Mutation and Learnability in Optimality Theory*

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1. Introduction

Because L1 learners of natural languages do not receive negative evidence, a basic challenge in designing a psychologically plausible learning algorithm is to ensure end-state restrictiveness. That is, the learner must be assured of arriving at a grammar which allows only the structures allowed in the target language, and no others. If the learner mistakenly posits a grammar which allows a proper superset of the structures allowed by the adult grammar, they will never get evidence forcing them to retreat from that hypothesis. In order to avoid such "superset traps", learning must proceed in such a fashion that the learner always hypothesizes the most restrictive grammar that would be compatible with the data they've seen so far (Gold 1967, Baker 1979, Angluin 1980, Berwick 1985).

In phonological learning, one place where potential superset traps arise is in languages where a particular phonological configuration is allowed in the language, but only in certain morphological contexts. The best-known example (discussed in this regard by Hayes 2004) involves the counterbleeding of Canadian Raising by intervocalic flapping in Canadian English dialects that have the famous surface contrast between *writer* and *rider*:

(1) /ɹaɪt/ → [ɹəit] 'write' /ɹaɪt-əɹ/ → ɹəit-əɹ → [ɹəiɾəɹ] 'writer'
  /ɹaɪd/ → [ɹaɪd] 'ride' /ɹaɪd-əɹ/ → [ɹaɪɾəɹ] 'rider'

An Optimality-Theoretic (Prince & Smolensky 2004 [1993]) learner presented with the surface forms in (1) can entertain two hypotheses:

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(2) *Wrong, less restrictive*: The grammar being learned allows [əi] and [aɪ] to contrast before voiced consonants:

IO-FAITH(height) » $*\text{əiC}_{[+\text{voi}]}$

(3) *Right, more restrictive*: Affixed words like *writer* can have [əiɾ] due to OO-identity (Benua 1997) with vowel height in the base, but [əi] is otherwise banned before voiced consonants:

OO-FAITH(height) » $*\text{əiC}_{[+\text{voi}]}$ » IO-FAITH(height)

Hypothesis (2) attributes the violation of the markedness constraint $*\text{əiC}_{[+\text{voi}]}$ (which forbids raised vowel-voiced consonant sequences) in words like *writer* to IO-faithfulness, whereas hypothesis (3) attributes it to OO-Faithfulness. Hypothesis (2) is less restrictive, because it allows sequences like [əiɾ] to occur anywhere in the language, whereas hypothesis (3) allows [əiɾ] to occur only when the [əi] corresponds to an [əi] in a morphologically complex word's base of affixation. To ensure that learners arrive at restrictive final grammars, they must therefore have an *a priori* preference for (3) over (2). In the context of the Biased Constraint Demotion (BCD) algorithm for OT (Prince & Tesar 2004), this necessary preference takes the form of a bias for ranking OO-faithfulness constraints over IO-faithfulness constraints whenever this would be consistent with the learning data (McCarthy 1998, Hayes 2004, Tessier 2007).

This paper has two goals. The first is to point out that a bias for high-ranked OO-faithfulness will not solve all restrictiveness issues which involve marked phonological structures being allowed only in particular morphological contexts. This is because marked structures are sometimes allowed only when they are created through a morphological mutation process, which by definition results in *non*-identity with the base. The second goal is to argue that the learning issues which consequently attend to mutation processes give us reasons to prefer an item-based approach to morphology, in which the contents of morphs are specified in underlying forms, over a process-based one, in which the phonological shapes of morphs are specified by constraints.[1] The next section presents the item-based vs. process-based distinction; in the subsequent sections, the learning-related arguments for the item-based view are laid out.

2. Morphology as Items vs. Processes

Hockett (1954) identifies a distinction between two ways of thinking about morphology that have been entertained in linguistic theory. The most familiar is what can be called an *item-based* theory. In an item-based theory, the morphs which make up a word are regarded as objects—phonological underlying forms—which the morphology assembles together. This collocation of underlying forms then serves as the input to the phonology.

[1] See Bonet (2004) for a recent defense of the item-based view.

For example, the English word *writer* would be regarded as a collocation of a root morph /ɹaɪt/ and an agentive morph /əɹ/, as depicted above in (1).

