaquely with epenthesis, since epenthetic vowels in final syllables are unstressed, as we saw in the segolate nouns in (8). But segolate nouns are not the only words with epenthesis. Two other classes of words that typically show penultimate stress also have an epenthetic vowel in the final syllable: feminine nouns ending in [-ɛθ] and "truncated" forms (including jussives and imperfect consecutives) of *lamed-he* verbs (see Benua 1998: ch. 4, and Churchyard 1999: ch. 1 for discussion).[8] Some examples are shown in (14); related suffixed forms with no epenthesis are shown beneath the forms with epenthesis.

(14) Other forms with epenthesis

a. Feminine nouns in [-ɛθ]

gulgólɛθ	2 Kings 9:35	'skull'
gulgɔlt-ó:	Judg. 9:53	
gəvérɛθ	Isa. 47:5	'mistress'
gəvirt-í:	Gen. 16:8	
šɛ́vɛθ	1 Kings 10:19	'dwelling'
šivt-ó:	Obad. 3	
mɛmšɛ́lɛθ	Ps. 136:8	'rule'
mɛmšalt-ó:	1 Kings 9:19	

b. "Truncated" forms of *lamed-he* verbs[9]

way-yívɛz	Gen. 25:34	'despise'
way-yivz-é:hu:	1 Sam. 17:42	
way-yívɛn	Gen. 2:22	'build'
yivn-é:hu:	Job 20:19	
yíɣɛl	Job 20:28	'remove'
yiɣl-ú:	Amos 6:7	
way-yéɣɛl	2 Kings 17:6	'exile'
way-yaɣl-é:hɔ:	2 Kings 16:9	

[8] The vast majority of Hebrew verb roots are considered to consist of three consonants. The *lamed-he* verbs are those whose third consonant (etymologically [y] or [w]) is orthographically *h* and phonologically never present on the surface.

[9] Forms with [waC-] 'and' (where C = copy of the following consonant) are imperfect consecutive; forms without it are jussive.

yíxɛl yixl-ú:	Job 33:21 Isa. 1:28	‘be consumed’
wat-tɛ́mɛr tamr-ú:	Ezek. 5:6 1 Sam. 12:14	‘rebel’
way-yáʕal yaʕl-é:m	Gen. 8:20 Deut. 28:61	‘bring up’
way-yífɛn yifn-é:	Exod. 2:12 1 Sam. 13:17	‘turn’
way-yɛ́fɛr yafr-əxɔ́:	Ps. 105:24 Gen. 28:3	‘make fruitful’
way-yíšaʕ yišʕ-é:	Gen. 4:4 Isa. 17:7	‘look’
way-yɛ́θaʕ way-yaθʕ-é:m	2 Chron. 33:9 Job 12:24	‘cause to stray’
yírɛv yirb-əyú:n	Gen. 1:22 Deut. 8:13	‘multiply’

Stress placement affects the rightmost vowel in a word; segolate epenthesis supplies a vowel that is only one segment removed from the right edge of a word. Thus the two rules stand in a potential feeding relationship: if epenthesis precedes stress placement, the former feeds the latter, but if epenthesis follows stress placement, the former counterfeeds the latter. In fact, since the epenthetic vowel is not stressed, the two rules must stand in counterfeeding order. Also relevant to the present discussion are the rules of midding assimilation in (15) and spirantization in (16).

(15) Midding assimilation (Malone 1993: 64)
a → ɛ / __ C ɛ
[a] is raised to [ɛ] in an open syllable before an [ɛ] in the following syllable

(16) Spirantization (Idsardi 1998)[10]
[−son] → [+cont] / X ___
|
Nucleus
A stop becomes a fricative after a vowel.

The derivation of [mɛ́lɛx] 'king' is then as shown in (17).

(17) Derivation of [mɛ́lɛx]

Underlying representation	/malk/
	(×)
Stress placement	malk
Segolate epenthesis	lɛk
Midding assimilation	ɛ
Spirantization	x
Surface representation	[mɛ́lɛx]

The fact that stress falls on a nonfinal syllable shows that the ordering of stress placement before segolate epenthesis is opaque. The opacity would remain in a surface-oriented constraint-based analysis, because the facts of (11) and (12)a require a constraint ranking that results in final stress, which would be inconsistent with this form as well as with the other unsuffixed forms in (8) and (14). We will return to the interaction of stress placement and epenthesis in §7.1, where I argue that unsuffixed forms like those in (8) and (14) have penultimate stress for morphological rather than phonological reasons.

4 Epenthesis and ʔ-deletion

The second case of opacity found in TH involves ʔ/∅ alternations of the kind shown in (18).

(18) ʔ/∅ alternations

a.	/śaneʔ/	śɔ:né:	Deut. 12:31	'hate'
		śəne:ʔ-ɔ́:h	2 Sam. 13:15	

[10] The "emphatic" stops [ṭ] and [q] do not undergo spirantization; Idsardi suggests that spirantization adds not only [+cont] but also [+spread glottis] and that TH prohibits segments from being marked for all three of an oral place feature (coronal or dorsal), a laryngeal feature ([+spread glottis]), and a tongue root feature (on the assumption that the emphatics are marked [+RTR]). Geminates are also excluded from spirantization because of geminate inalterability (Guerssel 1977, Kenstowicz 1982, Hayes 1986, Schein and Steriade 1986, Inkelas and Cho 1993, Elmedlaoui 1993, Kirchner 2000).

b.	/ḥeṭʔ/	ḥeṭ	Lev. 19:17	‘sin’
		ḥɛṭʔ-ó:	Lev. 24:15	
c.	/gayʔ/	gay	Num. 21:20	‘valley’
		ge:ʔ-ó:θ	Ezek. 31:12	
d.	/yarʔ/	way-yár	Gen. 18:2	‘see’
		yirʔ-é:	Gen. 22:8	

Alternations like those in (18) lead to the conclusion that [ʔ] is deleted in syllable-final position. Idsardi’s (1998) rule of laryngeal deletion is stated in (19).

(19) Laryngeal deletion

X]$_\sigma$

╪

ʔ

But there is some inconsistency regarding word-final /Cʔ/ clusters. Sometimes the /ʔ/ is simply deleted and the preceding consonant surfaces as the word-final sound, as in (18)b–d. But in other cases, an epenthetic [ɛ][11] appears word-finally after the consonant, as in (20).

