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Covert Representations and the Acquisition of Lexical Accent

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Introduction

Lexical accent poses in a particularly sharp form two basic problems (Dresher 1999) that learning models must overcome: the Credit/Blame Problem and what I have called Meno’s Problem.

Dresher & Kaye (1990) attempted to address these problems in the context of a learning model for a parametric metrical phonology.

I will show how this model, as modified by Dresher (1994), can be extended to learn lexical accent, at least in the case of a constructed simple language inspired by Russian.

Introduction

Many of the problems in acquiring lexical accent have to do with hidden structure.

Hidden structure has been discussed in the context of ‘overt’ and ’covert’ structures. I argue that these categories are fluid, and not fixed, as might sometimes appear from other learning models.

Though I assume a parametric metrical theory, the basic strategies applied in learning can be adapted to OT, and have some affinity with ideas proposed by Tesar and his colleagues (Tesar et al. 2003, Tesar 2006, etc.).

Stress contours before setting metrical parameters

a. *América*   b. *Mànitóba*   c. *agénda*

```
   x              x        x        Line 2
   x          x   x        x        Line 1
x  x  x  x    x x x   x  x x   x    Line 0
S  S  S  S    S S S   S  S S   S    Syllables
America      Manito:ba   agenda
```

I assume that at some early stage learners have access to representations like the ones above.

However, these are not the adult surface representations. They indicate levels of stress, but no metrical organization.

According to conventional accounts of English stress, the metrical structures assigned to these words have the following properties:

Assignment of syllable quantity

```
a. América          b. Mànitóba          c. agénda
     x                      x                  x          Line 2
     x                  x   x                  x          Line 1
   x x x x              x x x  x             x x  x       Line 0
   L L L L              L L H  L             L H  L       Syllables
   America             Manito:ba             agenda
```

- The syllables are classified as being either ***light*** (**L**) or ***heavy*** (**H**)

Foot assignment

```
a. América   b. Mànitóba    c. agénda
     x                x         x        Line 2
     x           x    x         x        Line 1
   x(x x)x      (x x (x) x    x(x) x     Line 0
   L L L L       L L  H  L    L H  L     Syllables
   America      Mani to:ba    agenda
```

- The syllables are classified as being either *light* (L) or *heavy* (H)
- Some syllables are grouped into maximally binary ***feet*** in which the first syllable is strong and the second is weak (trochees)

Extrametricality

a. *América* b. *Mànitóba* c. *agénda*

```
  x                x         x        Line 2
  x           x    x         x        Line 1
x(x x) x     (x x (x) x    x(x) x     Line 0
L L L  L      L L  H  L    L H  L     Syllables
Ameri ca     Mani to:ba    agenda
```

- The syllables are classified as being either *light* (L) or *heavy* (H)
- Some syllables are grouped into maximally binary *feet* in which the first syllable is strong and the second is weak (trochees)
- Final syllables are ***extrametrical***, meaning they may not be incorporated into a foot

Main stress

```
a. América            b. Mànitóba            c. agénda
     x                           x                  x              Line 2
     x)                     x    x)                 x)             Line 1
   x(x x) x               (x x (x) x             x(x) x            Line 0
   L L L  L                L L  H  L             L H  L            Syllables
   Ameri ca               Mani to:ba             agenda
```

- The syllables are classified as being either *light* (L) or *heavy* (H)
- Some syllables are grouped into maximally binary *feet* in which the first syllable is strong and the second is weak (trochees)
- Final syllables are *extrametrical*, meaning they may not be incorporated into a foot
- The rightmost foot in each word is designated as strongest (***main stress***)

Stress contours after setting metrical parameters

```
a. América          b. Mànitóba          c. agénda
     x                      x                  x           Line 2
     x)                x    x)                (x)          Line 1
   x(x x) x          (x x (x) x             x(x) x         Line 0
   L L L  L           L L  H  L             L H  L         Syllables
   Ameri ca          Mani to:ba             agenda
```

These surface structures cannot be derived from the acoustic signal alone. For example, an unstressed syllable can have several metrical representations:

Stress contours after setting metrical parameters

a. *América* b. *Mànitóba* c. *agénda*

```
  x                       x             x            Line 2
  x)                  x   x)            x)           Line 1
x(x x)  x            (x x (x)  x      x(x)  x        Line 0
L L L   L             L L  H   L      L H   L        Syllables
Ameri ca             Mani to:ba       agenda
```

These surface structures cannot be derived from the acoustic signal alone. For example, an unstressed syllable can have several metrical representations:

- it can be ***unfooted***, like the first syllables in *America* and *agenda* and the final syllables in all these words;

Stress contours after setting metrical parameters

a. *América* b. *Mànitóba* c. *agénda*

```
  x                      x                  x            Line 2
  x)                x    x)                 x)           Line 1
x(x x) x          (x x (x) x              x(x) x         Line 0
L L L  L           L L  H  L              L H  L         Syllables
Ameri ca          Mani to:ba              agenda
```

These surface structures cannot be derived from the acoustic signal alone. For example, an unstressed syllable can have several metrical representations:

- it can be the ***weak position of a foot***, like the third syllable of *America* and the second syllable of *Manitoba*;

Stress contours after setting metrical parameters

```
a. América          b. Mànitóba           c. agénda
     x                        x                x          Line 2
     x)                  x    x)               x)         Line 1
   x(x x) x            (x x (x) x            x(x) x       Line 0
   L L L  L             L L  H  L            L H  L       Syllables
   Ameri ca            Mani to:ba            agenda
```

There is no evidence that these different types of unstressed syllables can be distinguished phonetically, or that foot boundaries can be consistently identified from the signal.

The only way to know which representation to assign in each case is to acquire the grammar of stress.

The Grammar of Stress

I will assume that the grammar of stress builds metrical representations consistent with the simplified bracketed grid (SBG) theory of Idsardi (1992), Halle and Idsardi (1995), Halle (1999), etc. (with some modifications).

Metrical structures result from the interaction of a number of ***parameters*** that govern how brackets and heads are assigned to the grid. The main options are as follows:

Designated Elements

The language **{does not/does}** distinguish between light and heavy syllables.

If yes: Heavy syllables project a left or right bracket on line 0.

```
x(x x x          x x)x x        Line 0
L H L L   or     L H L L        Syllables
```

Designated Elements

The language **{does not/does}** distinguish between light and heavy syllables.

If yes: Heavy syllables project a left or right bracket on line 0.