The other general approach to morphology is a *process-based* one. In process-based theories, morphologically-complex forms are built not by assembling underlying forms but by taking the simplex base form and applying rules which modify it in some way. Segmental affixation of the sort seen in *writer* can be regarded as a kind of modification: the rule which marks the meaning 'agentive' modifies the bare root /ɹaɪt/ by epenthesizing the segments /əɹ/. There are, however, other kinds of modification, which depart more radically from what is intuitively possible in an item-based theory. The example that I'll focus on in this paper occurs in Javanese. The elative form of Javanese adjectives is created by making the rightmost vowel in the adjective stem high and tense (Dudas 1976, Hargus 1993, Benua 1999):

(4)	*plain*		*elative*	
	alʊs	'refined'	alus	'most refined'
	aŋɛl	'difficult'	aŋil	'most difficult'
	abɔt	'heavy'	abut	'most heavy'
	rindɪʔ	'slow'	rindiʔ	'most slow'

This kind of morphology seems quite different from segmental affixation. However, in a process-based theory, the two are unified by assuming that 'affixation' is itself a (structure-adding) process, just as the vowel-mutation which marks the Javanese elative is a structure-modifying process.

In Optimality Theory, where there are no rules, various models have been proposed to implement process-based theories of morphology. One strategy involves positing constraints which demand that alternations occur between morphologically-related words. Models of this kind include Kurisu's (2001) REALIZE-MORPHEME theory and Alderete's (1999, 2001) Transderivational Anti-Faithfulness. Another approach is to posit 'declarative' constraints which demand that a word with certain morphological properties surface with certain phonological properties (Russell 1993, 1997, 1999, Hammond 2000, Bat-El 2003, MacBride 2004). I will generically refer constraints of either of these two kinds as 'RM' (for 'realize morpheme'), because the differences between them will not be relevant to my argument. In all of these various theories, RM succeeds in triggering phonological changes between simplex and complex forms by being ranked above the faithfulness constraint(s) which disfavor the relevant changes.

Advocates of item-based models have argued that feature-changing morphology like the Javanese elative can in fact be regarded as a concatenation of underlying forms if we adopt an elaborated theory of representations. In Autosegmental Phonology (Goldsmith 1976), phonological features are representational primitives in their own right, distinct from segmental root-nodes. This idea makes it possible to posit affixes whose underlying forms consist solely of 'floating' features that are unlinked to a root node (Goldsmith 1976, McCarthy 1983a,b, Lieber 1987, Akinlabi 1996, Gnanadesikan

1997, Wolf 2007). For Javanese, we can posit an elative suffix consisting solely of the features /[+high, +tense]/ (Benua 1999). In the next sections, I'll look at why the Javanese elative poses a restrictiveness challenge for learners, and how an autosegmental theory can overcome it in a more economical way than a theory based on RM constraints.

3. Restrictiveness in Javanese Elatives

The relevance of the Javanese elative for theories of phonological learning comes from the fact that it is not 'structure preserving'. As seen in (4), the mutation can create tense vowels in closed syllables. It does so in spite of the fact that, except in mimetic words and in vowels that have undergone the elative mutation, Javanese does not allow vowel tenseness in closed syllables (Dudas 1976, p. 116, fn. 10).[2] There are at least two pieces of evidence that the ban on closed-syllable tense vowels is active in the synchronic grammar of the language (as opposed to being merely a lexical accident). First, there are roots in which the rightmost vowel is lax when the root is unaffixed, but tense when the root-final syllable is opened by a V-initial suffix (Dudas 1976: 55-60):

(5) *unaffixed*	*affixed*	
a.pɪʔ	a.pi.ʔ-e	'good'
wi.wɪt	wi.wi.t-an	'beginning'

These alternations suggest an analysis in which the rightmost vowel of these roots is underlyingly tense, and undergoes a process of closed-syllable laxing in the unaffixed forms (as Dudas 1976 in fact proposes).

The second piece of evidence comes from the speech of Javanese-Indonesian bilinguals (Adiasmito-Smith 2004). Indonesian bans tense mid vowels in closed syllables, but unlike Javanese it allows tense high vowels in closed syllables. Monolingual Indonesian speakers show a gradient lowering/laxing of tense high vowels in closed syllables, whereas bilingual Javanese/Indonesian speakers show categorical laxing of high vowels in closed syllables when speaking Indonesian. This transfer of the ban on closed-syllable tense high vowels shows that it is an active part of adult Javanese speakers' grammars. Consequently, learners of Javanese need to arrive at the following constraint ranking (Benua 1999, Wolf 2007):

(6) a. *TENSE-CLOSED » MAX[+tense]
Underlying [+tense] vowels lose their [+tense] specification in closed syllables…

b. 'MUTATE' » *TENSE-CLOSED
…but the elative mutation can create [+tense] vowels, even in closed syllables

[2] Javanese is not alone in presenting a non-structure-preserving mutation. In Irish (Ní Chiosáin 1991), for example, certain segments only occur in initial position (or only occur at all) when they're created by one of the initial consonant mutations. Additional examples are discusses in Gnanadesikan (1997).

