# Class 8
# Dark Matter in Phonology: Prosodic Structure?

15.01.2021

## 1 Dark Matter

> "Dark matter is a form of matter thought to account for approximately 85% of the matter in the universe and about a quarter of its total mass–energy density or about $2.241\times10^{-27}$ kg/m$^3$. **Its presence is implied in a variety of astrophysical observations, including gravitational effects that cannot be explained by accepted theories of gravity unless <u>more matter is present than can be seen</u>.** For this reason, most experts think that dark matter is abundant in the universe and that it has had a strong influence on its structure and evolution."
>
> (https://en.wikipedia.org/wiki/Dark_matter)

⇒ **Linguistic "dark matter"** ≈ (representational?) complexity that is **not directly observable**, but is required in order to explain observable phenomena.

| **QUESTION:** Are there linguistic phenomena which require *dark matter*? |
|---|

## 2 Stress

### 2.1 Some stress patterns

- Here are the stress patterns for several languages. **Describe the patterns.**
  - "1" = primary stress, "2" = secondary stress, "0" = unstressed

(1) Maranungku (Tryon 1970; Hayes 1980:86–87)

| | | | | |
|---|---|---|---|---|
| a. | 2σ | tíralk | [10] | 'saliva' |
| b. | 3σ | mérepèt | [102] | 'beard' |
| c. | 4σ | yángarmàta | [1020] | 'the Pleiades' |
| d. | 5σ | lángkaràtetì | [10202] | 'prawn' |
| e. | 6σ | wélepènemànta | [102020] | 'kind of duck' |

(2) Pintupi (Hansen & Hansen 1969; Hayes 1995:62–63)

| | | | | |
|---|---|---|---|---|
| a. | 2σ | páɳa | [10] | 'earth' |
| b. | 3σ | tʲúʈaya | [100] | 'many' |
| c. | 4σ | máɭawàna | [1020] | 'through from behind' |
| d. | 5σ | púɭiŋkàlatʲu | [10200] | 'we (sat) on the hill' |
| e. | 6σ | tʲámulìmpatʲùŋku | [102020] | 'our relation' |
| f. | 7σ | ʈíɭirìŋulàmpatʲu | [1020200] | 'the fire for our benefit flared up' |
| g. | 8σ | kúranʲùlulìmpatʲùɻa | [10202020] | 'the first one (who is) our relation' |
| h. | 9σ | yúmaɻìŋkamàratʲùɻaka | [102020200] | 'because of mother-in-law' |

(3) Weri (Boxwell & Boxwell 1966; Hayes 1980:89)

| | | | | |
|---|---|---|---|---|
| a. | 2σ | ŋintíp | [01] | 'bee' |
| b. | 3σ | kùlipú | [201] | 'hair of arm' |
| c. | 4σ | ulùamít | [0201] | 'mist' |
| d. | 5σ | àkunètepál | [20201] | 'times' |

### 2.2 Describing the patterns

(1′) Maranungku:

a. Alternate between stressed and unstressed syllables, starting from the left
b. Primary stress on the first syllable

(2′) Pintupi:

a. Alternate between stressed and unstressed syllables, starting from the left, BUT
b. *The final syllable must be unstressed*
c. Primary stress on the first syllable

(3′) Weri:

a. Alternate between stressed and unstressed syllables, *starting from the right*
b. Primary stress on the *last* syllable

⋆ WHAT SORT OF BUILDING BLOCKS COULD WE USE TO GENERATE STRESS PATTERNS LIKE THESE?

## 3 A WYSIWYG (*what you see is what you get*) approach, or Stress without dark matter

- Alternating stress emerges from the combined effect of two constraints:

(4) a. ***CLASH** (Liberman & Prince 1977, Prince 1983, Kager 2001, Gordon 2002, van Urk 2013, *a.o.*)
Assign a violation for each sequence of two adjacent **stressed** syllables. [*σ́σ́]

b. ***LAPSE** (Prince 1983, Selkirk 1984, Kager 2001, 2005, Gordon 2002, *a.o.*)
Assign a violation for each sequence of two adjacent **unstressed** syllables. [*σ̆σ̆]

### 3.1 Maranungku

- In a 3 syllable word, these two constraints will narrow down the candidates to just two:
  - Candidate (5c) [101] stresses the first and last syllables, with the middle syllable unstressed.
    → No sequences of stressed syllables. No sequences of unstressed syllables. Fully alternating.
  - Candidate (5f) [010] stresses just the middle syllable unstressed. This has the same effect.
    → No sequences of stressed syllables. No sequences of unstressed syllables. Fully alternating.