(20) Word-final [ɛ] where input ends in /Cʔ/

a.	/gabʔ/	gévɛ	Isa. 30:14	‘pool’
		gəvɔ:ʔ-ɔ:w	Ezek. 47:11	
b.	/dašʔ/	déšɛ	Gen. 1:11	‘grass’
		dašʔ-ó:	(unattested)	
c.	/ṭanʔ/	ṭénɛ	Deut. 26:4	‘basket’
		ṭanʔ-ăxɔ́:	Deut. 28:5	
d.	/kɛlʔ/	kélɛ	1 Kings 22:27	‘imprisonment’
		kilʔ-ó:	2 Kings 25:29	
e.	/pɛlʔ/	pélɛ	Exod. 15:11	‘wonder’
		pilʔ-ăxɔ́:	Ps. 89:6	
f.	/pɛrʔ/	pérɛ	Hosea 8:9	‘wild ass’
		pərɔ:ʔ-í:m	Jer. 14:6	

[11] In this and similar forms I follow McCarthy (1999) in transcribing the final vowel as short. In fact, it is not known for certain whether this final unstressed vowel was long or short; Malone (1993) assumes such vowels were long.

g.	/yedʔ/	way-yéðɛ	Ps. 18:11	‘fly swiftly’
		yiðʔ-é:	Deut. 28:49	
h.	/telʔ/	wat-télɛ	Job 4:5	‘be weary’
		tilʔ-é:	Job 4:2	
i.	/yerʔ/	yérɛ	Exod. 5:21	‘see’
		yirʔ-é:	Gen. 22:8	

In these forms, there is an opaque interaction of ʔ-deletion with segolate epenthesis. ʔ-deletion counterbleeds segolate epenthesis in these forms by destroying part of the latter’s structural description after it has already applied. On the surface, segolate epenthesis appears to have overapplied, since the epenthetic vowel is not followed by a consonant. The derivation of [pɛ́lɛ] is shown in (21).

(21) Derivation of [pɛ́lɛ]

UR	/pɛlʔ/
	(×)
Stress placement	pɛlʔ
Segolate epenthesis	lɛʔ
ʔ-deletion	∅
SR	[pɛ́lɛ]

Ordering epenthesis before ʔ-deletion provides a derivational explanation for the opacity in this form, as does the sympathy theory analysis of McCarthy (1999), which brought TH opacity to the attention of phonologists. Bye (2003) proposes an analysis in Declarative Phonology, according to which the epenthetic [ɛ] appears before the position of a ʔ/∅ alternation, but is not regulated by syllable structure.

But none of these analyses is satisfying, since none of them accounts for the fact that not all instances of word-final /Cʔ/ surface opaquely as [Cɛ]: recall (18)b–d in which /Cʔ/ surfaces transparently as [C]. Malone (1993: 60) simply calls the rule of ʔ-deletion “uneven”, while Coetzee (1999: 76, 178) denies that the forms without epenthesis genuinely have /ʔ/ in their underlying representation. McCarthy (1999) and Bye (2003) fail to mention the transparent forms at all in their analyses. But the issue is addressed by Bruening (1999), who proposes that the transparent and opaque forms belong to different morphological classes with different prosodic requirements, a suggestion I pick up on and elaborate in §7.2.

5 Spirantization and syncope

The third opaque rule interaction found in TH is between spirantization (a singleton nonemphatic stop becomes a fricative after a vowel; see (16)) and a rule I call pretonic syncope, stated in (22).[12]

(22) Pretonic syncope

(. ×)

V → ∅ / V C __ C V

The weak vowel of an iamb in an open syllable after an open syllable is deleted.

By deleting a vowel, syncope can remove the environment for spirantization. But spirantization applies before syncope does, so syncope counterbleeds spirantization, resulting in an opaque interaction where spirantization appears to have overapplied. In the segolate nouns, this phenomenon is encountered in the construct plural, as shown by the derivation of [malxè:] 'kings (construct)' in (23).[13]

(23) Derivation of [malxè:]

UR	/malake:/
	(. ×)
Stress placement	malake:
Spirantization	x
Pretonic syncope	∅
SR	[malxè:]

Other forms also show the opaque interaction between spirantization and syncope, such as [kiθvú:] 'write (imperative plural)' < /kotobu:/. In §7.3 I will argue that overapplication of spirantization in TH is attributable to paradigm uniform-

[12] The rule I give as pretonic syncope is simplified from the rules given by Malone (1993) and Idsardi (1998). Malone (1993: 87) proposes a rule called Reduction, which is written in such a way as either (i) to reduce a pretonic vowel in an open syllable to [Ə], or (ii) to delete a vowel in that environment altogether if the preceding syllable is light and the intervening consonant is nonguttural. Idsardi (1998) breaks this up into two rules, one of vowel reduction that deletes a foot-initial grid mark before another grid mark, and one of schwa deletion that deletes "a reduced vowel (i.e. one without a grid mark) in an open syllable when the onset is not a guttural and the preceding syllable is also open." Here I have conflated the two rules and omitted the nonguttural restriction on the first syllable, since sometimes deletion does happen after gutturals, and also because I am not convinced that "nonguttural" is really a natural class.

[13] The construct is part of the same stress unit (Bruening 1999 suggests the prosodic word) as the noun that follows it, which is why the stress indicated on construct forms is secondary.

ity considerations, but first we turn our attention to how the problem of opacity has been approached by previous OT researchers.

6 Opacity in OT

In derivational phonology rule ordering is sufficient to account for the presence of opaque relationships like the ones described above. In OT phonology, however, over- and underapplication of phonological processes are very difficult to explain. Consider the interaction of epenthesis and ʔ-deletion discussed above in §4. In an OT analysis, both of these processes involve violation of faithfulness constraints: epenthesis violates DEP-IO(V) and ʔ-deletion violates MAX-IO(C). But the markedness constraints against complex codas and syllable-final [ʔ] outrank the faithfulness constraints, as is seen in (24) and (25). (Other processes, such as the raising of [a] to [ɛ] and the spirantization of [k] to [x] in (24) and the lengthening of [a] to [ɔ:] in (25), are not discussed as they are tangential to the issue at hand.)

(24) *CC]$_\sigma$ ≫ DEP-IO(V), from [mélɛx] ‘king’

/malk/	*CC]$_\sigma$	DEP-IO(V)
malk	* !	
☞ mélɛx		*

(25) *ʔ]$_\sigma$ ≫ MAX-IO(C), from [śɔ:né:] ‘he hated’

/śaneʔ/	*ʔ]$_\sigma$	MAX-IO(C)
śɔ:néʔ	* !	
☞ śɔ:né:		*

In the correspondence relationship /daš?/ ℜ [déšɛ], both markedness constraints are obeyed and *both* faithfulness constraints are violated; but the violation of DEP-IO(V) appears gratuitous. The competing candidate *[daš] also obeys both markedness constraints while violating only one of the faithfulness constraints, and is therefore predicted to win the evaluation.[14] (The symbol ☹ indicates the selection of an ungrammatical candidate.)

