Frequency, cyclicity, and optimality

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Thanks to: Andrew Carnie, Rachel Hayes, Diane Ohala, Adam Ussishkin, Natasha Warner, Andy Wedel, Gwanhi Yun, and especially James Myers.
Goals
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1. What is cyclicity?
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2. Rule-based and OT-based accounts
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3. Demonstrate a frequency effect with cyclic stress
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1. What is cyclicity?
2. Rule-based and OT-based accounts
3. Demonstrate a frequency effect with cyclic stress
4. Propose an account using lexically-restricted markedness
Organization
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1. Classical account of cyclic stress in English
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2. Problems with this account
Organization

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3. An OT-based account using lexically-restricted faithfulness
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4. Review of frequency effects
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5. A frequency effect with cyclic stress
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3. An OT-based account using lexically-restricted faithfulness
4. Review of frequency effects
5. A frequency effect with cyclic stress
6. A markedness-based account
Cyclic stress in English

còndènsátion

vs.

còmpensátion
Cyclic stress in English

còndènsátion (compare: condénse)

vs.

còmpensátion (compare: cómpensàte)
Cyclic stress in English

condensation (compare: condense)

vs.

compensation (compare: compensate)

(Chomsky & Halle, 1968)
There are more

preserved stress, cyclic:
condénsé  còndènsación
attést  àttèstátióń
objéctívë  òbjéctívïty
èlástícity
...

no preserved stress, cyclic:
cómpënsàte  còmpënsàtióń
démonstràte  dèmonstrátióń
ànecdòte  àncédòtal
...

5
Forms with no cyclic derivation

sèrendípity  Cônestóga  Trànsylvánia
Forms with no cyclic derivation

sèrendípity    Cônestóga    Trànsylvánia

These behave like the latter cases (like cómpensàte etc.).
Big picture

- còndènsátion:
- còmpensátion:
- sèrendípity:
Big picture

- còndènsàtion: stress preserved, related simple form (cyclic)
- còmpensàtion: no preserved stress, related simple form (cyclic)
- sèrendípity: no preserved stress, no related simple form (noncyclic)
Cyclic derivation

compensate

condense
Cyclic derivation

compensate → cómpensàte

condense → condénse
Cyclic derivation

compensate → cómpensàte → cómpensàtion

condense → condénse → condénsation
Cyclic derivation

compensate → cómpensàte → cómpensàtion → còmpensàtion

condense → condéense → condénsation → còndènsàtion
Halle & Kenstowicz (1991)
1. There are a number of items that do not exhibit cyclic stress even through they have bases of the right form, e.g. forms like *transformation*. 
Halle & Kenstowicz (1991)

1. There are a number of items that do not exhibit cyclic stress even through they have bases of the right form, e.g. forms like *trasformátion*.

2. There are a number of items like *condënsátion*, yet that have no cyclic base, e.g. forms like *östëntátion*. 
Should have a cyclic derivation

infórm  `információ
trànsfórm  trànsformáció
lámént  làmentáció
trànspórt  trànsportáció

(Halle & Kenstowicz, 1991: should be like còndënsáció)
Should not have a cyclic derivation

`ıncăntătion  òstěntáltion  `ıncărńáltion

(Halle & Kenstowicz, 1991: should be like sèrendípity)
Halle & Kenstowicz’s proposal:

Words like condensation and ostentation are treated alike: as instances of exceptional stress assignment, rather than cyclicity.

The cyclicity effect is simply exceptional stress.
This won’t work

While preservation of a rightmost primary stresses is subject to the exceptions Halle & Kenstowicz discuss, the preservation of a primary stress further to the left is not.

There are two classes of cases.
Cyclic stresses further to the left are regular

<table>
<thead>
<tr>
<th>WSW:</th>
<th>SSW:</th>
</tr>
</thead>
<tbody>
<tr>
<td>imáginé</td>
<td>imáginnation</td>
</tr>
<tr>
<td>arístocrát</td>
<td>arístocrátic</td>
</tr>
<tr>
<td>decápitát</td>
<td>decápitation</td>
</tr>
<tr>
<td>syllábicâte</td>
<td>syllàbicátion</td>
</tr>
<tr>
<td>óxygen</td>
<td>òxygennátion</td>
</tr>
<tr>
<td>péregrinátè</td>
<td>pèregrinátion</td>
</tr>
<tr>
<td>váriegátè</td>
<td>váriegátion</td>
</tr>
<tr>
<td>vítrìolàte</td>
<td>vitriolátion</td>
</tr>
</tbody>
</table>
What do we conclude?

