Colored Turbid accents and Containment: A case study from lexical stress

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1. Introduction

In contemporary Optimality Theoretic research (OT, Prince and Smolensky 1993), the focus has been primarily on constraint typology and the role of constraints in assessing the relative 'harmony' of candidate outputs. Representational issues and, especially, questions pertaining to possible restrictions imposed by representational assumptions on the phonological make-up of linguistic forms have received little attention. This paper aims at exploring, among other things, such restrictions on *Freedom of Analysis*. The empirical investigation focuses on lexical accent systems and, in particular, Greek and Russian. In such systems, stress can occur on any syllable of the word regardless of syllable structure, weight or edge-orientation. Accentuation can be straightforwardly accounted for only if direct reference to morphological constituent structure and the inherent accentual properties of morphemes is assumed. Although the literature is replete with examples of morpho-accentual processes[1] and discussions of the formal problems they pose for phonological theory, some issues still need to be further explored. In this paper, the focus is on the representation of lexical accents and the interface constraints that control accentuation.

There is little consensus in the literature regarding the way lexically-encoded information is represented. Most representational approaches attribute unpredictable or irregular stress to differences in the lexical specification of certain morphemes. For instance, in a language like Greek, the contrast between *monáxos* 'alone' and *monaxós* 'monk' derives from the different accentual status of the root. In the former word, the root bears an accent itself, whereas in the latter word, the root is post-accenting; that is, it places its inherent accent on the following element, i.e. the suffix *-os*. Likewise, an affix may require its inherent accent to land on the immediately preceding morpheme as in the case of the pre-accenting genitive singular ending *-u*, e.g. *anθróp-u* 'man-GEN.SG'. However, as we will show in the ensuing sections, analyses that adopt a representational

[1] E.g. Sanskrit (Kiparsky 1982), Russian (Halle 1973; Melvold 1990; Alderete 1999; Revithiadou 1999), Cupeño (Alderete 1999 *et seq.*), among others.

approach to lexical stress face various drawbacks at the theoretical and/or at the empirical level. The most important one is that they cannot provide a uniform representation and analysis for post-accentuation and pre-accentuation. Both accentual patterns share two basic properties: first, the accent always surfaces on a vowel of different morphological affiliation (migration) and, second, it never lands further than the immediately neighboring syllable (locality). Crucially, morphological affiliation and locality also characterize accent migration phenomena triggered by violations of window restrictions or deletion of vocalic material. Greek once again serves as an illustrative example. In pairs such as *fúrnaris* 'baker-NOM.SG', *furnáriðes* 'baker-NOM.PL', the root is lexically accented but its accent shifts one syllable to the right in the plural form in order to comply to the three-syllable window restriction. Here, accent migration is also minimal but, nevertheless, strictly limited within the morpheme it belongs to. We argue that the two types of migration, i.e. migration within the sponsoring morpheme and migration outside the sponsoring morpheme, are two different sides of the same coin and the locality effects they both exhibit are intimately related to their common origin. No previous account has managed to bring all these different aspects of lexical accentuation under the same roof and provide a uniform explanation for them. This task is undertaken in the present paper. More specifically, we propose a theory of enriched representations that builds upon Goldrick's (1998, 2000) *Turbidity Theory* (TT). A lexical accent is treated as an autosegmental feature that is associated with its sponsoring vowel by means of two relations: (a) a *projection* relation, that is, an abstract, structural relationship, part of a morpheme's lexical representation, and (b) a *pronunciation* relation which represents the output realization of structure and is subject to phonetic interpretation. We show that this dichotomy between input and output representations offers promising insights for the understanding of migration phenomena and locality effects in the distribution of accents and, more importantly, it makes accurate typological predictions about the inventory of accentual patterns crosslinguistically.

The morphology-oriented nature of lexical stress extends beyond the affiliation of lexical accents to specific morphological domains. Certain morphemes are accentually dominant in the sense that they claim stress from other morphemes within the word. For this reason, lexical accent systems provide a promising field for research on the morphology-phonology interface as well as on the typology of interface constraints. One way of explaining how morphological (and lexical) information is encoded in phonology is by means of *indexed* constraints. Anttila (2002) states that

these are mainly faithfulness constraints, which are indexed to refer to various aspects of morphological structure.[2] Critics of the indexed-constraint approach, however, call attention to the fact that in practice constraints can be indexed for almost anything (Anttila 2002). Moreover, indexing is not limited to faithfulness constraints alone since nothing precludes markedness constraints from also being indexed (Inkelas and Zoll 2003). The latter constraints, however, do not regulate the relation between morphological structure and prosodic form, therefore, it is only natural to assume that they should never be allowed to refer to aspects of the interface and, accordingly, be labeled for this. We propose instead that Van Oostendorp's (2004, this volume) *Colored Containment* (CC) model provides a principled basis for the formulation of interface constraints. The most important aspect of this model is that it allows phonology to 'see' the morphological affiliation, i.e. the morphological color, of phonological elements. Ideally, phonology 'mirrors' morphology in the sense that it provides enough cues to 'recover' morphological structure from prosodic form. This visibility proves valuable both for representational issues as well as for the formulation of interface constraints. We show that when such a theory is combined with a representational device such as TT, which offers the possibility to encode and track the morphological color of lexical accents by drawing a distinction between underlying structure and pronounced structure, it acquires the necessary explanatory power to successfully analyze complex morpho-accentual phenomena like the ones encountered in the languages under investigation.

To sum up, we show that the TT/CC model advanced in this paper unifies the representation of pre/post-accenting morphemes, it accounts for accent migration and locality phenomena and makes accurate typological predictions about the cross-linguistic distribution of accentual patterns. Moreover, we argue that it offers a restrictive theory of the morphology-phonology interface and, especially, the formulation of constraints that control the mapping between morphological structure and prosodic form.

