8   Covert Representations, Contrast, and the Acquisition of Lexical Accent

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8.1   Introduction

Lexical accent presents in a particularly sharp form some basic problems that learning models must overcome. Dresher & Kaye (1990) attempt to address these problems in the context of a learning model for a parametric metrical phonology for languages with predictable stress systems. I will show how this model, as modified by Dresher (1994), can be extended to learn stress systems that incorporate lexical accent, at least in the case of a constructed simple language inspired by Russian.

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.[1] Though I assume a derivational parametric metrical theory, the basic strategies have some affinity with ideas proposed by Tesar and his colleagues (Tesar et al. 2003; Tesar 2006; 2014) for learning an Optimality-Theoretic grammar.

The notion of contrast plays an important role in the acquisition of lexical representations, as suggested by Tesar (2006; 2014). I will extend the approach of Dresher (2009), which considers contrast in the context of segmental features, to lexical accent. Recognizing the role of establishing contrasts in the lexical inventory will also help to streamline the system of cues proposed by Dresher & Kaye (1990).

In particular, I show how the learning model in Dresher and Kaye (1990), as modified by Dresher (1994), can be revised and extended to learn the lexical accent system of a constructed simple language inspired by Russian. Importantly, this model compares multiple forms in order to establish contrasts in the lexicon. While the model is sufficiently specified to understand how it works on the simple constructed example, it remains to be implemented computationally.

The plan of this chapter is as follows. In Section 8.2, I briefly review what the grammar of stress and metrical representations look like in the Simplified Bracketed Grid theory. Problems attending to the acquisition of metrical representations and the grammar of stress are reviewed in Section 8.3, where I present the learning model of Dresher & Kaye (1990). Section 8.4 takes up stress systems characterized by lexical accent. In Section 8.4.1 I briefly review the PAKA world model of Tesar and his associates, and in Section 8.4.2 I outline a learning model for lexical accent that builds upon the proposals of Dresher & Kaye (1990) and Dresher (1994). The role of contrast in the acquisition of segmental and metrical representations is discussed in Section 8.5. Section 8.6 is a brief conclusion.

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[1] A partial list of learning models that take a different approach to the one proposed here includes those introduced in Tesar & Smolensky 2000, Apoussidou 2006, 2007, Merchant 2008, Heinz 2009, Akers 2012, and Jarosz 2013.

8.2   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 & Idsardi (1995), and Halle (1997), with some modifications proposed by Dresher (1994). Metrical structures result from the interaction of a number of parameters that govern how brackets and heads are assigned to a *metrical grid* (Liberman 1975). In the analysis of word stress, the grid is conventionally supposed to consist of three lines (1). Every element capable of bearing a stress (usually, the head of a syllable) is represented by a mark on line 0. SBG assumes that all interactions with the lexicon occur on this line. Constituents on this line, also called metrical *feet*, have their heads projected on line 1. Grid marks on line 1 are eligible to bear secondary stresses. The main word stress is projected onto line 2.

(1)   Illustration of a metrical grid

```
                 x                        Line 2
     x     x     x)                       Line 1
     x (x  x (x  x (x  x) x               Line 0
     S  S  S  S  S  S  S                  Syllables
```

Whereas the grid is conceived as a universal representation of prominence, languages differ with respect to which elements are projected onto the lines of the grid, and the placement of brackets. The main parametric options are presented below.

A basic decision has to do with whether *syllable quantity* is relevant to stress. In *quantity-insensitive* (QI) stress systems, all syllables are equal with respect to stress; in *quantity-sensitive* (QS) systems, the metrical system distinguishes between *light* (L) and *heavy* (H) syllables (2).

(2)   Quantity Sensitivity (QS)
        The language {does not/does} distinguish between light (L) and heavy (H) syllables.

In QS systems, heavy syllables are inherently prominent. In SBG, this is accounted for by positing that they project a left or right bracket on line 0, as in (3). I assume that line 1 heads must be projected from line 0 marks that are adjacent to these lexical brackets, with the result that heavy syllables are the heads of their own constituents. Thus, syllables that project a left parenthesis create feet that are headed on the left (3a), and those that project a right parenthesis create feet that are headed on the right (3b). Idsardi (1992) and Halle & Idsardi (1995) do not assume this, but strange results follow from not adopting this restriction (Dresher 1994: 83).[2]

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[2] For example, if heavy syllables project left boundaries, but line 0 heads are on the right, we would obtain a kind of anti-QS, wherein each heavy syllable throws a stress over a span of light syllables to the last light syllable in its constituent, as shown in (ia).

(3)   QS: Heavy syllables project a left or right bracket on line 0

    a. H projects (x   b. H projects x)

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

In some languages syllables are inherently unequal with respect to stress, not because they are light or heavy, but because some syllables have a lexical property called *accent*. Lexical accents function somewhat like heavy syllables in QS systems,[3] and are similarly represented with brackets in SBG (4). Again, I assume that line 1 heads must be projected from marks adjacent to these lexical brackets; indeed, such a restriction would appear to be required by the notion of 'lexical accent'. Note that the U and A indications in these examples are for the benefit of the reader, and not part of lexical representations.

(4)   Lexical accents (U = unaccented, A = accented)

    a. A projects (x   b. A projects x)

```
       x                       x                Line 1
     x (x  x  x               x  x) x  x         Line 0
       U A U U                 U A U U           Syllables
```

In addition to accented syllables of the form (x and x), we can also have postaccenting, x(, and preaccenting,)x, brackets as in (5).[4]

(5)   Preaccenting and postaccenting morphemes

    a. Preaccenting   b. Postaccenting

```
     )x  x                   x   x(            Line 0
      U U                    U U               Syllables
```

  (i)   'Anti-QS': Heavy syllables project a line 0 bracket not adjacent to a head

    a. H projects (x   b. H projects x)

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

The description of the stress system of such a language would state: stress final heavy syllables, and every light syllable which follows a heavy syllable and is also either final or immediately precedes a heavy syllable. I do not know of any language that works this way, or like its mirror image in (ib). See Dresher (1994) for further discussion.

[3] Compare van der Hulst (1999), who views lexical stress as diacritic weight.

[4] Syllables that project brackets as in (5) are outside the feet that they project. Therefore, it is not clear if they should also observe the adjacency restriction on heads that brackets projected by heavy and accented syllables observe. I leave this as an empirical issue, but do not impose such a requirement here.

In addition to lexical markings associated with particular syllables, SBG allows for a variety of *edge markings* on line 0 (6). Edge markings govern the position of stresses relative to morpheme or word edges, as well as the position of default stresses in the absence of lexical brackets.

(6)   Edge marking
        Insert a {left/right} bracket to the {left/right} of the {left/right}–most element on line 0.

