Implicational Constraints, Defaults and Markedness[*]

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1 Introduction

Once Prince & Smolensky (1993) set the theoretical underpinnings of Optimality Theory (OT), the organization and structure of the collection of universal constraints CON soon became a topic of some debate. One of the points that has received some attention has been the possibility to extend CON with complex constraints constructed out of the combination of two or more simple constraints.[1] A first idea in this direction was a proposal by Smolensky (1993, 1995), who suggested a mechanism of constraint combination that he called 'Local Conjunction' (henceforth LC). LC was intended as a device to refine the notion of markedness. Essentially the idea was to capture the fact that certain properties are more marked (and hence should incur in worse violations) in certain domains than in others. Smolensky (1995) illustrates this with the words **tab.da** and **tad.ba**. Both violate the constraints *PL/LAB and NOCODA, but the first one violates them in the same location, as indicated by the double underlining. Thus, given that there are languages with labials and codas, but the option of having labials in coda positions is the marked one, we want **tad.ba** to be better than **tab.da**. As the violation of two constraints is worse when occurring in the same location, LC yields the desired effect by combining the two simple constraints into a complex one. Smolensky explicitly stated that a representation violates a complex constraint $\mathbb{C}_{\mathcal{L}}$ made up of two locally conjoined constraints $\mathbb{C}_1$ and $\mathbb{C}_2$ if, and only if, it violates both $\mathbb{C}_1$ and $\mathbb{C}_2$ in $\mathbb{C}_{\mathcal{L}}$, but not if it violates only one of them. The desired result only follows, however, if CON incorporates the additional condition that $\mathbb{C}_{\mathcal{L}}$ outranks $\mathbb{C}_1$ and $\mathbb{C}_2$.

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[*] Part of this work has been presented at the Université de Nantes and the Universidad de Cádiz. We are grateful to the audiences there for their comments and suggestions. This research was partially supported by DGES PB96-1199-C04-01 (Balari & Marín), DGES PB96-1199-C04-04 (Vallverdú), CIRIT 1999SGR00113 (Balari, Marín & Vallverdú) and CREL-9 (Balari). Authors' names are arranged in alphabetical order. This paper will also be available in the Optimality Archive (http://ruccs.rutgers.edu/roa.html) with the provisional number ROA-391.

[1] Throughout this paper, we will use the term *constraint* referring to constraints that belong to the primitive CON set; with the term *complex constraint* we want to denote those constraints that are the result of combining two ore more (primitive or complex) constraints. In this paper we will focus on complex constraints containing logical operators like 'conjunction' or 'material implication'; we leave aside a number of issues arising from the use of 'negation' of which we will only make a limited use here.

But the denotational semantics of LC is confusing, since it diverges from the standard interpretation of logical ‘and’. Recall that according to this interpretation—which is, moreover, the one typically assumed within constraint-based systems[2]—a conjunctive proposition is false whenever one of the conjuncts is false. In fact, as pointed out by Crowhurst & Hewitt (1997), the semantics of LC coincides with that of classical disjunction; this is illustrated in the truth tables in (1):[3]

(1)

P	Q	(P □ Q)	(P Δ Q)	(P & Q)
T	T	T	T	T
T	F	F	T	T
F	T	F	T	T
F	F	F	F	F

Given this coincidence, Crowhurst and Hewitt suggest to use standard disjunction instead of LC. They also extend the OT constraint language to include, in addition to disjunction, the logical connectors for conjunction and material implication. However, the analyses they present in their paper using, respectively, conjunction and implication have, among other shortcomings, the consequence of forcing a non-standard interpretation of EVAL.

In this paper, following Crowhurst and Hewitt’s proposal of not inventing awkward interpretations for logical connectors, we want to present a revised analysis that eliminates those problematic aspects we mentioned above. In parallel, we will explore some of the consequences that the adoption of complex constraints has for OT, with special emphasis on the content and organization of the constraint set CON. As a conclusion, we will point out some pros and cons of this approach.

2 Complex Constraints and EVAL

As already pointed out in the introduction, Crowhurst and Hewitt’s (1997) (henceforth CH) main objective is to show that the classical interpretation of logical connectors is sufficient to provide an adequate denotational semantics for complex constraints (what

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[2] Restricting our attention to phonology, Scobbie (1991), Bird (1995), Bird & Klein (1994) and Höhle (1999) are illustrative examples.

[3] Here and throughout we will use the symbol ‘□‘ to denote logical ‘and’, and the symbol ‘&’ to denote ‘local conjunction and’.

they call *macro-constraints*). To support their claim, CH select a number of phenomena that appear to receive a much sensible treatment within an approach using this type of constraints. These phenomena fall, according to CH, under three classes depending on the type of complex constraint they require:

(2)

a. *Conjunctive Constraint*: Diyari Templatic stress, and Zezuru Shona Complex Tone Pattern.

b. *Implicative Constraint*: Dongolese Nubian stress.

c. (*Self-)Disjunctive Constraint*: Bolivian Guaraní mobile secondary stress.

We will have nothing to say here about (2c) and only a couple of comments to the Diyari case of (2a); we will concentrate instead on (2b) and the Zezuru Shona case of (2a). As we will see presently, these represent the weakest part of CH's approach, because of the rather problematic interpretation of EVAL they require and, in the Dongolese Nubian case, because of the wrong application of implicative constraints requiring a non-standard semantics.

Our main point will be that both the Zezuru Shona and the Dongolese Nubian cases fall under the same class of phenomena, requiring an analysis in terms of implicative constraints within a totally standard conception of the EVAL function and the semantics of the logical connector. This is a welcome result from the formal point of view, but also for descriptive reasons, as both cases are recognized by CH themselves as falling within the class of phenomena involving some conflicting directionality in the placement of stress or tone. An additional point that will be important in our discussion concerns the notion of 'default' in connection to that of 'markedness'. It is our contention that a number of shortcomings in the analyses of CH arise from a misidentification of the default pattern and from the use of different types of macroconstraints to capture phenomena of a very similar nature. Thus, our analyses of the Shona Complex Tone pattern and Dongolese Nubian stress both fall under the following general schema:

(3) IF P THEN Q, ELSE R

Where the implication describes a marked situation and R represents the default, general case (i.e., less marked). This schema follows naturally from the OT conception of constraint ranking by making the complex implicative constraint IF P THEN Q outrank the simple constraint R.