The remaining paper is organized as follows: In section 2, we present some representative examples of Greek and Russian stress and discuss a few interesting cases of accent migration. In section 3, we review various representational accounts of lexical stress and propose an enriched

[2] I.e. individual morphemes or lexemes (Hammond 1995), lexical strata (Fukazawa *et al.* 1998; Itô and Mester 1999), roots vs. affixes (McCarthy and Prince 1995; Alderete 1999), affix classes (Benua 1995, 1998), and so on.

representational device along the lines of TT. In section 4, we investigate a range of accent migration phenomena and provide an analysis based on the premises of CC. We also provide a more principled formulation of interface constraints than indexed-constraint accounts and offer a TT/CC analysis of lexical stress that relies on the notion of morphosyntactic headedness. An alternative analysis of the same morpho-accentual phenomena is discussed in section 5. In section 6, we conclude this paper.

2. Lexical accent systems: The facts

Greek is a bounded trochaic system; the scope of primary stress is limited to the last three syllables of the word. Syllable structure lacks distinctions of phonological weight. The same applies to Russian although the language lacks the window restriction. Words in both languages minimally consist of a root and an inflectional ending, e.g. Greek *anθrop-os* 'man', Russian *zérkal-o* 'mirror'. Representative examples from the Greek and Russian nominal system of are given in (1) and (2), respectively:

(1)	a.	ánθropos	anθrópu	'man-NOM/GEN.SG'
	b.	θálasa	θalasón	'sea-NOM.SG/GEN.PL'
	c.	fantáros	fantáru	'soldier-NOM/GEN.SG'
		stafíða	stafíðon	'raisin-NOM.SG/GEN.PL'
	d.	uranós	uranú	'sky-NOM/GEN.SG'
		aγorá	aγorón	'market-NOM.SG/GEN.PL'
(2)	a.	skovorodá	skóvorody	'frying pan-NOM.SG/PL'
	b.	rabóta	rabóty	'work-NOM.SG/PL'
	d.	gospožá	gospoží	'lady-NOM.SG/PL'

Let us begin with the examination of the Greek stress facts. In (1), stress is located on any of the three positions allowed by the window. The examples *ánθropos*, *fantáros*, *uranós* are morphologically equivalent but differ in the location of stress. Furthermore, in examples like (1a) and (1b) stress moves from the antepenultimate syllable in nominative singular to the penultimate syllable in genitive singular (*-os* class) and the ultimate syllable in genitive plural (*-a* class), respectively. Such stress shifts reveal the internal prosodic structure of suffixes.

Greek stress can be straightforwardly accounted for by reference to the inherent metrical structure of morphemes. More specifically, three

accentual classes of roots are distinguished: (a) accentless roots, e.g. /anθrop-/, which lack a pre-assigned accent; (b) accented roots, which bear an accent on some syllable e.g. /fantár-/, and (c) post-accenting roots, which carry an accent themselves but push it onto a following morpheme, e.g. /uran^-/, /aɣor^-/.[3] The same accentual typology applies to suffixes. An accentless root will be stressed by the language-specific *default* (i.e. antepenultimate stress for Greek) when combined with an equally accentless suffix. It will, however, lose stress to an inherently accented suffix. For instance, given that the roots /anθrop-/ and /θalas-/ are both accentless, the antepenultimate stress in the nominative results from the default. The stress mobility in the genitive, then, is attributed to the pre-accenting status of the suffix /-^u/ and the accented status of the suffix /-ón/, respectively. In Russian, accentuation works in a similar fashion with the difference that the default stress is initial (Halle 1973; Melvold 1990).

A few remarks with respect to post- and pre-accenting morphemes are in order here. In the languages under examination, such morphemes place their accent on an immediately following or preceding syllable. For instance, in the Russian word *gospož-ámi* 'lady-INSTR.PL' the accent sponsored by the root lands on the first syllable of the suffix which is the closest one to the root. Similarly, in pre-accentuation, the accent of the suffix never docks further than the last syllable of the root, e.g. *anθróp-u* 'man-GEN.SG'. In conclusion, in both cases the accent does not migrate too far from its morpheme of origin.

As mentioned in section 1, there are more instances of accent migration besides post-/pre-accentuation that are relevant for the analysis to be developed in the ensuing sections. In Greek, window restrictions often cause an accent to move away from its original position. For instance, the word *fúrnaris* (< /fúrnar-i(ð)-s/ [root - thematic constituent - inflection]) 'baker-NOM.SG' is accented on the initial syllable but when an extra syllable is added in the plural, *furnariðon* 'baker-GEN.PL', the distance between the accent and the right edge of the word is inevitably increased. Given the inviolability of the window, the accent must either reclaim the lost space or remain unpronounced. The surface form *furnáriðon* suggests that the latter option is chosen. It should be noted that the antepenultimate stress in this case can never originate from the default because the suffix *-on* is pre-accenting. The ungrammaticality, therefore, of a hypothetical

[3] The superscript circumflex '^' indicates that the accent is placed on a syllable outside the sponsoring morpheme.

form such as **furnaríðon* clearly shows that what keeps stress on the root is its inherent accent.

Accents may also migrate when the vowel that sponsors them deletes or loses its vocalic status. The following example from Greek is telling in this respect. The high front vowel /i/ turns into a palatal fricative before another vowel. For instance, in the genitive singular of neuter nouns, /i/ loses its vocalic status, as shown in (3b).[4] In this case, the accent moves to another vocalic peak of the same morpheme.