The examples in (7) show the four options at the left edge (there are a parallel number of right-edge options). Option (a) is the default, or unmarked, option. This edge marking can be abbreviated LLL: insert a {left} bracket to the {left} of the {leftmost} element on line 0. Option (b), LRL, gives the effect of extrametricality, by excluding the leftmost grid mark from the metrical constituent bounded by the bracket. Option (c) is preaccenting. I assume that option (d), which isolates the leftmost grid mark in a constituent that excludes the marks to its right, is a marked option that requires positive evidence.

(7)   Edge marking options on line 0 (left edge)

	a. LLL: Unmarked		b. LRL: Extrametricality	
	# (x x		# x(x	Line 0
	c. RLL: Preaccenting		d. RRL: Marked	
	#)x x		# x) x	Line 0

Edge marking applies also to line 1, though I assume that the options are more restricted there. While it has been proposed that feet can be extrametrical (Hayes 1995: 77–78), as in (8b), in the cases we will be concerned with line 1 brackets will be limited to the unmarked case (8a). Again, options on the right edge are mirror images to those in (8), but not shown here.

(8)   Edge marking options on line 1 (left edge)

	a. Unmarked		b. Extrametricality	
	# (x x		# x(x	Line 1

Many languages have an upper limit on how big a line 0 constituent, that is, a metrical foot, can be. This upper limit is typically two, resulting in maximally binary feet. Binary constituents are created by Iterative Constituent Construction (ICC), which inserts brackets on line 0 after every two grid marks (9).

(9)   Iterative Constituent Construction (ICC)
        Starting at the {right/left} edge, insert a {left/right} bracket for each pair of elements on line 0.

ICC must respect existing lexical and edge brackets; that is, ICC brackets are constructed later. In (10a), there is a right bracket at the right edge, so ICC (Left) starts at the right edge, and

groups grid marks in twos; the leftmost mark is by itself, and ICC does not apply to it. In (10b), there is a RLR edge bracket; since the rightmost grid mark is isolated by the edge bracket, the ICC does not have a pair of marks to group, so it skips the final grid mark and starts from the penultimate grid mark. In (10c) there are is a LLL edge bracket and a left lexical bracket. ICC (Left) begins at the right boundary and groups the last two marks. It then passes over the mark with the existing left bracket, and groups the two marks to its left. Notice that in (10c) ICC creates adjacent brackets; assuming that line 0 constituents are left-headed, these would create *stress clashes*. Some languages do not permit such clashes; in such languages (10d), a constraint against adjacent brackets would prevent ICC from applying.[5]

(10)   Examples of ICC inserting a left bracket starting at the right

        Lexical and edge brackets   ICC

    a. # x x x x x x x) #   # x (x x (x x (x x) #   Line 0
    b. # x x x x x x)x #   # (x x (x x (x x)x #   Line 0
    c. # (x x x (x x x #   # (x (x x (x (x x #   Line 0
    d. # (x x x (x x x #   # (x x x (x x x #   Line 0

In languages that do not have an upper bound on the size of metrical constituents (see Halle & Idsardi 1995 and the schematic lexical accent languages discussed below for examples), the ICC does not apply.

Every constituent on line 0 or 1 of the grid must have a *head* on the next line up, by projecting one of its marks onto the next line. SBG assumes that only a mark at an edge of a constituent may become a head, as in (11). Marks on line 1 represent potential secondary stresses, and the mark on line 2 represents the main stress in the word. A language may choose to suppress all but the main stress (12); in such a language, line 1 marks do not represent additional prominences, except for the one corresponding to the main stress. However, they may still be required to compute the position of main stress.

(11)   Projection of constituent heads
    a. Line 0 constituents project their {left/right}-most element onto line 1.
    b. Line 1 constituents project their {left/right}-most element onto line 2.

(12)   Phonetic realization of constituent heads
    a. Line 1 marks {are/are not} realized as secondary stresses.
    b. The line 2 mark is realized as main stress.

To show how these parameters work together to arrive at a metrical representation, consider the English stress rule for nouns. According to conventional accounts (Halle & Keyser 1971), this rule, which entered English via words borrowed from Latin (Dresher & Lahiri 2005), is given in (13). A translation into SBG is given in (14), and some sample representations are shown in (15); the steps in (15) are keyed to the items in (14).

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[5] See Halle & Idsardi (1995: 418–430) for further discussion of the ICC and its relation to avoidance constraints.

(13) English stress rule (nouns)
Main stress falls on the penultimate syllable if it is heavy (contains a long vowel or diph-thong, or is closed by a consonant); otherwise, on the antepenult. Secondary stresses fall on heavy syllables and alternating light syllables to the left of a stress.

(14) English noun stress in SBG
a. QS: A heavy syllable projects a left bracket to the left of its mark on line 0.
b. Edge marking on line 0: RLR (extrametricality on the right).
c. ICC: Starting at the right edge, insert a left bracket for each pair of elements on line 0.
d. Line 0 heads: Constituents project their leftmost element onto line 1.
e. Edge marking on line 1: RRR.
f. Line 1 heads: Constituents project their rightmost element onto line 2.
g. Phonetic realization of constituent heads: Line 2 marks are realized as main stress, other line 1 marks are realized as secondary stresses.

(15) a. QS: H projects (to the left of its line 0 mark

```
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
i.  A me ri ca    ii.  Ma ni to: ba    iii.  a gen da
```

b. Edge marking RLR on line 0

```
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
A me ri ca             Ma ni  to: ba       a gen da
```

c. ICC from the right

```
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
A me ri ca             Ma ni  to: ba       a gen da
```

d. Line 0 heads (left) project onto line 1

```
   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
A me ri ca             Ma ni  to: ba       a gen da
```

e. Edge marking RRR on line 1

```
   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
A me ri ca             Ma ni  to: ba       a gen da
```

f. Line 1 heads (right) project onto line 2

```
    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
   A me ri ca        Ma ni to: ba       a gen da
```

g. Phonetic realization of constituent heads

América   *Mànitóba*   *agénda*

The words in (15) all have a right bracket to the left of the rightmost line 0 mark by (14b). The words in (15i, ii) both have a left bracket by ICC (14c), and (15ii, iii) both have a left bracket due to QS (14a). Only (15ii) has more than one line 0 constituent; the head of the second constituent is realized as main stress, and the head of the first is realized as a secondary stress.

8.3 Acquiring the Grammar of Stress

On these assumptions, acquisition of the grammar of stress amounts to setting the metrical parameters in Section 8.2 to their correct values. Representations such as those in (15) must be constructed by learners: since all the choices in (14) are language particular, it is not possible to suppose that such representations are available to learners from the beginning. For the sake of concreteness, let us assume that learners have early representations such as in (16) prior to the setting of the metrical parameters. That is, I assume that learners have already made a (perhaps rough) division of words into syllables, represented here as S, can distinguish the relative prominences of these syllables, and can represent prominence on a metrical grid, which I assume to be innate.