2.1 Zezuru Shona Complex Tone Pattern

CH provide the following description of the phenomenon (their (36)):

(4) *Shona Complex Tone Pattern*: An inflectional H tone links to the second syllable of a verb stem when the initial syllable is not also H-toned (i.e. when it is L-toned); otherwise, the inflectional H links to the stem-final syllable.

That is, in the Shona lexicon two types of verbal roots are found: toneless ones and H-toned ones.[4] Such roots may undergo a number of suffixation processes giving rise to polysyllabic stems whose surface tone pattern depends on whether an additional inflectional H tone has been assigned or not. When there is no inflectional H, all syllables of a toneless stem simply default to L, whereas in H-toned stems, this initial H spreads a maximum of two syllables to the right with the remaining syllables (if any) defaulting to L. This is the simple pattern, which gives rise to the distribution of tones shown in (5) for trisyllabic, tetrasyllabic and pentasyllabic stems:

(5) Shona Simple Tone Pattern:

	σσσ	σσσσ	σσσσσ
toneless	LLL	LLLL	LLLLL
initial H	HHH	HHHL	HHHLL

If, on the other hand, an inflectional H is assigned to the stem, the distribution of tones is different for toneless and H-toned stems. For toneless stems, inflectional H is placed on the second syllable and it may spread a maximum of one syllable to the right, but never to the final vowel, the remaining toneless syllables (if any) defaulting to L. In H-toned stems, inflectional H is placed on the final vowel and it may never spread, the remaining syllables getting their tones by the same spreading principles operative in the simple pattern. The distribution of tones resulting from the complex pattern is exemplified in (6), again for trisyllabic, tetrasyllabic and pentasyllabic stems, where inflectional Hs are distinguished from initial Hs by appearing in boldface:

[4]Here we stick to CH's description of the phenomenon and to their assumption that non-H-toned roots are toneless and that get their L tone by default. The facts about the Shona tone system appear to be a little bit more complicated, however; for further details, see Myers (1994) and Kenstowicz (1994).

(6) Shona Complex Tone Pattern:

	σσσ	σσσσ	σσσσσ
toneless	L**H**L	L**HH**L	L**HH**LL
initial H	HL**H**	HHL**H**	HHHL**H**

Note two important descriptive facts about the complex pattern: first, for toneless stems, inflectional H may spread one syllable to the right as long as it does not fall on the final vowel; second, for stems with an initial H, it may spread two syllables to the right as long as the spreading does not yield a configuration where the penultimate syllable is also H-toned (i.e., where initial H and inflectional H are adjacent): there is always at least an L-toned syllable between initial H and inflectional H. This latter fact is taken by CH, following earlier work on the topic, to be a typical OCP effect and, as a consequence, they consider that the OCP must be one of the key constraints in the analysis. As for the impossibility for inflectional H to fall on final syllables in toneless stems it is taken by the authors to be a consequence of the tendency of inflectional H to be placed as further to the left as possible. They propose to capture this fact with the alignment constraint in (7) (their (41)):

(7) H-LEFT: Align(H, Left, Verb Stem, Left)
('Every H is left-aligned within some verb stem'; One * for every intervening syllable.)

Given (7), it appears that the optimal position for an inflectional H in toneless stems is the initial one. Since this is not the case, CH assume that a highly ranked constraint prevents H tones to fall on the first syllable. This is set in (8) (CH's (43)):

(8) NONINITIAL-H: The initial syllable of a verb stem is not associated to H.
(One * for every initial H-toned syllable.)

Now, in order to account for inflectional H placement in initially H-toned stems, CH propose the constraint in (9) (their (42)):

(9) H-RIGHT: Align(H, Right, Verb Stem, Right)
('Every H is right-aligned within some verb stem'; One * for every intervening syllable.)

The H-RIGHT constraint produces the opposite effect from H-LEFT, favoring a rightmost placement of inflectional H. The two constraints are thus in conflict, and the key of the analysis lies in finding an appropriate way to solve this conflict. The inventory is completed with the following constraint against floating tones in outputs (CH's (40)):

(10) *FLOAT: A tone must be associated with a syllable.
(One * per floating tone.)

As for the ranking, both *FLOAT and NONINIT-H are assumed to outrank H-LEFT, H-RIGHT and the OCP. The problem resides in determining what the relative ranking of the latter three constraints is. For toneless stems, it appears that constraints should be ranked as in (11), where the OCP is not included because it is irrelevant:

(11) *FLOAT, NONINIT-H >> H-LEFT >> H-RIGHT

The appropriateness of (11) is shown in the tableau in (12) for the input {vereng-es-er-a, H} for which the optimal candidate is (12a), 've.ré.nge.se.ra':

(12)

Candidates	*FLOAT	NONINIT-H	H-LEFT	H-RIGHT
a. ☞ ve re nge se ra (H linked to re)			*	***
b. ve re nge se ra (H linked to nge)			**!	**
c. ve re nge se ra (H linked to se)			**!**	
d. ve re nge se ra (H linked to ve)		*!		****
e. ve re nge se ra (H unlinked)	*!			

Observe how the candidate in (12a) is the winner against its direct competitors (12b) and (12c), with a single violation of H-LEFT; H-RIGHT is irrelevant in this case. Now, note that for initially H-toned stems, the required relative ranking between H-LEFT and H-RIGHT is the reverse. This is exemplified in (13) with input {tór-es-er-a, H}, the optimal output being (13a) 'tó.re.se.rá'. Here we do not include the *FLOAT constraint, but we add the OCP:

(13)

Candidates	NONINIT-H	OCP	H-RIGHT	H-LEFT
H H a. | | ☞to re se ra	*			***
H H b. | | to re se ra	*		*!	**
H H c. | | to re se ra	*	*!	**	*

Here all candidates violate NONINIT-H, so the responsibility goes to the OCP, who eliminates (13c). Eventually, H-RIGHT selects (13a). The important point here is that the reverse ranking between H-RIGHT and H-LEFT would select (13b) as the optimal candidate. This is the core of the problem: how is this contradiction to be solved?