The generalization is that a cyclic secondary stress is necessarily preserved in these cases, while it is only occasionally preserved in the original cases.

The difference is that in the original cases (like *condensation*), the preserved stress would otherwise end up adjacent to the new primary stress, while in these latter cases (like *imagination* and *peregrination*), the preserved stress ends up further from the new primary stress.
English stress with OT:  
Pater (2000) and/or Hammond (1999b)

PARSE-σ
Syllables must be parsed into feet.

TROCHEE
Feet are left-headed.

NONFINALITY
The final syllable is unfooted.
Some ranking arguments

- **TROCHEE** is never violated, so it must be ranked above anything that might conflict with it.

- The **NONFINALITY** constraint must outrank the **PARSE-σ** constraint, as final syllables are unfooted, despite the pressure to do so from **PARSE-σ**.

<table>
<thead>
<tr>
<th></th>
<th>TROCHEE</th>
<th>NONFINALITY</th>
<th>PARSE-σ</th>
</tr>
</thead>
<tbody>
<tr>
<td>/Can[a]da/</td>
<td><img src="image" alt="TROCHEE" /></td>
<td><img src="image" alt="NONFINALITY" /></td>
<td><img src="image" alt="PARSE-σ" /></td>
</tr>
<tr>
<td>/Caná[da]</td>
<td><img src="image" alt="TROCHEE" /></td>
<td><img src="image" alt="NONFINALITY" /></td>
<td><img src="image" alt="PARSE-σ" /></td>
</tr>
<tr>
<td>/Ca[náda]/</td>
<td><img src="image" alt="TROCHEE" /></td>
<td><img src="image" alt="NONFINALITY" /></td>
<td><img src="image" alt="PARSE-σ" /></td>
</tr>
<tr>
<td>Canada</td>
<td><img src="image" alt="TROCHEE" /></td>
<td><img src="image" alt="NONFINALITY" /></td>
<td><img src="image" alt="PARSE-σ" /></td>
</tr>
</tbody>
</table>
Stressing heavy syllables

**WSP**
Heavy syllables must be stressed (Pater doesn’t use this).

**FtBin**
Feet must be disyllabic (or bimoraic).

**WSP >> Nonfinality and FtBin**

<table>
<thead>
<tr>
<th>/chickadee/</th>
<th>WSP</th>
<th>Nonfin</th>
<th>FtBin</th>
<th>Parse-σ</th>
</tr>
</thead>
<tbody>
<tr>
<td>[chîcka][dée]</td>
<td></td>
<td>*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>[chîcka]ddee</td>
<td>*!</td>
<td>*</td>
<td>*</td>
<td>*</td>
</tr>
<tr>
<td>chi[ckádee]</td>
<td>*!</td>
<td>*</td>
<td></td>
<td>*</td>
</tr>
<tr>
<td>chicka[dée]</td>
<td></td>
<td>*</td>
<td></td>
<td><em>!</em></td>
</tr>
</tbody>
</table>
Finally, there is a general tendency to avoid adjacent stressed syllables that Pater formalizes as **CLASH-HEAD**.

**CLASH-HEAD**
A stress cannot be adjacent to the main stress.

This constraint prevents stresses from occurring next to a main stress, even if two heavy syllables should occur next to each other.

But such cases do occur, e.g. *càntánkerous*, etc.

Pater: **PARSE-σ >> CLASH-HEAD.**
Cyclicity in English with OT

Pater accounts for cyclic stress by adopting a correspondence constraint that requires that if a vowel is stressed in a base form, then it must be stressed in a derived form.