(16)   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
     A me ri ca           Ma ni to: ba            a gen da
```

Thus, early representations like (16) are converted into acquired representations like (15). How can this be done? It is evident that the acquired surface structures in (15)—that is, the brackets and categorization of syllables into heavy (H) and light (L)—cannot be obtained from the acoustic signal alone. For example, unstressed syllables in (15) have two distinct metrical representations: (a) they can be *unfooted*, like the initial syllables in *America* and *agenda*, and like the final syllables in all the words in (15); or (b) they can occur in the *weak position of a foot*, like the third syllable of *America* and the second syllable of *Manitoba*. There is no evidence that these different types of unstressed syllables can be distinguished phonetically, or that foot boundaries (the presence of brackets) 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.

Parameter setting is not as simple as one might think. It 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. 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 (Clark 1989): we do not know which parameter(s) is/are responsible for a miss, so we do not know which one(s) to change. The Credit/Blame Problem arises because the relationship between how many parameters in the learner's grammar are correct and how well the learner's productions or parses match the target is not *smooth* (Berwick & Niyogi 1996: 612, 614; Frank & Kapur 1996: 644; Turkel 1997; see Dresher 1999: 54–58 for discussion); in some cases, one wrong parameter may lead to big mismatches, whereas in other cases several wrong parameters may yield a result that looks fairly close to the target stress patterns.

The Epistemological Problem (Dresher 1999), which I have called Meno's Paradox (Dresher 2003), arises because some parameters are stated in terms of abstract entities and theory-internal concepts that the learner may not initially be able to identify. How can a learner equipped with the initial representations in (16) answer the questions in (17)? This is the paradox posed by the title character in Plato's dialogue *Meno*: How can one investigate what one does not know? If you stumble across it, how will you know it is the thing you are looking for?

(17)   Meno's Paradox applied to parameter setting

	Question	*Problem*
a.	Are feet binary or unbounded?	What is a foot?
b.	Are feet left-headed or right-headed?	Ditto?
c.	Is main stress on the left or on the right?	How does one tell?

Dresher (1999) shows how the discrepancy between the grammar and the observable results of the grammar—that is, between the I-grammar (I for 'internal' or 'intensional') and the E-language (E for 'external' or 'extensional')—defeats the learning model of Gibson & Wexler (1994), which tries above all to simply match the target forms. Dresher (1999) also shows that the model of Clark & Roberts (1993), which is based on a notion of goodness-of-fit, fails because the E-language measure of goodness that they use is not a reliable indicator of the goodness of the I-grammar. Robust Interpretive Parsing (Tesar & Smolensky 2000) is also shown to be defeasible because the OT grammar has no way to check that its corrective measures are actually improving the grammar.[6]

I conclude 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 & 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. Ingredients of this road map are discussed below.

We assume that Universal Grammar associates every parameter with a *cue* (aka 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.

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 de-

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[6] See Dresher (1999) for detailed discussion of these learning models.

pends on the results of earlier ones. Hence, cues can become increasingly abstract and grammar-internal the further along the learning path they are. The order proposed by Dresher & Kaye (1990) is given in (18).[7]

(18)　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).[8]
      [Requires no knowledge of syllable weight or metrical structure]

2. Extrametricality
   a. Parameter: A syllable on the {right/left} {is not/is} extrametrical.
   b. Cue: Stress on a peripheral syllable rules out extrametricality on that side.[9]

3. Bounded constituent construction
   a. Parameter: Line 0 constituents {are not/are} bounded.
   b. Cue: The presence of a stressed non-edge L indicates bounded constituents.[10]
      [Requires knowledge of syllable weight but not metrical structure]

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]

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[7] Dresher & Kaye (1990) assume a tree-based version of metrical theory derived from Liberman & Prince (1977) and Hayes (1981) that antedates SBG. While the specifics of metrical representation differ, the general character of the learning path in (18) remains relevant to the acquisition of SBG metrical representations. A revision of the learning path geared to SBG, and which takes into account lexical accent, is presented in Dresher (1994) and below. The revised learning path presented here also assigns a more defined role to contrast, thus making possible a more streamlined notion of cues.

[8] In the parameter set assumed by Dresher & Kaye (1990), QI and QS are the only options; therefore, showing that a system is not QI is equivalent to showing that it is QS. When we add the possibility of lexical accent, or stress that is sensitive to morphology, this is no longer the case. In the revised learning path proposed below, this cue still serves to exclude QI, but further steps are required before concluding that it is QS.

[9] If the learner is unable to rule out extrametricality at this stage, then it must retain the possibility of extrametricality as an option until it is either ruled out or ruled in later.

[10] One might suppose that a more obvious cue would be to look for alternating stress, but Dresher & Kaye (1990) show how such a cue cannot be counted on to be present or reliable.

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 the head of a foot (line 1 grid mark).

An example of a parameter that is early in the learning path is Syllable Quantity (18.1). Its cue (18.1c) 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. Main stress (18.4) is an example of a parameter that is set later in the learning path. Its cue requires knowledge of syllable weight and foot size, but not foot structure. The learner is still keeping track of patterns, but at a higher level of abstraction. Again, isolated exceptions should not count. 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.[11]

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.[12] 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 to the learner; as acquisition proceeds they gradually become overt. For example, syllable quantity (H or L) is often taken as overt in the data supplied to learning models, 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.[13]

8.4   Lexical Accent

Lexical accent poses a challenge, in that it appears to instantiate the basic learning problems in an extreme way: it is 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 postaccenting or preaccenting 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.

Optimality-Theoretic (OT) attempts to model the acquisition of lexical accent (Tesar et al. 2003; Tesar 2006; 2014) have taken lexical accent to be an example of the acquisition of under-

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[11] See Yang (2004) for detailed discussion of how statistics can work together with Universal Grammar.

[12] See the references in note 1 and Jarosz (2013) for an overview of some current approaches.

[13] While learners have to be able to distinguish different types of syllable structures before learning the grammar of stress, it is another matter to associate a particular type of syllable with H or L in a QS system; see further Dresher & Kaye (1990). For types of QS, see Goedemans (1996) and Zec (2011).