CH's diagnostic is the following (p. 37):

> Whatever the theoretical remedy, it must be capable of expressing an odd generalisation not often noticed: the optimal candidate is one which passes both H-LEFT and the OCP, modulo noninitiality.

This generalization is translated into the OT constraint language as the conjunctive constraint in (14) with the relative ranking shown in (15).

(14) H-LEFT □ OCP

(15) NONINITIAL-H >> H-LEFT □ OCP >> H-RIGHT

Now we can see the way out of the paradox by watching the conjunctive constraint at work with the same collection of candidates we had in (12) and (13). This is set in the tableaux (16) and (17), respectively, which we reproduce verbatim from CH's paper.

(16)

Candidates	NONINIT-H	H-LEFT □ OCP	H-RIGHT
H a. | ☞ ve re nge se ra		(*)	***
H b. | ve re nge se ra		* (**!)	**
H c. | ve re nge se ra		* (**!**)	
H d. | ve re nge se ra	*!		****

(17)

Candidates	NONINIT-H	H-LEFT □ OCP	H-RIGHT
H H a. | | ☞ to re se ra	*	* (**!*)	
H H b. | | to re se ra	*	* (**!)	*!
H H c. | | to re se ra	*	* (*) (*)	*!*

In the tableaux, parenthesized asterisks denote violations of individual constraints within a complex constraint, whereas a centered nonparenthesized asterisk denotes a violation of the complex constraint. The key issue here is how a violation of a complex constraint is determined. Consider (17) first. All candidates fail on NONINIT-H, so this constraint is not discriminatory. The conjunctive constraint is not discriminatory either, but it is interesting to see how failure is determined for each candidate. In CH's words:

> The best candidate for H-LEFT is (56c) [our (17c); BM&V]; the others fail H-LEFT, and therefore also the macro-constraint. However, the candidate (56c) which passes H-LEFT fails the OCP—leading to a penalty against the conjunction in this case as well.

Note how the evaluation of a complex constraint is supposed to proceed. First, the left-hand-side simple constraint in the conjunction is checked against *all* candidates, just as if the constraint were an independent one, and a winner is chosen with respect to that particular constraint. It is only after this partial evaluation that a 'true' or 'false' result is delivered for each and every candidate, where 'true' here has nothing to do with fulfilling a constraint but, rather, with being the winner in a complete evaluation round. Once the winner for the left-hand-side conjunct is chosen, the same is done with the right-hand side of the conjunction, and a winner (or collection of winners) is determined for that part. Thus, the winner (or winners) in the first part gets a 'true' for that part whereas losers get a 'false'; similarly for the second part. It is these truth-vales that are then checked for the conjunction independently of the other candidates. Thus, if we were to translate the relevant part of (17) using truth-values, the result would be something like (18):[5]

(18)

Candidates	NONINIT-H	H-LEFT □ OCP	H-RIGHT
H H a. | | ☞ to re se ra	*	*=F (**!*)=F ()=T	
H H b. | | to re se ra	*	*=F (**!)=F ()=T	*!
H H c. | | to re se ra	*	*=F (*)=T (*)=F	*!*

The example is illustrative because it shows that the source for a 'true' or a 'false' mark may be different depending on the nature of the constraint. Sometimes, as is the case of H-LEFT, the source is the exclamation mark (i.e., whether the candidate is optimal or not), whereas some other times, as is the case of OCP, the source is whether the constraint is violated or not. The problem is that, even though in OT these situations often coincide (i.e., non-optimal candidates for some constraint always violate it), one cannot assume that they are one and the same thing. In fact, it would go completely against the spirit of the theory to identify them, since constraint violation is a necessary, but not sufficient, condition for non-optimality. As the reader may have already appreciated, the problem here has to do with the special status of those constraints that are evaluated gradiently, since a candidate may violate one of these, once, twice or

[5]Hammond (2000) adresses directly the issue of assigning truth values to cells in a tableau. Unfortunately, his proposal does not help in solving the issue of truth value assignment to cells corresponding to complex constraints.

more times and still be optimal, relative to other candidates. This is never the case with non-gradient constraints, where violation is always fatal.[6]

The effect of this evaluation procedure is particularly striking in the case of (16). Observe that only three out of four candidates compete for optimality at the complex constraint, since (16d) is already out for failing NONINIT-H. Of the three candidates, (16a) violates H-LEFT only once, whereas (16b) and (16c) violate it two and four times, respectively. This gives a relative advantage to (16a) which, with a single violation, is the winner and, therefore, its unique star deserves a True truth value; the other two, on the other hand, get a False for H-LEFT, and, eventually, for the whole complex constraint, since no candidates violate the OCP.

We are well aware that this is not a knockdown argument against CH's analysis: it is certainly true that one cannot generally identify violation of a constraint by some candidate with non-optimality of that candidate, but such an identification is harmless for non-gradient constraints. On the face of this, CH might then argue that what really counts for the purposes of the evaluation of complex constraints is non-optimality of the candidates with respect to their constituent parts. The move would probably work at the cost of introducing a certain amount of notational ambiguity in tableaux between asterisks and exclamation marks, since the former sometimes will have the same interpretation as the latter (i.e., 'false'), and some other times not: there is certainly an issue with respect to the combination of gradient constraints with non-gradient ones. The problem is that CH are not consistent with their application of EVAL to complex constraints. Clarification of this point requires an excursus into CH's analysis of Diyari Templatic Stress.

2.1.1 The Conjunctive Analysis of Diyari Templatic Stress

In a nutshell, the facts about stress assignment in Diyari are the following:

1.- Primary stress is consistently word-initial, assigned to the first syllable of the root.

2.- In a root of more than three syllables, a secondary stress is assigned to the third syllable.

This pattern is easily accounted for by a standard footing procedure as shown in (19) below:[7]

[6]Unless all other candidates also violate the constraint, in which case the buck is passed over the next lower ranked constraint.

[7]Syllable and foot structure in Diyari examples are always as assumed in CH's paper. As for phonetic transcription, we follow CH adding some conventions from Poser (1986).