(3)	a.	/peð-í/	[peðí]	'child-NOM.SG'
	b.	/peð-íu/	[peðjú]	'child-GEN.SG'

We now turn to the issue of accent resolution. Elaborate prosodic structures arise when many morphemes with inherent accentual properties meet in the same word. Due to *culminativity* (Alderete 1999 and references cited therein) only one accent must prevail in the word. In *aɣorón* (post-accenting root + accented suffix), both root and suffix accent yield final stress. In *uranú* (post-accenting root + pre-accenting suffix), however, there is an accentual conflict, which is resolved in favor of the root accent.

In (4) and (5), we provide some representative examples from derivational morphology. The situation here is slightly different. In Greek, the diminutive/pejorative suffix *-ak* combines with nominal roots of various accentual patterns. Similarly in Russian, the derivational suffix *-ást*, which derives adjectives from nominals, attaches to roots of different accentual categories. Stress is on the (accented) derivational suffix regardless of the underlying accentual properties of the other morphemes.[5]

(4)	a.	ageláku	/agel-ák-^u/	'little angel-GEN.SG'
	b.	papaɣaláku	/papaɣál-ák-^u/	'little parrot-GEN.SG'
	c.	misθáku	/misθ^-ák-^u/	'small salary-GEN.SG'
(5)	a.	borodásta	/borod-ást-á/	'heavily bearded-NOM.SG'
	b.	gorlásta	/górl-ást-á/	'loud-mouthed-NOM.SG'
	c.	jazykásta	/jazyk^-ást-á/	'sharp-tongued-NOM.SG'

[4] The underlying form of the suffix, namely /-íu/, surfaces in archaic nouns and place names that tolerate hiatus in this environment, e.g. *monastiríu* 'monastery-GEN.SG', *vrisakíu* 'Vrysaki-GEN.SG'.

[5] Revithiadou (1999) explains why an analysis based on lexical strata is not preferable for the Greek and Russian stress facts.

To conclude, in this section we presented the basic patterns of nominal stress in Greek and Russian. The discussion made clear that any account of stress in these systems must refer to morphological structure. The formal details of the analysis are presented in section 4. The next section addresses the issue of representation of lexical accents.

3. The representation of lexical accents

3.1. Previous approaches

Most representational accounts concur that lexical stress should be pre-specified in the lexicon.[6] They differ, however, on how this information should be represented. Due to space limitations, we focus only on the prespecified-foot and the autosegmental/grid-mark approach. We begin with a critical review of both accounts and continue with introducing an enriched autosegmental device along the lines of TT.

Inkelas (1994/1999), on the basis of exceptional stress in Turkish, proposes that some morphemes are affiliated with a trochaic foot structure. To explain, both accented and pre-accenting suffixes are underlyingly specified with a trochaic foot. In pre-accenting suffixes, this foot has a segmentally empty prosodic head. However, representing lexical stress as an underlying foot is unmotivated in systems such as Turkish that show no other metrical evidence for footing. Building on Inkelas' idea, McCarthy (1995: 45–47) formulates prosodic faithfulness as a requirement on corresponding segments occupying particular prosodic roles, e.g. head or tail of a foot. Thus, given the appropriate ranking, morphemes with foot-initial segmental anchors, e.g. /-(ɪyor)/ 'PROGRESSIVE', will retain their inherent metrical structure. But this idea is not devoid of problems either. Although in such a model locality comes for free due to the boundedness of prosodic feet, post- and pre-accenting morphemes do not receive a uniform representation. Post-accenting morphemes are specified with iambic heads, $-V_1(_wV_2$, whereas pre-accenting morphemes are specified with trochaic tails, $-V_1)_wV_2$. More importantly, however, this approach makes the wrong empirical predictions. Recall the *fúrnaris – furnáriðon* example from Greek. Let us assume that the initial syllable of the root is pre-specified as a

[6] Non-representational accounts and their drawbacks are discussed in Revithiadou (1999). Representational approaches to lexical stress have been proposed by: Halle and Vergnaud (1987); Idsardi (1992); Halle and Idsardi (1995); McCarthy and Prince (1995); Alderete (1999 *et seq.*), among others.

foot-head, /(fúrnar-/, and the ending *-on* is pre-specified as a foot-tail, /-on)/. Strikingly, a form like **furnaríðon* /($_{s}$furna)(ríðon)$_{w}$/ is incorrectly predicted to be grammatical; it respects the window and satisfies the faithfulness requirements of the suffix and the root (provided that faithfulness is satisfied when the foot-head anchor is not primary stressed). In contrast, the grammatical form *furnáriðon* massively violates faithfulness to foot-internal positions. We conclude, therefore, that constructing the correct analysis on the basis of the proposed representational assumptions is a quite demanding task.

Alternatively, a lexical accent can be represented as an autosegmental unit, a grid mark which is projected onto the stress plane as an idiosyncratic property of a vocalic peak. However, this approach also faces a few drawbacks on the technical side. First, formulating faithfulness as a requirement on the prosodic structure itself makes it impossible to capture faithfulness in the segmentally-empty portion of prosodic structure in post-/pre-accenting morphemes (6a). A possible way out is to invoke empty vocalic positions, as shown in (6b), but this solution leads to further technical complications that, unfortunately, cannot be addressed here.

(6) a.

*	*
V_1V_2-	-V_1V_2

b.

*	*
$V_1V_2\square$-	-$\square V_1V_2$

Second, stress shifts of the *fúrnaris – furnáriðes* type raise another thorny technical problem for the autosegmental approach. Alderete (1999), based on morpho-accentual processes in Cupeño, argues that an accent is an autosegmental unit, namely a grid mark, which is encoded as an intrinsic feature of a vowel. Furthermore, he accounts for accent migration by means of the constraint NO-FLOP-PROM, stated in (7). Alternatively, one could also appeal to faithfulness constraints pertaining to the preservation (MAX-link) or insertion (DEP-link) of association lines.