lying representations (URs). It is true that lexical accent involves learning URs, but it is not 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). The notorious yers of Russian come to mind: these are historical ultra-short vowels that either do not surface at all, or surface as other vowels in conditions that are difficult to state precisely. Nevertheless, they have effects on stress, and so cannot be ignored in representations (see Halle 1997: 282–286). 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 QI or QS.

8.4.1   The PAKA World

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/, as in (19).[14] They assume the constraints in (20).

(19)   PAKA world (Tesar et al. 2003)

	Stems	Suffixes
Accented	ba	-ga
Unaccented	pa	-ka

(20)   PAKA world constraints (Tesar et al. 2003)

    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 world provides a useful laboratory in which to explore the learnability of lexical accent. However, the grammar in (20) does not make reference to the metrical grid, and does not posit representations consistent with SBG. Inspired by this model, in the next section I extend somewhat a PAKA-style lexicon, with representations and a learning model geared to acquiring SBG representations.[15]

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[14] The use of a voiceless onset with unaccented morphemes and a voiced onset with accented ones is intended as a mnemonic for the benefit of the reader, and is not a part of the learner's data.

[15] I will not discuss here the OT learning models proposed by Tesar and his collaborators (Tesar et al. 2003; Tesar 2006; 2014).

8.4.2 Learning Lexical Accent with SBG Representations: The AUP Language

For this discussion I assume an idealized language reminiscent of simplified Russian. This language, which I call AUP, has three types of stems—accented (A), unaccented (U), and post-accenting (P)—and two types of suffixes— accented (A) and unaccented (U), as shown in (21). As in the PAKA world, the segmental differences are mnemonics for the convenience of the reader: stems with initial voiced consonants are accented, stems with initial voiceless consonants are unaccented, and stems with initial nasal consonants are postaccenting; suffixes with non-high vowels (*a, e*) are accented, and suffixes with high vowels (*i, u*) are unaccented. A line under a vowel indicates an underlying accent, and a line under a final consonant signals a postaccenting morpheme.

(21)   AUP language morphemes

	Stems		Suffixes	
Accented	gor<u>o</u>v	d<u>o</u>lov	-<u>a</u>	-<u>e</u>
Unaccented	kolov	torov	-u	-i
Postaccenting	molo<u>v</u>	noro<u>v</u>		

There are two types of accented stems, so we potentially have eight different word patterns when we combine the stems and suffixes, as in (22).[16] As in Russian, I assume that the leftmost accented syllable in a word receives the stress (indicated with an acute accent), and that stress defaults to the left in a word with no underlying accents.

(22)   AUP language words (stem + suffix)

a. A + A
    gor<u>ó</u>v-<u>a</u>
    d<u>ó</u>lov-<u>a</u>

b. U + A
    kolov-<u>á</u>

c. P + A
    molo<u>v</u>-<u>á</u>

d. A + U
    gor<u>ó</u>v-u
    d<u>ó</u>lov-u

e. U + U
    kólov-u

f. P + U
    molo<u>v</u>-ú

I assume that a learner has access to the data in (22), including the breakdown into morphemes, but minus the information as to their accentual status. The learner's task is to arrive at the grammar of stress for this language, which includes assigning lexical brackets to underlying forms, as well as determining edge marks, heads, and other aspects of the grammar that need to be acquired in order to have a complete account of the stress patterns of AUP.

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[16] The two unaccented stems pattern identically with respect to stress, as do the two postaccenting stems and the accented and unaccented suffixes. Therefore, I have chosen one representative from each of these groups in (22).

Lexical Representations

As in the Dresher & Kaye (1990) model, I assume that words are classified based on their stress contours at the outset of the learning path, for these contours are the only aspect of metrical structure that is overt at this stage. We find conflicting patterns, as shown in (23). For example, *dólove* is a three syllable word consisting of a stressed syllable followed by two unstressed syllables, a contour we can represent as / ˘ ˘. This contour is in conflict with *goróve* (˘ / ˘) and with *norové* (˘ ˘ /). A learner would conclude from these conflicts that the system is not QI.

(23)   Conflicting patterns

    a. / ˘ ˘   b. ˘ / ˘   c. ˘ ˘ /

a.		b.		c.	
d<u>ó</u>lov-<u>e</u>	kólov-u	gor<u>ó</u>v-<u>a</u>	gor<u>ó</u>v-<u>e</u>	kolov-<u>á</u>	norov-<u>é</u>
d<u>ó</u>lov-i	tórov-i	gor<u>ó</u>v-u	gor<u>ó</u>v-i	torov-<u>é</u>	molov-ú
				molo<u>v</u>-<u>á</u>	noro<u>v</u>-í

The learner then considers whether the system is QS. If the system were QS, then the conflicting stress patterns could be associated with different syllable structures. In the English examples discussed above, the conflicting four-syllable words *América* (˘ / ˘ ˘) and *Mànitóba* (\ ˘ / ˘) have different syllable structures, which would enable learners to deduce that a long vowel makes a syllable H in English. Conflicts like that between *agénda* (˘ / ˘) and *álgebra* (/ ˘ ˘) would similarly show that closed syllables also count as H. But this is not the case here: the words in (23) all have the same syllable structure, by any syllabification algorithm: CV.CV.CV. Since the conflicting stress patterns in (23) cannot be resolved in terms of different syllable structures, the learner concludes that the language is not QS.

I assume that all the stems in question form nouns of the same general type, and that the suffixes cannot be fruitfully distinguished in terms of boundary type or by other morphological criteria.[17] A learner would conclude that morphology does not help in accounting for the different stress patterns, either.

Having excluded other possible sources for the differences in the patterns in (23), the learner posits that there must be inherent non-derivable lexical markings that distinguish the words. But what are they? It is now necessary to consider individual morphemes, that is suffixes and stems, rather than just complete words. As was the case at the complete-word stage, it is now necessary to know how many different types of stems and suffixes there are with respect to stress patterning. That is, I suppose that learners now keep track of individual stem and suffix types, sorted into groups that share the same stress patterns.

Looking first at the stems, the learner now detects the four AUP categories that correspond to the two types of accented stems, unaccented stems, and postaccenting stems (of course, the learner does not yet know that that is what they are). Of these, some always carry the stress, no matter what suffix follows. It is reasonable to assume that these stems have accents. In the SBG theory this means there are two possibilities: either they have a left bracket to the left (24a), or a right bracket to the right (24b); at this point we do not know which is correct.

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[17] For example, a distinction like that of the English stress-bearing versus stress-neutral suffixes (Fudge 1985; Kaisse 2005) would not work here, because all suffixes are capable of bearing stress.

(24)   Stems with lexical accent

    a. Left bracket to the left   b. Right bracket to the right

       (x   x   x (x   x) x   x x)
       d ó l o v   g o r ó v   d ó l o v   g o r ó v

Looking at the stems with variable stress, we know that they must be different from the accented stems. It follows that they do not have an accent on the first vowel, for then they would have the same representation as *dolov*. This could suggest that they have no accent; but there is a third class of stems that *never* take stress, and these must be distinguished from the variable stems. If there were no variable stems, we would suppose that such stems are simply unaccented. But viewed in contrast with accented and variable stems, never taking stress could suggest a positive mark that guarantees this result, rather than the lack of a mark. Before attempting to resolve this matter, let us look briefly at the 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.