**IDENT-STRESS**

If $\alpha$ is stressed, $f(\alpha)$ must be stressed.
**IDENT-STRESS >> CLASH-HEAD**

<table>
<thead>
<tr>
<th>/condensation/</th>
<th>I-S</th>
<th>C-H</th>
<th>FTBIN</th>
<th>PARSE-σ</th>
</tr>
</thead>
<tbody>
<tr>
<td>[còn][dèns][á]tion</td>
<td>*</td>
<td>*</td>
<td>*</td>
<td>*</td>
</tr>
<tr>
<td>[còndens][á]tion</td>
<td>*</td>
<td></td>
<td>*</td>
<td></td>
</tr>
<tr>
<td>con[dèns][á]tion</td>
<td>*</td>
<td></td>
<td>**!</td>
<td></td>
</tr>
</tbody>
</table>

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Exceptional cases and listing

- **IDENT-STRESS** also applies to forms like *östentátiōn*, requiring that input accent matches output stress.

- Forms that do not stress a heavy syllable before the main stress, like *sèrendípity*, and forms with cyclic bases where the relevant syllable isn’t stressed in the derived form, like *information* are treated by listing the forms that **IDENT-STRESS** applies to.

- Forms like *sèrendípity* and *ìnformátiōn* would then not be listed.
An exceptional case

<table>
<thead>
<tr>
<th>/information/</th>
<th>I-S</th>
<th>C-H</th>
<th>FtBIN</th>
<th>PARSE-σ</th>
</tr>
</thead>
<tbody>
<tr>
<td>[inform][ät]ion</td>
<td>*!</td>
<td></td>
<td></td>
<td>*</td>
</tr>
<tr>
<td>[inform][ät]ion</td>
<td></td>
<td></td>
<td></td>
<td>*</td>
</tr>
<tr>
<td>in[fôrm][ät]ion</td>
<td>*!</td>
<td></td>
<td></td>
<td>**</td>
</tr>
</tbody>
</table>
Two IDENT-STRESS constraints

- There is a second general IDENT-STRESS constraint that does not include lexical stipulations that is ranked below CLASH-HEAD.
- This second more general IDENT-STRESS constraint requires that all lexical accents and cyclic stresses be preserved.
- Thus all cyclic stresses, and lexical accents, that do not clash with the main stress are preserved.
Stresses further to the left

<table>
<thead>
<tr>
<th>/imagination/</th>
<th>C-H</th>
<th>I-S</th>
<th>FtBin</th>
<th>Parse-σ</th>
</tr>
</thead>
<tbody>
<tr>
<td>imàgi[nà]tion</td>
<td></td>
<td></td>
<td>**</td>
<td></td>
</tr>
<tr>
<td>[ima]gi[ná]tion</td>
<td>*!</td>
<td></td>
<td></td>
<td>**</td>
</tr>
</tbody>
</table>
Exceptional stress is treated with the same mechanism

<table>
<thead>
<tr>
<th>/ostèntation/</th>
<th>I-S(...)</th>
<th>C-H</th>
<th>I-S</th>
</tr>
</thead>
<tbody>
<tr>
<td>[òs][tèn][tá]tion</td>
<td></td>
<td>*</td>
<td></td>
</tr>
<tr>
<td>[òsten][tá]tion</td>
<td>*!</td>
<td></td>
<td>*</td>
</tr>
</tbody>
</table>
Frequency effects
Frequency effects

- Fidelholtz (1975)
Frequency effects

- Fidelholtz (1975):astrónomy vs. gàstrónomy
Frequency effects

- Fidelholtz (1975): *astrónomy* vs. *gàstrónomy*
- Hooper (1976)
Frequency effects

- Fidelholtz (1975): astrónomy vs. gàstrónomy
- Hooper (1976): mem(o)ry vs. mammory
Frequency effects

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- Hicks et al. (2000)
Frequency effects

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Frequency effects

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Frequency effects

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- Hicks et al. (2000): únfít móther vs. únfít fáther
- Hammond (1999a): náîve friénd vs. òbése chîld
Open questions
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1. Does medial clash-based destressing/reduction as in words like *trànsformátion* also respect frequency?
Open questions

1. Does medial clash-based destressing/reduction as in words like \textit{transformation} also respect frequency?

2. If so, is it the frequency of \textit{transformation} or the frequency of \textit{transform} that plays a role?
Open questions

1. Does medial clash-based destressing/reduction as in words like *trànsformátiòn* also respect frequency?

2. If so, is it the frequency of *trànsformátiòn* or the frequency of *trànsfórm* that plays a role?

3. If there is a role to be played by frequency, how should it be modeled using OT?
A study

Is reduction in words with a cyclic derivation also subject to a frequency effect?