[14] Note that closed syllables are freely allowed in Hebrew, e.g. [su:s] ‘horse’; thus it is not the fact that *[daš] is a closed syllable that renders it ungrammatical.

(26) Constraint ranking fails on [dɛ́šɛ] ‘grass’

/daš?/	*CC]$_\sigma$	*?]$_\sigma$	DEP-IO(V)	MAX-IO(C)
daš?	* !	*		
dɛ́šɛ?		* !	*	
dɛ́šɛ			* !	*
☹ daš				*

McCarthy’s (1999) solution to this paradox is sympathy theory. According to sympathy theory, the optimal candidate in an evaluation must not only maximize unmarkedness and faithfulness to the input in the conventional manner, but also maximize faithfulness to the so-called “sympathetic candidate” (marked with ❀ in tableaux) chosen by a special constraint called the selector constraint (marked with ✭ in tableaux). The selector constraint may be ranked anywhere in the hierarchy but behaves as if it were top-ranked for purposes of selecting a sympathetic candidate. In the case of /daš?/ ℜ [dɛ́šɛ], the selector constraint is MAX-IO(C) and the sympathetic candidate is [dɛ́šɛ?]. The optimal candidate must obey a faithfulness constraint to the sympathetic candidate, in this case MAX-❀O(V). This constraint compares each candidate not against the input /daš?/ but against the sympathetic candidate [dɛ́šɛ?] and gives a violation mark to any candidate lacking a vowel present in the sympathetic candidate. The optimal candidate [dɛ́šɛ] obeys MAX-❀O(V) while the transparent candidate [daš] fatally violates it. The tableau for the entire sympathy interaction is shown in (27).

(27) Sympathy analysis of [dɛ́šɛ] ‘grass’

/daš?/	*CC]$_\sigma$	*?]$_\sigma$	MAX-❀O(V)	DEP-IO(V)	✭MAX-IO(C)
daš?	* !	*	*		
❀ dɛ́šɛ?		* !		*	
☞ dɛ́šɛ				*	*
daš			* !		*

The selection of the sympathetic candidate is achieved by imagining that the selector constraint, in this case MAX-IO(C), is top-ranked. If it were, [dɛ́šɛ?] would win, because [dɛ́šɛ] and [daš] would fatally violate MAX-IO(C), and [daš?] would fatally violate *CC]$_\sigma$.

A very similar result is obtained in a different OT approach to opacity, namely stratal OT (McCarthy and Prince 1993 (appendix); Kenstowicz 1995; Booij 1996, 1997; Noyer 1997; Paradis 1997; Rubach 1997; Kiparsky 2003), which follows lexical phonology in assuming different levels of phonological activity. Under stratal OT, the output of one level becomes the input to the next

level. In the TH example, a stratal OT analysis would argue that level 1 has the crucial ranking MAX-IO(C) ≫ *ʔ]$_{\sigma}$, picking [dɛ́šɛʔ] as the optimal output to the input /dašʔ/. At the next level, the input is /dɛ́šɛʔ/ and MAX-IO(C) is demoted below *ʔ]$_{\sigma}$; the crucial ranking is now *ʔ]$_{\sigma}$ ≫ MAX-IO(C), MAX-IO(V). The output of the level 2 constraint interaction is [dɛ́šɛ].

(28) /dašʔ/ ℜ [dɛ́šɛ] in stratal OT

a. Level 1

/dašʔ/	MAX-IO(C)	*CC]$_{\sigma}$	*ʔ]$_{\sigma}$	MAX-IO(V)	DEP-IO(V)
dašʔ		* !	*		
☞ dɛ́šɛʔ			*		*
dɛ́šɛ	* !				*
daš	* !				

b. Level 2

/dɛ́šɛʔ/	*CC]$_{\sigma}$	*ʔ]$_{\sigma}$	MAX-IO(C)	MAX-IO(V)	DEP-IO(V)
dɛšʔ	* !	*		*	
dɛ́šɛʔ		* !			
☞ dɛ́šɛ			*		
dɛš			*	* !	

The problem with stratal OT is that it eliminates the parallelism of traditional OT. One of the main characteristics that distinguish OT from derivational phonology is that OT establishes a correspondence between an input and an output that does not assume any serial derivation or change over time from the input to the output. Parallelist OT does not assume any intermediate stages "between" the input and the output; the input does not come "before" the output in any way. Stratal OT, on the other hand, is derivational: first there is an evaluation at one level, then there is a second evaluation with a new input and a new constraint ranking. Moreover, in a case like this there is no independent evidence, such as the addition of a morpheme, for two separate levels. Traditionally in lexical phonology each level corresponded to some level of morphological affixation. That is not always the case in opacity cases, rendering stratal OT analyses of opacity somewhat ad-hoc.

Sympathy theory is an attempt to sidestep this problem by ostensibly allowing a fully parallel selection of both the sympathetic candidate and the optimal candidate, but it is unclear to what extent this is conceptually really possible. If the selection of the optimal candidate depends on faithfulness to the sympathetic candidate, then the selection of sympathetic candidate must happen in some sense "before" the selection of the optimal candidate. If this is the case, then there is no substantial difference between sympathy theory and stratal OT,

and the tableau in (27) is just a shorthand for the two tableaux in (28).

A further conceptual problem with both sympathy theory and stratal OT is their reliance on faithfulness to a nonexistent form. The output [dɛ́šɛ] clearly exists, as this is the form the speaker articulates and the listener perceives; the input exists as well, as this is the form that the speaker (and the listener as well) has listed in the lexicon. But the form [dɛ́šɛʔ] cannot be said to exist in the same way: it is a *hypothetical* form that is neither the lexical representation nor the surface form, and yet the grammar is somehow supposed to compare the candidates for faithfulness against both the lexical input /dašʔ/ and the hypothetical form [dɛ́šɛʔ]. Serious questions about learnability are raised here: the learner acquires the output [dɛ́šɛ] by hearing it, and the lexical input /dašʔ/ by induction, comparing it to related forms like [dašʔó:] 'his/its grass', but how does the learner acquire the "sympathetic candidate" or "intermediate input" [dɛ́šɛʔ]? For that matter, how does the learner learn to use the relatively low ranked selector constraint (in sympathy theory) or to rerank constraints between levels (in stratal OT)? The most successful models of learning OT grammars, such as the gradual learning algorithm (Boersma 1998, 2000) make no provision for treating a low ranking constraint as if it were high ranking or for reranking constraints in the course of a single instance of harmonic evaluation.

The [dɛ́šɛ] paradox relies crucially for its existence on the assumption that the /dašʔ/ ℜ [dɛ́šɛ] correspondence is purely phonological in character. If morphological constraints play a role, then the output [dɛ́šɛ] could be superior to its competitor *[daš] for nonphonological reasons. In the next section I will argue that this is indeed the case.