I also assume that line 1 heads must be adjacent to these lexical brackets. Halle and Idsardi do not assume this, but strange results follow from not adopting this restriction.

```
   x                x              Line 1
 x(x  x  x        x  x)x  x        Line 0
 L  H  L  L   or   L  H  L  L      Syllables
```

Designated Elements

Similarly, lexical accents are represented as brackets. In addition to (x and x), we can also have postaccenting (x and preaccenting)x brackets.

```
)x x          x x(      Line 0
 S S    or    S S       Syllables
```

Designated Elements

Similarly, lexical accents are represented as brackets. In addition to (x and x), we can also have postaccenting (x and preaccenting)x brackets.

Again I assume that line 1 heads must be adjacent to these lexical brackets.

```
 x                  x         Line 1
  )x x           x x(         Line 0
   S S    or     S S          Syllables
```

Edge Markings

SBG allows for a variety of edge markings on line 0:

Insert a {left/right} bracket to the {left/right} of the {left/right}–most element on line 0.

The examples below show the 4 options at the left edge (the right edge options are parallel).

Option B gives extrametricality. C is preaccenting. I assume that D is a marked option that requires positive evidence. This leaves A as the unmarked option.

A.	B.	C.	D.	
`#(x x...`	`#x(x...`	`#)x x...`	`#x)x...`	Line 0

Other Parameters

Bounded constituents are created by Iterative Constituent Construction, but this will not be relevant to the cases I wish to discuss.

Line 0 constituents project their {left/right}-most element onto line 1.

Similarly, the {left/right}-most line 1 mark is projected onto line 2 to give main stress.

Acquisition of Stress

On these assumptions, acquisition of the grammar of stress amounts to setting these metrical parameters to their correct values.

Stress contours before setting metrical parameters

a. *Américа*   b. *Mànitóba*   c. *agénda*

```
  x               x          x        Line 2
  x           x   x          x        Line 1
x x x x       x x x  x     x x  x     Line 0
S S S S       S S S  S     S S  S     Syllables
America      Manito:ba     agenda
```

Stress contours after setting metrical parameters

a. *Américа*   b. *Mànitóba*   c. *agénda*

```
  x                x         x        Line 2
  x)          x    x)        x)       Line 1
x(x x) x     (x x (x) x    x(x) x     Line 0
L L L  L      L L  H  L    L H  L     Syllables
Ameri ca     Mani to:ba    agenda
```

Two Problems in Parameter Setting

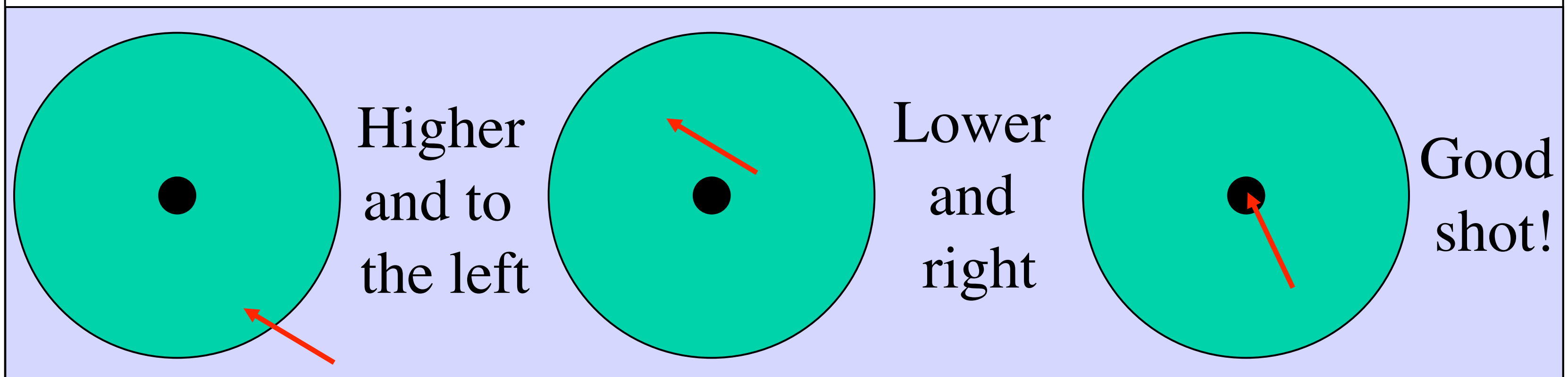
Parameter setting is not as simple as one might think. There are two main problems:

- **The Credit/Blame Problem (Clark 1989)**

- The Epistemological Problem (Meno's Paradox)

The Credit/Blame Problem

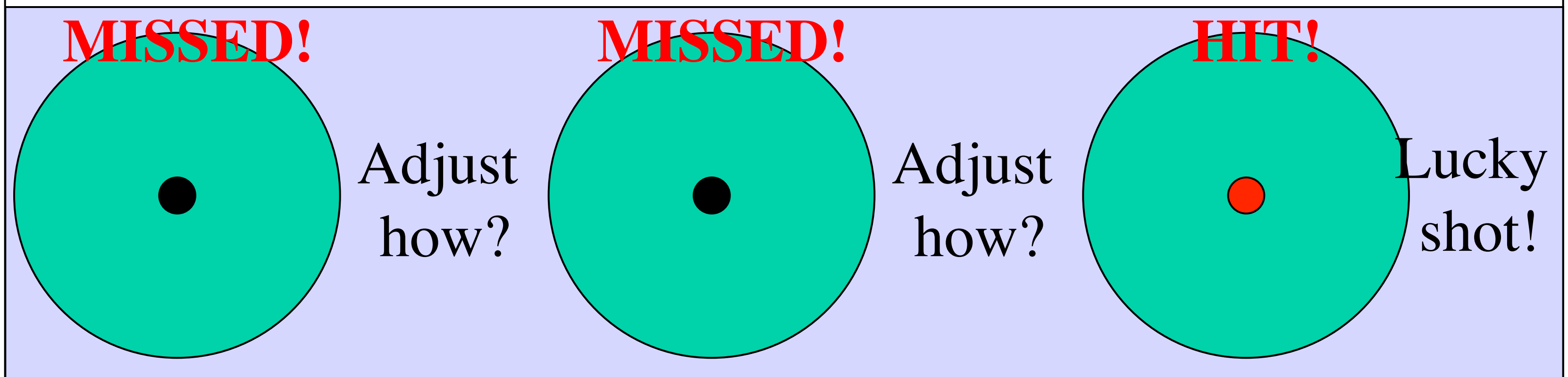
Parameter setting is not like trying to hit a target by adjusting one's aim based on where the last shot landed.



If it were, one could use an error-driven algorithm based on feedback as to how good one's current grammar is.