The challenge is ensuring that Javanese learners arrive at this ranking, and not on a less restrictive one. A standard assumption in the OT learning literature (Hayes 2004, Prince & Tesar 2004, Tesar & Prince to appear) is that learners begin by passing through a stage of phonotactic learning, during which they are oblivious to morphological structure. During this stage, a child learning Javanese will be exposed to elative words like [alus] which violate *TENSE-CLOSED, and will feed these adult productions into their developing grammar to see if they surface faithfully. In the learner's initial state, markedness is ranked over faithfulness,[3] so an error will occur when this is done:

(7) *Learner's error with M » F initial state and assumed identity map*

/alus/	*TENSE-CLOSED	MAX[+tense]
a. ☞ [alʊs]		1
b. [alus]	W_1	L

(8) *Resulting mark-data pair*

Input	*winner ~ loser*	*marks (loser)*	*marks (winner)*
/alus/	[alus] ~ [alʊs]	MAX[+tense]	*TENSE-CLOSED

The child will then learn from the mark-data pair in (8) by installing MAX[+tense] above *TENSE-CLOSED. That, however, leaves the learner with an under-restrictive grammar which preserves the tenseness of closed-syllable vowels across the board, not just in elative words. Consequently, once the learner progresses from phonotactic to morphophonemic learning, we need to ensure that they recalculate their grammar hypothesis in a manner that avoids the superset trap resulting from (7)-(8). That is, once the learner begins to discover alternations, they need to attribute violations of *TENSE-CLOSED to 'MUTATE' instead of to MAX[+tense] whenever they can. In BCD terms, this means that learner must have a bias for ranking 'MUTATE' over IO-Faithfulness.

What exactly 'MUTATE' is depends on the theory of morphology that we adopt. In a declarative theory, it would be some kind of RM constraint. In an item-based theory, it will be some constraint which favors the docking of floating features onto root segments. In the next section, I will show how the 'MUTATE' » IO-F bias reduces to an independently-required Specific-F » General-F bias under the item-based view.

4. Learning Javanese with Floating Features and a Specific-F » General-F Bias

Docking floating features onto stem segments violates faithfulness constraints which protect those segments' underlying feature specifications. Therefore, some higher-ranked constraint must exist to compel the docking. Zoll (1996) and Wolf (2007) propose that this constraint is a faithfulness constraint which demands the preservation of features which are underlyingly floating. For Javanese, I will assume that the constraint of interest is specific to [+tense]:

[3] See, among others, Sherer (1994), Demuth (1995), Smolensky (1996), Pater (1997), Bernhardt & Stemberger (1998), van Oostendorp (2000), Gnanadesikan (2004), Hayes (2004), and Prince & Tesar (2004).

(9) MAXFLT[+tense]
For all tokens *α* of [+tense] that are floating in the input:
α has a correspondent in the output.

MAXFLT[+tense] is an IO-faithfulness constraint, so learners begin by placing it in the lowest stratum, below all of the markedness constraints. It will still be there at the end of phonotactic learning, because the inputs tested by the learner during phonotactic learning are simply the adult outputs, which don't have floating features in them. Therefore, given the error brought on by (7)-(8) which Javanese learners are destined to make during the phonotactic stage, the following ranking will exist at the end of phonotactic learning:

(10) MAX[+tense] » *TENSE-CLOSED » MAXFLT[+tense]

The learner will retreat from this error once they begin to discover alternations and succeed in separating elative words like [alus] into a stem /alʊs/ and a floating-feature suffix /[+high, +tense]/. Segmenting the surface form [alus] into its constituent morphs will induce the learner to perform Surgery (Tesar *et al*. 2003). That is, the learner will calculate a new grammar hypothesis based upon their revised assumption about the input—specifically, that the input for the target surface form [alus] is /alʊs [+tense +high]/, rather than /alus/:

(11) a. *Original mark-data pair*

Input	*winner ~ loser*	*marks (loser)*	*marks (winner)*
/alus/	[alus] ~ [alʊs]	MAX[+tense]	*TENSE-CLOSED

b. *Revised mark-data pair arrived at after morphological reparsing*

Input	*winner ~ loser*	*marks (loser)*	*marks (winner)*
/alʊs/ [+hi, +tense]	[alus] ~ [alʊs]	MAX[+tense] MAXFLT[+tense]	*TENSE-CLOSED

In the original mark-data pair (11)a, the constraint MAXFLT[+tense] was irrelevant, because the input that the learner was assuming had no floating features in it. After Surgery, the learner is assuming floating features in the input, which means that MAXFLT[+tense] now exerts a preference between the target winning candidate [alus] and its competitor [alʊs]. Consequently, the learner now has a choice of two loser-mark-assigning constraints to install above the winner-mark-assigning *TENSE-CLOSED in order to ensure that [alus] wins.