(5) Maranungku 3$\sigma$ words

| /merepet/ | | | | *CLASH | *LAPSE |
|---|---|---|---|---|---|
| a. | | mérépét | [111] | ** | |
| b. | | mérépet | [110] | * | |
| c. | ☞ | mérepét | [101] | | |
| d. | | mérepet | [100] | | * |
| e. | | merépét | [011] | * | |
| f. | 💣 | merépet | [010] | | |
| g. | | merepét | [001] | | * |
| h. | | merepet | [000] | | ** |

- We can implement the other generalization (*always stress the first syll.*) directly as well:

(6) **STRESSL:** Assign a violation if the leftmost syllable is unstressed. [*#σ̆]

(7) Maranungku 3$\sigma$ words (continued)

| /merepet/ | | | | StressL | *Clash | *Lapse |
|---|---|---|---|---|---|---|
| a. | | mérépét | [111] | | ** | |
| b. | | mérépet | [110] | | * | |
| c. | ☞ | mérepét | [101] | | | |
| d. | | mérepet | [100] | | | * |
| e. | | merépét | [011] | * | * | |
| f. | | merépet | [010] | $\boxed{*}$ | | |
| g. | | merepét | [001] | * | | * |
| h. | | merepet | [000] | * | | ** |

⋆ These three constraints, no matter their ranking, derive the Maranungku pattern in full.

[We'll need another constraint, something like "MainStressLeft" to determine where primary stress goes. We will need something equivalent in the alternative analysis, so I'll ignore this.]

## 3.2 Pintupi

- Pintupi differs from Maranungku in exactly one way: *final syllables can't be stressed.*

- Again, we can do this directly:

(8) **NonFinality** (Prince & Smolensky [1993] 2004, Gordon 2002, Hyde 2011)
Assign a violation if the rightmost syllable is stressed. [*$\acute{\sigma}$#]

- No we finally have *constraint conflict*:
  → in three-syllable words, it's impossible to satisfy all four constraints simultaneously.
- The observed candidate is (11d) [100] shows a lapse at the end.

(9) Crucial candidate comparisons
   a. (11d) [100] ≻ (11c) [101] NonFin ≫ *Lapse
   b. (11d) [100] ≻ (11f) [010] StressL ≫ *Lapse
   c. (11d) [100] ≻ (11b) [110] *Clash ≫ *Lapse

(10) **Pintupi Ranking:** NonFin, StressL, *Clash ≫ *Lapse

(11) Pintupi 3$\sigma$ words

| /tʲuʈaya/ | | | | NonFin | StressL | *Clash | *Lapse |
|---|---|---|---|---|---|---|---|
| a. | | tʲúʈáyá | [111] | *! | | *!* | |
| b. | | tʲúʈáya | [110] | | | *! | |
| c. | | tʲúʈayá | [101] | *! | | | |
| d. | ☞ | tʲúʈaya | [100] | | | | * |
| e. | | tʲuʈáyá | [011] | *! | *! | *! | |
| f. | | tʲuʈáya | [010] | | *! | | |
| g. | | tʲuʈayá | [001] | *! | | | * |
| h. | | tʲuʈaya | [000] | | *! | | ** |

▷ Grayed out rows are candidates which are "**harmonically bounded**": candidates that have a superset of violations of another candidate.
   ○ In Standard OT, because of strict ranking, these candidates can *never win.*

## 3.3 Maranungku revisited

- Now that we know NONFINALITY exists, we need to come back to Maranungku and make sure this doesn't mess up our analysis.

- In Maranungku, the winning candidate (12b) [101] *violates* NONFINALITY.
- All we need to do is rank NONFINALITY below the other three constraints, which we know are all satisfied.

(12) Maranungku 3$\sigma$ words, now with NONFINALITY

| /merepet/ | | | | STRESSL | *CLASH | *LAPSE | NONFIN |
|---|---|---|---|---|---|---|---|
| a. | | mérépet | [110] | | *! | | |
| b. | ☞ | mérepét | [101] | | | | * |
| c. | | mérepet | [100] | | | *! | |
| d. | | merépet | [010] | *! | | | |

(13) **Maranungku Ranking:** STRESSL, *CLASH, *LAPSE ≫ NONFIN

- In this approach, the difference between Maranungku and Pintupi boils down to the difference in which constraint is lowest ranked and thus can be violated under conflict.

(14)

| | Maranungku | Pintupi |
|---|---|---|
| Descriptive difference | *stress the final* | *don't stress the final* |
| Lowest ranked constraint | NONFINALITY | *LAPSE |

## 3.4 Weri

- In three syllable words (and indeed all odd-numbered syllable words), Weri has the same pattern as Maranungku (modulo the position of primary stress: initial in Maranungku, final in Weri).
  - So we could be tempted to use the ranking in (13).
- However, in even-numbered syllable words, we see a difference:

(15)

| | Maranungku | Weri |
|---|---|---|
| 2$\sigma$ | [10] | [01] |
| 4$\sigma$ | [1020] | [0201] |
| 6$\sigma$ | [102020] | [020201] |

- Going back to our descriptions, we said that the difference between the two languages was whether it alternated *from the left* (Maranungku) or *from the right* (Weri).
- We can implement this by adding one more constraint, the mirror-image of STRESSL:

(16) **STRESSR:** Assign a violation if the rightmost syllable is unstressed. [*$\breve{\sigma}$#]

(17) Weri 4$\sigma$ words with STRESSR

| /uluamit/ | | | | STRESSR | *CLASH | *LAPSE | NONFIN | STRESSL |
|---|---|---|---|---|---|---|---|---|
| a. | | úluámit | [1010] | *! | | | | |
| b. | ☞ | ulúamít | [0101] | | | | * | * |
| c. | | úluamít | [1001] | | | *! | * | |
| d. | | úlúamít | [1101] | | *! | | * | |

- We can't use the mirror-image of NONFINALITY (18). If it is ranked high enough generate the right pattern for 4$\sigma$ words (19), it wrongly selects *[010] in 3$\sigma$ words (20).