The Credit/Blame Problem

Rather, parameter setting is like trying to hit a target where one is told only that one has hit or missed:



This is known as the ***Credit/Blame Problem***: We do not know which parameter(s) is/are responsible for a miss, so we don't know which one(s) to change.

The Credit/Blame Problem

The Credit/Blame Problem arises because the relationship between the number of parameters correct and how well the learner's productions or parses match the target is not ***smooth***: depending on the particular case,

- One wrong parameter may lead to big mismatches
- Several wrong parameters may not look too bad

Two Problems in Parameter Setting

The second problem in setting parameters:

- The Credit/Blame Problem

- **The Epistemological Problem (Meno's Paradox)**

The Epistemological Problem

Some parameters are stated in terms of abstract entities and theory-internal concepts that the learner may not initially be able to identify.

The Epistemological Problem

a. *América* b. *Mànitóba* c. *agénda*

```
  x              x            x       Line 2
  x         x    x            x       Line 1
x x x x     x x  x  x     x x    x    Line 0
S S S S     S S  S  S     S S    S    Syllables
America    Manito:ba      agenda
```

How can a learner equipped with these initial representations answer the following questions:

- Are feet binary or unbounded? [*what's a foot?*]
- Are feet left-headed or right-headed? [*ditto?*]
- Is main stress on the left or on the right? [*how to tell?*]

The Epistemological Problem

This is the paradox posed by the title character in Plato's dialogue *The Meno*:

How can one investigate what one does not know?

If you stumble across it, how will you know it is the thing you did not know?

Consequences of the Two Problems in Parameter Setting

The discrepancy between the grammar and the observable results of the grammar — that is, between the ***I-grammar*** (***internal*** or ***intensional***) and the ***E-language*** (***external*** or ***extensional***) — defeats learning models that try above all to simply match the target forms (Gibson and Wexler 1994).

Consequences of the Two Problems in Parameter Setting

For the same reason, models based on a notion of goodness-of-fit (Clark and Roberts 1993) fail, because an E-measure of goodness is not a reliable indicator of the goodness of the I-grammar.

For similar reasons, Robust Interpretive Parsing (Tesar and Smolensky 2000) fails, because the OT grammar has no way to check that it’s corrective measures are actually improving the grammar.

Two Problems in Parameter Setting: A Solution

It follows from the above considerations that the learner's goal should not be to match target forms, but to look for evidence bearing on how to set parameters.

Dresher and Kaye (1990), following Lightfoot (1989), propose that learners must be born with some kind of a road map that guides them in setting the parameters.

Some ingredients of this road map are the following:

Built-in Cues (Triggers)

Universal Grammar associates every parameter with a ***cue*** (that is, a ***trigger***), something in the data that signals the learner how that parameter is to be set.

- The cue might be a pattern that the learner must look for, or simply the presence of some element in a particular context.
- A cue does not have to be an utterance or word. It may require the learner to compile statistics.

Parameters are Ordered

Parameter setting proceeds in a (partial) ***order*** set by Universal Grammar: this ordering specifies a ***learning path*** (Lightfoot 1989).

- The setting of a parameter later on the learning path depends on the results of earlier ones.
- Hence, cues can become become increasingly abstract and grammar-internal the further along the learning path they are.

Dresher & Kaye (1990) Model for Setting Metrical Parameters

1. Syllable Quantity

a. Parameter: The language {does not/does} distinguish between light and heavy syllables (a heavy syllable may not be a dependent in a foot).

b. Default: Assume all syllables have the same status (QI).

c. **Cue: Words of n syllables, conflicting stress contours (QS).**

[Requires no knowledge of syllable weight or metrical structure]

2. Extrametricality

a. Parameter: A syllable on the {right/leftt} {is not/is} extrametrical.

b. Cue: Stress on a peripheral syllable rules out extrametricality on that side.

3. Bounded constituent construction

a. Parameter: Line 0 constituents are bounded.

b. **Cue: The presence of a stressed non-edge L indicates bounded constituents.**

[Requires knowledge of syllable weight but not metrical structure]

Dresher & Kaye (1990) Model for Setting Metrical Parameters

4. Main stress

a. Parameter: Project the {left/right}-most element of the line 1 constituent.

b. **Cue: Scan a foot-sized window at the edge of a word. Main stress should consistently appear in either the left or right window.**

[Requires knowledge of syllable weight and foot size but not structure]

5. Headedness and directionality of feet

a. Parameters: {Left/right}-headed feet are constructed from the {left/right}.

b. Cue: Scanning from the {left/right}, a light syllable {following/ preceding} any other syllable must be unstressed.

c. Example: Scanning from the left, if for all (X L), L is unstressed, then direction = Left, Headedness = Left. If for all (L X) L is unstressed, then headedness = Right.

6. Destressing (conflates a number of separate parameters)

a. Parameters: {Various types of}feet are destressed in {various situations}.

b. Main Cue: The absence of stress on a foot.

c. Example: The lack of stress on the first syllable of agénda, with acquired foot structure (à)(gén)<da>, shows that this foot is destressed

Example: Setting an Early Parameter

1. **Syllable Quantity**

a. *Parameter:* The language {does not/does} distinguish between light and heavy syllables (a heavy syllable may not be a dependent in a foot).

b. *Default:* Assume all syllables have the same status (QI).

c. ***Cue:* Words of n syllables, conflicting stress contours (QS).**

[Requires no knowledge of syllable weight or metrical structure]

Cue for Setting Syllable Quantity

2-syllable words

QI

All words have the same stress

/ x		x /
páta	pátan	Berlín
pánta		pántam

I.e., almost all words: a few exceptions are not sufficient to set up a new stress class.

QS

Conflicting stress contours

/ x	x /	\ /
páta	patán	pàntám
pánta		

In QS systems conflicting stress patterns are systematic and pervasive.