- all English nouns ending in -ation, along with their putative cyclic bases, e.g. trànsfórm and trànsformátion (from the MRC Psycholinguistic Database).
- Stressed syllable closed by a sonorant.
- Stressed vowel quality as distinct as possible from schwa.
- Forms with ambiguous stress were thrown out.
Coding

Reduction was coded along a four-point scale depending on how the relevant vowel was represented in *Webster’s New Collegiate Dictionary*.

- If only a reduced pronunciation was given, it was coded as a 3;
- if only an unreduced pronunciation was given, it was coded as a 0;
- If both pronunciations were given, then it was coded as a 1 or a 2, depending on which pronunciation was given first: unreduced or reduced respectively.
Frequency information

Frequency information was then collected on both members of the pair from the Brown Corpus with a Perl script written by the author.

(There are approximately 1,026,604 words in the Brown Corpus.)
A sample of the data

<table>
<thead>
<tr>
<th>red.</th>
<th>base</th>
<th>freq.</th>
<th>derived</th>
<th>freq.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>condemn</td>
<td>4</td>
<td>condemnation</td>
<td>7</td>
</tr>
<tr>
<td>1</td>
<td>conform</td>
<td>10</td>
<td>conformation</td>
<td>3</td>
</tr>
<tr>
<td>0</td>
<td>debark</td>
<td>0</td>
<td>debarkation</td>
<td>0</td>
</tr>
<tr>
<td>0</td>
<td>decant</td>
<td>0</td>
<td>decantation</td>
<td>0</td>
</tr>
<tr>
<td>1</td>
<td>deform</td>
<td>0</td>
<td>deformation</td>
<td>5</td>
</tr>
<tr>
<td>1</td>
<td>deport</td>
<td>1</td>
<td>deportation</td>
<td>0</td>
</tr>
<tr>
<td>1</td>
<td>disembark</td>
<td>0</td>
<td>disembarkation</td>
<td>0</td>
</tr>
<tr>
<td>1</td>
<td>embark</td>
<td>5</td>
<td>embarkation</td>
<td>0</td>
</tr>
<tr>
<td>0</td>
<td>exalt</td>
<td>1</td>
<td>exaltation</td>
<td>1</td>
</tr>
<tr>
<td>1</td>
<td>exhort</td>
<td>0</td>
<td>exhortation</td>
<td>0</td>
</tr>
<tr>
<td>1</td>
<td>export</td>
<td>25</td>
<td>exportation</td>
<td>0</td>
</tr>
</tbody>
</table>

...
A regression analysis was performed, a statistical test that allows us to see whether some numerical distinction correlates with another numerical distinction.
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There was a significant correlation with reduction: $R^2 = 0.087$, $p < 0.0028$ for base frequency and $p < 0.0006$ for derived frequency.
Interpreting the results

- The correlation with the frequency of the derived form means that the more frequent the form is, the more likely it is to undergo reduction.
- The correlation with the frequency of the base form means that the more frequent the base form, the more likely the derived form is to undergo reduction.
Consequences

1. These results thus mirror the results in Hammond (1999a) and Hicks et al. (2000).

2. The fact that there is an effect of base frequency on reduction of the derived word shows that the cyclic stress cases, like condënsåtion, are empirically distinct from the exceptional stress cases, like òstëntåtion.

3. Thus, on empirical grounds, an analysis that groups these together cannot be correct.

4. The effect of base frequency is perhaps quite counterintuitive.
Modeling frequency effects with OT

Pater: cyclicity with IDENT-STRESS(...), where specific lexical items are specified in the constraint.

To have frequency play the correct role in Pater’s analysis, we would need for forms to be mentioned in that constraint as an inverse function of their lexical frequency.
Examples

- *rèprésentation* occurs with sufficiently high frequency that it can undergo reduction. Hence, this word is not included in the IDENT-STRESS(...) constraint.

- On the other hand, *èxàltátion* occurs sufficiently infrequently that it can get mentioned.
Base frequency

The more frequent the base, the more likely reduction in the derived form.