(18) **NONINITIALITY:** Assign a violation if the leftmost syllable is stressed. [*#$\acute{\sigma}$]

(19) Weri 4$\sigma$ words with NONINIT

| /uluamit/ | | | | NONINIT | *CLASH | *LAPSE | NONFIN | STRESSL |
|---|---|---|---|---|---|---|---|---|
| a. | | úluámit | [1010] | *! | | | | |
| b. | ☞ | ulúamít | [0101] | | | | * | * |
| c. | | úluamít | [1001] | | | *! | * | |
| d. | | úlúamít | [1101] | | *! | | * | |

(20) Weri 3$\sigma$ words with NONINIT

| /kulipu/ | | | | *CLASH | *LAPSE | NONINIT | NONFIN | STRESSL |
|---|---|---|---|---|---|---|---|---|
| a. | | kúlípu | [110] | *! | | *! | | |
| b. | ☹ | kúlipú | [101] | | | *! | * | |
| c. | | kúlipu | [100] | | *! | *! | | |
| d. | 💣 | kulípu | [010] | | | | | * |
| e. | | kulípú | [011] | *! | | | * | * |

- We do still need this constraint in CON, because some other systems do show NONINITIALITY effects. This means it must be present but low-ranked in Weri, and the other languages we're talking about.

### 3.5 Local summary

- In this approach, all you need are constraints referencing surface configurations of the following elements:

(21)
   a. Stressed syllables
   b. Unstressed syllables
   c. Word edges

⋆ There are of course other things that go into the distribution of stress, especially syllable weight, but this gets you the basics.

## 4 Alternation through footing, or Stress with dark matter

- This is not the standard approach to stress these days. The standard approach is to use **prosodic/metrical structure** (Nespor & Vogel 1986; McCarthy & Prince 1986), namely, ***feet*** (Liberman & Prince 1977, Hayes 1980, 1995, et seq.; Kager 1999:Ch. 4).

(22) **Prosodic hierarchy**

Prosodic Phrase
|
Prosodic Word
|
Foot
|
Syllable
|
Mora

- Elements lower down in the prosodic hierarchy are parsed (via GEN, in OT terms) into elements of higher categories (the immediately higher category, by default).
  → *hierarchical structure all the way down*
- The prosodic word ( ≈ *word*) comprises one or more feet.
- Feet are comprised of syllables, normally one **strong** syllable (the head) and one **weak** syllable.
  → Foot-heads attract stress.

⋆ In OT terms, CON has constraints that refer to different properties of feet, and EVAL optimizes over possible foot parses.

⇒ Prosodic structure is "**dark matter**": feet and other prosodic categories are representational devices that have no directly observable consequences.

## 4.1 Foot parses

- Foot-based analyses of the data at hand would posit the outputs below, where sets of ( )'s [ = foot boundaries] are a crucial part of the output representations.

(23) Maranungku (Tryon 1970; Hayes 1980:86–87)

| | | | | |
|---|---|---|---|---|
| a. | 2$\sigma$ | tíralk | **[(10)]** | 'saliva' |
| b. | 3$\sigma$ | mérepèt | **[(10)(2)]** | 'beard' |
| c. | 4$\sigma$ | yángarmàta | **[(10)(20)]** | 'the Pleiades' |
| d. | 5$\sigma$ | lángkaràtetì | **[(10)(20)(2)]** | 'prawn' |
| e. | 6$\sigma$ | wélepènemànta | **[(10)(20)(20)]** | 'kind of duck' |

(24) Pintupi (Hansen & Hansen 1969; Hayes 1995:62–63)

| | | | | |
|---|---|---|---|---|
| a. | 2$\sigma$ | páɳa | **[(10)]** | 'earth' |
| b. | 3$\sigma$ | tʲúʈaya | **[(10)0]** | 'many' |
| c. | 4$\sigma$ | máɭawàna | **[(10)(20)]** | 'through from behind' |
| d. | 5$\sigma$ | púɭiŋkàlatʲu | **[(10)(20)0]** | 'we (sat) on the hill' |
| e. | 6$\sigma$ | tʲámulìmpatʲùŋku | **[(10)(20)(20)]** | 'our relation' |
| f. | 7$\sigma$ | ʈíɭirìŋulàmpatʲu | **[(10)(20)(20)0]** | 'the fire for our benefit flared up' |
| g. | 8$\sigma$ | kúranʲùlulìmpatʲùɻa | **[(10)(20)(20)(20)]** | 'the first one (who is) our relation' |
| h. | 9$\sigma$ | yúmaɻìŋkamàratʲùɻaka | **[(10)(20)(20)(20)0]** | 'because of mother-in-law' |