There are independent grounds for assuming that the learner has a bias towards choosing MAXFLT[+tense] rather than the general MAX[+tense] as the constraint to install above *TENSE-CLOSED. OT learners have been argued to require a bias for ranking specific faithfulness constraints over more general ones for two reasons. The first (Smith 2000, Hayes 2004, cf. Prince & Tesar 2004) is to ensure end-state restrictiveness when the target language allows a marked structure only in a prominent position protected by a positional faithfulness constraint (Beckman 1998). The second is that there are many documented cases of children passing through *positional faithfulness stages*. These are stages in which the child's grammar allows some marked structure only in certain prominent positions, while the target grammar allows the same structures in a proper superset of those positions (see, among others, Rose 2000, Goad & Rose 2004, Tessier 2006, 2007, to appear, Jesney & Tessier 2007, these volumes).[4]

In many cases, determining which of two faithfulness constraints is 'more specific' is a nontrivial issue (Hayes 2004, Prince & Tesar 2004, Tessier 2006, 2007). However, in the case of the present example, the specific/general relation falls out automatically, because MAXFLT[+tense] is operative in a proper subset of the contexts that MAX[+tense] is. As such, a learner presented with the mark-data pair in (11)b will choose to install MAXFLT[+tense] rather than general MAX[+tense] above *TENSE-CLOSED, yielding the desired target grammar for Javanese:

(12) *Installing MAXFLT[+tense] gives correct target grammar*

/alʊs [+tns +hi]/	MAXFLT[+tense]	*TENSE-CLOSED	MAX[+tense]
a. ☞ [alus]		1	
b. [alʊs]	W_1	L	W_1

In an item-based theory of morphology, as we've just seen, end-state restrictiveness in a language like Javanese that has a non-structure-preserving mutation process is ensured by the Specific-F » General-F bias. This is because, in such a theory, there are of necessity positional faithfulness constraints to floating-feature affixes.

In a process-based theory, the picture is at once similar and different. By an argument exactly parallel to the one presented above for the item-based theory, we would have to assume that a Javanese learner had a bias for ranking RM above IO-faithfulness. The ranking $RM_{elative}$ » *TENSECLOSED » MAX[+tense] allows tense vowels in closed syllables only when they are tense as a result of the mutation process, so it's more restrictive than a ranking in which MAX[+tense] dominates *TENSECLOSED. The differences from the item-based theory are twofold. First, since RM is not a faithfulness constraint, the bias for ranking RM above IO-F is not an instance of the Specific-F » General-F bias. Occam's Razor thus recommends the item-based theory, since the process-based theory requires a distinct RM » IO-F bias in addition to the independently-needed Specific-F » General-F bias. By contrast, the item-based theory needs only the latter bias. The second difference is explored in the next section, which discusses child-language data indicating that RM constraints would have to be ranked *a priori* below IO-F, implying a bias exactly the opposite of what we've just seen to be needed for end-state restrictiveness in Javanese.

[4] In order to attribute learners' intermediate stages to the biases of the BCD algorithm, we need a means of making the algorithm operate gradually; see Tessier (2006, 2007, to appear) for a proposal in this direction. For a different approach to gradualness based on weighted rather than strictly-ranked constraints, see Jesney & Tessier (2007, these volumes).

5. Child Stages Incompatible with an RM » IO-F Bias

Adam & Bat-El (to appear), who assume a process-based model of affixation, argue on the basis of data from Hebrew-learning children that RM constraints are bottom-ranked in the initial state. That is, the data require a bias of IO-F » RM—the opposite of what a process-based theory needs for Javanese. In this section, I'll argue that for an item-based theory, the Hebrew and Javanese facts are not inconsistent, and in fact both can be attributed to the Specific-F » General-F bias.

Adam (2002), in a longitudinal study of 10 Hebrew-learning children, identifies a stage in which stems are truncated to a final trochee:[5]

(13)

	Adult	*Child*
	[...σ́σ]$_{PWd}$	[(σ́σ)$_{Ft}$]$_{PWd}$
	[...σσ́]$_{PWd}$	[(σ́)$_{Ft}$]$_{PWd}$

Children's productions at this stage can be analyzed with the ranking depicted in the following tableaux (Tessier to appear):[6]

(14) *Adult target with penult stress is truncated to [(σ́σ)]*

/avokádo/ 'avocado'	ALL-FT-L	TROCHEE	IDENT(stress)	MAX	IAMB
a. ☞ [(ká.do)]				3	1
b. [a.vo.(ká.do)]	W_1			L	1
c. [a.(vo.ká).do]	W_1	W_1		L	L
d. [(vo.ká)]		W_1		3	L
e. [(ká)]				W_5	L