Hence, if IDENT-STRESS(...) only includes very infrequent bases, it will have the consequence of blocking reduction just in case the base is infrequent.
Problems

1. Doesn’t generalize to novel or nonsense words.
2. Doesn’t generalize to phrasal rhythm.
An alternative

There is no constraint $\text{IDENT-STRESS(\ldots)}$, and that the $\text{CLASH-HEAD}$ constraint is instead lexically specified: $\text{CLASH-HEAD(\ldots)}$.

The difference is that now the most frequent items would be referred to by this constraint.
For example

<table>
<thead>
<tr>
<th>/transformation/</th>
<th>C-H(...)</th>
<th>I-S</th>
</tr>
</thead>
<tbody>
<tr>
<td>[tràn̂sfr][má]tion</td>
<td></td>
<td>*!</td>
</tr>
<tr>
<td>[tràn̂s][fó̂r][má]tion</td>
<td></td>
<td>*!</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>/exaltation/</th>
<th>C-H(...)</th>
<th>I-S</th>
</tr>
</thead>
<tbody>
<tr>
<td>[èx][àl][tá]tion</td>
<td></td>
<td></td>
</tr>
<tr>
<td>[èxal][tá]tion</td>
<td></td>
<td>*!</td>
</tr>
</tbody>
</table>
How to model the effect of the frequency of the base on the likelihood of reduction in the derived form

Specifically, if the relatively high frequency of occurrence of *comménd* is what triggers reduction of the relevant syllable in *commendáti*on, then we need a mechanism whereby the high frequency of the base makes it more likely that the derived form will be included in CLASH-HEAD(...).
A natural way to do this

• Suppose that the frequency of a complex derived form is a partial function of the frequency of its parts.

• Thus the computed frequency for *transformation* should be a function not only of how frequent the whole form is, but also how frequent each of its component morphemes are: *transfórm* and *-ation*.

• This is, in fact, what the psycholinguistic literature tells us (Taft, 1979).
Thus:

On this view, *commendátion* is more likely to be referred to by CLASH-HEAD(...) because its frequency is increased by the relatively high frequency of its component morphemes.
Evidence that this assumption is on the right track comes from English Latinate prefixes.

Chomsky & Halle (1968) show that the Latinate prefixes of English—those prefixes showing up in borrowings from Latin and French—exhibit reduction even when heavy.

This is true regardless of the frequency of the word in question.
For example

- Thus an unprefixed word like *çonchólogy* does not undergo initial reduction (as expected).

- However, a prefixed word like *convénticle* does undergo initial reduction (even though the word is extremely infrequent).

- SPE accounts for this by proposing a special class of prefixes and allowing their rule for reduction to be sensitive to this class.
An alternative account
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- Notice that though a word like *converticle* is frighteningly rare, the prefix *con-* is, in general, quite common.
An alternative account

- Notice that though a word like *conventicle* is frighteningly rare, the prefix *con-* is, in general, quite common.

- In the Brown corpus, *conventicle* doesn’t occur at all, yet words beginning with *con-* occur 6647 times.
An alternative account

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• If we factor the later into the former, then we make the prediction that we should get reduction of words with Latinate prefixes in a clash environment.
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- In the Brown corpus, *conventicle* doesn’t occur at all, yet words beginning with *con-* occur 6647 times.

- If we factor the later into the former, then we make the prediction that we should get reduction of words with Latinate prefixes in a clash environment.

- Words with Latinate prefixes undergo reduction, not because there is a special clause for Latinate prefixes, but because Latinate prefixes are generally quite frequent.
An additional benefit

- An additional benefit of this analysis is that we now have only a single IDENT-STRESS constraint and a single CLASH-HEAD(...) constraint.

- Pater’s analysis needs two separate IDENT-STRESS constraints.
Empirical conclusions
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1. There is a frequency effect with cyclic stress.
Empirical conclusions

1. There is a frequency effect with cyclic stress.
2. There is an effect of base frequency as well.
Empirical conclusions

1. There is a frequency effect with cyclic stress.
2. There is an effect of base frequency as well.
3. This effect is parallel to the frequency effects for the rhythm rule.
Theoretical conclusions
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1. We need lexically-restricted markedness.
Theoretical conclusions

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2. Exceptional stress cannot be equated with cyclic stress in English.
Theoretical conclusions

1. We need lexically-restricted markedness.
2. Exceptional stress cannot be equated with cyclic stress in English.
3. A naive exemplar-based account won’t work.