(25) Weri (Boxwell & Boxwell 1966; Hayes 1980:89)

| | | | | |
|---|---|---|---|---|
| a. | 2$\sigma$ | ŋintíp | **[(01)]** | 'bee' |
| b. | 3$\sigma$ | kùlipú | **[(2)(01)]** | 'hair of arm' |
| c. | 4$\sigma$ | ulùamít | **[(02)(01)]** | 'mist' |
| d. | 5$\sigma$ | àkunètepál | **[(2)(02)(01)]** | 'times' |

**QUESTION:** WHAT ARE SOME OF THE PROPERTIES THAT DISTINGUISH THE DIFFERENT FOOT PARSES?

## 4.2 Footing parameters and constraints

⋆ All the constraints in this section have their roots in Prince & Smolensky ([1993] 2004), adapting the insights from Hayes (1980, 1995) and others.

### 4.2.1 FOOT FORM

- The central difference between Maranungku and Pintupi, on the one hand, and Weri, on the other, is the type of feet that the language exhibits.

(26)

| | | | | | |
|---|---|---|---|---|---|
| Maranungku/Pintupi: | **[(10)]** | ⇒ | *left-headed* | ⇒ | TROCHAIC |
| Weri: | **[(01)]** | ⇒ | *right-headed* | ⇒ | IAMBIC |

- The constraints implementing this get called various things, but usually something like the following:

(27) a. **FOOTFORM=TROCHAIC [TROCHEE]:**
Assign a violation for each foot which is not left-headed (i.e. stresses a syllable which is not at the left edge of the foot).

b. **FOOTFORM=IAMBIC [IAMB]:**
Assign a violation for each foot which is not right-headed (i.e. stresses a syllable which is not at the right edge of the foot).

- A language with trochaic footing (e.g. Maranungku/Pintupi) is thus one where TROCHEE ≫ IAMB (28).
- Conversely, a language with iambic footing (e.g. Weri) is one where IAMB ≫ TROCHEE (29).

(28) Trochees in Maranungku

| /tiralk/ | TROCHEE | IAMB |
|---|---|---|
| a. ☞ tíralk [(**1**0)] | | * |
| b. tirálk [(0**1**)] | *! | |

(29) Iambs in Weri

| /ŋintip/ | IAMB | TROCHEE |
|---|---|---|
| a. ☞ ŋíntip [(**1**0)] | *! | |
| b. ŋintíp [(0**1**)] | | * |

#### 4.2.2 FOOT BINARITY

- The main difference between Pintupi and Maranungku is what happens in odd-numbered syllable words.
  - Pintupi leaves the final syllable unstressed (and, crucially, unfooted).
  - Maranungku stresses it (by making it its own foot).

(30) a. Pintupi: *$t^j$úʈaya* **[(10)<u>0</u>]**
b. Maranungku: *mérepèt* **[(10)<u>(2)</u>]**

- In foot-based terms, this difference reduces to *whether the language requires feet to be binary.*
  - Pintupi requires all feet to be binary (2 syllables), and therefore prefers to leave a stray syllable "unparsed".
  - Maranungku has the reverse preference, preferring to parse all its syllables into feet, even if this means building a unary foot.
- The two constraints which conflict to derive this difference are:

(31) a. **FOOT BINARITY [FOOTBIN]:**
Assign a violation for each foot which is not comprised of two syllables (or moras).

b. **PARSE SYLLABLE [PARSE-σ]:**
Assign a violation for each syllable which is not parsed into some foot.

- The ranking FOOTBIN ≫ PARSE-σ generates Pintupi's demand for binary feet (32).
- The ranking PARSE-σ ≫ FOOTBIN generates Maranungku's demand for exhaustive footing (33).

(32) Unparsed final odd-numbered syllables in Pintupi

| /$t^j$uʈaya/ | FOOTBIN | PARSE-σ |
|---|---|---|
| a. ☞ $t^j$úʈaya [(10)<u>0</u>] | | * |
| b. $t^j$úʈayá [(10)(<u>1</u>)] | *! | |

(33) Unary feet in final odd-numbered syllables in Maranungku

| /merepet/ | PARSE-σ | FOOTBIN |
|---|---|---|
| a. mérepet [(10)<u>0</u>] | *! | |
| b. ☞ mérepét [(10)(<u>1</u>)] | | * |

- Weri shares Maranungku's ranking of PARSE-σ ≫ FOOTBIN. However, because of other differences (e.g. foot type), it's unary foot is at the left edge (34).

(34) Unary feet in initial syllables of odd-numbered words in Weri

| /kulipu/ | PARSE-σ | FOOTBIN |
|---|---|---|
| a. kulipú [<u>0</u>(01)] | *! | |
| b. ☞ kúlipú [(<u>1</u>)(01)] | | * |

### 4.2.3 Location and Directionality

- The trickiest part of the foot-based approach to stress is getting your feet to show up in the right place.

