

Lexical stratification of Hebrew – the disyllabic maximum*

Michael Becker
University of Massachusetts, Amherst
michael@linguist.umass.edu

0. Introduction

In this paper, I point out that mobile stress roots of Modern Hebrew (e.g. *kodkód* – *kodkod-ím*) are maximally disyllabic, and that roots that are not restricted to a maximum of two syllables have fixed stress (e.g. *fonológ* – *fonológ-im*). I propose an account of this generalization, in which the lexicon is divided into strata, along the lines of Itô and Mester (1999). Each stratum is targeted by different rankings of constraints on size and stress, and the different rankings account for the differences in phonological behavior between the strata.

1. Stress patterns of Hebrew

Following Bat-El (1993), I divide the lexical items of Hebrew into two groups. The first group, exemplified in (1), includes final mobile stress items. These items have final stress on in their unsuffixed form, and when suffixes are added, stress shows up on the last suffix.¹

This group includes many nouns and adjectives (mostly native) and all the verbs.

(1) Mobile stress

| | Singular | Plural | |
|-------------|-----------------|--------------------|---------------|
| Nouns: | <i>dikdúk</i> | <i>dikduk-ím</i> | ‘grammar’ |
| | <i>dód</i> | <i>dod-ím</i> | ‘uncle’ |
| | <i>matan-á</i> | <i>matan-ót</i> | ‘gift’ |
| Adjectives: | <i>dikduk-í</i> | <i>dikduk-i-ím</i> | ‘grammatical’ |
| | <i>šakrán</i> | <i>šakran-ím</i> | ‘liar’ |
| | <i>tóv</i> | <i>tov-ím</i> | ‘good’ |
| Verbs: | <i>šamár</i> | <i>šamr-ú</i> | ‘keep’ |
| | <i>bizbéz</i> | <i>bizbez-ú</i> | ‘spend’ |

* Thanks to Joe Pater and Outi Bat-El for much guidance and discussion. I would also like to thank the audiences at IATL and the UMass phonology reading group.

¹ Some suffixes have their own stress properties, and they interact with roots in other ways. I set aside these suffixes, which are not immediately relevant to the discussion. For more about suffixes in Hebrew, see Bat-El (1993) and Graf (2001).

The second group, exemplified in (2), includes items that have fixed stress. These items have stress lexically marked on some syllable of the root (for some speakers, stress has to be on one of the last three syllables). The addition of a suffix does not change the location of stress.

This group includes nouns and adjectives, most of which are foreign, but no verbs. It should be noted at this point that adjectives in this group can only have their stress on the last syllable of the root.

(2) Fixed stress

| | | | |
|-------------|------------|--------------------------|--|
| Nouns: | kópirayter | kópirayter-im | ‘copywriter’ |
| | ámbulans | ámbulans-im ² | ‘ambulance’ |
| | diktátor | diktátor-im | ‘dictator’ |
| | pílpel | pílpel-im | ‘bell pepper’ |
| | tút | tút-im | ‘strawberry’ |
| | fonológ | fonológ-im | ‘phonologist’ |
| Adjectives: | malyán | malyán-im | ‘rich’ |
| | fonológ-i | fonológ-i-im | ‘phonological’ |
| | modiín-i | modiín-i-im | ‘relating to military intelligence’ |

2. Size restrictions

The shape of Hebrew verbs is heavily constrained by restrictions on size, and also by the choice of vowels. Bat-El (1994) points out that all verbs fit into a disyllabic template. In terms of Optimality Theory (Prince and Smolensky 1993), this restriction has been rephrased in terms of alignment. Ussishkin (2000) treats the Hebrew verbal system using the concept of Harmonic Alignment (Itô, Kitagawa & Mester 1996), asserting that in verbs, syllables must be aligned with some edge of the word.

Looking at denominal verbs, one sees in (3) that where the input noun ranges between 1 to 3 syllables, the output verb is always disyllabic.

| (3) | Noun | Verb | |
|-----|---------|------|------------------------------|
| 1σ | flírt | 2σ | flirtét ‘flirt / to flirt’ |
| 2σ | fíltér | 2σ | filtér ‘filter / to filter’ |
| 3σ | télefon | 2σ | tilfén ‘telephone / to call’ |

² When suffixation puts the stressed syllable outside the tri-syllabic window, some speakers move the stress two syllables to the right, so one also hears *kopiráyter*, *kopiráyter-im* and *ambuláns-im*. See more about this phenomenon in Bat-El (1993).