(15) *Adult target with final stress is truncated to [(σ́)]*

/kadúr/ 'ball'	ALL-FT-L	TROCHEE	IDENT(stress)	MAX	IAMB
a. ☞ [(dúr)]				2	
b. [(ka.dúr)]		W_1		L	
c. [(ká.dur)]			W_1	L	W_1
d. [ka.(dúr)]	W_1			L	

The undominated statuses of ALL-FT-LEFT, TROCHEE, and IDENT(stress) mean, respectively, that children in this stage can only produce outputs where there is a single

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[5] At a later stage, final-stressed targets are truncated to a disyllabic iamb: [(σσ́)]. Children progress to this stage for nouns sooner than they do for verbs. This is yet another positional faithfulness stage, on the view that nouns are afforded special faithfulness protection (Smith 2001). See Tessier (to appear) and Jesney & Tessier (2007, these volumes) for discussion of the learnability implications of this fact.

[6] Adam & Bat-El (to appear) actually use different constaints in their analysis of this stage. However, the difference won't affect my argument.

foot at the left edge; where that foot is a trochee; and where main stress is on the same syllable as in the adult target form. Ranking these constraints above MAX allows segments from the beginning of the word to be deleted in order to get the single permitted foot to be at the left edge. (For visual clarity, subsequent tableaux will not depict candidates that violate any of the three undominated constraints.) The ranking MAX » IAMB is necessary to prevent candidates like (14)e, which undergo further deletion to produce a monosyllabic foot (which is both an iamb and a trochee because stress is aligned with both edges of the foot) from beating ones like (14)a, which satisfies TROCHEE but violates IAMB.

The relevance of this situation for morphological theory comes from the fact that children in (and past) the trochaic minimal-word stage rarely produce suffixed verb forms. For an adult verb form like [na.fál-ti] 'I fell', children have [fál] (and in a somewhat later stage of prosodic development, [na.fál]), but productions with the suffix /-ti/ are rare. The problem seemingly posed for an item-based theory then is this: if the input for 'I fell' is is /nafál-ti/, it should act the same as penult-stressed stems like /avokádo/. This is shown in the following tableau:

(16) *Retention of suffix expected with final-stressed stem*

/nafál-ti/	MAX	IAMB
a. 💣 [(fá.ti)]	3	1
b. ☞ [(fál)]	W_4	L

The choices that would satisfy the three undominated constraints are to truncate to just the stressed syllable, as in (16)b, or to truncate to the stressed syllable plus the suffix syllable, yielding a bisyllabic trochee, as in (16)a. The bisyllabic option is [(fá.ti)] rather than [(fál.ti)] because Hebrew-learning children in this stage don't yet allow medial codas (Adam & Bat-El to appear: fn. 13). Option (16)b does better on IAMB, but (16)a is expected to win because it has fewer deletions, and consequently does better on MAX. The problem is that the attested winner is (16)b. The word /nafál-ti/ thus defies expectations by behaving as if the /ti/ weren't there underlyingly, and the input was final-stressed /nafál/ (which we *would* expect to truncate to [(fál)]).

Adam & Bat-El (to appear) propose to solve this problem by assuming that the input for adult [na.fál.ti] really is /nafál/, with the /ti/ being absent from the input. They assume further that affix segments are, in the adult grammar, epenthesized under the compulsion of RM constraints like the following:

(17) ALIGN&MATCH$[\text{-ti}]_{\text{Past.1sg}}$
Align the left edge of the string [-ti] with the right edge of a stem which has the morphological features 'past' and '1st person singular'. *[n.b.: constraint definition mildly paraphrased]*

Finally, they assume these constraints to be bottom-ranked in the initial state. Such a ranking means that learners will initially be unable to epenthesize affix segments in order to satisfy A&M constraints, accounting for the absence of affixes in the trochaic minimal-word stage:

(18) *Bottom-ranked A&M results in omission of suffix segments*

/nafál-$_{Past.1sg}$ /	MAX	IAMB	A&M[-ti]$_{Past.1sg}$
a. ☞ [(fál)]	2		1
b.[(fá.ti)]	W_3	W_1	L

This approach gives the desired result because omitting the affix no longer violates MAX. Consequently, [(fál)] now gets one fewer MAX violation than [(fá.ti)] does, which results in [(fál)] winning. The constraint A&M[-ti]$_{Past.1sg}$ favors [(fá.ti)], but its preference loses out to that of the faithfulness constraint MAX, because A&M constraints are initially ranked below IO-faithfulness.