- Typically, this is done through some version of ALIGNMENT constraints (McCarthy & Prince 1993, Prince & Smolensky [1993] 2004, McCarthy 2003a; cf. Gordon 2002, Hyde 2012).

(35) a. **ALIGN(FOOT, L; WD, L) [ALL-FEET-L]:**
For each foot, assign one violation mark for each syllable which intervenes between the left edge of that foot and the left edge of the word.

b. **ALIGN(FOOT, R; WD, R) [ALL-FEET-R]:**
For each foot, assign one violation mark for each syllable which intervenes between the right edge of that foot and the right edge of the word.

- These constraints want all feet to be as close to the specified edge as possible.
- By definition, the more feet you have, the more displaced from the edge some of them will be. Therefore, these constraints can have the effect of limiting parsing to a single foot when they outrank PARSE-$\sigma$:

(36) ALL-FEET-L/R ≫ PARSE-$\sigma$ derives a single foot

| /$\sigma\sigma\sigma\sigma\sigma$/ | CULMINATIVITY | ALL-FEET-L | PARSE-$\sigma$ |
|---|---|---|---|
| a. $\sigma\sigma\sigma\sigma\sigma$ | *! | | ***** |
| b. ☞ $(\sigma\sigma)\sigma\sigma\sigma$ | | | *** |
| c. $\sigma(\sigma\sigma)\sigma\sigma$ | | *! | *** |
| d. $(\sigma\sigma)(\sigma\sigma)\sigma$ | | *!* | * |
| e. $(\sigma\sigma)\sigma(\sigma\sigma)$ | | *!** | * |
| f. $(\sigma)(\sigma\sigma)(\sigma\sigma)$ | | *! *** | |

- Languages with a single fixed stress are quite well attested. The interaction between edges and foot types yields four possible placements for a fixed stress (37), all of which are attested (see Gordon 2002:494, based on Hyman 1977).

(37) Position of single fixed stresses

| | Left | | Right | |
|---|---|---|---|---|
| **Trochee** | Initial | [#($\acute{\sigma}\sigma$)...] | Penultimate | [...($\acute{\sigma}\sigma$)#] |
| **Iamb** | Peninitial | [#($\sigma\acute{\sigma}$)...] | Final | [...($\sigma\acute{\sigma}$)#] |

⋆ There are also plenty of languages with antepenultimate stress, and probably some with post-peninitial (3rd) syllable stress. Additional constraints are necessary to derive these.

- But if PARSE-$\sigma$ outranks the alignment constraint, we generate **iterative** footing (multiple feet).

- The ranking FOOTBIN ≫ PARSE-$\sigma$ ≫ ALL-FT-L has the following effects:

(38) a. All feet have to be binary (FTBIN undominated)
b. Don't parse an odd number of syllables (FOOTBIN ≫ PARSE-$\sigma$)
c. Whatever feet you do parse, get arrange them so they each can be as close to the left as possible (PARSE-$\sigma$ ≫ ALL-FT-L)

→ This is Pintupi (when TROCHEE ≫ IAMB).

(39) Iterative (but non-exhaustive) footing in Pintupi (5$\sigma$ word)

| /$\sigma\sigma\sigma\sigma\sigma$/ | FtBin | Parse-$\sigma$ | All-Feet-L |
|---|---|---|---|
| a. $\sigma\sigma\sigma\sigma\sigma$ | | **!*** | |
| b. $(\acute{\sigma}\sigma)\sigma\sigma\sigma$ | | **!* | |
| c. ☞ $(\acute{\sigma}\sigma)(\acute{\sigma}\sigma)\sigma$ | | * | ** |
| d. $(\acute{\sigma}\sigma)(\acute{\sigma}\sigma)(\acute{\sigma})$ | *! | | ** **** |
| e. $(\acute{\sigma})(\acute{\sigma}\sigma)(\acute{\sigma}\sigma)$ | *! | | * *** |

- Recall that the main difference between Pintupi and Maranungku was that Maranungku parses stray syllables into unary feet. So, we might expect that just swapping the ranking of FtBin and Parse-$\sigma$ would give us Maranungku. It doesn't. (See Hyde 2012.)

(40) Trying to get Maranungku

| /$\sigma\sigma\sigma\sigma\sigma$/ | Parse-$\sigma$ | FtBin | All-Feet-L |
|---|---|---|---|
| a. $\sigma\sigma\sigma\sigma\sigma$ | *!**** | | |
| b. $(\acute{\sigma}\sigma)\sigma\sigma\sigma$ | *!** | | |
| c. $(\acute{\sigma}\sigma)(\acute{\sigma}\sigma)\sigma$ | *! | | ** |
| d. ☹ $(\acute{\sigma}\sigma)(\acute{\sigma}\sigma)(\acute{\sigma})$ | | * | ** ***!* |
| e. 💣 $(\acute{\sigma})(\acute{\sigma}\sigma)(\acute{\sigma}\sigma)$ | | * | * *** |

- Because the stray syllable now has to be footed, All-Feet-L cares where it ends up. Since it is a shorter foot than the binary ones, All-Feet-L will actually want it to come first.
  ↪ This allows the second and third feet to each be one syllable closer to the left ((40e) ≻ (40d)).