(19)
a. (ka@.˜a) ‘man’
b. (pi@.na).du ‘old man’
c. ‘to close’
(Na@n.da).(wa›l.ka)

A further source for secondary stress is suffixation, as long as suffixes are bi- or tetrasyllabic, in which case secondary stress is suffix-initial. Monosyllabic suffixes are never stressed, even when appearing in a sequence. Some illustrative examples are given in (20):

(20)
a. (ma@.Ía)-la-ni ‘hill-CHARACTERISTIC-LOCATIVE’
b. (pu@.lu).ru-ni-(ma) ‘mud-LOCATIVE-IDENT’
c. (ka@.˜a)-(wa$.}a) ‘man-PLURAL’
d. (pi@.na).du-(wa$.}a) ‘old man-PLURAL’

Observe that a number of syllables in some of the words in (20) remains stranded. These are not assigned to any foot and thus do not count for stress assignment. The point appears to be that foot boundaries may never cross morpheme boundaries or, to put it differently, foot structure may never be built out of heteromorphemic syllables. As noted by CH and others (e.g., Poser 1986), the theoretical challenge posed by Diyari, then, consists in ‘accounting for the unusually intimate relationship between metrical and morphological structure’.

Exploring an analysis based on alignment constraints, CH eventually conclude that:

> The intuition we seek to capture […] is that every morpheme is required to begin and end with some foot. Proper dual-edge alignment, furthermore, is the only way to satisfy the template; alignment at one edge of a morpheme is no better than alignment ad neither edge. In fact, when a morpheme cannot be aligned at both edges with a foot, it is usually better not to have foot structure at all.

This conclusion is forced by the evidence supplied by monomorphemic words with an odd number of syllables greater than three, which, contrary to what is expected given descriptive generalization 2 above, do not bear secondary stress on the third syllable. The relevant example is given in (21):[8]

(21) (wi@n.ta).ra.(na$.ya) ‘how long’

The authors suggest, then, that the solution might be the conjunction of two alignment constraints into a single complex constraint. We reproduce them in (22):

(22)

a. INITIAL-FT: Align (Morpheme, Left, Foot, Left).

b. FINAL-FT: Align (Morpheme, Right, Foot, Right)

(where: Every morpheme is left/right aligned with some foot; one * per misaligned morpheme)

c. INITIAL-FT FINAL-FT

In addition to the constraint in (22c) there are two more constraints, one to avoid foot structure (*STRUC(FT)), outranked by (22c), and another preventing the construction of monosyllabic degenerate feet (FTMIN(σ)), which outranks the other two. This is summarized in (23):

(23)

a. *STRUC(FT): Avoid foot structure (One * for every foot not present at input)

b. FTMIN(σ): *[σ] (One * per monosyllabic foot)

c. FTMIN(σ) >> INITIAL-FT FINAL-FT >> *STRUC(FT)

Now we can watch all these constraints at work with some relevant examples in the following tableau:

[8] As CH note, referring to a personal communication by Peter Austin, the word in (21) is exceptional in being the only pentasyllabic monomorphemic (i.e., not derived via suffixation or reduplication) word in Diyari.

(24)

Inputs: /{wintaranaya}/; /{ka˜a}$_{\alpha}${wa}a}$_{\beta}$/ and /{ma@.Ía}$_{\gamma}${la}$_{\delta}${ni}$_{\varepsilon}$/

Candidates:		FTMIN(σ)	INITIAL-FT □ FINAL-FT	*STRUC(FT)
a.☞	(wi@n.ta).ra.(na$.ya)			**
b.	(wi@n.ta).ra.na.ya		*! (*)	*
c.	(wi@n.ta).(ra$.na).ya		*! (*)	**
d	win.ta.ra.(na$.ya)		*! (*)	*
e.	win.ta.ra.na.ya		*! (*) (*)	
f.☞	(ka@.˜a)-(wa$.}a)			**
g.	(ka@.˜a)-wa.}a		*β! (*β) (*β)	*
h.	ka.˜a-(wa@.}a)		*α! (*α) (*α)	*
i.	ka.˜a-wa.}a		*α!*β (*α*β) (*α*β)	
j.	(ma@.Ía)-(la$-ni)		*ε*δ (*ε) (*δ)	**!
k.☞	(ma@.Ía)-la-ni		*ε*δ (*ε*δ) (*ε*δ)	*
l.	ma.Ía-la-ni		*γ*δ*ε! (*γ*δ*ε) (*γ*δ*ε)	
m.	(ma@.Ía)-(la$)-(ni$)	*!*		***

All examples are equally relevant for the point we want to make here, but the case of (24j–m) is particularly illustrative. Note that, as the pointing hand indicates, the winner candidate is (24k), as it beats its competitor (24j) in *STRUC(FT). (24m) was already out at FTMIN(σ), and (24l) was eliminated from the competition at the complex constraint, where (24j-k) tied. This result is achieved in the following way: (24j) gets one star for violating INITIAL-FT at foot ε and another one for violating FINAL-FT at foot δ; these two stars are then 'percolated' up and yield two stars for the complex constraint. As for (24k), it gets two stars for feet ε and δ both for INITIAL-FT and FINAL-FT, and these are then ‘percolated’ up as two (not four) stars for the complex constraint, yielding a tie with (24j). (24l) is out because its six stars (three for INITIAL-FT and three for FINAL-FT) are translated into three stars for the complex constraint.

Now, note how this evaluation procedure is different from the one assumed in the case of the Zezuru Shona tone system. Had the latter procedure been used here, no tie between (24j) and (24l) would have been occurred, since (24j) is a relative winner for both INITIAL-FT and FINAL-FT, with a single violation for each against the two and three violations induced by (24k) and (24l). Recall that in the analysis of the Shona Complex Tone Pattern, candidates are evaluated first with respect to the left-hand side of the complex constraint and a winner for that part is chosen, which is the one incurring is less violations (not necessarily zero); next, candidates are evaluated with respect to the right-hand side of the constraint and, again, the candidate incurring in less violations is the winner. In (24), this procedure is not used, otherwise (24j), which is the optimal candidate with respect to both the right- and left-hand sides of the conjunctive constraint, would not violate the complex constraint and should be the winner instead of (24k).

Back to the Zezuru Shona case, note that the evaluation system used in (24) yields the incorrect result, since (16a-c) would tie at the conjunctive constraint and H-RIGHT would select (16c) as the winner, instead of (16a).