(7) NO-FLOP-PROM (Alderete 1999: 18): For *x* a prominence, *y* a sponsor, and *z* an autosegmental link, $\forall x \forall y \forall z$ [x and y are associated via z in $S_1 \rightarrow \exists x' \exists y' \exists z'$ such that (x, y, z)*R*(x', y', z') and x' and y' are associated via z' in S_2].
'Corresponding prominences must have corresponding sponsors and links.'

NO-FLOP-PROM is violated in the output form in (8) because the prominence has shifted to another vocalic peak yielding a correspondence violation to IO prominences, their vocalic sponsors and their links. In this paper, we claim that constraints such as the one in (7) should be banned from Universal Grammar. Association lines are not linguistic entities like moras, segments or features; they rather indicate a relation holding between an autosegmental unit and its sponsor and, as such, they cannot be subject to faithfulness.[7] We, therefore, need a representational device that will be able to capture accent migration from one vocalic peak to the other without resorting to movement of the association line that links the respective autosegmental elements.

(8)

*			*	
|		→	|	
V_1V_2-V_3V_4	input		V_1 V_2-V_3V_4	output

Despite the technical problems, in this paper, we adopt the autosegmental approach because it allows us to develop a uniform representation for post- and pre-accentuation. These accentual patterns seem to be the mirror-image of each other. Intuitively, a post-/pre-accenting morpheme desires to push the lexical accent outside its domain (migration) but not too far away (locality). A successful representational theory, among other things, must also be able to articulate the inverse relation that seems to hold between different accentual patterns and migration (i.e. migration is always within the sponsor in accented morphemes but outside the sponsor in post-/pre-accenting ones), and tie it to locality. We, therefore, conclude that a better model for the representation of lexical accents is needed. In the next section, we explore the possibilities offered by TT towards this direction.

3.2. The Turbidity Theory of accents

Goldrick (1998, 2000) in an attempt to handle opacity effects (Kiparsky 1971 *et seq.*) in OT develops a richer representational device which allows for *turbid* (covert) structures. This means that "the output of the grammar will contain unpronounced material which 'can' influence the surface – the portion of the output which is pronounced." (Goldrick 2000: 2). According

[7] I wish to thank Marc van Oostendorp for pointing out this problem to me and also for the stimulating discussion that followed his comment.

to *Turbidity Theory*, two relations hold between a vowel and, in general, any autosegmental feature sponsored by it:

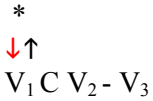
- projection (up-arrow ↗): an abstract, structural relationship holding between the vowel and the autosegmental unit.
- pronunciation (down-arrow ↘): an output relation that holds between the autosegmental unit and the vowel and describes the output realization of structure.

The unmarked case is for projection and pronunciation to match.[8] The result then is a transparent, non-turbid relation. Structural harmony constraints, however, can override this pressure and give rise to opaque relations. To illustrate with an example, in Luganda, vowel length is contrastive but vowel deletion in hiatus triggers lengthening of the surviving vowel (Goldrick 2000). For instance, the input form /ka-oto/ surfaces as *koːto* 'fireplace-DIM' (cf. /ka-tiko/→ *katiko* 'mushroom'). In traditional autosegmental terms, hiatus resolution triggers re-association of the mora of the deleted vowel to the second vowel, as shown in (9a). In TT, however, the story is as follows: the first vowel projects its mora which is then pronounced on the second vowel, as depicted in (9b). As a consequence, the first vowel is silenced.

(9) a. 

b. 

An implementation of TT for accentuation translates as follows: In accented morphemes, there is a transparent relation between the vocalic peak and the accent. As shown by the abstract example in (10), the accent is projected and pronounced by V_1.

(10) 

Although the default case for the accent is to be pronounced on the vowel that projects it, other forces may cause it to be pronounced elsewhere. Remarkably, this split between projection and pronunciation paves the way

[8] This is achieved by high ranking the constraint RECIPROCITY (If *Y* projects to *X*, then *X* must pronounce *Y*, Goldrick 2000: 3).

for handling accent shifts triggered by structural constraints (e.g. *fúrnaris – furnáriðon*, *peðí – peðjú*). In this case, the accent will still be projected by V_1 but it will be pronounced on V_2. In its current version, however, TT leaves unaccounted for the fact that the accent cannot be pronounced on a neighboring syllable of a different morpheme (e.g. outputs such as **furnaríðon* and **péðju* are ungrammatical).

In contrast, a turbid relation is assumed to hold between accents and their vocalic peaks in post-/pre-accented morphemes. In particular, we claim that the accent is floating, hence not bound by projection to a specific vowel of its sponsor. In (11a) the accent is sponsored by the root but is pronounced on the suffix, whereas in (11b) the opposite holds. Note, however, that we still cannot explain why the accent migrates instead of being pronounced on its sponsor.

(11) a. $\overset{*}{\underset{\searrow}{V_1\,C\,V_2}}\,\text{-}\,V_3$ b. $\overset{*}{\underset{\swarrow}{V_1\,C\,V_2}}\,\text{-}\,V_3$

To summarize, TT constitutes an advantageous representational apparatus because it represents all lexical accents as autosegmental units. Furthermore, the split between projection and pronunciation lines allows us to capture accent migration phenomena without having to resort to movement of association lines. This offers a possible solution to the faithfulness problem of previous autosegmental approaches. However, in its current version, the model does not really preclude movement of projection lines. Ideally, the representational device should also be able to encode morphological information, which seems to be important for explaining the inverse relation that holds between type of accent (i.e. linked vs. floating), on the one hand, and domain of migration, on the other.