- Counter-intuitively, the way to generate Maranungku is to use All-Ft-R not All-Ft-L:

(41) Maranungku

| /$\sigma\sigma\sigma\sigma\sigma$/ | Parse-$\sigma$ | FtBin | All-Feet-R | All-Feet-L |
|---|---|---|---|---|
| a. $\sigma\sigma\sigma\sigma\sigma$ | *!**** | | | |
| b. $(\acute{\sigma}\sigma)\sigma\sigma\sigma$ | *!** | | *** | |
| c. $(\acute{\sigma}\sigma)(\acute{\sigma}\sigma)\sigma$ | *! | | * *** | ** |
| d. ☞ $(\acute{\sigma}\sigma)(\acute{\sigma}\sigma)(\acute{\sigma})$ | | * | * *** | ** ***!* |
| e. $(\acute{\sigma})(\acute{\sigma}\sigma)(\acute{\sigma}\sigma)$ | | * | ** ***!* | * *** |

- Likewise, Weri requires All-Feet-L to ensure that its unary foot is on the left.

## 4.3 Local Summary

- Using feet to determine stress placement requires a substantial number of constraints that refer to various properties of the feet themselves:

(42)
  a. Foot type (headedness)
  b. Binarity
  c. Alignment

- It turns out, though, that you still need a constraints like *Lapse, *Clash, and NonFinality to fix some of the problems (see, e.g., Kager 1999, 2005), mostly relating to the position of word-internal feet.

⋆ This would seem to be a point in favor of the foot-free approach.
  → You can get the same patterns without extra constraints and extra dark matter representations.

- But there are other stress patterns, mostly related to the interaction between syllable weight and word-internal stresses, that the foot-free approach has trouble with.
- I think most (fair-minded) people would say that the empirical coverage of the two approaches is similar in the realm of stress typology.

- The strongest arguments for feet, to my mind, come from other domains...

# 5 Other (claimed) sources of evidence for feet

## 5.1 Prosodic morphology

- Feet have long been invoked as a driver of "prosodic morphology" (McCarthy & Prince 1986).
  - Analysts have used feet and other aspect of the prosodic hierarchy to generating "templatic" effects in a wide variety of phenomena, including:
    - reduplication
    - root-and-pattern morphology
    - truncation
    - infixation
    - etc...

→ I think you can do without it in most cases.
  - See, e.g., Zukoff (2016) on reduplication.
  - See, e.g., Zukoff (2020, 2021) on root-and-pattern morphology and infixation.

## 5.2 Stress shift under deletion

- There are (allegedly) a number of cases where stressed vowels delete, and stress shifts to the other syllable within the (presumed) foot.
  - See Hayes (1995:42) for a list of them.
- The best-known such case is from Bedouin Hijazi Arabic (BHA; Al-Mozainy 1981, Al-Mozainy, Bley-Vroman, & McCarthy 1985).

### 5.2.1 BHA stress

- According to Al-Mozainy (1981:132ff.), stress is assigned as follows:

(43) a. If the final syllable is superheavy (CVCC or CVːC), stress the final. (44a)
b. Otherwise, if the penult is heavy (CVC or CVː), stress penult. (44b)
c. Otherwise, stress the antepenult. (44c)

- The foot-based analysis would say that you build one moraic trochee, preferentially around the rightmost heavy syllable (final mora is "extrametrical", i.e. invisible to footing).

(44) **Stress in BHA** (Al-Mozainy 1981:131)

| | | | | *Foot parses (moraic trochees)* |
|---|---|---|---|---|
| (44) | a. | maktúːb | 'written' | [mak(túː)<b>] |
| | | ðˤarábt | 'I hit' | [ðˤa(ráb)<t>] |
| | b. | maktúːfah | 'tied (FEM.SG)' | [mak(túː)fa<h>] |
| | | gaːbílna | 'meet us (MASC.SG)' | [gaː(bíl)<na>] |
| | c. | máːlana | 'our property' | [(máː)la<na>] |
| | | yáʃribin | 'they (FEM) drink' | [(yáʃ)rɨbi<n>] |

- Important fact: if the antepenult is (super)heavy and the penult is light, you should stress the antepenult.

#### 5.2.2 Stress shift under deletion

- BHA has various processes of vowel reduction and vowel deletion. These processes target, for example, the underlying antepenultimate /a/ in (45) deletes.

(45) 'she got broken' /ʔink**a**sarat/ → [ʔinksarat] (Al-Mozainy 1981:140)

- If stress applied transparently to the output of deletion, we would expect *[ʔínksarat] (46):

(46) /ʔinkasarat/ $\xrightarrow{deletion}$ *ʔinksarat* $\xrightarrow{stress}$ *[ʔínksarat]

- Instead, the actual output is [ʔinksárat], with penultimate stress.
- Al-Mozainy, Bley-Vroman, & McCarthy (1985) argue for an opaque (sequential) analysis:
  - Stress applies first (47a).
  - Then vowel deletion applies (47b), but the stress does not get deleted along with its host vowel.
  - Then stress is restricted to shifting **within its original foot** (47c).