We are thus confronted with two different conceptions of EVAL: one, which is exemplified by (24), is fairly standard; the other, as exemplified specially in (16), is presented as the favored alternative by CH. In addition to the inconsistency that we have just mentioned, their proposal suffers from another important shortcoming.

Let us go back to (16) again, which we reproduce below, and call the attention of the reader to the fact that the candidate in (16d) is not evaluated with respect to the complex constraint. If it were so, the single violation of H-LEFT incurred by (16a) would be fatal, because (16d) completely satisfies this constraint. In this case, (16a-c) would tie at the conjunctive constraint and H-RIGHT would wrongly select (16c) as the winner. Compare (16) with (25), where the influence of candidate (d) has been considered at moment of selecting a winner for the H-LEFT part of the complex constraint.

(16)

Candidates	NONINIT-H	H-LEFT □ OCP	H-RIGHT
H a. | ☞ ve re nge se ra		(*)	***
H b. | ve re nge se ra		* (**!)	**
H c. | ve re nge se ra		* (**!**)	
H d. | ve re nge se ra	*!		****

(25)

Candidates	NONINIT-H	H-LEFT □ OCP	H-RIGHT
H a. | ve re nge se ra		* (*!)	*!**
H b. | ve re nge se ra		* (*!*)	*!*
H c. | ☞ ve re nge se ra		* (*!***)	
H d. | ve re nge se ra	*!		****

CH are rather explicit in this point: they defend the idea that candidates rejected by some constraint are never evaluated for lower-ranked constraints. As CH themselves put it “the violations represented in shaded boxes in OT tableaux for failed and for optimal candidates are not merely irrelevant —*they are never assigned*.”

An important theoretical aspect that derives from this assumption is that it imposes an extrinsic ordering on the application of constraints, since the only possible way to achieve the desired results is to apply constraints following the ordering defined by the ranking. This conception of constraint evaluation is totally against the spirit of OT.

Before exploring possible solutions to these shortcomings, let us turn to another case that makes use of the same evaluation procedure assumed for (16), and, in addition, employs a non-standard interpretation of material implication.

2.2 Dongolese Nubian Stress Assignment

The principles of stress assignment in this language show a similar situation of conflict directionality as the Zezuru case:

(26) Dongolese Nubian stress
(i) In forms with one or more heavy syllables (CVV), stress the rightmost heavy;
(ii) When only light syllables (CV, CVC) are present, stress the initial syllable.

Following this pattern, which, according to Hayes (1995, p. 296), is followed by many other languages, the authors claim that Dongolese Nubian stress assignment is quantity sensitive, and, consequently, it is assigned to the rightmost bimoraic head of a foot, if there is one. Otherwise, stress is word initial. Two relevant examples are the following:

(27) a. maa.(súu).ra
b. (mú.go).san

CH account for these facts by appealing to a constraint on stress placement and two alignment constraints:

(28) a. HEAVYHEAD: The head σ of a foot is bimoraic, μμ.
b. HEADS-RIGHT: Align (Head(F), Right, PrWd, Right)
c. HEADS-LEFT: Align (Head(F), Left, PrWd, Left)

HEAVYHEAD requires stressed syllables to be heavy. HEADS-RIGHT and HEADS-LEFT require that the stressed head of a foot be aligned to the right or left edge of the prosodic word containing it. Violations are assigned gradiently, so that a mark is returned for every syllable separating the stress-head from the specific edge.

The next issue regards the relative ranking of these three constraints. As for HEAVYHEAD the authors observe: "to capture the basic descriptive generalisation that stress falls on a heavy syllable in Dongolese Nubian if there is one, HEAVYHEAD must be highly ranked in any account."[9] With respect to HEADS-RIGHT and HEADS-LEFT, the

[9]This is probably wrong, as, contrary to what appears to be the case, HeavyHead seems to capture the default case and, consequently, should be lower ranked.

ranking between both constraints has to be different in forms containing heavy syllables and in forms with no heavy syllables. This leads to an ordering paradox, similar to the one observed in the Zezuru Shona case.

After considering a number of possibilities, including complex conjunctive constraints, the authors eventually conclude that a macro-constraint has to be used, but, in this case, the relation between its two members is an implicative one. In short, the following ranking is assumed:[10]

(29) HEAVYHEAD ∅ HEADS-LEFT >> HEADS-RIGHT

Concerning the interpretation of implication and how implicative constraints are evaluated, the authors state:

(30) *Implication :* A∅ B

a. *Boolean*: If A is true, then the truth value for B determines the truth value of A∅ B:

If B is true, then A∅ B is true;
If B is false, then A∅ B is false.

If A is false, then A∅ B is false, and the truth value of B is irrelevant.

b. *Constraints* If Cand passes A, then Cand is evaluated with respect to B:

If Cand passes B, then Cand passes A∅ B;
If Cand fails B, then Cand fails A∅ B.

If Cand fails A, then Cand fails A∅ B and Cand's success on B is irrelevant.

And illustrate their analysis with the following tableau:

[10] We use the arrow to denote material implication instead of their symbol ">".

(31)

Candidates	HEAVYHEAD ∅ HEADS-RIGHT	HEADS-LEFT
a.☞ maa (súu) ra	(*)	*
b. (máa) suu ra	*! (**)	
c. (màa) (súu) ra	*! (***)	*
d. maa suu (rá)	*! (*)	**
e. ☞ (mú go) san	* (*) (**)	
f. mu (gó san)	* (*) (*)	*!
g. mu go (sán)	* (*)	*!*

The first thing to note here is their non-standard conception of implication, which states that an implication is false whenever the antecedent is false, regardless of the truth value of the consequent. The translation of this conception to constraint evaluation is that whenever a candidate fails the antecedent it fails the implicative constraint and the consequent is no longer evaluated. It is only through this awkward interpretation that the desired results follow.[11]

First, as the following truth table shows, material implication is false only when the antecedent is true and the consequent is false:

[11]CH are not particularly explicit on this point, but note that a possible motivation for giving this interpretation to the implicative constraint is the fact that, on the authors' assumptions, a candidate failing a constraint is never evaluated for the following ones. This idea applied to the evaluation of a complex constraint may be implemented assuming that failure of the left-hand side automatically kills a candidate and that it is no longer available for evaluation of the right-hand side. If this so, note that there is no real logical connection between the two simple constraints making up the complex one, but just some kind of encapsulation where two or more simple constraints form a subroutine that a candidate gets into just before being able to be evaluated by lower-ranked constraints. Once within this 'capsule' every candidate must pass a constraint before being able to be evaluated by the next; if some constraint is not satisfied, the candidate is killed, it is not evaluated for other constraints, and it fails the whole 'capsule'.