The explanatory force of TT can easily be enhanced, if we add some 'morphological color'. Van Oostendorp's (2004, this volume) *Colored Containment* model offers the appropriate theoretical framework for such an endeavor. In the classical version of OT, GEN is restricted by *Consistency of Exponence* (CoE) (McCarthy and Prince 1993ab):

(12) No changes in the exponence of a phonologically-specified morpheme are permitted.

This means that "the phonological specifications of a morpheme (segments, moras, or whatever) cannot be affected by GEN" (McCarthy and Prince

1993a: 22). CoE implies that morphological affiliation is visible to phonology and, therefore, can distinguish between elements of different morphological affiliation or no morphological affiliation at all (e.g. epenthetic material). Classic OT also endorses *Containment* (Prince and Smolensky 1993):

(13) No element may be literally removed from the input form. The input is contained in every candidate form.

Thus, for a given input /takp/, the output [tak] is assumed to contain the unpronounced segment /p/ as well. Van Oostendorp (2004, this volume) proposes that CoE and containment should be integrated again into OT. In this model, the different morphological affiliation of phonological elements is visualized in terms of colors. For instance, in the abstract word CV_1C-V_2, V_1 is affiliated to the root (blue color) whereas V_2 is affiliated to the suffix (red color). The most important aspect of CC is that it allows the morphological affiliation of phonological elements to be 'visible' in the surface structure. It is precisely this visibility that will help us solve the migration puzzle.

Lexical accents are born with a specific morphological color because they are part of the input. Here, we extend this claim to projection lines as well. To explain, we take projection lines to represent the lexical state of affairs, that is, to be part of the lexical representation of a morpheme and hence to have the same color as their sponsor. In conformity with CoE, therefore, they cannot be altered by GEN. Such a move would be tantamount to changing the structure of a morpheme but, in CC, CoE is a principle of grammar and not a violable constraint (contra Walker and Feng 2004). In the same spirit, a floating accent cannot be assigned a projection line simply because it lexically lacks one. This means that a representation such as (15) can never be a legitimate member of the candidate set for either input in (14a-b). Given input (14a), the projection line of output (15) moves one syllable to the right thus changing the phonological exponent of the morpheme. Given input (14b), output (15) also defies CoE because a projection line has been added that was not present in the input. In this case, the projection line is inevitably of a different color than the sponsoring morpheme and, given the inviolability of CoE, it is not legitimate to assume that it will be morphologically absorbed by the color of the sponsoring morpheme. Consequently, only pronunciation lines, which are not part of the input, can be subject to the function GEN.

(14) a. *
↑
$V_1V_2V_3$-V_4

b. *
$V_1V_2V_3$-V_4

(15) *
↑
$V_1V_2V_3V_4$

The combined effects of TT and CC, therefore, yield the following restriction on Freedom of Analysis:

(16) Projection lines are inalterable by GEN.

The proposed model provides the analytical tools to account for accent migration without resorting to faithfulness to association line constraints. According to (16), projection lines cannot move. Thus, migration of linked accents can only result from the manipulation of pronunciation lines.

In light of CC, the constraints on the pronunciation and projection of lexical accents are formulated as follows:[9]

(17) a. V↗LA: A vowel *V* of morpheme/color *M* which carries a lexical accent *LA* must project it at the phonological level.

b. LA↘: Lexical accents must be pronounced.

c. RECIPROCITY$^{LA}_{V}$: If a vowel *V* of morpheme/color *M* projects a lexical accent *LA*, then the lexical accent *LA* must be pronounced on the vowel *V* of morpheme/color *M*.

As shown in (18), these constraints favor as optimal an output in which the lexical accent is pronounced on the vowel that projects it. Candidate (18b) pronounces the accent on another vowel whereas candidate (18c) leaves the

[9] Drawing a parallelism between the constraints in (17) and traditional OT constraints is not an easy task. Constraints linking pronunciation to projection and vice versa resemble markedness constraints because they strive towards wellformedness of phonological structure. At the same time, however, they act as traditional faithfulness constraints (e.g. PARSE, IDENT) because they keep track of whether, for instance, the underlying form (projection) is pronounced by the phonetics (pronunciation), i.e. the relevant feature is associated in the output to the element it is associated to underlyingly.

accent unpronounced. Consequently, both are doomed to fail. Note that RECIPROCITY is violated when a projection line is not matched by pronunciation or is not pronounced at all.

(18)

$\acute{V}_1V_2$-, -V_3	V↗LA	RECIPROCITY$^{LA}_{V}$	LA↘
* ↑↓ ☞ a. V_1V_2-V_3			
* ↑↘ b. V_1V_2-V_3		*!	
* ↑ c. V_1V_2-V_3		*!	*

To conclude, TT makes sense only within the CC model because the latter guarantees that lexical accents and underlying projection lines will not be literally removed or changed. The split between projection and pronunciation is superfluous, if underlying material is freely allowed to delete. Deleted material cannot enforce any pronunciation relation thus rendering this dimension redundant. Furthermore, CC enables the encoding of morphological information on phonological representations. This piece of information is crucial for understanding the different behavior of linked and unlinked accents in migration. Inversely, TT becomes handy for a theory like CC. More specifically, the split between underlying and surface structure at the representational level allows CC to: (a) handle certain migration phenomena without having to resort to movement of association lines and, consequently, faithfulness constraints that refer to non-linguistic entities (e.g. MAX/DEP/PARSE-link), and (b) account for deletion without actually appealing to the physical removal of features, a significant benefit for any theory that endorses containment.