7 A reexamination of the TH facts

In order to come up with a successful analysis of the TH facts, it will be necessary in this section to reexamine the data in the context of TH morphology.

7.1 Coda clusters in TH

The first fact to be considered is that it is not the case that coda clusters are completely forbidden in TH, as both the derivation epenthesis rule (10) and the constraint ranking *CC]$_\sigma$ ≫ DEP-IO(V) would imply. There are an (admittedly very small) number of nouns which end in consonant clusters, such as [qošṯ] 'truth' (Prov. 22:21) and [nerd] 'spikenard' (Song of Sol. 4:14), which Coetzee (1999: 183) considers to be lexically marked as exceptional. In verbs, however, final clusters are regularly found in jussive/imperfect consecutive forms of *lamed-he* verbs (cf. (14)b) when the cluster is of falling sonority.

(29) Final clusters in jussive/imperfect consecutive forms of *lamed-he* verbs

way-yišb	Num. 21:1	‘take captive’
way-yift	Job 31:27	‘be simple’
way-yešt	Gen. 9:21	‘drink’
way-yevk	Gen. 27:38	‘weep’
yeśṭ	Prov. 7:25	‘turn aside’
way-yašq	Gen. 29:10	‘give water to’

Final clusters are the norm in the second person singular feminine perfective form of verbs, where the ending [-t] is attached directly to the final consonant of the root.

(30) Second person singular feminine perfective verb forms

hɔ:láxt	Ezek. 16:47	‘walk’
yɔ:láðt	Judg. 31:3	‘bear’
liqqáṭt	Ruth 2:19	‘glean’
yɔ:náqt	Isa. 60:16	‘suck’
niθpáśt	Jer. 50:24	‘be taken’

Benua (1998: ch. 4) and Churchyard (1999: ch. 1) attribute the presence of final clusters in (29) and (30) to output-output faithfulness between a base and its truncated form. The forms in (29) are held to be truncated from full forms of the imperfective like those shown in (31).

(31) Full forms corresponding to (29)

yišbɛ́:	(unattested)	‘take captive’
yiftɛ́:	Deut. 11:16	‘be simple’
yištɛ́:	Gen. 44:5	‘drink’
tivkɛ́:	1 Sam. 1:7	‘weep’
tiśṭɛ́:	Num. 5:29	‘turn aside’
yašqɛ́:	Num. 5:26	‘give water to’

The presence of word-final clusters in (29) can be explained by ranking output-output faithfulness between full forms and truncated forms above *CC]$_{\sigma}$.

As for the forms in (30), these are considered to be truncated from /-ti:/ (on the basis of suffixed forms like [yəliðtí:-ni:] ‘you (f. sg.) have borne me’, Jer. 15:10). When not truncated, this ending is homophonous with that of the first person singular, shown in (32).

(32) First person singular equivalents of the forms in (30)

hɔ:láxti:	Ruth 1:21	‘walk’
yɔ:láðti:	Gen. 21:7	‘bear’

liqqáṭti: (unattested) ‘glean’
yɔ:náqti: (unattested) ‘suck’
niθpáśti: (unattested) ‘be taken’

However, the argument that the forms in (29)–(30) stand in a base-truncation correspondence relationship with the forms in (31)–(32) derives solely from the desire to explain the presence of consonant clusters in these forms. There is otherwise no independent evidence that these forms need to be in especially close correspondence with each other, nor that truncation is employed in TH inflectional morphological. Truncation usually has the nature of a hypocoristic (as the nickname *Lar* [lær] truncated from *Larry*, discussed by Benua in chapter 2); it is not clear that it is an advantage to morphological theory to propose that one verb form can be derived from another by truncation. A much simpler explanation would be that the ending of the second person singular feminine perfective is [-t], and its status is entirely parallel to that of other endings like [-ti:] (first person singular perfective) and [-tɔ:] (second person singular masculine perfective). Similarly, the input for a “truncated” jussive/imperfect consecutive form like [yišb] would be simply /yišb/, not /ya-šbɛ:-TRUNC/ as Benua proposes.

If, then, it is the case that the inputs of, say, [liqqáṭt] and [yišb] are /liqqaṭt/ and /yišb/, then it is clear that DEP-IO(V) outranks *CC]$_{\sigma}$ in TH, i.e. that coda clusters are phonologically tolerated and surface faithfully. Nouns like [qošṭ] and [nerd] are no longer a problem either. If this is the case, then correspondence relationships like /malk/ ℜ [mélɛx] and /mɛmšalt/ ℜ [mɛmšélɛθ] need to be rethought and a new motivation for the vowel epenthesis found.

Bruening (1999) has argued that morphological classes in TH make reference to prosodic templates, but that these templates are not inputs (as was generally held in pre-OT templatic morphology theory) but are rather output conditions (consistent with the output-based orientation of OT generally). Under this analysis, the difference between segolate nouns and other nouns is that segolate nouns have to meet a trochaic template, while other nouns have to meet an iambic template. Bruening assumes that the trochee of the template is a moraic trochee and thus equally well achieved by (L L) or by (H). Both iambic and trochaic templates are to be aligned at the left edge of the prosodic word; this has the effect of allowing the suffixed forms of segolate nouns to conform to the template, e.g. [(mal)(kí:)] ‘my king’ with a moraic trochee (mal) at the left edge. But Bruening does not address feminine nouns in [-ɛθ] like [gəvérɛθ] ‘mistress’ where there is no trochee at the left edge of the word.

If we modify Bruening’s suggestion and assume that the trochaic template of TH is syllabic, not moraic, we can account for the difference between [mélɛx] with epenthesis and [qošṭ] and [nerd] without epenthesis. [qošṭ] and [nerd] belong to the first declension, whose template is an iamb (H) or (L H). Iambs are

always moraic, as has been shown by Prince (1990), Kager (1993), Hayes (1995), and Eisner (1997). [mélɛx], on the other hand, belongs to the second declension, whose template is a syllabic trochee, i.e. a foot of the shape (σ́ σ).

In fact, it is not necessary to assume a lexically marked iambic template. Rather, since the iambic pattern is the more widespread in TH, we may assume that it is the pattern called for by the purely phonological constraints of the language. Therefore we can say that segolate nouns and feminines in [-ɛθ] are marked in the lexicon with a diacritic requiring them to end in a trochee, while other nouns have no lexical marking and take the iambic pattern by default. I will indicate the trochaic diacritic as "Tr".