Cue for Setting Syllable Quantity

3-syllable words

QI

All words have the same stress

x / x		/ x x
patáka	pantárka	Hélsinki *exception*
pantáka	pantákar	
patánka	patánkar	
patákan	pantárkam	

QS

Conflicting stress contours

x / x	\ / x	\ x /
patáka	pàntáka	pàtakán
patánka	pàntárka	pàntakár

x \ /	\ \ /
patànkár	pàntàrkám

Cue for Setting Syllable Quantity

4-syllable words

QI

All words have the same stress

\ x / x
pàtakána pàtarkána pàntakála
pàtakánar pàtakárta pàtarkánam
pàtarkálna pàntakánam
pàtakárnam pàntakárna
pàntarkána pàtarkántal
pàntarkánam pàntakárnam
pàntarkálna pàntarkálnam

QS

Conflicting stress contours

<table>
<tr><td rowspan="2">\ x / x
pàtakána
pàtakárta
pàntakála
pàntakárna</td><td>x\ x /
patàkanár
patàrkanám</td><td>x\ / x
patàrkána
patàrkálna</td></tr>
<tr><td>x \ \ /
patàrkàntál</td><td>\ \ \ /
pàntàrkàlnám</td></tr>
<tr><td>\ x \ /
pàtakàrnám
pàntakàrnám</td><td>\ \ x /
pàntàkanám
pàntàrkanám</td><td>\ \ / x
pàntàrkána
pàntàrkálna</td></tr>
</table>

Example: Setting an Early Parameter

1. **Syllable Quantity**

   ***Cue:* Words of n syllables, conflicting stress contours (QS).**

This relatively early cue requires no knowledge of syllable weight or metrical structure, knowledge which the learner does not yet have.

It *does* require the learner to keep track of patterns, and compile statistics as a way of filtering out incidental exceptional forms.

Example: Setting a Later Parameter

1. Main Stress

a. *Parameter:* Project the {left/right}-most element of the line 1 constituent (i.e., foot).

b. ***Cue:* Scan a foot-sized window at the edge of a word. Main stress should consistently appear in either the left or right window.**

This cue requires knowledge of syllable weight and foot size but not foot structure.

Cue for Main Stress

Main Stress Right in this case

Main stress always in a foot-sized window on the right edge

```
   x               x             x          x
   x               x        x    x          x    x
  (x x)           (x)      (x   (x  x)     (x   (x  x)
   L L          L  H        H    H  L       H    H  L
  páta         pa tán      pàn tárka       Hél  sìnki
```

```
        x                  x                  x
   x    x           x      x        x   x     x
  (x x (x x)     x (x x   (x)      (x  (x    (x x)
   L L  L L      L  L L    H        H   H     L L
  pàta kána     pa tàka   nár      pàntàr    kána
```

The learner is still keeping track of patterns, but at a higher level level of abstraction.

Cue for Main Stress

Main Stress Right in this case

Main stress always in a foot-sized window on the right edge

```
   x              x            x             x
   x              x        x   x          x  x
  (x  x)         (x)      (x  (x   x)    (x (x   x)
   L  L        L  H        H   H   L      H  H   L
  páta       pa tán      pàn tárka      Hél sìnki
```

```
         x                 x                x
   x     x          x      x       x    x   x
  (x  x (x  x)   x (x  x) (x)     (x   (x) (x  x)
   L  L  L  L    L  L  L   H       H    H   L  L
  pàta kána     pa tàka   nár    pàntàr    kána
```

The learner is still keeping track of patterns, but at a higher level level of abstraction. Again, isolated exceptions should not count.

Statistics and UG

There is no issue here of whether a learner appeals to UG *or* to statistics, as if the two represent competing approaches.

In both cases discussed above, the collection of patterns and statistics *is informed by* UG.

Overt and Covert Forms

The problem of hidden structure is often expressed in terms of ‘overt’ and ‘covert’ structure: the idea is to use the overt structure to acquire the covert structure.

While this is correct in general, it is important to keep in mind that these categories are not fixed, but fluid: at the outset most aspects of structure are covert; as acquisition proceeds they gradually become overt.

For example, syllable quantity (H or L) is often taken as overt in the data supplied to the learner, reflecting the fact that correct QS is a prerequisite to acquiring metrical representations; but it is in fact covert to begin with, as shown above.

Lexical Accent

Lexical accent poses a challenge, in that it appears to instantiate the basic learning problems in an extreme way: it's a bit like learning QS, but with all the syllables covered up).

Moreover, lexical accent does not go easy on the learner in other ways, but appears to pile on the complexity: lexical accent systems can have post- and pre-accenting morphemes, which are not found in QS systems, and special rules moving or deleting accents, all of which add to the difficulty of acquiring the system.

OT Learning of Lexical Accent

OT attempts to model the acquisition of lexical accent (Tesar et al. 2003, Tesar 2006) have taken lexical accent to be a typical example of the acquisition of underlying forms (URs).

It is true that lexical accent involves learning URs, but I don't think it is a typical example of this problem. Typically, the problem of learning URs involves alternations that are caused by diverse processes that may interact with stress (e.g., epenthesis or deletion of vowels that may obscure the stress pattern.

OT Learning of Lexical Accent

The notorious yers of Russian come to mind. Solving the problem of URs thus involves combining input from various parts of the phonology and morphology.

In the case of lexical accent, however, the learner has to acquire accented or unaccented URs based only on the facts of stress. That is, lexical accent is a 'stress-internal' problem, a lot like the problem of determining if a system is QS.

OT Learning of Lexical Accent

Tesar et al. (2003) consider a very simple lexicon and set of constraints they call the PAKA world. It contains two stems, unaccented /pa/ and accented /ba/, and two suffixes, unaccented /-ka/ and accented /-ga/.

	Stem	Suffix
Accented:	b<u>a</u>	-g<u>a</u>
Unaccented:	pa	-ka

(The use of voiceless onset with unaccented morphemes and voiced with accented is just intended as a mnemonic, not a real part of the data.)

They assume the following constraints:

PAKA World Constraints

A.	MAINLEFT (ML):	Stress the leftmost syllable.
B.	MAINRIGHT (MR):	Stress the rightmost syllable.
C.	FAITHACCENT (F):	Stress an accented syllable.
D.	FAITHACCENTROOT (FR):	Stress an accented root syllable.

The PAKA grammar does not make reference to the metrical grid, however.

Inspired by this model, I tried something a little more complicated, with a learning model geared to acquiring SBG representations.

AUP Language

For this discussion I assume an idealized language reminiscent of Russian, which has 3 types of stems: accented, unaccented, and postaccenting; and 2 types of suffixes: accented and unaccented (the segmental differences are mnemonics):

Accented stems:	goróv	dólov
Unaccented stems:	kolov	torov
Postaccenting stems:	molov	norov
Accented suffixes:	-a	-e
Unaccented suffixes:	–u	-i

AUP Words

There are 2 types of accented stems, so we have potentially 8 different word patterns in this set:

A + A	U + A	P + A
goróv-a	kolov-á	molov-á
dólov-a		
A + U	**U + U**	**P + U**
goróv-u	kólov-u	molov-ú
dólov-u		

Learning Path for Lexical Accent

At the outset, words are classified based on their stress contours, the only aspect of metrical structure that is overt at this stage. We find conflicting patterns, so no QI.