As I've mentioned, though, there is a problem: we've adduced from the Javanese data that RM constraints must be biased towards a ranking above faithfulness. Applying this bias to the A&M approach to Hebrew would mean that A&M constraints were ranked *a priori* above faithfulness, and specifically that A&M[-ti]$_{Past.1sg}$ would start out above MAX. That spoils the analysis, owing to A&M[-ti]$_{Past.1sg}$'s preference for [(fá.ti)]:

(19) *Putting A&M above IO-F gives wrong outcome*

/nafál-$_{Past.1sg}$ /	A&M[-ti]$_{Past.1sg}$	MAX	IAMB
a. 💣 [(fá.ti)]		3	1
b. ☞ [(fál)]	W_1	L_2	L

Some other way therefore needs to be found to ensure that the grammars of Hebrew-learning children in the trochaic stage 'don't care' about having affix segments present in the output. Recall that the analysis in (18) worked because omitting the suffix segments no longer violated MAX, resulting in [(fál)] getting fewer marks from that constraint than [(fá.ti)] did. An alternative way of getting this effect would be to assume that the MAX constraint that's ranked immediately above IAMB isn't general MAX but instead MAX(stem), which only protects stem segments (McCarthy & Prince 1995, Beckman 1998).[7]. This approach will give us the correct outcome:

(20) *Positional faithfulness analysis of suffix-omission*

/nafál-ti/ 'I fell'	MAX(stem)	IAMB	MAX
a. ☞ [(fál)]	2		4
b.[(fá.ti)]	W_3	W_1	L_3

[7] Strictly speaking these works propose that there are positional faithfulness constraints for *roots*. I'm invoking MAX(stem) here in order to bypass the debated issue of whether (as traditionally assumed) roots in Semitic consist of just consonants, with the stem vowels belonging to a separate morph. See (among others on both sides of the debate) Ussishkin (1999) for arguments against the consonantal root, and Nevins (2005) for arguments in favor of it.

The Hebrew data can thus be seen as a positional faithfulness stage: while general MAX must eventually be installed above IAMB,[8] learners show an intermediate stage where general MAX remains in the lowest stratum, while MAX(stem) has moved up in ranking.

Consequently, in an item-based theory of morphology, the Javanese and Hebrew facts are perfectly compatible. Both result from positional faithfulness constraints being installed above markedness before general faithfulness constraints are. This stands in stark contrast with a process-based view of morphology, where the Javanese and Hebrew data are in tension. The former data require RM constraints to be *a priori* above faithfulness, whereas the latter require them to start out below faithfulness. We therefore have an empirical argument in favor of the item-based view, complementing the parsimony argument adduced in the previous section. In sum, then, we can make headway towards settling the item-based vs. process-based debate if we consider the different predictions of the two theories with regards to learnability and acquisition.

References

Adam, Galit (2002). *From Variable to Optimal Grammar: Evidence from Language Acquisition and Language Change*. Doctoral dissertation, Tel Aviv University. [ROA-567]

Adam, Galit, and Outi Bat-El (to appear). Morphological knowledge without morphological structure: Morphology-prosody interface in the first Hebrew verbs. In Sharon Armon-Lotem, Gabi Danon and Susan Rothstein (eds.), *Generative Approaches to Hebrew Linguistics*. Amsterdam: John Benjamins.

Adiasmito-Smith, Niken (2004). *Phonetic and Phonological Influences of Javanese on Indonesian*. Ph.D. dissertation, Cornell University, Ithaca, NY.

Akinlabi, Akinbiyi (1996). Featural affixation. *Journal of Linguistics* **32**, pp. 239-289. [ROA-185]

Alderete, John D. (1999). *Morphologically Governed Accent in Optimality Theory*. Ph.D. dissertation, University of Massachusetts, Amherst. [ROA-309]

Alderete, John D. (2001). Dominance effects as trans-derivational anti-faithfulness. *Phonology* **18**, pp. 201-253.

Angluin, Dana (1980). Inductive inference of formal languages from positive data. *Information and Control* **45**, pp. 117-135.

Bat-El, Outi (2003). Anti-faithfulness: An inherent morphological property. In Jacqueline Lecarme (ed.), *Research in Afroasiatic Grammar II*. Amsterdam: John Benjamins, pp. 21-34.

Baker, C.L. (1979). Syntactic theory and the Projection Problem. *Linguistic Inquiry* **10**, pp. 533-581.

Beckman, Jill (1998). *Positional Faithfulness*. Ph.D. dissertation, University of Massachusetts, Amherst. [ROA-234]

Benua, Laura (1997). *Transderivational Identity: Phonological Relations between Words*.

[8] Once Hebrew-learning children pass out of the stage of banning medial codas, the relevant competitors will be [(fál)] and [(fál.ti)]. These tie on MAX(stem), and IAMB prefers [(fál)]. Therefore, in order for candidates like [(fál.ti)] that retain the affix to begin winning, general MAX will have to get above IAMB.