(33) Nouns with and without the trochaic diacritic

Input	Output	Gloss
/malk/$_{\text{Tr}}$	mélɛx	'king'
/gabɛrt/$_{\text{Tr}}$	gəvérɛθ	'mistress'
/qošṭ/	qošṭ	'truth'
/dabar/	dɔ:vɔ́:r	'word'
/raʕabo:n/	rəʕɔ:vó:n	'hunger'

A constraint corresponding to the stress placement rule of (13) is StressRight (34).

(34) StressRight
Align-R(PWord, σ́)
The right edge of a prosodic word is aligned with the right edge of a stressed syllable.

This constraint achieves the final stress seen in the forms in (11) and (12)a. But for words marked with the trochaic diacritic, the constraint Trochee takes precedence.

(35) Trochee
Align-R(PWord$_{\text{Tr}}$, Trochee)
The right edge of a prosodic word associated with the diacritic Tr is aligned with the right edge of a trochee.

Trochee outranks StressRight (a case of Pāṇinian ordering since Trochee is more specific than StressRight), as shown in the tableaux in (36). This results in epenthesis in [mélɛx] and [gəvérɛθ], both with the trochaic template, but not in [qošṭ] with no lexically marked template.[15]

[15] Bruening himself actually assumes phonological epenthesis (i.e. *CC]$_{\sigma}$ ≫ Dep-IO(V)), but then he does not address forms like [qošṭ].

(36) Nouns with and without lexically specified templates

a. Trochaic diacritic: [mélɛx] ‘king’

/malk/$_{Tr}$	TROCHEE	STRESSRIGHT	DEP-IO(V)	*CC]$_{\sigma}$
(malk)	* !			*
☞ (mélɛx)		*	*	

b. Trochaic diacritic: [gəvérɛθ] ‘mistressˈ’

/gabɛrt/$_{Tr}$	TROCHEE	STRESSRIGHT	DEP-IO(V)	*CC]$_{\sigma}$
ga(vért)	* !			*
☞ gə(vérɛθ)		*	*	

c. No diacritic: [qošṭ] ‘truth’

/qošṭ/	TROCHEE	STRESSRIGHT	DEP-IO(V)	*CC]$_{\sigma}$
☞ (qošṭ)				*
(qóšɛṭ)		* !		
(qəšé:ṭ)			* !	

Epenthesis in segolate and [-εθ] nouns is thus driven not by the desire to avoid final clusters, but rather by the lexically imposed requirement to have a (σ́ σ) trochee at the end of the word.

Verbs almost always follow the iambic pattern (abstracting away from unstressed suffixes and endings like those seen in (12)b), so that [liqqáṭt] and [yišb] surface without epenthesis.

(37) Verb forms not marked with Tr diacritic

a. [liqqáṭt] ‘glean’ (2 sg. fem. perf.)

/liqqaṭt/	STRESSRIGHT	DEP-IO(V)	*CC]$_{\sigma}$
☞ (liq)(qáṭt)			*
(liq)(qáṭɛθ)	* !		
(liq)(qəṭé:θ)		* !	

b. [yišb] ‘take captive’ (jussive)

/yišb/	STRESSRIGHT	DEP-IO(V)	*CC]$_{\sigma}$
☞ (yišb)			*
(yíšɛv)	* !		
(yəšé:v)		* !	

Under this analysis, there is no opacity between stress placement and epenthesis in TH after all. It is not the case that epenthetic vowels are unstressed because they are added after stress has already been assigned. Rather, epenthetic vowels are unstressed because they are added only into words that are required to end in

a syllabic trochee and thus in an unstressed syllable.

Compliance with the lexical diacritic may perhaps be overridden by phonotactic considerations. Consider the jussive/imperfect consecutive forms of various *lamed-he* verbs: the forms in (38)a–f are repeated from (29) and the forms in (38)g–r from (14)b.

(38) Jussive/imperfect consecutive forms of *lamed-he* verbs

a.	way-yíšb	Num. 21:1	‘take captive’
b.	way-yíft	Job 31:27	‘be simple’
c.	way-yéšt	Gen. 9:21	‘drink’
d.	way-yévk	Gen. 27:38	‘weep’
e.	yeśṭ	Prov. 7:25	‘turn aside’
f.	way-yášq	Gen. 29:10	‘give water to’
g.	way-yívɛz	Gen. 25:34	‘despise’
h.	way-yívɛn	Gen. 2:22	‘build’
i.	yíɣɛl	Job 20:28	‘remove’
j.	way-yéɣɛl	2 Kings 17:6	‘exile’
k.	yíxɛl	Job 33:21	‘be consumed’
l.	wat-tɛ́mɛr	Ezek. 5:6	‘rebel’
m.	way-yáʕal	Gen. 8:20	‘bring up’
n.	way-yífɛn	Exod. 2:12	‘turn’
o.	way-yɛ́fɛr	Ps. 105:24	‘make fruitful’
p.	way-yíšaʕ	Gen. 4:4	‘look’
q.	way-yéθaʕ	2 Chron. 33:9	‘cause to stray’
r.	yírɛv	Gen. 1:22	‘multiply’

The forms in (38)a–f all end in a cluster with falling sonority; furthermore they all have final stress and thus conform to basic TH stress pattern. The forms in (38)g–q would all end in a cluster with level or rising sonority if the epenthetic vowel were not present; they all have penultimate stress and thus conform to the trochaic template, but because level and rising sonority clusters are prohibited in word-final position in TH it is unclear whether these words are trochaic for phonotactic reasons or because they are conforming to a lexically specified trochaic diacritic. But the form [yírɛv] in (38)r is clearly lexically marked for the trochaic diacritic since the alternative without the epenthetic vowel, *[yirb], is phonotactically permitted as it ends in a cluster with falling sonority. Thus we may conclude that some jussive/imperfect consecutive forms of *lamed-he* verbs are marked for the trochaic diacritic, while others are not so marked, but for many it is ambiguous to which they belong.

7.2 Epenthesis and ʔ-deletion

Turning to the next supposed example of opacity in TH, that between epenthesis and ʔ-deletion, we find that the derivational analysis, under which epenthesis precedes (and is counterbled by) ʔ-deletion, predicts that all cases of underlying word-final /Cʔ/ surface as [Cɛ], as we saw above in (20). However, this is not the case. There are nouns like [ḥeṭ] 'sin' ((18)b) and [gay] 'valley' ((18)c) and verb forms like [way-yár] 'see (imperfect consecutive)' ((18)d) where [ʔ] is deleted without epenthesis before it. Recall from (26) that /Cʔ/ ℜ [C] is the predicted, transparent relation. In fact, the only place where the correspondence relationship /Cʔ/ ℜ [Cɛ] holds is in segolate nouns (e.g. [dɛ́šɛ] 'grass') and in the "truncated" forms (jussives and imperfect consecutives) of *lamed-he* verbs whose second consonant is [ʔ], e.g. [way-yéðɛ] 'fly swiftly (imperfect consecutive)' (root *d-ʔ-h*). As we saw in the previous section, segolate nouns and "truncated" forms of some *lamed-he* verbs are lexically marked with the diacritic Tr, requiring them to have a syllabic trochee (σ́ σ) at their right edge. The forms without final [ɛ] do not have this diacritic. The purpose of the epenthesis is thus not to break up the /Cʔ/ cluster but to provide an unstressed final syllable so that the (σ́ σ) template can be met, as Bruening (1999) argued. The constraint hierarchy is shown in the tableaux in (39), on the basis of first declension (no diacritic) [ḥeṭ] 'sin' and second declension (trochaic diacritic) [dɛ́šɛ] 'grass'.