/ x x	x / x	x x /
dólov-e	goróv-a	kolov-á
dólov-i	goróv-u	torov-é
kólov-u		molov-á
tórov-i		norov-é
		molov-ú
		norov-í

Learning Path for Lexical Accent

These conflicting stress patterns cannot be resolved in terms of different syllable structures, hence the language is not QS; nor does morphology help.

/ x x	x / x	x x /
dólov-e	goróv-a	kolov-á
dólov-i	goróv-u	torov-é
kólov-u		molov-á
tórov-i		norov-é
		molov-ú
		norov-í

Learning Path for Lexical Accent

At this point the learner concludes that there must be lexical markings that distinguish the words. But what ? It is now necessary to consider suffixes and stems.

/ x x	x / x	x x /
dólov-e	goróv-a	kolov-á
dólov-i	goróv-u	torov-é
kólov-u		molov-á
tórov-i		norov-é
		molov-ú
		norov-í

Stems With Fixed Stress

Looking at the stems, we find that some always carry the stress, no matter what suffix follows. It is reasonable to assume that these stems have accent.

/ x x	x / x	x x /
dólov-e	goróv-a	kolov-á
dólov-i	goróv-u	torov-é
kólov-u		molov-á
tórov-i		norov-é
		molov-ú
		norov-í

Stems With Fixed Stress

In the SBG theory this means there are two possibilities: they have a left bracket to the left or a right bracket to the right; at this point we don't know which.

/ x	x /	
(x x d <u>ó</u> l o v	x (x g o r <u>ó</u> v	
or	*or*	
x) x d <u>ó</u> l o v	x x) g o r <u>ó</u> v	

Stems With Variable Stress

Looking at the stems with variable accent, we know that they must be different from the accented stems. So, they do not have an accent on the first vowel.

/ x x	x / x	x x /
dólov-e	gorów-a	kolov-á
dólov-i	gorów-u	torov-é
kólov-u		molov-á
tórov-i		norov-é
		molov-ú
		norov-í

Stems With Variable Stress

This could suggest they have no accent. This conclusion is in fact correct, but let's make sure we are not using faulty reasoning.

/ x x	x / x	x x /
dólov-e	goróv-a	kolov-á
dólov-i	goróv-u	torov-é
kólov-u		molov-á
tórov-i		norov-é
		molov-ú
		norov-í

Stems With No Stress

A third class of stems never take stress. We might conclude that they don't have accent, but then we could not distinguish them from the variable stems.

/ x x	x / x	x x /
dólov-e	goróv-a	kolov-á
dólov-i	goróv-u	torov-é
kólov-u		molov-á
tórov-i		norov-é
		molov-ú
		norov-í

Stems With No Stress

Never taking stress could suggest a positive mark that guarantees this result, rather than the lack of a mark. Let us look at the suffixes for a minute.

/ x x	x / x	x x /
dólov-e	goróv-a	kolov-á
dólov-i	goróv-u	torov-é
kólov-u		molov-á
tórov-i		norov-é
		molov-ú
		norov-í

Suffixes

The suffixes fall into two groups: those that take stress only after stems that never take stress, and those that also take stress after variable stems.

After variable stems	After stressless stems
kolov-á	molov-á
torov-é	norov-é
kólov-u	molov-ú
tórov-i	norov-í

Stress Only When Adjacent

Dresher & Kaye (1990) have a cue for bounded (binary) constituents that is relevant to this situation.

We might think that we can find binary feet by looking for alternating stresses, but these may be lacking in languages that realize only the main stress in a word.

In unbounded QS stress systems, stress falls on heavy syllables. The only way light syllables can get a stress is if they are at an edge.

Stress Only When Adjacent

Therefore, an effective cue for boundedness is:

A non-edge stressed light syllable indicates bounded feet (that is, constituents are bounded by something other than edges and heavy syllables).

The more general idea is that if an element with no special marking (a light syllable, in the above example) receives a stress, we must consider all the things that could cause it.

In the case of lexical accent, an unaccented element can receive a stress if it is at an edge, or if it is adjacent to an element that provides it with a mark.

Suffixes

This suggests that the suffixes that receive stress only when adjacent to never-stressed stems are receiving a mark from those stems.

After variable stems	After stressless stems
kolov-<u>á</u>	molo<u>v</u>-<u>á</u>
torov-<u>é</u>	noro<u>v</u>-<u>é</u>
kólov-u	molo<u>v</u>-ú
tórov-i	noro<u>v</u>-í

Stems With No Stress

In the SBG theory a postaccenting morpheme has a lexical left bracket to the right of its last mark.

		x x / x x (m o l o v x x (n o r o v

Stems With Variable Stress

This is leaves the variable stems as having no accents.

```
  x  x
k o l o v

 x   x
t o r o v
```

Suffixes

Suffixes that have stress only after postaccenting stems also have no accent; the other suffixes are accented. That is, they get a bracket, but we don't know which kind, as with the stems.

Suffixes

x	x
-u	-i
(x	(x
-<u>a</u>	-<u>e</u>

or

x)	x)
-<u>a</u>	-<u>e</u>

Underlying Representations

At this point we have arrived at representations for the three classes of stems and two classes of suffixes.

	Stems	Suffixes
Unaccented	x x k o l o v	x -u
Accented	(x x d $\underline{o}$ l o v *or* x) x d $\underline{o}$ l o v x (x g o r $\underline{o}$ v *or* x x) g o r $\underline{o}$ v	(x -$\underline{a}$ *or* x) -$\underline{a}$
Postaccenting	x x (m o l o $\underline{v}$	

Underlying Representations

Accented morphemes still have two possible representations.

	Stems	Suffixes
Unaccented	x x k o l o v	x -u
Accented	(x x x) x d o l o v *or* d o l o v x (x x x) g o r o v *or* g o r o v	(x x) -a *or* -a
Postaccenting	x x (m o l o v	

The Rest of the Learning Path

Now the learning path is almost the same as for unbounded stress systems (Dresher 1994).

	Stems	Suffixes
Unaccented	x x k o l o v	x -u
Accented	(x x *or* x) x d <u>o</u> l o v *or* d <u>o</u> l o v x (x *or* x x) g o r <u>o</u> v *or* g o r <u>o</u> v	(x *or* x) -<u>a</u> *or* -<u>a</u>
Postaccenting	x x (m o l o <u>v</u>	

Extrametricality

Though extrametricality does not exist in the SBG theory in terms of special marking of extrametrical syllables, SBG does allow edge markings that exclude the last or first element in a word.

These edge markings could cause the learner to be misled as to where the effective edges of the word are.