(47) Shifting analysis

| | | /ʔinkasarat/ |
|---|---|---|
| a. | **Stress** | ʔin(kása)rat |
| b. | **Deletion** | ʔin(k ´sa)rat |
| c. | **Shift** | ʔin(ksá)rat |
| | | [ʔin(ksá)rat] |

- According to Hayes (1995), all known cases of stressed-vowel deletion have this same character, of shifting within the foot.

⋆ If this is true, then this is a really strong argument not only for feet, but for sequential derivation (unless we want to adopt really wonky parallel technology like Sympathy Theory (McCarthy 1999, 2003b)).

→ I'm skeptical...

#### 5.2.3 It might not actually be shifting...

- I think Al-Mozainy's (1981) stress algorithm is slightly off, in an important way.

- Al-Mozainy doesn't separate out [...HL{L/H}] words from [...LL{L/H}] words.
  - The algorithm in (43) predicts antepenultimate stress in both cases (48a,c).
  - As far as I can tell (also Gordon 2001:215, fn. 14), we actually get penult stress in the latter case (48d).
    - (There are not many such cases, because that vowel is usually targeted for deletion.)

(48) Antepenultimate stress?

| | **Predicted** | **Actual(?)** | | |
|---|---|---|---|---|
| [...HL{L/H}] | a. Antepenult [...**Ή**L{L/H}] | b. Antepenult | [...**Ή**L{L/H}] | ✓ |
| [...LL{L/H}] | c. Antepenult [...**Ĺ**L{L/H}] | d. Penult | [...L**Ĺ**{L/H}] | ✗ |

- If this is correct, then the "underlying" position of stress in /ʔinkasarat/ is actually the penult not the antepenult (49a).
  → This means that it is not a stressed vowel which is deleted in the first place, making the question of shifting moot.
  → Likewise, the same result obtains whether you do your stress with feet or not.

(49) No shift necessary, no feet necessary

| | | *With feet* | *Without feet* |
|---|---|---|---|
| | | /ʔinkasarat/ | /ʔinkasarat/ |
| a. | **Stress** | ʔinka(sára)t | ʔinkasárat |
| b. | **Deletion** | ʔink(sara)t | ʔinksárat |
| c. | **Shift** | *not applicable* | *not relevant* |
| | | [ʔink(sára)t] | [ʔinksárat] |

⋆ It's worth pointing out that stress is still opaque under this reanalysis.
  ◦ The stress algorithm would still rather stress a heavy antepenult than a light penult.
  ◦ But this is a more typical type of opacity, that we can argue about vis-à-vis simultaneous vs. sequential another day.

- It's also worth noting that this description of stress leads us to a straightforward foot-free analysis (following Rasin & Nasrallah 2020), which is not available under the description in (43):

(50) **Foot-free stress analysis:**
  a. WSP($3\mu$) ≫ NonFinality ≫ WSP($2\mu$) ≫ *LapseR
  b. *ExtendedLapseR ≫ WSP($2\mu$)

(51) a. **Weight-to-Stress($2\mu$) [WSP($2\mu$)]:** Assign a violation for each syllable with 2 or more moras that does not bear stress.
  b. **Weight-to-Stress($3\mu$) [WSP($3\mu$)]:** Assign a violation for each syllable with 3 or more moras that does not bear stress.

(52) a. ***LapseR:** Assign a violation for each sequence of 2 unstressed syllables at the right edge of the word.
  b. ***ExtendedLapseR:** Assign a violation for each sequence of 3 unstressed syllables at the right edge of the word.

### 5.3 Metrically-conditioned syncope

- Metrically-conditioned syncope refers to classes of processes where unstressed vowels are deleted in such a way that they opacify the stress algorithm. The BHA case is essentially of this character.
  ◦ These patterns are often most easily describable in terms of foot-based sequential derivation (see, e.g., McCarthy 2008).
- But there's some evidence that the most extreme types, for which feet seem most necessary, might actually be unlearnable (Bowers 2015).
  → Also, I think you might be able to get most of it with foot-free stress + Base-Derivative faithfulness.

## 6 Conclusion

⋆ Do we need dark matter in phonology?
→ Still an open question, intrinsically tied to the question of simultaneous vs. sequential architecture.

# References


Al-Mozainy, Hamza Qublan. 1981. Vowel Alternations in a Bedouin Hijazi Arabic Dialect: Abstractness and Stress. PhD Dissertation, University of Texas at Austin.

Al-Mozainy, Hamza Qublan, Robert Bley-Vroman & John J. McCarthy. 1985. Stress Shift and Metrical Structure. *Linguistic Inquiry* 16(1):135–144.

Bowers, Dustin Andrew. 2015. A System for Morphophonological Learning and its Consequences for Language Change. PhD Dissertation, UCLA.