(39) Treatment of final Cʔ clusters

a. First declension (no diacritic) [ḥeṭ] 'sin'

/ḥeṭʔ/	*ʔ]$_{\sigma}$	TROCHEE	STRESSRIGHT	MAX-IO(C)	DEP-IO(V)	*CC]$_{\sigma}$
(ḥeṭʔ)	* !					*
☞ (ḥeṭ)				*		
(ḥĕṭé:)				*	* !	
(ḥéṭɛ)			* !	*	*	

b. Second declension (trochaic diacritic) [dɛ́šɛ] 'grass'

/dašʔ/$_{Tr}$	*ʔ]$_{\sigma}$	TROCHEE	STRESSRIGHT	MAX-IO(C)	DEP-IO(V)	*CC]$_{\sigma}$
(dašʔ)	* !	*				*
(daš)		* !		*		
☞ (dɛ́šɛ)			*	*	*	

The same tableaux would hold for /waC-yarʔ/ ℜ [way-yár] 'see (imperfect consecutive, no diacritic)' and /waC-yedʔ/$_{Tr}$ ℜ [way-yéðɛ] 'fly swiftly (imperfect consecutive, trochaic diacritic)'.

7.3 Spirantization after consonants

The third opacity of TH is that between syncope and spirantization, as illustrated by the relationship /malake:/ ℜ [malxè:] 'kings (construct)' (Gen. 17:16). The normal application of spirantization can be attributed to the constraint interaction *V⁀[−cont] ≫ *NONSIBILANT FRICATIVE ≫ IDENT-IO(cont). The constraint *V⁀[−cont] prohibits postvocalic stops, the constraint *NONSIBILANT FRICATIVE (*NONSIBFRIC) prohibits the feature cooccurrence [−son, +cont, −sib] (penalizing [f θ x v ð ɣ] while permitting [s ś z ṣ š][16]), and IDENT-IO(cont) prohibits a mismatch in the feature [continuant] between the input and the output.[17] In §2 it was mentioned that the principle of richness of the base predicts that the correct distribution of stops and fricatives will be achieved regardless of whether it is stops or fricatives that are present in the input. To show this, in the tableaux in this section, two inputs will be provided for each form, input (α) with stops and input (β) with fricatives. The constraint interaction responsible for the distribution of stops and fricatives is illustrated in (40) by [kɔ:θáv] 'he wrote' (Josh. 8:32). (The relationship between input /a/ and output [ɔ:] in the first syllable is not analyzed here.)

(40) *V⁀[−cont] ≫ *NONSIBFRIC ≫ IDENT-IO(cont), from [kɔ:θáv]

(α) /katab/ (β) /xaθav/	*V⁀[−cont]	*NONSIBFRIC	IDENT-IO(cont)	
kɔ:táb	*!*		(α)	
			(β)	**
☞ kɔ:θáv		**	(α)	**
			(β)	*
xɔ:θáv		***!	(α)	***
			(β)	

But in the opaque relationship /malake:/ ℜ [malxè:], the fricative [x] surfaces even though a consonant precedes on the surface. This looks like a gratuitous violation of *NONSIBFRIC; the transparent candidate would be *[malkè:]. The constraint LAPSE prohibits a sequence of two unstressed light syllables in a row.

[16] Cf. Benua's (1998) constraint *SPIR.

[17] The nonspirantization of [ṭ q] may be attributed to undominated markedness constraints against the "emphatic" nonsibilant fricatives [θ̣] and [χ].

(41) Transparent candidate *[malkè:] wins instead of [malxè:] ‘kings (construct)’

(α) /malake:/ (β) /malaxe:/	LAPSE	*V⁀[−cont]	*NONSIBFRIC	MAX-IO(V)	IDENT-IO(cont)
məlәkè:	* !	*			(α) (β) *
məlәxè:	* !		*		(α) * (β)
☹ malkè:				*	(α) (β) *
malxè:			* !	*	(α) * (β)

This overapplication of spirantization is found in only a few morphological contexts in TH.[18] First, it is found in imperative verb forms in the second person singular feminine, the second person plural masculine, and the second person singular masculine when this is augmented by the emphatic suffix [-ɔ:]. Examples are shown in (42), where overapplication of spirantization is indicated by italics.[19]

(42) Overapplication of spirantization in imperatives

a. Second person feminine singular

šix*v*í:	‘lie down!’	2 Sam. 13:11
šif*x*í:	‘pour out!’	Lam. 2:19
məl*x*í:	‘rule!’	Judg. 9:10

b. Second person masculine plural

kiθ*v*ú:	‘write!’	Deut. 31:19
wə-ʕiv*ð*ú:	‘and serve!’	Exod. 10:11
məš*x*ú:	‘draw!’	Ezek. 32:20
ḥɔr*v*ú:	‘be wasted!’	Jer. 2:12

c. Second person masculine singular + emphatic suffix [-ɔ:]

ʕɔz*v*-ɔ́:	‘leave!’	Jer. 49:11
šix*v*-ɔ́:	‘lie down!’	Gen. 39:7
ʕɛr*x*-ɔ́:	‘set in array!’	Job 33:5

In nouns, overapplication of spirantization is found in the plural construct, in-

[18] It is also found in a few foreign (Persian) names, such as [ḥar*v*o:nɔ́:], [biɣ*θ*ɔ́:], [ʔăvaɣ*θ*ɔ́:] in Esther 1:10.