(25)   Suffixes by stress patterns

        After variable stems   After stressless stems
    a. kolov-á   b. molov-á
        torov-é   norov-é
    c. kólov-u   d. molov-ú
        tórov-i   norov-í

In thinking how to interpret this pattern, the cue for bounded (binary) constituents given in (18.3b) above is instructive: in that cue, a non-edge stressed light syllable indicates bounded feet (ICC). That is, we can conclude that 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, or an unaccented syllable in our current 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 bracket. In the latter case, we can posit the cue in (26).

(26)   Cue for a pre- or postaccent
      If an unaccented element receives a stress that is not due to an edge, then it is adjacent to
      an element that provides it with a bracket.

In the current example, the suffixes actually do occur at an edge, so it is potentially possible that their stresses are due to an edge mark. But this hypothesis quickly runs into a contradiction: if suffixes are stressed because of an edge mark, then in cases where they are unstressed the edge mark must be being overruled by another mark to the left, that is, by a lexical accent. But we know that *kólovu* cannot have a lexical accent, or else it would be identical to *dólovi*. Attributing suffix stresses to an edge mark might be feasible if there were only two types of stems, but cannot account for why there are three (or more) types.

If edge marks are not a solution, it remains possible that the suffixes that receive stress only when adjacent to never-stressed stems are receiving a bracket from those stems. In the SBG theory a postaccenting morpheme has a lexical left bracket to the right of its last mark (27). This leaves the variable stems as having no accents (28).

(27)   Postaccenting stems: Left bracket to the right of the rightmost mark

          x x(x x(
          m o l o v̲   n o r o v̲

(28)   Unaccented stems: No brackets

           x x   x x
           k o l o v   t o r o v

Returning now to the suffixes, we can conclude that suffixes that have stress only after post-accenting stems also have no accent (29), and that the other suffixes are accented (30). That is, they get a bracket, but we do not know which kind, as with the stems.

(29)   Unaccented suffixes: No brackets

             x   x
             -u   -i

(30)   Suffixes with lexical accent

        a. Left bracket to the left   b. Right bracket to the right

            (x   (x   x)   x)
            -á̲   -é̲   -á̲   -é̲

At this point we have arrived at representations for the three classes of stems and two classes of suffixes; unaccented and postaccenting morphemes have unique representations, and accented morphemes still have two possible representations.[18] The rest of the learning path is almost the same as for unbounded stress systems, as set out by Dresher (1994).

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[18] An anonymous reviewer asks if it is possible to make more precise the order in which the learner surveys the lexicon. The reviewer demonstrates that a learner that proceeds by making pairwise comparisons between types of stems could be easily misled. For example, a learner that tries to draw conclusions from looking only at A and U stems, or only U and P stems, may not succeed in acquiring a consistent set of representations. The learner proposed here does not make pairwise comparisons, but tries to determine how many different contrasting types there are. It is an interesting empirical question whether the particular path proposed here for AUP also works for other types of lexical accent systems, or if one can identify more efficient ways of processing the data; see Section 8.5 for further discussion of contrast acquisition.

Secondary Stress

A learner could easily notice that there are no audible secondary stresses in this language. This does not mean that only one grid mark can be projected to line 1 in each word; that is, that there can be only one line 0 constituent (foot) per word. Rather, it means that only the line 2 grid mark is realized as phonetic prominence. In principle, this cue can take effect at any time in the learning path, as it is not dependent on the setting of other metrical parameters.

Extrametricality

Though extrametricality does not exist in the SBG theory in terms of special marking of extra-metrical syllables, SBG does allow edge markings that exclude the last or first element in a word, as we saw in (7b), repeated here as (31a), along with its mirror-image corresponding bracket on the right edge in (31b). These edge markings could cause the learner to be misled as to where the effective edges of the word are. However, words with edge stresses exclude these edge markings (32).[19]

(31)   Extrametricality via edge marking

    a. Left edge: LRL   b. Right edge: RLR

       # x (x x…   …x x) x #

(32)   No extrametricality in AUP

a. No left edge LRL		b. No right edge RLR		
x		x		Line 2
x		x		Line 1
# x x x #		# x x x #		Line 0
d o̱ l o v - u		m o l o v̱ - a̱		Syllables

Bounded constituents

I have mentioned above that the test for bounded constituents is to see if there exist stressed elements whose stress cannot be attributed to either a lexical accent or to an edge. A search through the words of AUP in (22) turns up no potential candidates of this type. Therefore, there is no evidence that ICC applies in this language.

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[19] This conclusion holds for languages where all words are subject to the same edge markings, as I assume to be the case here. Roca (2005) and Doner (2013) argue that Spanish stems and words may be specified for specific edge markings; thus, a stress on a final syllable in one class of words would not rule out an extrametrical edge setting in other classes. However, variable edge setting is itself a form of lexical accent that would have to be diagnosed by a learner prior to arriving at this point in the learning path. How this kind of lexical accent can be acquired is an interesting question that I cannot pursue here.

Line 0 heads

Words consisting only of unaccented morphemes have no brackets except for edge marking, so they can tell us which side line 0 heads are on. There are two possible edge settings for the bracket (33); though we cannot at this point decide which is correct, in either case heads on line 0 must be on the left.

(33)   Line 0 heads: Left

    a. Left bracket on the left edge   b. Right bracket on the right edge

x	x	Line 2
x	x	Line 1
# (x x x #	# x x x) #	Line 0
k o l o v - u	t o r o v - i	

Lexical accents again

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 bracket must be adjacent to its head element. It follows that lexical accents must be, as in (34), on the left, and not on the right, as the latter would imply a right-headed constituent in *goróv*, incorrectly yielding **górov*.

(34)   Morphemes with lexical accent: Left bracket to the left

    a. Stems   b. Suffixes

x	x	x	x
(x x	x (x	(x	(x
d ó l o v	g o r ó v	-á	-é

Main stress

We can now determine the position of main stress, which must consistently appear in either the leftmost or rightmost line 1 constituent. In words with only a single line 0 constituent (foot), such as *dólovu*, the position of main stress is ambiguous, for any setting would yield the same result. We have more than one foot in the case of words with at least two accents, and such words are informative concerning the position of main stress. We find that main stress appears consistently in the leftmost constituent, suggesting that line 1 constituents have a left bracket and are headed on the left.[20]

---

[20] In theory, line 1 could have an edge bracket RRR and still be headed on the left, as shown in (i). However, as we are dealing with non-compound words, there will always be only a single constituent at line 1, so there is no empirical difference between grouping the line 1 marks with a left bracket or a right bracket. Therefore, I limit the choice to what I consider to be the

(35)   Main stress: Line 1 head left, edge LLL