(32)

P	Q	(P ∅ Q)
T	T	T
T	F	F
F	T	T
F	F	T

According to the classical interpretation, failure of the antecedent never implies failure of the implicative constraint, and, therefore, there are no reasons for the candidate not to be evaluated by the consequent. So, assuming their own conception of EVAL, but making use of the classical interpretation of material implication, the final results are quite different. These are shown in (33):

(33)

Candidates	HEAVYHEAD ∅ HEADS-RIGHT	HEADS-LEFT
a. maa (súu) ra	*! (*!)	*
b. (máa) suu ra	*! (*!*)	
c. (màa) (súu) ra	*! (*!**)	*
d.☞ maa suu (rá)	(*!)	**
e. ☞ (mú go) san	(*) (**)	
f. mu (gó san)	(*) (*)	*!
g. mu go (sán)	(*)	*!*

The interesting case is (33a-d). Following the evaluation procedure assumed by CH, candidates are evaluated first with respect to the antecedent (HEAVYHEAD). The only candidate failing it is (33d), which therefore deserves a 'false', whereas the other three get a 'true'. This means that, in order to satisfy the complex constraint, (33a-c) must pass the consequent. Unfortunately, this is not the case, since the optimal candidate for

HEADS-RIGHT is, precisely (33d). Allowing (33d) to be evaluated for the consequent has the effect of making (33a) non-optimal and, as a consequence, (33a-c) are false. In fact, the only candidate that satisfies the implicative constraint is (33d), and it is wrongly selected as the optimal one. (33e-g) do not pose a problem for any of the two conceptions of implication.

2.3 Summary

To sum up, then, we have seen two phenomena involving conflicting directionality in the assignment of stress or tone. The solution proposed by CH is different for each language: in the Shona case, a conjunctive constraint was suggested as the way to capture the facts, whereas in the Dongolese Nubian case, an implicative constraint is used. This is in itself a surprising result: that two phenomena that are so similar at the surface require such different formal solutions. This would not be too bad if it were not for the number of additional shortcomings that we have pointed out throughout the preceding discussion. In particular, we noted an inconsistency in the evaluation mechanisms, and a non-standard conception of material implication. With respect to the particular evaluation procedure proposed by CH, it was noted that it has the undesirable consequence of imposing an extrinsic ordering in the evaluation of constraints and of giving some constraints in certain circumstances the power of killing candidates, in the sense of preventing them from being evaluated by lower-ranked constraints.

In the next section, we expect to show that it is still possible to use complex constraints in OT, without adopting a particular conception of EVAL and using a classical denotational semantics for logical connectors.

3 Material Implication and Default Patterns

In this section, we present a unified analysis of both the Zezuru Shona Complex Tone Pattern and Dongolese Nubian Stress, as described in the preceding section. In this analysis, and following the proposal of Zoll (1997), we defend that phenomena involving conflicting directionality can be accounted for by a specific organization of constraints. In particular, we demonstrate that constraints should be structured according to the following general schema:

(34) IF P THEN Q, ELSE R

In this schema, P and Q are two primitive constraints combined into a complex one using implication; R is a lower-ranked simple constraint. The consequence of this ranking is that the complex constraint captures the marked pattern, while R represents the default, less marked case.

Besides, the analysis we present makes use of a standard interpretation of EVAL, and stays within a classical denotational semantics for logical connectors.

3.1 Zezuru Shona

Recall that the Shona verbs fall into two sub-classes: (i) toneless roots and (ii) H-toned roots. The latter have their high tone associated to the first syllable. When an inflectional high tone is added, it falls on the second syllable of a toneless stem, and on the last syllable of H-toned stems. Representative examples of these patterns are (35a) and (35b), respectively:

(35) a. ve.ré.nge.se.ra
b. tó.re.se.rá

From this, the following descriptive generalization can be derived:

(36) If there is an initial high tone, inflectional high tone falls on the rightmost syllable; otherwise, it is placed as close to the left edge of the verb stem as possible.

Formally, this can be captured by two alignment constraints and a third one requiring the presence of a High tone on the first syllable:

(37) a. H-LEFT: Align(H, Left, Verb Stem, Left)
('Every H is left-aligned within some verb stem'; One * for every intervening syllable.)
b. H-RIGHT: Align(H, Right, Verb Stem, Right)
('Every H is right-aligned within some verb stem'; One * for every intervening syllable.)
c. INITIAL-H: The initial syllable of a verb stem is associated to H.
(One * for every non-H-toned initial syllable.)

As the generalization in (36) implies, the marked pattern is that where the inflectional High tone falls on the last syllable because of the presence of a High tone on the initial one. The default case corresponds to the situation where the inflectional High tone falls on the second syllable. This indicates that a logical dependency exists between constraints (37b) and (37c), such that when (37c) holds, also (37b) must hold for a candidate to be optimal. The way to get this result is to combine both constraints into a complex implicative one:

(38) INITIAL-H ∅ H-RIGHT

If INITIAL-H is violated, H-RIGHT is irrelevant, and the default case, i.e. H-LEFT, has to be satisfied by the optimal candidate. Therefore, the ranking between these constraints must be the following:

(39) INITIAL-H ∅ H-RIGHT>>H-LEFT

That the optimal candidates selected by this ranking are the correct ones is shown in (40):

(40)