3. Putting together restrictions on size and stress

As has been known, Hebrew verbs have mobile stress, and their roots are disyllabic. Some verbal suffixes result in non-final stress in some forms; however there is no faithfulness to stress in the verbal system. Stress is fully predictable in this system.

The co-occurrence of mobile stress with a disyllabic maximum can be taken one step further, to nouns. Roots of mobile stress nouns are maximally disyllabic. It should be noted that the disyllabic restriction does not always hold on the surface, since a number of epenthesis processes intervene. This is true of both nouns and verbs. A grocery-list of epenthesis processes in Hebrew is given in Appendix A. Nouns that have fixed stress are not subject to any apparent size restriction.

Finally, looking at adjectives, it is again true that roots of mobile stress adjectives are maximally disyllabic, while there is no size restriction on fixed stress adjectives.

The generalization that holds across lexical categories is bi-directional: roots of mobile stress lexical items are subject to a disyllabic restriction, whereas roots that are not subject to the size restriction must have fixed stress.

4. Stratification of the lexicon

This paper offers a model of the Hebrew lexicon, following Itô and Mester (1999). The lexicon is divided into strata, based on phonological behavior. Each stratum defines a set of restrictions on the form of a possible word. This is shown in Figure 1.

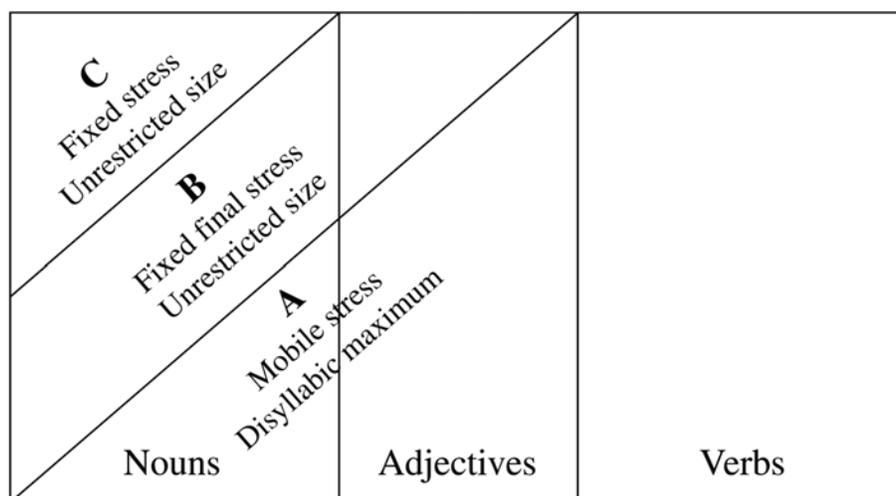


Figure 1: a stratified model of the Hebrew lexicon

Stratum A includes all the mobile stress items, which are subject to the disyllabic maximum restriction. This includes all the verbs, some adjectives, and some nouns. Most native adjectives and nouns are found in this stratum.

Strata B and C include all the fixed stress items, which are not subject to any size restriction. Stratum B includes all items that have fixed stress on their last syllable, many of which are loan-words. This stratum also includes most acronym words and all the adjectives that do not belong in stratum A.

Stratum C has no restriction on the location of stress, and it includes nouns only, most of which are loan-words.

5. Predictions

The model in §4 makes a number of predictions:

a. When a morphological process creates mobile stress items, which amounts to feeding stratum A, then these items must be disyllabic. This follows from the interdependence of mobile stress and the disyllabic maximum. Examples of this are given in §6 below.

b. When a morphological process creates items that are not restricted in size, which amounts to feeding stratum B or C, then these items must have fixed stress. This is the case of acronym words, which are discussed in §7 below.