```
  x                            x                    Line 2
 (x        x                  (x      x             Line 1
#(x   x    (x #            # x (x     (x #          Line 0
 d o l o v - a               g o r o v - e
```

Edge marks

Words with accented morphemes now resolve where the line 0 edge mark must go. If the edge bracket is on the left, stress should always fall on the initial syllable (36), which is not the case. Putting the edge mark at the right edge works in all cases (37).

(36)   Line 0 edge on the left (incorrect)

```
 *x                          *x                    Line 2
  (x        x                 (x   x    x          Line 1
 # (x   x    (x #           # (x (x     x #         Line 0
  k o l o v - e               g o r o v – i
```

(37)   Line 0 edge: RRR

    a. U + A   b. A + U

```
         x                            x            Line 2
        (x                           (x            Line 1
    # x  x    (x) #            # x  (x     x) #     Line 0
     k o l o v - e              g o r o v – i
```

    c. U + U   d. P + U

```
     x                                   x         Line 2
    (x                                  (x         Line 1
   # x  x    x) #            # x   x(     x) #      Line 0
    t o r o v - u              m o l o v - i
```

---

unmarked option (compare lexical brackets), where the edge bracket is on the same side as the head.

(i)   Main stress: Line 1 head left, edge RRR

```
   x                          x                    Line 2
   x        x)                x      x)            Line 1
  # (x   x    (x #          # x (x    (x #         Line 0
   d o l o v - a             g o r o v - e
```

Summary

We have now set all the relevant metrical parameters for the AUP language. We have arrived at the lexical representations shown in (38), and the metrical grammar is summed up in (39).

(38)   Lexical representations for the AUP language

		Stems		Suffixes	
		x x	x x	x	x
a.	Unaccented	k o l o v	t o r o v	-u	-i
		(x x	x (x	(x	(x
b.	Accented	d o̲ l o v	g o r o̲ v	-a̲	-e̲
		x x(	x x(		
c.	Postaccenting	m o l o v̲	n o r o v̲		

(39)   SBG metrical parameters for AUP
   a. Lexical accents: An accented syllable projects (x on line 0; a postaccenting syllable projects x(on line 0.
   b. Edge marking on line 0: RRR.
   c. No ICC.
   d. Line 0 heads are on the left.
   e. Edge marking on line 1: LLL.
   f. Line 1 heads are on the left.
   g. Only a line 2 mark (main stress) is phonetically realized as a prominence.

   The learning path outlined above that leads to the acquisition of the above grammar can be summarized as in (40).

(40)   Summary of learning path (results for AUP)
   a. Look for: Identical word types with conflicting stress contours.
       Result: Succeed.
       Conclude: Stress is not predictable by assuming simple QI.
   b. Repeat (a) several times, checking in turn for QS and morphological influence.
       Result: Neither QS nor morphology helps to eliminate conflicts. Find 4 types of stems and 2 types of suffixes.
       Conclude: Presence of lexical accents.
   c. Look for: Stems with fixed stress
       Result: Succeed.
       Conclude: Stems with fixed stress have lexical accent, either (x or x).
   d. Look for: Stems which never take stress in contrast to variable stems.
       Result: Succeed.
       Conclude: Variable stems are unaccented; stems that never take stress are postaccenting, x(.

e. Look for: Suffixes with fixed stress.
    Result: Fail.
    Conclude: Cannot conclude there are accented suffixes.
f. Look for: Suffixes that never take stress in contrast to variable suffixes.
    Result: Fail.
    Conclude: Cannot conclude there are unaccented suffixes.
g. Look for: Suffixes that take stress only with poststressing stems.
    Result: Succeed.
    Conclude: Such suffixes are unaccented; other variable suffixes are accented, either
                     (x or x).
h. Look for: Secondary stresses.
    Result: Fail.
    Conclude: Only the line 2 grid mark is realized as stress.
i. Look for: Stressed syllable at the left and right edges.
    Result: Succeed.
    Conclude: No extrametricality: no #x(or)x# on line 0.
j. Look for: Stressed nonaccented or nonedge syllable.
    Result: Fail.
    Conclude: ICC does not apply on line 0.
k. Look for: Stress on the left or right of words with only unaccented morphemes (i.e.,
                     with only edge marks on line 0).
    Result: Succeed on the left.
    Conclude: Line 0 heads are on the left.
l. Look for: Stress falling in constituent-sized windows in words with accented
                     morphemes, trying (x and x).
    Result: Succeed with (x.
    Conclude: Accented morphemes are (x.
m. Look for: Main stress in a constituent-sized window at either word edge.
    Result: Succeed on the left.
    Conclude: Line 1 constituents are left headed, and have an edge bracket set LLL: #(x.
n. Look for: Effect of a line 0 edge bracket LLL or RRR in words with one accented
                     morpheme.
    Result: Succeed on the right.
    Conclude: Line 0 has an edge bracket set RRR: x)#.

8.5   Contrast and Metrical Representations

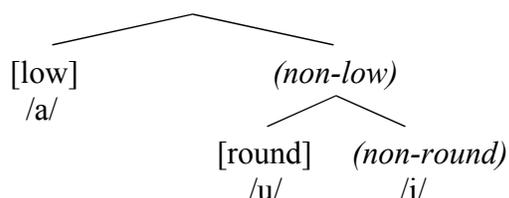The learning path sketched above relies on a general principle of contrast (41):

(41)   Principle of contrast
       Do not make more distinctions than are required.
       Or more positively:
       Create only 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, as expressed in de Saussure's ([1916] 1972: 166) famous maxim, "dans la langue il n'y a que des différences".

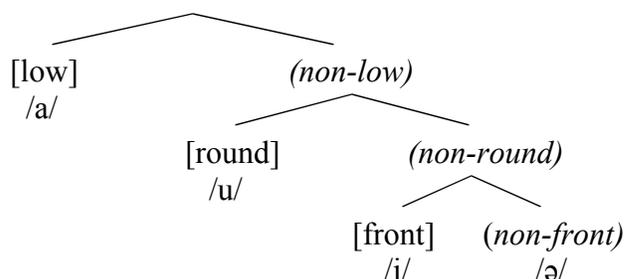*8.5.1   Contrast in Segmental Representations*

I have argued (Dresher 2009) that the same principle of contrast holds for segmental phonology: only as many features as are required to distinguish phonemes are specified. For example, a three-vowel inventory requires exactly two features, if vowels are evaluated as a group, apart from consonants. The tree in (42) shows a three-vowel inventory assigned the contrastive features [low] and [round]; in this case, [low] is ordered first and is contrastive over all three vowels; it takes scope over [round], which is contrastive only in the non-low vowels. I assume that both the choice of features and their ordering may vary from language to language.

(42)   A three-vowel inventory, [low] > [round]

$$\begin{array}{ccc} & \diagup \quad \diagdown & \\ \text{[low]} & & \textit{(non-low)} \\ \text{/a/} & & \diagup \quad \diagdown \\ & \text{[round]} & \textit{(non-round)} \\ & \text{/u/} & \text{/i/} \end{array}$$

The addition of vowels creates more contrasts, which may require additional features; an example of adding a fourth vowel to the inventory of (42) is (43). Notice that what appears to be the 'same' vowel /i/ in the two systems receives different contrastive specifications.[21]

(43)   A four-vowel inventory, [low] > [round] > [front]

$$\begin{array}{cccc} & \diagup \quad \diagdown & & \\ \text{[low]} & & \textit{(non-low)} & \\ \text{/a/} & & \diagup \quad \diagdown & \\ & \text{[round]} & & \textit{(non-round)} \\ & \text{/u/} & & \diagup \quad \diagdown \\ & & \text{[front]} & \textit{(non-front)} \\ & & \text{/i/} & \text{/ə/} \end{array}$$

A similar principle holds for lexical accent: in the AUP language we have 4 different stem patterns, hence we need 4 different types of URs (38): an unaccented stem, two different types of accented stems, and a postaccenting stem. As in segmental phonology, the way a morpheme patterns with respect to stress must be viewed in the context of the morphemes it is in contrast with: hence, we cannot conclude that a morpheme in another language that patterns similarly to an AUP morpheme will have the same UR.

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[21] See Compton & Dresher's (2011) analysis of Inuit vowel systems, on which these examples are based.

8.5.2   The UP Language

Consider, for example, a language like AUP—call it UP—that has no accented stems but otherwise patterns exactly like AUP. We might initially suppose that it has the same representations as in (38), minus the accented stems (44). The UP language would have sample words as in (45); according to (44), these would be assigned representations as in (46).

(44)   Lexical representations for the UP language (first version = AUP)

		Stems		Suffixes
		x x x x		x
a.	Unaccented	k o l o v t o r o v		-u
				(x
b.	Accented			-a̲
		x x(x x(		
c.	Postaccenting	m o l o v̲ n o r o v̲		

(45)   UP language words

a. U + A   b. P + A
    kolov-á̲   molo̲v-á̲

c. U + U   d. P + U
    kólov-u   molo̲v-ú

(46)   UP language words: Metrical representations according to (44)

a. U + A   b. P + A

         x   x   Line 2
        (x   (x   Line 1
    # x x   (x) #   # x x((x) #   Line 0
     k o l o v- á̲   m o l o v̲ - á̲

c. U + U   d. P + U

      x   x   Line 2
     (x   (x   Line 1
    # x x   x) #   # x x(x) #   Line 0
     k ó l o v - u   m o l o v̲ - ú

The representations in (44) and (46) are those carried over from the AUP language. However, if the only words learners are exposed to are like these, it is unlikely they would arrive at the above analysis, which makes different two-way contrasts in stems and suffixes. Rather, a simpler analysis is available as in (47), in which stems that never take a stress could be analyzed as unaccented, and variable stems as accented. As opposed to the leftward orientation of AUP, in UP—which should now be renamed UA—stress is oriented to the right. Thus, accents project a

right bracket to the right, the edge on line 0 is a left bracket on the left, and the heads of line 0 and 1 are on the right. In this analysis, morphemes have the lexical representations in (48), and words have the metrical structures in (49). This analysis makes fewer types of contrasts; all other things being equal, this would be the preferred analysis.

(47)　SBG Metrical parameters for UP (revised = UA)
　　　a.　Lexical accents: An accented syllable projects x) on line 0.
　　　b.　Edge marking on line 0: LLL.
　　　c.　No ICC.
　　　d.　Line 0 heads are on the right.
　　　e.　Edge marking on line 1: RRR.
　　　f.　Line 1 heads are on the right.
　　　g.　Only a line 2 mark (main stress) is phonetically realized as a prominence.

(48)　Lexical representations for the UP language (revised version = UA)

		Stems		Suffixes
		x x	x x	x
a.	Unaccented	m o l o v	n o r o v	-u
		x) x	x) x	x)
b.	Accented	k o̲ l o v	t o̲ r o v	-a̲

(49)　UP (UA) language words: Metrical representations according to (48)

　　a.　A + A　　　　　　　　　b.　U + A