<table>
<tr><th>Candidates</th><th>INITIAL-H ∅ H-RIGHT</th><th>H-LEFT</th></tr>
<tr><td>H
a. |
☞ ve re nge se ra</td><td>(*) (***)</td><td>*</td></tr>
<tr><td>H
b. |
ve re nge se ra</td><td>(*) (**)</td><td>**!</td></tr>
<tr><td>H
c. |
ve re nge se ra</td><td>(*)</td><td>**!**</td></tr>
<tr><td>H
d. |
ve re nge se ra</td><td>*!
(****)</td><td></td></tr>
<tr><td>H
e. |
ve re nge se ra</td><td>(*) (*)</td><td>**!*</td></tr>
<tr><td>H H
f. | |
☞ to re se ra</td><td></td><td>***</td></tr>
<tr><td>H H
g. | |
to re se ra</td><td>*!
(*)</td><td>**</td></tr>
</table>

h. H H
    | |
    to re se ra
	*!
	(**)
		*

Consider first (40a-e). The only candidate failing the complex constraint is (40d), precisely because it is the only one that satisfies the antecedent of the implication: given the semantics of classical implication, satisfaction of INITIAL-H requires satisfaction of the consequent, H-RIGHT. As for the rest of the candidates, all violate the antecedent, which makes satisfaction of the consequent irrelevant. Therefore, they satisfy the complex constraint. H-LEFT is violated by all candidates with exception of (40d), which has already been rejected, although an optimal one is selected anyway. (40a) is the winner, because it incurs in less violations.

As for (40f-h), all candidates satisfy the antecedent of the conditional, but the only candidate also satisfying the consequent is (40f). As a consequence, (40g-h) are eliminated by the complex constraint, and (40f) is selected as the optimal candidate even though it is the one with more violations of the default pattern.

Nothing special has to be said about EVAL, since the same mechanisms assumed in the OT literature are at work here.

3.2 Dongolese Nubian

As we already noted, stress assignment in this language shows a similar situation of conflicting directionality as the one observed in Shona tone assignment. The Dongolese Nubian stress system is of the unbounded type. Such systems, as characterized by Hayes (1995), "are sensitive to syllable weight but place no limits on the distance between stresses or between stress and word boundary." Hayes distinguishes two subtypes of unbounded systems depending on whether the default stress falls on the same or on the opposite side of the marked stress. Within the latter class, Hayes lists a number of languages presenting the same pattern observed in Dongolese Nubian:[12]

(41) a. In forms with one or more heavy syllables (CVV), stress the rightmost heavy.
b. When only light syllables (CV, CVC) are present, stress the initial syllable.

[12] A cautionary note is at stake here. What is relevant is the "Rightmost Heavy Syllable, Otherwise Leftmost Syllable" pattern and not what counts as a heavy or a light syllable in each language. For example, Hayes includes languages like Classical Arabic in this class where both CVV and CVC syllables are heavy.

The traditional interpretation of a generalization like (41) has taken a derivational perspective. According to this a stress assignment algorithm is supposed to place stress on the rightmost heavy syllable if there is one, otherwise, stress must be placed on the leftmost syllable. If we were to use Kiparsky's (1973) terminology, stress assignment to heavy syllables would be considered the "special rule" and stress assignment to light syllables would be the "general rule" or "elsewhere case". This way of looking at things has lead to an identification of "elsewhere case" with "default case" and to an identification of "default case" with "less marked".

Under this interpretation, (41a) would be the special case and (41b) the default. This is the view taken by CH, following Hayes (1995) among others. Note, however, that from the perspective of a theory of markedness, stressed light syllables are more marked than stressed heavy ones. This implies that it is wrong to identify "elsewhere" with "unmarked" and, we believe, it is also wrong to identify "elsewhere" with "default". Rather, it appears that default patterns correspond to unmarked patterns; see Bird (1995) for discussion of this point.

Under a declarative perspective, their interpretation is even worse, since in this case patterns are not derived but only licensed. Here (41) should be translated into (42):

(42) a. If there is a stressed light syllable, then it has to be leftmost.
b. Otherwise, stress on the heavy syllable must be rightmost.

Note that if a representation does not conform to the description in the antecedent of (42a), (i.e., it does not have a stressed light syllable), then it necessarily satisfies the description in (42b).

The generalization in (42) is then what we must express in terms of constraints and constraint ranking. As for (42a), we can capture it with the complex constraint in (43a), and (42b) with the constraint in (43b):

(43) a. LIGHTHEAD ∅ HEADS-LEFT
b. HEADS-RIGHT

The constraints HEADS-LEFT and HEADS-RIGHT are defined as in (28) above (repeated below as (44b,c), whereas LIGHTHEAD is defined as in (44a):

(44) a. LIGHTHEAD: The head σ of a foot is monomoraic, μ.
b. HEADS-RIGHT: Align (Head(F), Right, PrWd, Right)

c. HEADS-LEFT: Align (Head(F), Left, PrWd, Left)

As the reader may easily verify, with the ranking LIGHTHEAD ∅ HEADS-LEFT >> HEADS-RIGHT, the correct results follow. This is shown in tableau (45):

(45)

Candidates	LIGHTHEAD ∅ HEADS-LEFT	HEADS-RIGHT
a. ☞ maa (súu) ra	(*) (*)	*
b. (máa) suu ra	(*)	**!
c. (màa) (súu) ra	(*) (*)	**!*
d. maa suu (rá)	*! (**)	
e. ☞ (mú go) san		*
f. mu (gó san)	*! (*)	
g. mu go (sán)	*! (**)	

Observe how the implicative constraint has the effect of passing the buck over HEADS-RIGHT when the head is a heavy syllable, since it is entirely innocuous for candidates having this property. Only when the head is a light syllable, the complex constraint is decisive, since it requires stressed light syllables to be word initial.

However, there is a potential problem with this solution. It appears that, under most commonly accepted OT assumptions, markedness effects should derive from the presence in the constraint set of a single constraint requiring unmarked structures. Thus, for instance, the universal preference for CV syllables is captured by two constraints, namely, ONSET and NOCODA; crucially, their counterparts requiring marked structures, NOONSET and CODA, are never explicitly considered to be part of CON. In (45), LIGHTHEAD is precisely a constraint of the second kind, requiring a marked structure.

A possible way out of this problem would be to assume that CON contains both constraints requiring marked and unmarked structures, where the relative ranking is universally fixed with the latter overanking the former. Following Smolensky (1995), we could then assume that complex constraints are always made up with pre-existing simple constraints, which are ranked below it. This, in itself, does not justify the presence of constraints requiring marked structures within CON, although such constraints have occasionally been used in order to capture certain phenomena. For example, Prince & Smolensky (1993; §9.1.2), to account for coronal unmarkedness, propose the following constraint ranking: *PL/LAB >> *PL/COR, where *PL/COR is a constraint requiring marked structures; see also Smolensky (1993) and Kager (1998). Similarly, the translation of the sonority scale to a collection of binary constraints as proposed, again, by Prince & Smolensky (1993; §8.1.2) is an example of the need for constraints requiring marked structures as part of the CON set.