Boxwell, Helen & Maurice Boxwell. 1966. Weri Phonemes. In S. A. Wurm (ed.), *Papers in New Guinea Linguistics No. 5* (Pacific Linguistics - Series A 7), 77–93. Canberra: Australian National University.

Gordon, Matthew. 2001. Syncope Induced Metrical Opacity as a Weight Effect. In Karine Megerdoomian & Leora Anne Bar-el (eds.), *Proceedings of the 20th West Coast Conference on Formal Linguistics*, 206–219. Somerville, MA: Cascadilla Press.

———. 2002. A Factorial Typology of Quantity-Insensitive Stress. *Natural Language & Linguistic Theory* 20(3):491–552.

Hansen, K. C. & L. E. Hansen. 1969. Pintupi Phonology. *Oceanic Linguistics* 8(2):153–170.

Hayes, Bruce. 1980. A Metrical Theory of Stress Rules. PhD Dissertation, MIT.

———. 1995. *Metrical Stress Theory: Principles and Case Studies.* Chicago and London: The University of Chicago Press.

Hyde, Brett. 2011. Extrametricality and Non-Finality. In Marc van Oostendorp, Colin Ewen, Elizabeth Hume & Keren Rice (eds.), *The Blackwell Companion to Phonology*, vol. 3, 1027–1051. Malden, MA: Wiley-Blackwell.

———. 2012. Alignment Constraints. *Natural Language & Linguistic Theory* 30(3):789–836.

Hyman, Larry M. 1977. On the Nature of Linguistic Stress. In Larry M. Hyman (ed.), *Studies in Stress and Accent* (Southern California Occasional Papers in Linguistics 4), 37–82. Los Angeles: Department of Linguistics, University of Southern California.

Kager, René. 1999. *Optimality Theory.* Cambridge: Cambridge University Press.

———. 2001. Rhythmic Directionality by Positional Licensing. Paper presented at the Fifth HIL Phonology Conference (HILP 5), University of Potsdam.

———. 2005. Rhythmic Licensing Theory: An Extended Typology. In *Proceedings of the Third International Conference on Phonology*, 5–31. Seoul: Seoul National University.

Liberman, Mark & Alan Prince. 1977. On Stress and Linguistic Rhythm. *Linguistic Inquiry* 8(2):249–336.

McCarthy, John J. 1999. Sympathy and Phonological Opacity. *Phonology* 16(3):331–399.

———. 2003a. OT Constraints are Categorical. *Phonology* 20(1):75–138.

———. 2003b. Sympathy, Cumulativity, and the Duke-of-York Gambit. In Caroline Féry & Ruben van de Vijver (eds.), *The Syllable in Optimality Theory.* Cambridge: Cambridge University Press. https://works.bepress.com/john_j_mccarthy/80/.

———. 2008. The Serial Interaction of Stress and Syncope. *Natural Language & Linguistic Theory* 26(3):499–546.

McCarthy, John J. & Alan Prince. 1986. Prosodic Morphology. *Linguistics Department Faculty Publication Series* 13 (1996 version). http://scholarworks.umass.edu/linguist_faculty_pubs/13.

———. 1993. Generalized Alignment. In Geert Booij & Jaap van Marle (eds.), *Yearbook of Morphology 1993*, 79–153. Kluwer.

Nespor, Marina & Irene Vogel. 1986. *Prosodic Phonology.* Dordrecht: Foris.

Prince, Alan. 1983. Relating to the Grid. *Linguistic Inquiry* 14(1):19–100.

Prince, Alan & Paul Smolensky. [1993] 2004. *Optimality Theory: Constraint Interaction in Generative Grammar.* Malden, MA: Blackwell Publishing.

Rasin, Ezer & Radan Nasrallah. 2020. Feeding-Duke-of-York Derivations in Nazarene Arabic and Their Implications for Phonological Architecture. Ms., Leipzig University and TAU.

Selkirk, Elisabeth. 1984. *Phonology and Syntax: The Relation Between Sound and Structure.* Cambridge, MA: MIT Press.

Tryon, D. T. 1970. *An Introduction to Maranungku (Northern Australia)* (Pacific Linguistics, Series B 15). Canberra: Australian National University.

van Urk, Coppe. 2013. Clash Placement in Quantity-Insensitive Languages. Ms., MIT.

Zukoff, Sam. 2016. Stress Restricts Reduplication. In Adam Albright & Michelle Fullwood (eds.), *Supplemental Proceedings of the Annual Meetings on Phonology 2014*, 1–12. Washington, DC: LSA. doi:http://dx.doi.org/10.3765/amp.v2i0.3742.

———. 2020. The Mirror Alignment Principle: Morpheme Ordering at the Morphosyntax-Phonology Interface. Ms., Leipzig University, 8/24/2020. https://ling.auf.net/lingbuzz/005374.

———. 2021. Deriving Arabic Verbal “Templates” without Templates. Paper presented at the 2021 LSA Annual Meeting, online, January 7-10. https://www.samzukoff.com/lsa2021handout.