The majority of acronym words happen to be disyllabic, but some are not. All acronym words must have fixed stress, because the process that creates them does not impose a size restriction. The assumption is that a single morphological process can only feed a single stratum.

c. If a root is more than two syllables long, then it must have fixed stress. This is a static restriction on the lexicon which follows from the model. This prediction is discussed in §8 below.

d. If a root has fixed stress on its final vowel, and it is not longer than two syllables, then it might turn into a mobile stress root through a process of historic change. In other words, if a root has fixed final stress but it is longer than two syllables, it is predicted not to become a mobile stress word. Examples are given in §9 below.

6. Mobile-stress output → maximally disyllabic

Most of the word formation processes of Hebrew feed stratum A. This applies, of course, to all the processes that create verbs, since verbs can only be in stratum A. Deverbal nouns and adjectives go mostly in stratum A, too. In (4), there are examples of some nonce verbs and various adjectives and nouns that can be productively derived from them. Each word in (4) represents a productive word formation process of Hebrew, and hundreds of examples may be given for each.

| | | | |
|-----|----------------------|----|---------------------------------|
| (4) | Nonce verbs: | 2σ | xagán, xigén, hixgín, hit-xagén |
| | Deverbal adjectives: | 2σ | xagún, xagín, xagnán... |
| | Deverbal nouns: | 2σ | xagin-á, xigún, haxgan-á... |

7. No size restriction on output → Fixed stress assigned

Acronym words (such as the English RADAR, NELS or WCCFL) are very common in Hebrew. The combined effect of minimality and economy make the majority of acronym words disyllabic. However, there is no size restriction on this word formation process, and tri-syllabic acronym words are fairly common.

As predicted by the model, the lack of size restriction entails that all acronym words must have fixed final stress.³ This prediction is nicely borne out. Examples are in (5).

| | | | | | |
|-----|----|----------|-------------|---|--------------------------------|
| (5) | 1σ | mák | mák-im | (< <u>m</u> efaked <u>k</u> ita) | ‘squad commander’ |
| | 2σ | rasáp | rasáp-im | (< <u>r</u> av <u>s</u> amal <u>p</u> lugati) | ‘company sergeant’ |
| | 3σ | katagmár | katagmár-im | (< <u>k</u> cin <u>t</u> irgum <u>m</u> erxavi) | ‘regional translation officer’ |

8. More than two syllables → must have fixed stress

Normativists usually insist on final stress in nouns and adjectives, regardless of their length. This is strongly rejected by native speakers; especially by those who have little access to normative Hebrew. These speakers use the forms under the column entitled “colloquial” in (6).

| (6) | | Normative | Colloquial | |
|-----|-------------|--------------|--------------|----------------|
| | Nouns: | ʔictadyon-ím | ʔictadyón-im | ‘stadium’ |
| | | ʔictrubal-ím | ʔictrubál-im | ‘pine cone’ |
| | Adjectives: | proporcyon-í | proporcyón-i | ‘proportional’ |
| | | funkcyonal-í | funkcyónál-i | ‘functional’ |
| | | yoguslav-í | yogusláv-i | ‘Yugoslav’ |
| | | yisraʔel-í | yisraʔél-i | ‘Israeli’ |

³ It should be noted that vowel-final acronym words are regularly assigned penultimate stress, e.g. *káca*, *xasámba*. A ranking of FtBin_B >> FinalStress can derive this stress pattern, while still keeping all acronym words uniformly in stratum B.

9. Maximally disyllabic, fixed final stress → may become mobile

In their unsuffixed forms, nouns with final stress are ambiguous between mobile stress and final fixed stress. Loan words of this sort are treated by some speakers as fixed stress words, and by some as mobile stress words.