Back to (45), we could assume that both HEAVYHEAD and LIGHTHEAD are present as simple constraints with HEAVYHEAD (the unmarked one) universally outranking LIGHTHEAD (the marked one). LIGHTHEAD would then be picked in order to construct the higher-ranked implicative constraint.

An alternative solution would reject the presence of constraints requiring marked structures at the cost of enriching our constraint language with the negation operator. In this case, only HEAVYHEAD would exist as a simple constraint. In order to build the appropriate implicative constraint, its negation should be used in (45) instead of LIGHTHEAD.[13] It is obvious that LIGHTHEAD is logically equivalent to ¬HEAVYHEAD:

[13] Smolensky (1993), in order to account for the Coda Condition, faces a similar problem. To favor the presence of coronals in coda positions he needs a constraint that allows for codas to be conjoined with a constraint forbidding labials, outranking another conjunction forbidding coronals in codas. The resulting constraints are: *PL/LAB&CODA>>*PL/COR&CODA, where CODA is, in fact, not a universal constraint requiring marked structures, but the result of taking the negation of NOCODA (i.e., ¬NOCODA).

(46)

Candidates	¬HEAVYHEAD ∅ HEADS-LEFT	HEADS-RIGHT
a. ☞ maa (súu) ra	(*) (*)	*
b. (máa) suu ra	(*)	**!
c. (màa) (súu) ra	(*) (*)	**!*
d. maa suu (rá)	*! (**)	
e. ☞ (mú go) san		*
f. mu (gó san)	*! (*)	
g. mu go (sán)	*! (**)	

4 Conclusion

In this paper, we have presented an analysis of two phenomena involving conflicting directionality. Following CH, our proposal involves complex constraints, a formal device which has independently been used to account for different kinds of problems (Itô&Mester, 1996; 1997. Smolensky, 1993;1995). Unlike previous approaches, however, ours makes use of a classical interpretation for logical connectors and a standard evaluation procedure.

In addition, we have managed to capture the similarity between both phenomena by using a complex constraint of the same type. Recall that CH were forced to use an implication and a conjunction, whereas our analyses both use implicative constraints. In fact, our proposal is similar to that of Zoll (1997). In her paper, she makes a description of the stress assignment pattern in Selkup that coincides with the one we gave for Dongolese Nubian, and her interpretation of the notions of 'default' and 'markedness' is identical to the one we argued for in the text. She claims, however, to be able to solve conflicting directionality phenomena by means of alignment constraints. Thus, her constraints governing placement of the stressed syllable in Selkup are defined as follows:

(47) ALIGN-RIGHT (σ′,PRWD) ‘Stressed syllable should be word final’

∀ σ′ ∃ Prosodic Word such that the stressed syllable coincides with the rightmost syllable in the Prosodic Word.

(48) ALIGN-LEFT (Σ'_M,PRWD) ‘Light stressed syllable should be word initial’

∀ σ′ ∃ Prosodic Word such that the light stressed syllable coincides with the leftmost syllable in the Prosodic Word.

Where (48) outranks (47). Observe that in Zoll's analysis (48) describes the marked pattern and (47) is the unmarked one and that, just like in the analysis we have just presented, the former outranks the latter.

We believe that the only shortcoming of this analysis, and here we agree completely with CH’s diagnostic, is that (48) is in fact a hidden complex constraint. Note that it combines two separate requirements: if a syllable is the head of a foot, and if it is light, then it must occur at the left edge. If we were to unpack Zoll’s alignment constraint, the resulting one would be identical to our implicative constraint.

In any event, we believe that one of the important implications of our analysis of conflicting directionality is that Smolensky’s (1995) intuition that certain phenomena require a treatment in terms of complex constraints is correct. The point here is that markedness appears to be a matter of degree, but this gradation is much more subtle than the original conception of optimality suggests. In fact, a representation may be more marked than another one just because it accumulates violations of markedness statements, but also because such violations are restricted to specific domains or are somehow related. For example, and borrowing Smolensky’s (1995) example, assume we have three representations, namely, **tas.da**, **tas.ba** and **tab.da**; assume, moreover, that we have two constraints: *PL/LAB and NOCODA. The first representation violates NOCODA, but the other two both violate NOCODA and *PL/LAB; by themselves, these two constraints are too weak to capture the difference in markednes between **tas.ba** and **tab.da**, where the second is more marked than the first. The only possible way to get a 'ganging up' effect where both constraints cooperate is to combine them into a single, larger constraint that includes both. So far, our argument is not too different from Smolensky's, apart from the fact that he appears to assume that such cases are limited to the combination of marked specifications into particular marked domains, whereas what our analyses show is that languages may adopt the strategy of placing certain marked structures or specifications (e.g., light stressed syllables) in specific—not necessarily marked—domains or locations (e.g., word-initial syllables). For instance, the typology of unbounded stress systems established by Hayes (1995) does not seem to indicate that there is any reason whatsoever to assume that placing main stress on the leftmost syllable is more or less marked than placing it on the rightmost one. It is just a design choice for languages within the unbounded class. Only once a positioning principle has been chosen, the possibility exists that, as a marked option, the opposite principle is also operative.

In this connection, it is interesting to note the similarities between the conflicting directionality phenomena analyzed here and the 'emergence of the unmarked' phenomena described by McCarthy & Prince (1994). In both cases, there is an unmarked pattern accounted for by some constraint that is outranked by some other constraint or collection of constraints that account for some marked pattern. Under this organization, the unmarked (usually less specific) pattern only arises if the marked (usually more specific) pattern does not hold, which is the typical behavior of a default. These results present a difference with respect to the ranking of constraints in dominance hierarchies corresponding to harmony scales, since, in these cases, constraints demanding unmarked structures dominate constraints demanding marked ones. This fact opens a new area of discussion within the theory of markedness, which is particularly relevant for Optimality Theory.

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