[19] There are occasional exceptions such as [ʔis*p*í:] ‘gather! (2 f. sg.)’ (Jer. 10:17) beside expected [ʔis*f*ú:] ‘gather! (2 m. pl.)’ (Ps. 50:5).

cluding forms with a possessive suffix. Examples are shown in (43).[20]

(43) Overapplication of spirantization in plural construct forms

a. Unsuffixed forms

biɣ*ð*è:	‘garments’	Gen. 27:15
zan*v*ò:θ	‘tails’	Isa. 7:4
ḥas*ð*è:	‘mercies’	Isa. 55:3
ḥɔr*v*ò:θ	‘ruins’	Isa. 5:17
yiq*v*è:	‘vats’	Zech. 14:10
yiθ*ð*ò:θ	‘pins’	Exod. 27:19
kan*f*è:	‘wings’	Exod. 19:4
kan*f*ò:θ	‘wings’	Deut. 22:12
kiθ*f*ò:θ	‘shoulders’	Exod. 28:12
ʕiq*v*è:	‘heels’	Song of Sol. 1:8

b. Forms with possessive suffix

biɣ*ð*o:θ-é:xɔ:	‘your (m. sg.) garments’	Ps. 45:19
ḥɔr*v*o:θ-áyix	‘your (f. sg.) ruins’	Isa. 49:19
kan*f*e:-hém	‘their (m.) wings’	1 Kings 6:27
kan*f*e:-hén	‘their (f.) wings’	Ezek. 17:3

The third context where overapplication of spirantization is consistently found is with the accusative/possessive suffixes [-xɔ́:] ‘you/your (m. sg.)’, [-xém] ‘you/your (m. pl.)’ and [-xén] ‘you/your (f. pl.)’, which always begin with the fricative [x], regardless of whether a vowel or a consonant precedes. Examples of these suffixes occurring after a consonant are shown in (44).

(44) Accusative/possessive suffixes beginning with [x] even after a consonant

a. 2nd person masculine singular

ʔăxɔl-*x*ɔ́:	‘your eating’	Gen. 2:17
bin-*x*ɔ́:	‘your son’	Gen. 22:2
u-ve:rax-*x*ɔ́:	‘and he will bless you’	Deut. 7:13
go:ʔal-*x*ɔ́:	‘your Redeemer’	Isa. 48:17
ḥibbəláθ-*x*ɔ:	‘she bore you’	Song of Sol. 8:5

[20] Here too there are occasional exceptions such as [ʔɔs*p*é:] ‘gatherings’ (Mic. 7:1), [ḥɛr*p*ó:θ] ‘reproaches’ (Ps. 69:10), [ṭar*p*é:] ‘preys’ (Ezek. 17:9), [kas*p*e:-hém] ‘their (m.) silver coins’ (Gen. 42:25), [nis*k*e:-xém] ‘your (m. pl.) drink offerings’ (Num. 29:39), [ṣim*d*é:] ‘pairs’ (Isa. 5:10), [riš*p*é:] ‘flames’ (Song of Sol. 8:6, beside expected [riš*f*é:] at Ps. 76:4). Since spirantization (or lack of it) is indicated by the vowel pointing, which was not devised until several centuries after Hebrew had stopped being used as a spoken language, it is impossible to know to what extent exceptions such as these were genuinely present in the living language.

	wə-ʔɛʕɛś-*x*ɔ́:	‘and I make you become’	Gen. 12:2
	šim-*x*ɔ́:	‘your name’	Gen. 17:5
b.	2nd person masculine plural		
	ʔaðmaθ-*x*ém	‘your ground’	Gen. 47:23
	ʔăxɔl-*x*ém	‘your eating’	Gen. 3:5
	ʔɛθ-*x*ém	‘you (acc.)’	Gen. 47:23
	bi-vśar-*x*ém	‘in your flesh’	Gen. 17:13
	dim-*x*ém	‘your blood’	Gen. 9:5
	bə-yɛð-*x*ém	‘into your hand’	Gen. 9:2
	mišmar-*x*ém	‘your ward’	Gen. 42:19
	ʕɔrlaθ-*x*ém	‘your foreskin’	Gen. 17:11
c.	2nd person feminine plural		
	lə-qaðmaθ-*x*én	‘to your former state’	Ezek. 16:55

Finally, overapplication of spirantization is found when one of the proclitics [bə] ‘in’, [wə] ‘and’, [kə] ‘like, according to’, [lə] ‘to’ is attached to a word beginning [C_1əC_2-]. The result is [biC_1C_2-], [uC_1C_2-], [kiC_1C_2-], [liC_1C_2-] with spirantization of both C_1 (normal application) and C_2 (overapplication), if possible.

(45) Overapplication of spirantization after proclitics

a.	šəɣɔ:ɣɔ́:	‘error’	Num. 15:25
	bi-š*ɣ*ɔ:ɣɔ́:	‘in error’	Lev. 4:2
b.	gəvó:l	‘a border’	Gen. 10:19
	u-ɣ*v*ó:l	‘and a border’	Num. 34:6
c.	ləvɔ:v-ó:	‘his heart’	Deut. 2:30
	ki-l*v*ɔ:v-ó:	‘according to his heart’	1 Sam. 13:14
d.	bəθu:làθ	‘a virgin (construct)’	Deut. 22:19
	li-v*θ*u:làθ	‘to a virgin (construct)’	Lam. 1:15

All of these cases of overapplication of spirantization can be attributed to paradigm uniformity/uniformity of exponence effects (Kenstowicz 1996, 1997, Buckley 1999, Steriade 2000, Downing et al. forthcoming).

Consider first the cases in (42). The imperative forms listed there are the only ones in the entire verbal paradigm where the third consonant of the verbal root follows a consonant. In all other forms, the third consonant follows a vowel and thus undergoes spirantization regularly. The spirantization in the imperative forms can thus be considered analogical, occurring in order to reduce variation within the paradigm. The first and second consonants of the root do alternate between stops and fricatives (provided they belong to the class of consonants allowing this alternation), but the third consonant is invariably spirantized. Tak-

ing as an example the form [kiθvú:] ‘write!’ (2 m. pl.) from (42)b, t he paradigm of the qal binyan of the root *k-t-b* ‘write’ is given in (46); note that [k] and [θ] alternate with [x] and [t] in the imperfective, but [v] is invariant across all forms.

(46) Qal binyan of *k-t-b* ‘write’

	Perfective	Imperative	Imperfective
1 sg.	kɔ:θávti:		ʔɛxtó:v
2 m. sg.	kɔ:θávtɔ:	kəθóv/kiθ*v*ɔ́:	tixtó:v
2 f. sg.	kɔ:θavt	kiθ*v*í:	tixtəví:
3 m. sg.	kɔ:θáv		yixtó:v
3 f. sg.	kɔ:θəvɔ́:		tixtó:v
1 pl.	kɔ:θávnu:		nixtó:v
2 m. pl.	kəθavtɛ́m	kiθ*v*ú:	tixtəvú:
2 f. pl.	kəθavtɛ́n	kəθóvnɔ:	tixtóvnɔ:
3 m. pl.	kɔ:θəvú:		yixtəvú:
3 f. pl.	″		tixtóvnɔ:
Infinitive construct		kəθòv	
Infinitive absolute		kɔ:θó:v	
Active participle		ko:θé:v	
Passive participle		kɔ:θú:v	

There are many proposals for analyzing paradigm uniformity effects in OT (see references mentioned above), and this is not the place to discuss the merits and liabilities of each. Suffice it to say the reason the italicized sounds in (46) are fricatives rather than stops is not because of an underlying vowel before them which causes spirantization before disappearing, but rather because of the desire to reduce intraparadigm variation and allow the third consonant of the root to surface in a uniform manner. The stop/fricative alternations of the first and second consonants are widespread and systematic within the paradigm and therefore tolerated.