```
        x                              x              Line 2
    x        x)                        x)             Line 1
  # (x)  x    (x) #          # (x   x    x) #          Line 0
   k o̲ l o v- á              m o l o v - á
```

　　c.　A + U　　　　　　　　　d.　U + U

```
    x                              x                  Line 2
    x)                             x)                 Line 1
  # (x)  x     x #          #( x   x     x #           Line 0
   k ó̲ l o v - u             m o l o v - ú
```

To sum up, this example demonstrates that the same stress patterns that lead a learner to one analysis in the AUP language lead to an entirely different analysis when some patterns are *subtracted*. It follows that a learner must have a good sense of all the contrasting patterns in a language before trying to acquire the grammar of any part of it.

8.5.3   The AP Language

To take one more example, suppose now that we had only the accented and postaccenting stems from the AUP language, along with accented and unaccented suffixes; call this the AP language, with lexical representations as in (50), words as in (51), and metrical representations as in (52).

(50)   Lexical representations for the AP language (first version = AUP)

	Stems		Suffixes
a. Unaccented			x -u
b. Accented	(x x d o̲ l o v	x (x g o r o̲ v	(x -a̲
c. Postaccenting	x x (m o l o v̲	x x (n o r o v̲	

(51)   AP language words

a.   A + A   b.   A + A   c.   P + A
     dó̲lov-a̲   goró̲v-a̲   molov̲-á

d.   A + U   e.   A + U   f.   P + U
     dó̲lov-u   goró̲v-u   molov̲-ú

(52)   AP language words: Metrical representations according to (50)

a.   A + A   b.   A + A   c.   P + A

```
   x                         x                         x        Line 2
   (x      x                 (x     x                  (x       Line 1
 # (x   x   (x) #           # x (x   (x) #           # x  x(   (x) #   Line 0
   d ó̲ l o v- a̲            g o r ó̲ v- a̲           m o l o v̲ - á
```

d.   A + U   e.   A + U   f.   P + U