Extrametricality in SBG

x (x x x x #   # x x x x) x

Extrametricality

Words with edge stresses exclude these edge markings.

No Extrametricality in AUP

```
   x                              x
   x                              x
# x   x   x #        # x  x   x #
d o l o v - u        m o l o v - a
```

Line 0 Heads: Left

Words with only unaccented morphemes have only edge marks, so they tell us which side line 0 heads are.

There are two possible edge settings for the bracket, but in either case heads on line 0 must be on the left.

Unaccented Words

```
     x                              x
     x                              x
 # ( x   x    x #               #   x   x    x) #
  k o l o v - u        or        t o r o v - i
```

Lexical Accents: (x

Having established that line 0 heads are on the left, we can now resolve the ambiguity in marking lexical accents. This is because a lexical accent must be adjacent to its head.

It follows that lexical accents must be (x, not x), as the latter would imply a right-headed constituent.

	Stems		Suffixes	
	x	x	x	x
	(x x	x (x	(x	(x
Accented	d $\underline{o}$ l o v	g o r $\underline{o}$ v	-$\underline{a}$	-$\underline{e}$

Main Stress

We can now determine the position of main stress, which must consistently appear in either the left or rightmost line 1 constituent. We will have more than one foot in the case of words with at least two accents.

Line 1 Head Left

```
  x
  x         x           x     x
 (x  x     (x        x (x    (x
d o l o  v - a   g o r o  v – e
```

Line 1 Head Right

```
  x                 x
  x        x        x       x
 (x  x    (x      x (x     (x
d o l o v - a   g o r o  v – e
```

Main Stress: Left

Main stress appears consistently in the leftmost constituent, suggesting that line 1 constituents have a left bracket and are headed on the left.

Line 1 Head Left

```
  x                          x
 (x        x             x  (x     x
 (x  x    (x           x (x  (x
d o l o v - a        g o r o v – e
```

Edge Marks

Words with accented morphemes now resolve where the edge mark must go.

If the edge bracket is on the left, stress should always fall on the initial syllable, which is not the case.

Line 0 Edge Left

```
*x                 *x
 x           x       x   x
(x   x      (x      (x  (x       x
k o l o  v - e     g o r o  v – i
```

Line 0 Edge Right

```
                 x              x
                 x              x
 x   x          (x)      x  (x       x)
k o l o  v - e     g o r o  v – i
```

Edge Marks: x)#

Putting the edge mark at the right edge works in all cases. We have now set all the relevant metrical parameters.

Line 0 Edge Right

```
          x               x              x
         (x              (x    x        (x
  x  x   (x)           x (x    x)        x   x    x)
k o l o  v - e        g o r o  v – i    t o r o  v – u
```

Contrast and Metrical Representations

The learning path sketched above relies on a general principle of contrast:

Principle of Contrast

Do not make more distinctions than are required.

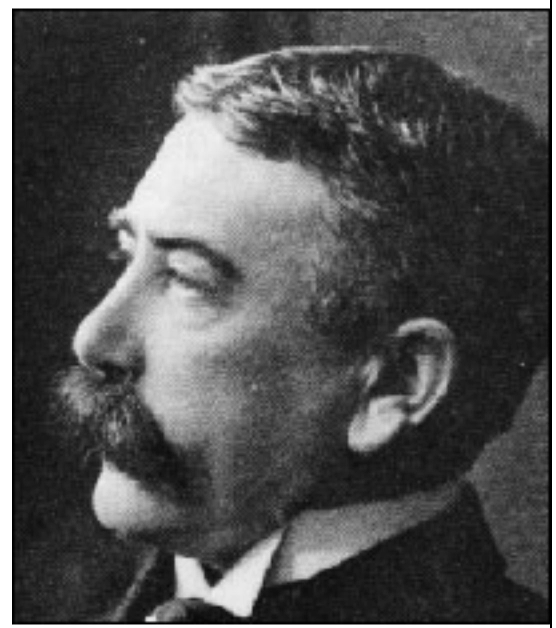
Or more positively:

Create as many distinctions as are required.

Thus, the learner assumes QI (all syllables have equal value) before trying QS, which requires a contrast between light and heavy syllables.

The contrast principle is basic to modern linguistics:

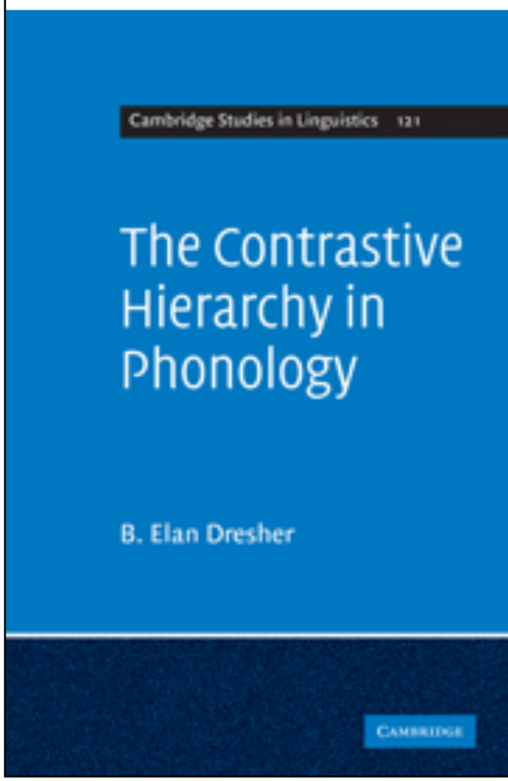
"dans la langue il n'y a que des différences"



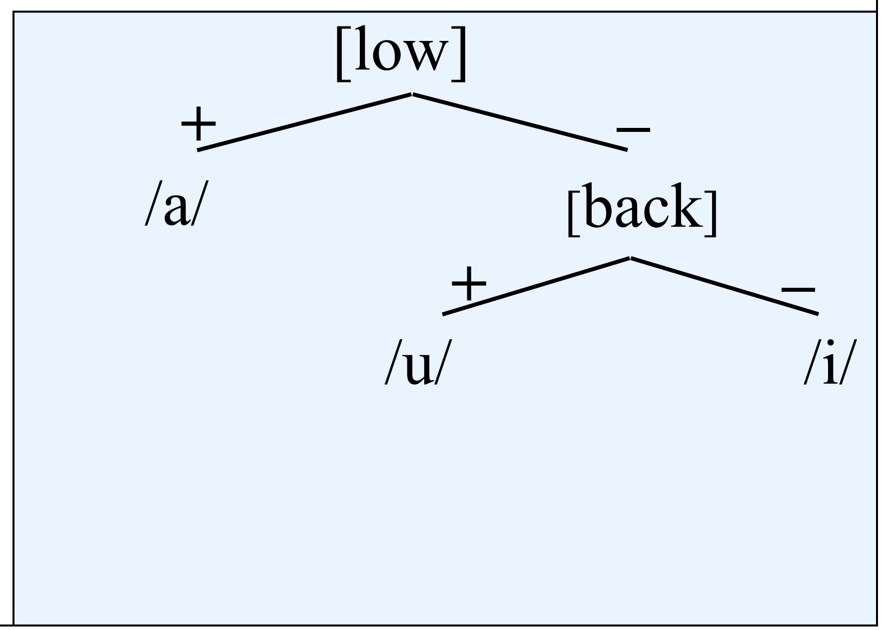
Ferdinand de Saussure, *Cours de linguistique générale* ([1916] 1972:166)