The fact that nouns in the construct plural show spirantization of the final consonant after another consonant, as shown in (43), can also be attributed to paradigm uniformity. Consider the paradigms of an iambic-template noun such as [zɔ:nɔ́:v] ‘tail’ and a trochaic-template (i.e. segolate) noun such as [mɛ́lɛx] ‘king’. As shown in (47), the iambic-template noun has a vowel before the root-final consonant in all forms of the singular as well as in the plural absolute, so that a fricative is phonologically predicted here. It is only in the construct plural that the root-final consonant follows another consonant; phonologically a stop would be expected, but in fact a fricative occurs.

(47) Paradigm of [zɔ:nɔ́:v] ‘tail’ (first declension)

	Singular	Plural
Absolute	zɔ:nɔ́:v	zənɔ:vó:θ
Construct	zənàv	zan*v*ò:θ
Construct suffixed	zənɔ:v-ó:	zan*v*o:θ-e:hɛ́m

In segolate nouns, there is a stop/fricative alternation in the singular, but none in the plural, as shown in (48).

(48) Paradigm of [mɛ́lɛx] ‘king’ (second declension, i.e. segolate)

	Singular	Plural
Absolute	mɛ́lɛx	məlɔ:xí:m
Construct	mɛ́lɛx	mal*x*è:
Construct suffixed	malk-ó:	mal*x*e:-hɛ́m

The fact that the segolate paradigm contains both stop and fricative allophones led Benua (1998) to argue that overapplication of spirantization in plural construct forms cannot be attributed to output-output faithfulness.[21] I disagree and would argue that in both (47) and (48), the spirantization of the root-final consonant in the construct plural may be analyzed as analogical to the absolute plural, where the spirantization is phonological. In the case of first-declension nouns like [zɔ:nɔ́:v], the singular may be exerting analogical influence as well. Segolate (second-declension) nouns generally tolerate the stop/fricative alternation in the singular, but there are a few nouns like [bɛ́ɣɛð] ‘garment’ that consistently retain the fricative even in singular suffixed forms: [biɣ*ð*-í:] ‘my garment’ (Ezra 9:3), [biɣ*ð*-ó:] ‘his garment’ (Gen 39:12); another example is [yiq*v*-ɛ́:xɔ:] ‘your (m. sg.) wine vat’ (Deut. 15:14). These cases show that the paradigmatic pressure for a consistently spirantized root-final consonant has begun to spread to the segolate construct singular as well.

As for the suffixes in (44), they may be analyzed as obeying a high-ranking uniformity of exponence constraint requiring them to surface with [x]. Another option would be to posit /x/ rather than /k/ in the input, but this analysis comes into conflict with richness of the base. In an alternation like [zɔ:xár] ‘he remembered’ (Gen. 40:23)/[yizkó:r] ‘he will remember’ (Hosea 8:13), richness of the base predicts that in allophonic variation, the correct allophones will surface regardless of which allophone is present in the input, i.e. even the input /zakar/ should surface as [zɔ:xár], and even the input /yizxo:r/ should surface as [yizkó:r]. So if the constraint ranking is such that the optimal output of /yizxo:r/ is [yizkó:r], then the optimal output of /binxɔ:/ ‘your son’ should likewise be *[binkɔ́:], not [binxɔ́:]. Therefore it is preferable to assume a constraint unique

[21] Instead, she outlines a possible sympathy theory analysis.

to these three possessive suffixes requiring them to surface with [x], rather than attempting a purely phonological analysis of the facts of (44).

Finally, the data in (45) are also best explained as the result of uniform exponence. The forms [šəɣɔ:ɣɔ́:], [gəvó:l], [ləvɔ:vó:], and [bəθu:làθ] have a phonologically expected spirant as their second consonant; this spirant remains in the forms [bi-šɣɔ:ɣɔ́:], [u-ɣvó:l], [ki-lvɔ:vó:], [li-vθu:làθ] with a proclitic. If a stop were to occur in the forms with the proclitics, the relationship between the basic form and the extended form would be made less transparent, damaging recoverability. The one exception to the generalization that words beginning [C_1əC_2-] retain the spirantization of C_2 when a proclitic precedes is when the proclitic [lə] attaches to an infinitive like [kəθó:v] 'write'. In this case, the result is not *[lixθó:v] but rather [lixtó:v] 'to write' (Josh. 18:8) with a stop. With other proclitics, infinitives behave normally, e.g. [bixθó:v] 'in writing' (Ps. 87:6). Idsardi (1998), arguing against an output-output correspondence analysis, accounts for this difference by analyzing [lə] as being [+cyclic] and [bə] as [−cyclic] and arguing that [+cyclic] forms behave in such a way as to delete vowels by syncope before spirantization has a chance to apply, where as [−cyclic] forms trigger syncope only after spirantization has already applied. But forms like [li-vθu:làθ] beside [bi-šɣɔ:ɣɔ́:] prove that the difference is not between [lə] and [bə], but rather between [lə] + noun and [lə] + infinitive. Gesenius (1910: 123–24, 348–51) has argued that [lə] + infinitive is a distinct grammatical form (he calls it "a kind of gerund"); if this is so, then a gerund like [lixtó:v] is sufficiently removed from the infinitive [kəθó:v] that the [t/θ] alternation is accepted between them, whereas [bi-xθó:v], being simply a proclitic + infinitive and not a distinct grammatical form, requires a greater degree of identity to [kəθó:v].

8 Conclusions

In this paper I have argued that the various alleged opaque relationships of TH do not refute OT, nor do they require any additional mechanism like sympathy theory. My analysis supports the hypothesis of Sanders (2003) that there is no instance of opacity in a purely phonological relationship (i.e. one that is free of morphological influence). All of the apparently opaque relationships in TH are influenced heavily by the morphology, in particular by the presence of trochaic templates for some words, including the declension class of segolate nouns. It is conformity to the trochaic template that causes the nonfinal stress discussed in §3 as well as the apparently unmotivated final epenthetic vowel discussed in §4. The overapplication of spirantization discussed in §5 is due to paradigm uniformity or uniformity of exponence considerations.

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