The model predicts that only nouns that are no longer than two syllables may be treated as mobile stress nouns, and this prediction is nicely borne out, with examples given in (7).⁴

| | | | | | |
|-----|---------|-------------|-------|---------------|-------------|
| (7) | balón | balón-im | also: | balon-ím | ‘balloon’ |
| | salát | salát-im | | salat-ím | ‘salad’ |
| | bristól | bristól-im | | bristol-ím | ‘cardboard’ |
| | But: | kurasón-im | | * kurason-ím | ‘croissant’ |
| | | ʔartišók-im | | * ʔartišok-ím | ‘artichoke’ |
| | | katalóg-im | | * katalog-ím | ‘catalog’ |

10. The disyllabic maximum and ineffability

The requirement that mobile stress nouns be maximally disyllabic seems to have a solid psycholinguistic reality among native speakers. When speakers are asked to supply the plural of nouns, they do it very quickly and easily for most nouns. When speakers were asked about the nouns in (8), some said that “there is no plural”, while others took a very long time before they treated them as fixed stress nouns.

| | | |
|-----|------------|-------------------|
| (8) | duxifát | ‘hoopoe’ |
| | ʔizdaréxet | ‘Chinaberry tree’ |

The lack of a plural form is not due to semantic considerations (names for other birds and trees are easily pluralized), the problem is purely phonological: while these nouns seem to be “native” (probably because of the occurrence of the uvular fricative *x* in them, and the suffix *-et* in *ʔizdaréxet*), they cannot be mobile stress nouns because they are too long.

11. OT Analysis: Disyllabic maximum in stratum A, any size in B and C

The restrictions on possible words of Hebrew, as laid out in the model in section 4, can be formalized in terms of rankings of universal constraints on size and stress. In stratum A, no roots are more than two syllables long. This is both a static restriction on the roots of the lexicon, and a restriction on the derivation of new

⁴ There seem to be no mono-syllabic nouns that went from being fixed-stressed to mobile-stressed. This might be due to a requirement of a disyllabic *minimum*, a subject not explored here.

words. Within Optimality Theory, the two kinds of restrictions follow from a single constraint hierarchy. This is known as the principle of Richness Of The Base, which says that there are no restrictions on inputs, only on outputs. The grammar works as a filter to produce grammatical outputs only.

The disyllabic maximum is imposed by deletion, which is a violation of the constraint MAX (9). Ranked above MAX, we have ALIGN-σ (10), which is a constraint against forms longer than two syllables. This ranking selects deletion in order to satisfy the disyllabic requirement, as exemplified with a schematic form in (11).

In strata B and C, there is no size restriction, i.e. nothing is deleted in order to satisfy the disyllabic requirement. This is achieved by ranking MAX above ALIGN-σ, as exemplified in (12).

(9) MAX (McCarthy & Prince 1995)
Don't delete.

(10) ALIGN-σ (Itô, Kitagawa & Mester 1996, Ussishkin 2000)
Every syllable is aligned with some edge of a word

(11)

| /σσσ/A | MAX _{B,C} | ALIGN-σ | MAX _A |
|--------|--------------------|---------|------------------|
| ☞ σσ | | | * |
| σσσ | | *! | |

(12)

| /σσσ/B,C | MAX _{B,C} | ALIGN-σ | MAX _A |
|----------|--------------------|---------|------------------|
| σσ | *! | | |
| ☞ σσσ | | * | |

The constraint MAX is marked by a subscript of the stratum it applies to. This notation allows a single ranking hierarchy to apply to all the forms of the language.

12. Final stress in strata A and B, faithful stress in C

Strata A and B have final stress, while stratum C allows non-final stress if it is present underlyingly. In Strata A and B, final stress is the result of satisfying FINALSTRESS (13), which demands that stress be on the final syllable. In (15), non-final stress is present in the input, and FINALSTRESS forces an unfaithful mapping.

In stratum C, FAITHSTRESS (14) is ranked above FINALSTRESS, so non-final stress can surface faithfully. This is exemplified in (16).

(13) FINALSTRESS (Inkelas 1999)
= ALIGN(PWd,R,σ,R)

The stressed syllable is aligned with the right edge of the prosodic word.

- (14) FAITHSTRESS (Alderete 2001, Graf 2000)
If a vowel is stressed in the input, it is also stressed in the output.

(15)

| /óσ/A,B | FAITHSTRESS _C | FINALSTRESS | FAITHSTRESS _{A,B} |
|---------|--------------------------|-------------|----------------------------|
| ☞ σó | | | * |
| óσ | | *! | |

(16)

| /óσ/C | FAITHSTRESS _C | FINALSTRESS | FAITHSTRESS _{A,B} |
|-------|--------------------------|-------------|----------------------------|
| σó | *! | | |
| ☞ óσ | | * | |

13. Fixed stress in strata B and C, mobile stress in A

While strata A and B share the property of having final stress on unsuffixed forms, they differ when a suffix is added. In stratum A, the satisfaction of FINALSTRESS results in stress on the last available vowel, as shown in (18).