The Principle of Contrast

I have argued that the same principle holds for segmental phonology: only as many features as are required to distinguish phonemes are specified.

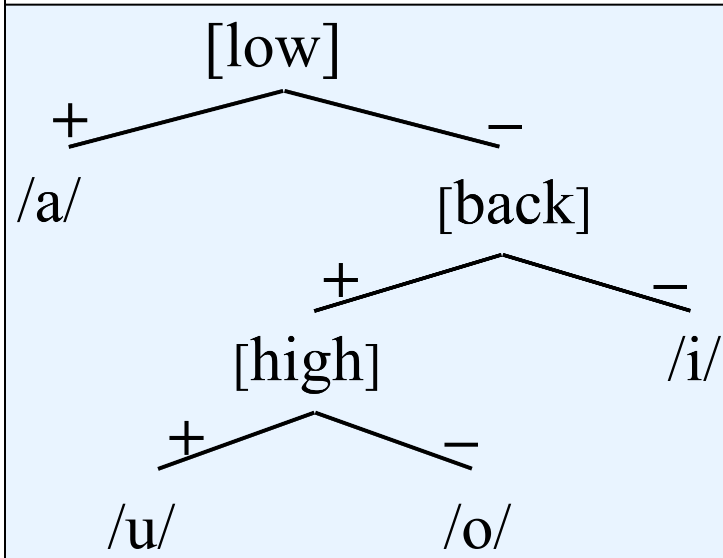


Three vowels require only two features:

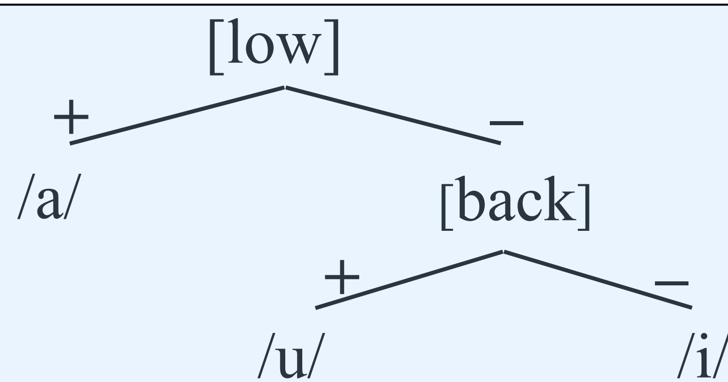


The Principle of Contrast

More vowels may require additional features:



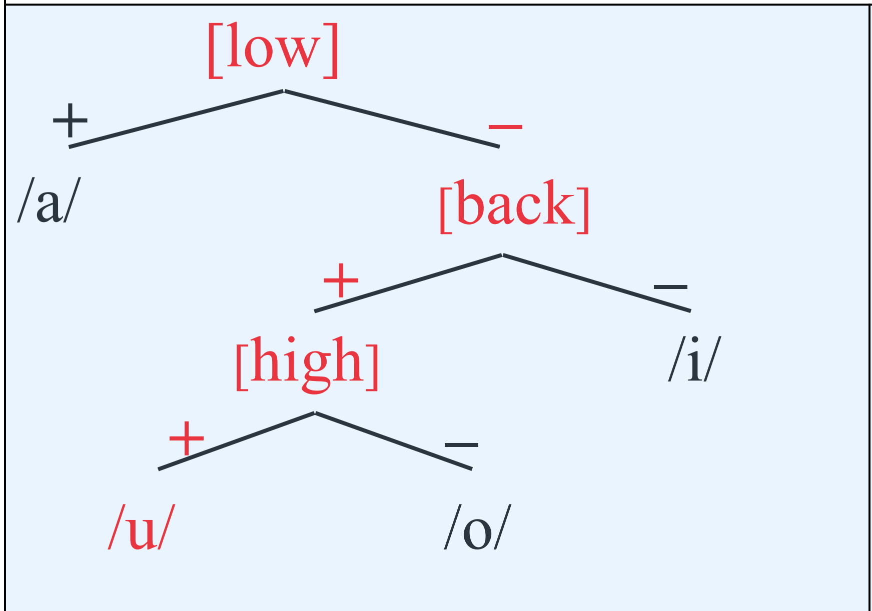
Three vowels require only two features:



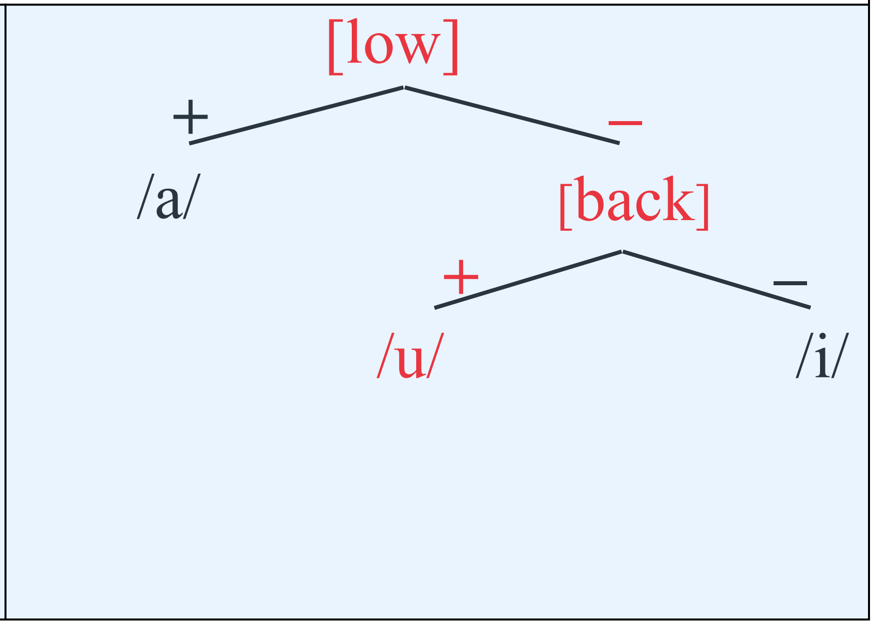
The Principle of Contrast

What appears to be the 'same' vowel in the two systems receives different contrastive specifications.