4. A TT/CC analysis of lexical accentuation

4.1. Accent migration and locality

In this section, we examine accent migration as exhibited by post-/pre-accentuation and various accent shift phenomena. Locality is closely related to both types of migration and needs to be accounted for as well. We will begin with the first type of migration. Why are floating accents not pronounced within their sponsoring morpheme?

RECIPROCITY$^{LA}{}_{V}$ guarantees locality in the realization of linked accents. Ideally, an accent is pronounced on the vowel it is lexically associated with. In the case, however, that such a lexical association is not provided, migration is not bound by the color of the accent. But what drives the accent away? Recall the restriction in (16): projection lines cannot be added, if they are not lexically present, or changed, if they are present. In some abstract sense, therefore, the migration of floating accents has a *derived environment* flavor. A floating accent cannot be associated with 'old' material, and all vowels of the same color constitute 'old' material. Therefore, the accent has to migrate to another domain. In other words, in the absence of projection lines, the scope of the lexical accent is inevitably broadened and automatically all vowels of the same color are cancelled out as potential docking (pronunciation) sites. As a consequence, the accent either has to migrate or, alternatively, be left unpronounced. We claim that the principle responsible for floating accent migration is *Invariance*:[10]

(19) INVARIANCE: A lexical accent *LA* is pronounced within morpheme/color *M* iff it is projected by a vowel *V* of morpheme/color *M*.

The effects of (19) are illustrated in (20). The optimal output is the one in which the accent of the root is pronounced on the suffix. Outputs that choose to locally pronounce their accent (20b) or leave it unpronounced (20c) (the acute here is due to the default) fare worse than (20a) and, consequently, they are rejected.

(20)

V_1V_2^-, -V_3	LA↘	INVARIANCE	DEFAULT[11]
* ↘ ☞ a. V_1V_2-V_3			*
* ↓ b. V_1V_2-V_3		*!	*
* c. V́$_1V_2$-V_3	* !		

[10] This constraint is inspired by Wheeler's (1981, 1988) *Principle of Invariance* which states that once an interpretation has been established for a constituent, that interpretation cannot be changed.

[11] The DEFAULT is a cover term for constraints that derive antepenultimate stress.

Invariance is also responsible for accent migration triggered by window restrictions or vowel deletion. In the by now familiar example *fúrnaris – furnáriðes* 'baker-NOM.SG/PL', the accent does not really move to the right because in TT/CC projection lines cannot 'move'. It is simply pronounced on a vowel that satisfies the window requirement, as shown in (21a). Furthermore, due to invariance, the accent sticks to the same color and never migrates to a different morpheme, e.g. the thematic constituent *-ið*. The same applies to the case of hiatus resolution in (21b).[12]

(21)

	*	*
	↑↓	↑↘
a.	furnar-is	furnar-ið-es
b.	peð-i	peð-ɟ u

Turning now to the issue of locality, by migrating to another morpheme, a floating accent expands its scope, that is, the domain of possible associators, by *1, 2,...n* number of syllables, depending on how far from its source it drifts away. What pulls the accent back to its birthplace is SCOPE, stated in (22). This is a gradient constraint which is violated every time the 'old' territory of an accent is expanded by the addition of 'new' material. The tableau in (23) illustrates how this constraint works. [A subscript letter indicates the affiliation of the accent; *r* stands for root, *s* stands for suffix.]

(22) SCOPE(LA) ≡ M: The scope in which a lexical accent *LA* of morpheme/color *M* is pronounced equals the total number of segments the morpheme/color *M* consists of and no other.

(23)

$V_{1r}V_{2r}$^-, -$V_{3s}V_{4s}$	SCOPE(LA) ≡ M
*r ↓ ☞ a. {$V_{1r}V_{2r}$}-$V_{3s}V_{4s}$	
*r ↘ b. {$V_{1r}V_{2r}$-V_{3s}}V_{4s}	*V_{3s}
*r ↘ c. {$V_{1r}V_{2r}$-$V_{3s}V_{4s}$}	*V_{3s}*V_{4s}

[12] The analysis developed here correctly predicts that an accented /i/ that belongs to a root will shift its accent to the left, e.g. /oksí-/ 'acid', *óks(j)-os* 'vinegar'.

Interestingly, the interaction of SCOPE with the other constraints of the system results in the typology in (24). Ranking (24a) yields local migration of floating accents in languages like Greek and Russian.[13] This is illustrated by the tableau in (25) where only candidates with pronounced accents are taken into consideration. Ranking (24b), in which SCOPE crucially outranks INVARIANCE, leads to pronunciation of all accents (linked and floating) within their morphological color and, consequently, to neutralization of the accented vs. post-/pre-accenting distinction. This ranking characterizes languages which lack post-/pre-accenting morphemes, e.g. Cappadocian. Finally, ranking (24c) causes floating accents to be left unpronounced. The effects of unpronounced floating accents can be witnessed in various downstep phenomena.

(24) a. LA↘ » INVARIANCE » SCOPE(LA) ≡ M
b. LA↘ » SCOPE(LA) ≡ M » INVARIANCE
c. INVARIANCE, SCOPE(LA) ≡ M » LA↘

(25)

$V_{1r}V_{2r}$^-, -$V_{3s}V_{4s}$	INVARIANCE	SCOPE(LA) ≡ M
a. {$V_{1r}V_{2r}$}-$V_{3s}V_{4s}$	* !	
☞ b. {$V_{1r}V_{2r}$-V_{3s}}V_{4s}		*V_{3s}
c. {$V_{1r}V_{2r}$-$V_{3s}V_{4s}$}		*V_{3s}*V_{4s}!