Ph.D. dissertation, University of Massachusetts, Amherst [ROA-259]

Benua, Laura (1999). Identity and ablaut in Javanese elatives. In Sachiko Aoshima, John Drury, and Tuomo Neuvonen (eds.), *University of Maryland Working Papers in Linguistics* **8**. College Park: UMDWPL, pp. 1-31.

Bernhardt, Barbara H., and Joseph P. Stemberger (1998). *Handbook of Phonological Development from the Perspective of Constraint-Based Nonlinear Phonology.* San Diego: Academic Press.

Berwick, Robert (1985). *The Acquisition of Syntactic Knowledge*. Cambridge, MA: MIT Press.

Bonet, Eulàlia (2004). Morph insertion and allomorphy in Optimality Theory. *International Journal of English Studies* **4**.2, pp. 73-104. [ROA-734]

Demuth, Katherine (1995). Markedness and the development of prosodic structure. In Jill N. Beckman (ed.), *Proceedings of NELS 25*. Amherst: GLSA, pp. 13-25. [ROA-50]

Dudas, Karen (1976). *The Phonology and Morphology of Modern Javanese*. Ph.D. dissertation, University of Illinois, Urbana-Champaign.

Gnanadesikan, Amalia (1997). *Phonology with Ternary Scales*. Ph.D. dissertation, University of Massachusetts, Amherst. [ROA-195]

Gnanadesikan, Amalia (2004 [1995]). Markedness and faithfulness constraints in child phonology. In René Kager, Joe Pater, and Wim Zonneveld (eds.), *Fixing Priorities: Constraints in Phonological Acqusition*. Cambridge: Cambridge University Press, pp. 73-108. [ROA-67]

Goad, Heather, and Yvan Rose (2004). Input elaboration, head faithfulness, and evidence for representation in the acquisition of left-edge clusters in West Germanic. In René Kager, Joe Pater, and Wim Zonneveld (eds.), *Fixing Priorities: Constraints in Phonological Acquisition*. Cambridge: Cambridge University Press, pp. 109-157.

Gold, E. Mark (1967). Language identification in the limit. *Information and Control* **10**, pp. 447-474.

Goldsmith, John (1976). *Autosegmental Phonology*. Ph.D. dissertation, MIT, Cambridge, MA.

Hammond, Michael (2000). There is no lexicon! *Coyote Papers* **10**, pp. 55-77. [ROA-43]

Hargus, Sharon (1993). Modeling the phonology-morphology interface. In Sharon Hargus and Ellen M. Kaisse (eds.), *Phonetics and Phonology* **4**: *Studies in Lexical Phonology*. San Diego: Academic Press, pp. 45-74.

Hayes, Bruce (2004). Phonological acquisition in Optimality Theory: The early stages. In René Kager, Joe Pater, and Wim Zonneveld (eds.), *Fixing Priorities: Constraints in Phonological Acquisition*. Cambridge: Cambridge University Press, pp. 158-203.

Hockett, Charles F. (1954). Two models of grammatical description. *Word* **10**, pp. 210-231.

Jesney, Karen, and Anne-Michelle Tessier (2007). Re-evaluating learning biases in Harmonic Grammar. In Michael Becker (ed.), *University of Massachusetts Occasional Papers in Linguistics* **36**: *Papers in Theoretical and Computational Phonology*. Amherst: GLSA, pp. 69-110.

Kurisu, Kazutaka (2001). *The Phonology of Morpheme Realization*. Ph.D. dissertation, University of California, Santa Cruz. [ROA-490]

Lieber, Rochelle (1987). *An Integrated Theory of Autosegmental Processes*. Albany: State University of New York Press.

MacBride, Alexander (2004). *A Constraint-Based Approach to Morphology*. Ph.D. dissertation, University of California, Los Angeles.

McCarthy, John J. (1983a). Consonantal morphology in the Chaha verb. In Michael Barlow, Daniel P. Flickinger, and Michael T. Westcoat (eds.), *Proceedings of the Second West Coast Conference on Formal Linguistics*. Stanford: Stanford Linguistics Association, pp. 176-188.

McCarthy, John J. (1983b). Phonological features and morphological structure. In John F. Richardson, Mitchell Marks, and Amy Chukerman (eds.), *Papers from the Parasession on the Interplay of Phonology, Morphology and Syntax*. Chicago: CLS, pp. 135-161.

McCarthy, John J. (1998). Morpheme structure constraints and paradigm occultation. In M. Catherine Gruber, Derrick Higgins, Kenneth Olson, and Tamra Wysocki (eds.), *CLS 32, vol. 2: Papers from the Panels*. Chicago: CLS, pp. 123-150.