In stratum B, $\acute{\sigma} \in \text{ROOT}$ (17) demands that stress fall on a root vowel rather than on a suffix vowel, which is a part of the requirement that roots be more prominent than suffixes (Smith 2002). This is shown in (19).

- (17) $\acute{\sigma} \in \text{ROOT}$ (cf. Smith 2002, also Kenstowicz 1996)
The stressed vowel is a root vowel.

(18)

| /σσ+σ/A | $\acute{\sigma} \in \text{ROOT}_{B,C}$ | FINALSTRESS | $\acute{\sigma} \in \text{ROOT}_A$ |
|---------|--|-------------|------------------------------------|
| ☞ σσ+ó | | | * |
| óσ+σ | | *! | |

(19)

| /σσ+σ/B,C | $\acute{\sigma} \in \text{ROOT}_{B,C}$ | FINALSTRESS | $\acute{\sigma} \in \text{ROOT}_A$ |
|-----------|--|-------------|------------------------------------|
| σσ+ó | *! | | |
| ☞ óσ+σ | | * | |

A sample derivation is given in (20). In (a), antepenult stress on a tri-syllabic root can be faithfully mapped by situating the noun in stratum C. When an adjective is formed from this noun, as in (b), it can no longer be in stratum C, since adjectives belong in strata A and B. Putting the adjective in stratum B, rather than A, allows faithfulness to the tri-syllabic root, but the non-final stress is lost.

Finally, if a verb is to be formed, as in (c), it must go in stratum A, where all verbs are. Both final stress and disyllabicity must be achieved, at the price of a doubly unfaithful mapping.

- (20) (a) Noun: /téléfon/ → [téléfon]
(b) Adjective: [telefón-i]
(c) Verb: [tilfén]

14. Conclusions

The phonological behavior of the various parts of the Hebrew lexicon was shown to follow from a model that posits a stratified structure of the lexicon. Three strata were motivated; each stratum corresponds to a different kind of phonological behavior.

Constraints on size and stress were indexed for strata, creating different rankings in different strata. Both faithfulness and markedness constraints had to be indexed.

The core stratum includes all verbs, some adjectives and some nouns. This stratum is productively fed by WRFs, creating new verbs, adjectives and nouns that are no more than two syllables long.

An intermediate stratum contains the rest of the adjectives and some nouns. This stratum is productively fed by WFRs, creating adjectives and acronym words that are not limited in size.

The third and outmost stratum defines the weakest possible restrictions on a possible word of Hebrew. This stratum contains those nouns that have underlying stress on a non-final syllable.

References

- Alderete (2001) *Root-Controlled Accent in Cupeño*. *Natural Language and Linguistic Theory* 19:455-501
- Bat-El, Outi (1993) *Parasitic Metrifaction in the Modern Hebrew Stress System*. *The Linguistic Review* 10:189-210.
- Bat-El, Outi (1994) *Stem Modification and Cluster Transfer in Modern Hebrew*. *Natural Language and Linguistic Theory* 12:571-593.
- Becker, Michael (2003) *Hebrew stress: Can't you hear those trochees?* In Kaiser and Arunachalam (eds.) *Proceedings of PLC 26* 9.1:45-48.
- Graf, Dafna (2000) *Stress assignment in the nominal system of Modern Hebrew*. *IATL 7*, Proceedings of the Fifteenth Annual Conference of the Israeli Association for Theoretical Linguistics:51-70. Bar-Ilan University.
- Inkelas, Sharon (1999) *Exceptional Stress-Attracting Suffixes in Turkish: Representations vs. the Grammar*. In H. van der Hulst, R. Kager, and Wim Zonneveld (eds.), *The Prosody-Morphology Interface*. Cambridge University Press.
- Itô, Junko, Yoshihisa Kitagawa, and Armin Mester (1996) *Prosodic faithfulness and correspondence: Evidence from a Japanese argot*. *Journal of East Asian Linguistics* 5:217-294.