We conclude from the above that the TT/CC approach to lexical accentuation enjoys certain advantages. First, it offers a uniform representation and analysis for post-/pre-accenting morphemes. Second, it

[13] The choice of domains comes for free in constructions that consist of two morphemes. The system described here, however, remains agnostic with respect to the pronunciation site of a floating accent sponsored by a derivational suffix in constructions such as [root-der.suffix-infl.suffix]. In this case, the decision is left on the markedness system. For instance, in Russian and Greek, the accent is pronounced in outermost domains, whereas in Turkish, it is pronounced in innermost domains. This analysis predicts that there cannot be post- and pre-accenting patterns within the same morphological category of suffixes, e.g. derivational suffixes or inflectional suffixes. Greek confirms this prediction.

predicts a restricted and attested typology for floating accents. Third, it provides the means to express and analyze accent deletion/non-realization phenomena, without invoking additional machinery. Fourth, it brings migration of lexical accents and locality under the same roof: INVARIANCE restrains migration of linked accents but triggers migration of floating ones. Locality in both cases is a side-effect of the requirement that the accent must stick to its morphological color.

Alternatively, a Correspondence Theoretic analysis (McCarthy and Prince 1995) of floating accent migration and related locality effects must employ a faithfulness constraint like NO-FLOP in (7) and a markedness constraint such as *DOMAIN (Revithiadou 1999, after Myers and Carleton 1996), given in (26).[14]

(26) *DOMAIN: $*\mathrm{LA}_{\alpha}$

$$
\begin{array}{c}
*\mathrm{LA}_{\alpha} \\
| \\
[\ldots \mathrm{V} \ldots]_{\alpha}
\end{array}
$$

In languages like Greek this constraint must be parameterized to refer to association lines that link floating accents to their sponsors. This is because linked accents migrate within their domain, contra to the dictates of (26). Migration, therefore, is articulated rather crudely as a prohibition against the association of a floating accent to the morphological domain *α* of its sponsor. The actual docking site of the floating accent is decided by some alignment constraint which, preferably, will also derive the locality effect. It is obvious that such a solution falls short in explanatory power since, first, it fails to establish a connection between migration and locality and, second, it employs markedness constraints that are indexed to refer to an underlyingly distinct class of morphemes, i.e. those that lack inherent association lines.

4.2. Accent resolution at the interface

In this section, emphasis is on accent resolution. In Greek and Russian, derivational suffixes that carry an accent are dominant when competing with other elements in the word, whereas root accents prevail in inflected constructions. In Revithiadou (1999), it is proposed that the morpho-syntactic head of the word is the element that determines which accent will

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[14] The same effect can also be achieved with an indexed DEP constraint which prohibits insertion of a lexical accent to specific morphemes.

eventually surface with stress prominence.[15] Following Hoeksema and Janda (1988: 220), the notion 'head' is defined in terms of the more basic notions 'functor' and 'argument':[16]

(27) Head($f(\alpha)$) = α if Cat(α) = Cat($f(\alpha)$)
= f otherwise

The definition in (27) basically states that the output category of a functor + argument combination $f(\alpha)$ is specified by the functor category. If, however, the functor is a modifier, it can be viewed as an operator performing the identity operation on the category of its argument. In this case, the argument determines the category of the combination.

Head dominance is an instantiation of the 'mirroring' relation that holds between morphology and phonology. Van Oostendorp (2004, 2005), proposes that the principle behind mirroring is *morphological recoverability* (Kaye 1974) which, roughly, states that ideally morphological structure should be reconstructed from the prosodic form. This principle gives rise to a range of interface constraints, called here *mirroring constraints*, that require the two dimensions to be parallel. From this perspective, RECIPROCITY$^{LA}_{V}$ can be viewed as a mirroring constraint that requires a projection line, which is a morphological entity, to match with the pronunciation line, which is its phonological realization.

In order to delve into the nature of interface constraints, however, we first need to determine which aspects of morphology are *visible* to phonology. CC offers some interesting insights into this issue. Phonology can 'see' morphological colors and domains. We take this statement one step further and extend visibility to hierarchical relations holding between nodes, i.e. headedness. This idea is captured by the following constraint:

(28) MIRROR-HEAD (MH): The lexical accent of the morphological head is the head of the prosodic word.

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[15] An interesting prediction of head theory is that elements that are not heads will not exhibit accentual dominance effects, even if they carry an accent. This prediction is empirically verified. For instance, in Russian, the diminutive suffix *-íc(-a)* is accented, e.g. /čast'/ (fem) 'part' *častíca* (fem). However, because it is morphologically transparent and hence not a head, it loses stress to an accented root, e.g. /lúž-a/ (fem) 'puddle' *lúžica* (fem).

[16] A *functor* is an element that carries information about its combination with other constituents. It is an incomplete expression that receives as an *argument* an element that is chosen on the basis of its subcategorization information.

MH guarantees that in accentual conflicts the score is settled by the head element of a particular construction. This is because the head of the prosodic word must mirror the head of the morphological word. In inflected words, this element is the root. The abstract example in (29) helps us visualize the point. The winning candidate, (29a), is the one that pronounces the accent of the head.

