Cumulative constraint interaction and the equalizer of HG and OT

Introduction. We show that, in general, Optimality Theory (OT) grammars containing a restricted family of locally-conjoined constraints (Smolensky 2006) make the same typological predictions as corresponding Harmonic Grammar (HG) grammars, adding structure to claims about the (non)equivalence of HG and OT with local conjunction (Legendre et al. 2006, Pater 2016). Building on an example case, we propose a general method for identifying the constraints from this restricted family of local conjunctions in the *equalizer* of OT and HG.

The contrast/neutralization typology. The types of constraints necessary to describe different patterns of contrast and neutralization in OT are familiar from McCarthy & Prince (1995, 1999). We rely here on an idealized example of palatalization, following Carroll (2012).

(1) **Specific markedness:** **si* — violated by [si] sequences (i.e. unpalatalized consonants in palatalizing contexts).

General markedness: **ʃ* — violated by [ʃ] (i.e. palatalized consonants generally).

Faithfulness: **s*↔*ʃ* — violated by mappings from /s/ to [ʃ] and from /ʃ/ to [s] (i.e. from palatalized to unpalatalized consonants and vice-versa).

The factorial typology for these three constraints results in the four familiar patterns shown in (2a-d), with unfaithful mappings indicated with ***italicized boldface type***. (Note that /a/ is used here to represent the complementary set of non-palatalizing contexts.) The HG typology for the same three constraints results in the same four patterns captured by OT plus one additional language (2e), with contrast in the palatalizing context and neutralization in non-palatalizing contexts (attested in Gujarati; see Carroll 2012).

(2)

		/si/	/ʃi/	/sa/	/ʃa/	
a.	**Full contrast:**	[si]	[ʃi]	[sa]	[ʃa]	OT & HG
b.	**Contextual neutralization:**	[***ʃ***i]	[ʃi]	[sa]	[ʃa]	
c.	**Complementary distribution:**	[***ʃ***i]	[ʃi]	[sa]	[***s***a]	
d.	**Absolute neutralization:**	[si]	[***s***i]	[sa]	[***s***a]	
e.	**Reverse neutralization:**	[si]	[ʃi]	[sa]	[***s***a]	HG only

This additional pattern is made possible by *constraint ganging*: specifically, the summed weight of **s*↔*ʃ* and **ʃ* is greater than the weight of **si* ⟦w(**s*↔*ʃ*)+w(**ʃ*) > w(**si*)⟧, though the weights of each of the former constraints individually is less than that of the latter ⟦w(**si*) > w(**s*↔*ʃ*) and w(**si*) > w(**ʃ*)⟧. Constraint ganging is a class of cumulative constraint interactions in which violations of two or more weaker constraints overcome the violations of a single stronger constraint (Jäger & Rosenbach 2006, Pater 2016, Shih 2017). In HG, constraint ganging is accomplished through weight additivity and does not require the existence of complex constraint types. In contrast, constraint ganging effects cannot be modelled in OT without the inclusion of *locally conjoined constraints*; strict ranking otherwise prohibits OT from modelling these types of cumulative interactions. While in certain cases, additivity in HG and local conjunction in OT account for the same phonological patterns (Smolensky 2006, Pater 2016), in general, these two approaches to constraint ganging do not make the same predictions (i.e., "Ban Only the Worst of the Worst" (BOWOW) patterns and superadditivity; Smolensky 2006, Padgett 2002, Legendre et al. 2006, Shih 2017).

The entire set of typological predictions of HG in (2) can be modeled in OT with the addition of a local conjunction with the necessary gang effect: **ʃ*&**s*↔*ʃ*. The addition of this constraint effectively renders faithfulness asymmetrical, separately penalizing *s*→*ʃ* mappings. Indeed, the predicted typologies of both OT and HG are exactly the five patterns in (2) with *ʃ&*s↔ʃ (equivalently, *s→ʃ) added to those in (1). (Adding an asymmetrical *ʃ→s constraint, or substituting it for symmetrical *s↔ʃ, has no effect on either typology.)

A general formula for modelling HG grammars in OT. Here we define a set of constraint sets that are in the *equalizer* of HG and OT. In other words, for constraint sets of the type we define, typologies generated by HG and OT are equivalent. Given an arbitrary set Con of (non-conjoined) constraints, the typology predicted by HG (HG-Con_{typ}) is generally a superset of that predicted by OT, due to the potential for constraint ganging in HG. Constraint sets in the equalizer of HG and OT thus require the addition of just those local conjunctions of constraints that crucially participate in constraint ganging in the HG typology. Stated slightly more formally, constraint sets in the equalizer of HG and OT can be generated as in (3). We follow Pater (2016: 10) in defining a *distinguishing constraint* as "a constraint that distinguishes an optimum from another candidate – that is, on which the optimum and some other candidate have different violation scores."

(3)
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def equalize(Con):
    for pattern in HG-Con_typ:
        for tableau in pattern:
            ℂ_dist = the distinguishing constraint with the highest weight
            if ℂ_dist does not prefer the optimal candidate:
                for loser in tableau:
                    conjuncts = {ℂ in Con | loser violates ℂ and w(ℂ_dist) > w(ℂ)}
                    conjunction = conjoin(conjuncts)
                    Con += conjunction
    return Con
```

Discussion. Adding local constraint conjunction to OT increases the theory's expressivity, allowing it to capture patterns that require cumulative constraint interaction. However, with increased expressivity comes vulnerability to overgeneration; thus, a number of proposals attempt to limit the expressivity of local conjunction by placing restrictions on the types of constraints that are permitted to be conjoined with one another (Kirchner 1996, Fukazawa & Miglio 1998, Baković 1999, Łubowicz 2005). In identifying properties of constraint sets in the equalizer of HG and OT, we show that the consequences of local conjunction are structured, bearing a principled relationship with weight additivity in HG. Ongoing work investigates the properties of other constraint sets in the equalizer of HG and OT, such as the two sets of positional licensing constraints discussed by Jesney (2016).

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