```
   x                         x                         x        Line 2
   (x                        (x                        (x       Line 1
 # (x   x   x) #            # x (x    x) #           # x  x(    x) #   Line 0
   d ó̲ l o v- u            g o r ó̲ v- u           m o l o v̲ – ú
```

Again, it is unlikely that a learner approaching this data fresh would maintain this analysis. 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. This analysis, summarized in (53), requires that lexical accents project a right bracket to the right, the edge on line 0 is a right bracket on the right, and the heads of line 0 are on the right. A left bracket is projected to the left of the leftmost mark on line 1, and line 1 heads are on the left.

(53)   SBG Metrical parameters for AP (revised = AU)
  a.   Lexical accents: An accented syllable projects x) on line 0.
  b.   Edge marking on line 0: RRR.
  c.   No ICC.
  d.   Line 0 heads are on the right.
  e.   Edge marking on line 1: LLL.
  f.   Line 1 heads are on the left.
  g.   Only a line 2 mark (main stress) is phonetically realized as a prominence.

This analysis is shown in (54) and (55). As before, the revised analysis makes fewer types of contrasts and is simpler than the analysis based on AUP, and would be preferred, all other things being equal.

(54)   Lexical representations for the AP language (second version = AU)

		Stems		Suffixes	
		x x	x x	x	x
a.	Unaccented	m o l o v	n o r o v	-u	-a
		(x x	x (x		
b.	Accented	d o̲ l o v	g o r o̲ v		

(55)   AP (AU) language words: Metrical representations according to (54)

a. A + U   b. A + U   c. U + U

```
    x                         x                         x          Line 2
   (x      x                 (x    x                   (x          Line 1
 # x) x   x) #             # x  x)   x) #           # x  x   x) #   Line 0
 d o̲ l o v- a             g o r o̲ v- a             m o l o v – á
```

d. A + U   e. A + U   f. U + U

```
    x                         x                         x          Line 2
   (x      x                 (x    x                   (x          Line 1
 # x) x   x) #             # x  x)   x) #           # x  x   x) #   Line 0
 d o̲ l o v- u             g o r o̲ v- u             m o l o v – ú
```

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), shown in (56). Alderete (1999) in fact assumes that unaccented noun stems do not play a role in the core analysis of Russian accent. Halle (1997: 281) points out that unaccented stems include many widely used nouns, which may counter the low type frequency. And 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.[22]

(56)   Distribution of stem types in Russian (Zaliznjak 1967)

	Stem type	Example	Number	Percent
a.	Unaccented	*gorod*	273	0.8%
b.	Accented	*gorox*	30,100	91.6%
c.	Postaccenting	*korol*	2,176	6.6%

8.5.4   Contrast and the Nature of Cues

Awareness of the role of contrast in language acquisition can help to strengthen the relation between parameters and their cues. As Pearl (2007: 196) points out, "the cues method requires the learner to be equipped with additional knowledge (cues) to solve the language learning task." It would be desirable to minimize the 'additional knowledge' required as much as possible. Dresher & Kaye (1990) propose an Appropriateness principle for cues (57). The intention of this principle is to ensure that a cue has a principled connection to its parameter and is not 'opportunistic' (that is, works for some coincidental reason not connected to the inherent nature of the parameter).

(57)   Appropriateness (Dresher & Kaye 1990: 157)
        Cues must be appropriate to their parameters with regard to their scope and operation.

Nevertheless, one could question in what way Dresher & Kaye's cue for QS in (18.1) is appropriate to its parameter. The defining characterization of a QS system in standard accounts of metrical theory is that a heavy syllable may not be a dependent in a foot; in terms of SBG, a heavy syllable projects a bracket on line 0.[23] But the cue for QS in (18.1) looks for words with conflicting stress contours; the cue has no direct connection to the parameter, which governs the projection of a bracket on line 0.

The above discussion of contrast, however, puts this cue into a different light. Looking for words with conflicting contours is not, in fact, a direct cue to QS, or to lexical accent. Rather, looking for conflicting stress contours is a way of determining how many contrasting types of underlying elements need to be posited. If all words of *n* syllables have the same stress contours, then no contrasts in syllables, or morphology, or underlying accent, need be posited as far as the stress system is concerned. If conflicting stress patterns are found, however, then it follows that

---

[22] See Yang (2005) for discussion and a proposed principle for deciding whether a group of forms should be treated as a rule or simply treated as exceptions. It is clear that diachronic change in stress systems can serve as an illuminating window on what cues are important to learners; see Kabak & Revithiadou (2009) for an account of how lexical accent systems can develop from edgemost stress systems, and Forbes (2015) for a discussion of how languages with predictable root stress can develop lexical accent.

[23] The connection between the pre-SBG and SBG accounts of QS is made by the constraint proposed by Dresher (1994), that a heavy syllable must be the head of the constituent its bracket projects.

lexical representations must be elaborated in some way, either by distinguishing light from heavy syllables, or by morphology, or by positing lexical accents.

As the discussion of the AUP, UP, and AP languages demonstrates, learners do not posit certain types of lexical accents purely by observing the stress patterning of individual stems or suffixes; it is also important to know what sort of contrasting stems and suffixes there are. Thus, a stem that never has a stress on the surface is likely to be analyzed as an unaccented morpheme in a language like AP or UP, where such stems contrast with only one other type of stem, but as a postaccenting stem in an AUP language, where it participates in a three-way contrast (accented, unaccented, and postaccenting).

Recognizing that some cues are looking for contrasts rather than specific structures allows us to limit the other cues to looking for evidence of bits of structure closely related to the parameters. This brings the metrical learning system closer to the Structural Triggers Learners (STLs) proposed by Fodor (1998a; b) and Sakas & Fodor (2001). In the STL framework, a parameter is a bit of structure ('treelet') that does or does not exist in a particular grammar; the cue (or trigger, in their terminology) for setting the parameter is the discovery by the learner that the treelet is required for parsing an input string.[24]

In sum, we can now understand the learning model of Dresher & Kaye (1990) and the variation of it proposed here as containing two types of cues: cues for discovering how many contrasting elements there are, and cues for identifying specific bits of structure that may be parametrically present or absent. Viewing cues in this way reduces the distance between parameters and their cues.[25]

8.6   Conclusion

The learning model proposed in this article remains to be implemented computationally. However, any attempt to solve the problem of the acquisition 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 (cf. Tesar 2014).[26]

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[24] See Pearl (2007) and Sakas & Fodor (2012) for further discussion of STLs and other parameter-setting models.

[25] Pearl (2007: 255) considers ways in which the order of parameter setting (the learning path) can be derived from other properties of the learning system. If the learning path in (40) could be so derived, this would be another simplification of the learning model, in that the learning path would not have to be separately specified. It may be possible to extend Pearl's approach to the current set of parameters, but I cannot pursue this question here.

[26] Tesar (2014: 322–323) comments that his approach represents a shift away from traditional error-driven learning, "away from the question of whether a given word is generated by the learner's hypothesized grammar, and towards the question of whether a given word can provide any new information with respect to the space of grammars the learner has under consideration."

In this model, lexical representations are elaborated as required by contrast. Distinguishing between contrast-driven learning and the acquisition of bits of metrical structure allows for a more constrained set of cues that are closely related to their respective parameters. Finally, the notion of covert structure is fluid; different covert structures become overt to the learner at different points in the learning path.

Acknowledgements

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