McCarthy, John J., and Alan Prince (1995). Faithfulness and reduplicative identity. In Jill N. Beckman, Laura Walsh Dickey, and Suzanne Urbanczyk (eds.), *University of Massachusetts Occasional Papers in Linguistics* **18***: Papers in Optimality Theory*. Amherst: GLSA, pp. 249-384. [ROA-103]

Nevins, Andrew Ira (2005). Overwriting does not optimize in nonconcatenative morphology. *Linguistic Inquiry* **36**, pp. 275-287.

Ní Chiosáin, Máire (1991). *Topics in the Phonology of Irish*. Ph.D. dissertation, University of Massachusetts, Amherst.

van Oostendorp, Marc (2000). *Phonological Projection: A Theory of Feature Content and Prosodic Structure*. Berlin: Mouton de Gruyter. [Revision of 1995 doctoral thesis, Tilburg University, available as ROA-84]

Pater, Joe (1997). Minimal violation and phonological development. *Language Acquisition* **6**, pp. 201-253.

Prince, Alan, and Paul Smolensky (2004 [1993]). *Optimality Theory: Constraint Interaction in Generative Grammar*. Oxford: Blackwell. [ROA-537]

Prince, Alan, and Bruce Tesar (2004). Learning phonotactic distributions. In René Kager, Joe Pater, and Wim Zonneveld (eds.), *Fixing Priorities: Constraints in Phonological Acquisition*. Cambridge: Cambridge University Press, pp. 245-291. [ROA-353]

Rose, Yvan (2000). *Headedness and Prosodic Licensing in the L1 Acquisition of Phonology*. Ph.D. dissertation, McGill University, Montréal.

Russell, Kevin (1993). *A Constraint-Based Approach to Morphology*. Ph.D. dissertation, University of Southern California, Los Angeles.

Russell, Kevin (1997). Optimality Theory and morphology. In Diana Archangeli and D. Terence Langendoen (eds.), *Optimality Theory: An Overview*. Oxford: Blackwell, pp. 102-133.

Russell, Kevin (1999). *MOT: Sketch of an Optimality Theoretic Approach to Morphology*. Ms., University of Manitoba, Winnipeg.

Sherer, Tim (1994). *Prosodic Phonotactics*. Ph.D. dissertation, University of Massachusetts, Amherst. [ROA-54]

Smith, Jennifer L. (2000). Positional faithfulness and learnability in Optimality Theory. In Rebecca Daly and Anastasia Riehl (eds.), *Proceedings of ESCOL '99*. Ithaca: CLC, pp. 203-214.

Smith, Jennifer L. (2001). Lexical category and phonological contrast. In Robert Kirchner, Joe Pater, and Wolf Wilkey (eds.), *Proceedings of the Workshop on the Lexicon in Phonetics and Phonology*. Edmonton: University of Alberta, pp. 61-72.

Smolensky, Paul (1996). On the comprehension/production dilemma in child language. *Linguistic Inquiry* **21**, pp. 720-731.

Tesar, Bruce, John Alderete, Graham Horwood, Nazarré Merchant, Koichi Nishitani, and Alan Prince (2003). Surgery in language learning. In Gina Garding and Mimu Tsujimura (eds.) *WCCFL 22 Proceedings*. Somerville, MA: Cascadilla Press, pp. 477-490.

Tesar, Bruce, and Alan Prince (to appear). Using phonotactics to learn phonological alternations. In *Proceedings of the 39th Regional Meeting of the Chicago Linguistic Society, vol. II: The Panels*. Chicago: CLS. [ROA-620]

Tessier, Anne-Michelle (2006). Stages of phonological acquisition and error-selective learning. In Donald Baumer, David Montero, and Michael Scanlon (eds.), *Proceedings of the 25th West Coast Conference on Formal Linguistics*. Somerville, MA: Cascadilla Proceedings Project, pp. 408-416.

Tessier, Anne-Michelle (2007). *Biases and Stages in Phonological Acquisition*. Ph.D. dissertation, University of Massachusetts Amherst. [ROA-883]

Tessier, Anne-Michelle (to appear). Slowly learning to be faithful: Frequency of violation and constraint-based learning. *Alberta Working Papers in Linguistics*.

Ussishkin, Adam (1999). The inadequacy of the consonantal root: Modern Hebrew denominal verbs and output-output correspondence. *Phonology* **16**, pp. 401-442.

Wolf, Matthew (2007). For an autosegmental theory of mutation. In Leah Bateman, Michael O'Keefe, Ehren Reilly, and Adam Werle (eds.), *University of Massachusetts Occasional Papers in Linguistics* **32**: *Papers in Optimality Theory III*. Amherst: GLSA, pp. 315-404. [ROA-754]

Zoll, Cheryl (1996). *Parsing Below the Segment in a Constraint-Based Framework*. Ph.D. dissertation, University of California, Berkeley. [ROA-143]

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