- Itô, Junku and Armin Mester (1999) *The Structure of the Phonological Lexicon*. In Tsujimura, Natsuko (ed.) *The Handbook of Japanese Linguistics*, Blackwell Publishers. pp. 62-100.
- Kenstowicz, Michael (1996) *Quality-sensitive stress*. *Rivista di Linguistica* 9:157-87.
- Smith, Jennifer (2002) *Phonological Augmentation in Prominent Positions*. Doctoral Dissertation, UMass Amherst.
- Ussishkin, Adam (2000) *The Emergence of Fixed Prosody*. Ph.D. Dissertation, UCSC.

Appendix A: The disyllabic maximum and epenthesis

General phonotactic restrictions trigger vowel epenthesis in Hebrew. This is due to a general constraint schema of the form MARKEDNESS >> DEP-V.

When mobile-stress forms violate phonotactic restrictions, epenthesis gives rise to surface forms that may have more than two vowels in their roots. This is a source of opacity.

Opacity in Optimality Theory is a subject of much debate, and in this paper I shall not attempt to argue in favor of any approach. However, for the sake of completeness, I offer a list of the epenthesis processes of the language, together with some examples of mobile stress nouns and adjectives whose surface forms are longer than two syllables. Epenthetic vowels are italicized.

- a. #ʔ__C clusters are broken by *a*-epenthesis

ʔakavis, ʔataléf, ʔafarsék, ʔaxbaróš, ʔadrixál, ʔamargán, ʔaxarón, ʔalaxsón ...
spider, bat, peach, rat, engineer, manager, last, diagonal...

- b. Coda glottals are repaired by *a*-epenthesis

yahalóm, saharón, raʔašán, taʔaríx ...
diamond, crescent, noise-maker, date...

- c. #[+son]__C clusters are broken by *e*-epenthesis

mehandés, mesukán, leʔuman-í ...
engineer, dangerous, nationalist...

- d. Medial CC__C is broken by *e*-epenthesis

tarnegól, palsefán, šafcerán, stagletán, saxsexán, bazbezán ...
rooster, smart alec, untrustworthy, adaptive, conflict-promoting, lavish spender...

- e. Identical consonants are separated by *e*-epenthesis

šaxexán, xafefán, xatetán, barerán, sanenán ...
forgetful, wishy-washy, prying, picky, call-screener...

- f. Combinations of the above:

ʔafarsemón (a+d), melafefón (c+e)...
persimmon, cucumber...

Appendix B: Iambic analysis of mobile stress roots?

Mobile stress roots are of the form $\sigma\acute{\sigma}$, which looks like an iamb, i.e. a disyllabic metrical foot with stress on its final syllable. Some authors have suggested analyses of Hebrew stress which involved iambs, as in Ussishkin (2000), Graf and Ussishkin (2002), and Landau (1998).

It should be noted that the analysis proposed here makes iambs an unnecessary and therefore an undesirable part of the analysis. The $\sigma\acute{\sigma}$ form turns out to be nothing more than a co-occurrence of two separate restrictions: Final stress (enforced by FINALSTRESS), and a size restriction (enforced by ALIGN- σ). That these two requirements are separate can be seen from the behavior of stratum B adjectives and acronym words, where FINALSTRESS applies, but the size restriction does not.

The absence of iambs from the analysis is consistent with the trochaic analysis of Hebrew in Becker (2003). Another case of the co-occurrence of FINALSTRESS and ALIGN- σ can be found in French, where a truncation process selects an output that looks like an iamb:

| | | | | |
|------------|--------------|------------|-------|-----------------|
| 3 σ | sinemá | 2 σ | siné | ‘cinema’ |
| 4 σ | ordinatóór | 2 σ | ordí | ‘computer’ |
| 5 σ | manifestasyó | 2 σ | maníf | ‘demonstration’ |

In French, FINALSTRESS is enforced throughout. Only the process of truncation shows the added effect of the disyllabic maximum, and there is no need to assume an iambic foot in any level of the analysis.