More vowels may require additional features:



Three vowels require only two features:



Contrast and Lexical Accent

A similar principle holds for lexical accent: in the AUP language we have 4 different stem patterns, hence we need 4 different URs: 1 unaccented stem, 2 different accented stems, and 1 postaccenting stem.

	Stems		Suffixes
Unaccented	x x k o l o v		x -u
Accented	(x x d $\underline{\text{o}}$ l o v	x (x g o r $\underline{\text{o}}$ v	(x -$\underline{\text{a}}$
Postaccenting	x x (m o l o $\underline{\text{v}}$		

Contrast and Lexical Accent

Consider now a language like AUP—call it UP—that has no accented stems but otherwise patterns exactly like AUP.

	Stems	Suffixes
Unaccented	x x k o l o v	x -u
Accented		(x -<u>a</u>
Postaccenting	x x (m o l o <u>v</u>	

UP Words

If the only words we have are like these, it is unlikely we would arrive at the previous analysis, which makes different two-way contrasts in stems and suffixes.

```
  U + A              P + A
       (x                 (x
   x x  (x)         x  x( (x)
 kolov-á          molov-á

 U + U              P + U
  (x                     (x
   x  x   x)        x  x(  x)
 kólov-u          molov-ú
```

UP Words

Rather, stems that never take a stress could be analyzed as unaccented, and variable stems as accented. Accents project), edge on line 0 is #(, heads of line 0 and 1 are R.

<table>
<tr><td>U + A</td><td>P + A</td><td>A + A</td><td>U + A</td></tr>
<tr><td>(x</td><td>(x</td><td>x x)</td><td>x)</td></tr>
<tr><td>x x (x)</td><td>x x((x)</td><td>(x)x x)</td><td>(x x x)</td></tr>
<tr><td>kolov-<u>á</u></td><td>molo<u>v</u>-<u>á</u></td><td>k<u>o</u>lov-<u>á</u></td><td>molov-<u>á</u></td></tr>
<tr><td>U + U</td><td>P + U</td><td>A + U</td><td>U + U</td></tr>
<tr><td>(x</td><td>(x</td><td>x)</td><td>x)</td></tr>
<tr><td>x x x)</td><td>x x(x)</td><td>(x)x x</td><td>(x x x</td></tr>
<tr><td>kólov-u</td><td>molo<u>v</u>-ú</td><td>k<u>ó</u>lov-u</td><td>molov-ú</td></tr>
</table>

Contrast and Lexical Accent

This analysis makes fewer types of contrasts; all other things being equal, this would be the preferred analysis.

	Stems	Suffixes
Unaccented	x x m o l o v	x -u
Accented	x) x k o l o v	x) -a
Postaccenting		

Contrast and Lexical Accent

Suppose now that we had only accented and post-accenting stems, along with accented and unaccented suffixes; call this the AP language:

	Stems		Suffixes
Unaccented			x -u
Accented	(x x d $\underline{o}$ l o v	x (x g o r $\underline{o}$ v	(x -$\underline{a}$
Postaccenting	x x (m o l o $\underline{v}$		

AP Words

Again it is unlikely that we would maintain this analysis, for a similar reason as before.

A + A

```
   x             x
  (x  x         (x      x
 x(x  (x)       (x x   (x)
gorόv-a        dόlov-a
```

A + U

```
  (x            (x
 x (x   x)      (x x    x)
gorόv-u        dόlov-u
```

P + A

```
        x
       (x
 x  x( (x)
molov-á
```

P + U

```
       (x
 x  x(  x)
molov-ú
```

AP Words

Rather, we appear to have a simple contrast between accented and unaccented stems; there is no evidence for a distinction in the suffixes at all.

A + U		U + U

<pre>   x
  (x x
 x x) x)
goróv-a</pre>
	<pre> x
	 (x x
	  x) x x)
	dólov-a</pre>
		<pre> x
		     (x
		 x x x)
		molov-á</pre>

<pre>   x
  (x x
x x) x)
goróv-u</pre>
	<pre> x
	 (x x
	  x) x x)
	dólov-u</pre>
		<pre> x
		     (x
		 x x x)
		molov-ú</pre>

Contrast and Lexical Accent

As before, this analysis makes fewer types of contrasts and is simpler, and would be preferred, all other things being equal.

	Stems		Suffixes
Unaccented	m o l o v		x x -u -a
Accented	(x x d $\underline{o}$ l o v	x (x g o r $\underline{o}$ v	
Postaccenting			

Russian as a Near-AP Language?

This situation takes on more interest when we consider that Russian is not far from an AP language, according to the distribution of types of noun stems (Zaliznjak 1967).

Alderete (1999) in fact assumes that unaccented noun stems do not play a role in the core analysis of Russian accent.

	Stems	Number	Percent
Unaccented	gorod	273	0.8%
Accented	gorox	30,100	91.6%
Postaccenting	korol	2,176	6.6%

Russian as a Near-AP Language?

Halle (1997) points out that unaccented stems include many widely used nouns, which may counter the low type frequency.

Russian may have other relevant forms that distance it from the simple AP language. In any case, these numbers show that we might want to use caution in using statistics to filter out forms as exceptions.

	Stems	Number	Percent
Unaccented	gorod	273	0.8%
Accented	gorox	30,100	91.6%
Postaccenting	korol	2,176	6.6%

Conclusion

While not a formal model, any attempt to solve the problem of lexical accent must incorporate some of the properties of this model.

There must be a way of detecting inconsistency; that is, acquisition cannot work on one form at a time without a way of comparing it with other forms.

Also, learning cannot be purely error driven, or concerned with matching surface forms, but must focus on using input forms to gain information about particular aspects of the grammar.

Conclusion

Lexical representations are elaborated as required by contrast.

The notion of covert structure is fluid; different covert structures become overt to the learner at different points in the learning path.

THANK YOU!

Some of this material was presented in the Fall 2012 Advanced Phonology seminar at the University of Toronto, and I thank the students and auditors for discussion, and for giving up their last class so I could be here.

This talk has also benefitted from discussion with Harry van der Hulst, Bill Idsardi, and Bruce Tesar.

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