(29)

$V_1\acute{V}_{2Head}$-, -$\acute{V}_3$	MH	LA↘
* * ↑↓ ↑ ☞ a. V_1V_2-V_3		$*_{infl}$
* * ↑ ↑↓ b. V_1V_2-V_3	*!	$*_{root}$

An approach that endorses TT/CC has some significant implications for phonological theory and, especially, for common assumptions about the nature of interface constraints. Under TT/CC, 'not anything goes'. Interface constraints are simply faithfulness constraints that control the mapping between morphology and phonology. Markedness constraints do not regulate the relation between morphological structure and prosodic form; therefore, they can never refer to (aspects of) the interface. Moreover, because visibility derives from mirroring, interface constraints can only refer to strictly morphological information such as morphemes, domains, and hierarchical relations between nodes, but never to lexical information (e.g. affix classes, lexical strata, individual lexemes, and so on).

5. An alternative: Transderivational Anti-Faithfulness

Alderete (1999, 2001ab) proposes the theory of *Transderivational Anti-Faithfulness* (TAF) in order to account for morpho-accentual processes like the ones discussed in this paper. He draws a distinction between root-controlled and affix-controlled accent (ACA). The latter refers to dominance effects triggered by suffixes and is morpheme-specific. Alderete argues that the two types of morphologically-governed accentual phenomena must receive separate treatment. McCarthy and Prince's (1995) Root-Affix metaconstraint can easily treat root-controlled accent whereas TAF is introduced to exclusively handle ACA. TAF operates between morphologically-related words and encourages dissimilation between them.

Strict base-mutation is one of its most important properties. An example will clarify how this model works.

In Russian inflected words, root-accent prevails, as shown by the examples in (30) (Alderete 1999: 163–170). Alderete assumes the default stress to be on the post-stem syllable. In short, there are no lexically specified post-accenting roots in Russian. This assumption is crucial, as will be shown below.

(30)	a.	/rák-u/	ráku	'crayfish-DAT.SG'
	b.	/stol-u/	stolú	'table-DAT.SG'

TAF accounts for ACA exhibited by the words in (31). The suffix *-úx*, which attaches to adjectival and verbal roots to form nouns, is accented. Moreover, it is dominant and base-mutating, i.e. it changes the accentual status of the root it attaches to. For instance, the bases *s'ív-* and *skak-* are accented and accentless, respectively. However, the accent of the base in *s'ív'* 'gray', does not survive in the derived form because of the base-mutating character of the suffix *-úx*.[17] This implies that the morpheme-specific (and hence indexed) anti-faithfulness constraint $\neg OO_{Dom}$(acc) outranks the other constraints of the system and, especially, the one that encourages similarity between morphologically related forms, i.e. OO(acc). The latter constraint requires, for instance, a stressless root to remain stressless in all of its derivatives.

(31)	a.	/s'ív-úx-a/	siv'úxa	'raw alcohol'
	b.	/skak-úx-a/	skakúxa	'frog'

In contrast, recessive suffixes such as *-ic* (see fn 15), for instance, belong to another affixal class which is associated with the anti-faithfulness constraint $\neg OO_{Rec}$(acc). The effects of $\neg OO_{Rec}$, however, are masked by a ranking in which this constraint is placed at the bottom of the hierarchy: $\neg OO_{Dom}$(acc) » OO(acc) » $\neg OO_{Rec}$(acc).

The TAF approach enjoys several merits, the most important one being that it can handle a wide range of morpho-accentual processes. However, it faces some serious drawbacks. Due to space limitations, we focus on the most significant ones here (see also Apoussidou 2003 for detailed discussion). First, it misses the generalization that, in Russian,

[17] Alderete (1999) does not discuss examples such as (31b) where the root is accentless and the suffix fails to show any base-mutating effects.

recessive suffixes are always non-heads, regardless of whether they are inflectional or derivational. There is a principled reason behind the dominant vs. recessive distinction, but TAF accounts for it by means of suffix class-specific constraints. This, in turn, suggests that suffixes have a more elaborate specification than roots since they encode information on inherent accents as well as class membership (dominant vs. recessive). Second, an empirical problem is raised by the assumption that base-mutation is a property of dominance. Imagine a situation where a post-accenting root, e.g. Greek /uran^-/, combines with a dominant post-accenting suffix, e.g. /-ik^/. The result is a word with stress on the inflectional ending, *uranikós* 'of heaven'. But no base-mutation is exhibited in this case: the root remains stressless. Thus, the very architecture of the TAF model leads Alderete (1999: 214) to preclude the existence of post-accenting roots (hence the post-stressing default in Russian), which is of course empirically false. Finally, the locality restrictions exhibited by post-/pre-accenting morphemes are derived with the help of an extra mechanism, namely constraint conjunction.

To sum up, we end up with a rather heavy theoretical apparatus that employs lexical specification, metaconstraints, morpheme-specific constraints, paradigmatic identity relations and constraint conjunction. In contrast, the proposal advanced in this paper can capture both root- and affix-controlled dominance and, at the same time, provide a uniform interpretation for various instances of accent migration and locality that are in effect in lexical accent systems by means of a model of enriched representations and an interface theory that incorporates CoE and the principle of mirroring in its theoretical apparatus.

6. Conclusions

In this paper, we took a fresh look at morpho-accentual processes that carry heavy lexical baggage and crucially call upon the assistance of interface constraints. More specifically, we developed an analysis that makes use of enriched representations and builds on an interface theory that endorses two basic principles of classic OT, namely containment and CoE. Enriched representations allow us to capture the difference between linked and unlinked accents and also describe a wide range of accent migration phenomena. CC provides an explanation for the locality conditions that accompany accent migration. In addition, the proposed account offers a more principled and restrictive typology for interface constraints than alternative analyses (e.g. TAF). Finally, because TT and CC both rely on

the notion of 'visibility' in phonology, an interface theory that brings them together attains the explanatory force required to resolve the intricacies of lexical stress. It also offers exciting possibilities for current challenges to OT that hinge on hidden structure such as, for instance, opacity.

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