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Just How Many Languages Are There?

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Abstract

Optimality Theory assumes the candidate set generated for any given input is of infinite cardinality. If all of the candidates in the candidate set were potential winners (optimal candidates under some ranking), then OT would have predicted an infinite typology—there would be infinitely many possible languages. However, Samek-Lodovici and Prince (1999) have shown that in standard OT (with only markedness and IO Correspondence constraints), only a finite number of candidates from the infinite candidate set, can actually be winners—the (infinite) majority of the candidates in the candidate set is harmonically bounded, and will therefore never be selected as winners under any ranking.

Their argument for the finite cardinality of the set of potential winners rests on the assumption that cardinality of CON is finite. If every possible ranking between the *n* constraints in CON were to select a unique winner, then there can be maximally *n*! different winners for any given input.

The addition of non-IO Correspondence constraints to CON threatens this general result. Both OO Correspondence constraints and Sympathy constraints can result in an otherwise harmonically bounded candidate being selected as winner. Non-IO Correspondence constraints therefore decrease the size of the set of harmonically bounded candidates and increase the size the set of potential winners. A question that therefore needs answering: Is the set of potential winners still of finite cardinality in an OT grammar with Sympathy constraints and OO Correspondence constraints? If this question can be answered in the affirmative, then OT predicts a finite typology even with non-IO Correspondence constraints added to CON. However, if the addition of non-IO Correspondence constraints increases the set of potential winners to an infinite size, then an OT grammar with these constraints added to CON will predict an infinite typology.

In this paper I argue that under reasonable assumptions it can be shown that the cardinality of the set of potential winners is finite even with the addition of Sympathy and OO Correspondence constraints. I argue that each of Sympathy Theory OO Correspondence Theory adds only finitely many constraints to CON. I then use the same argument that Samek-Lodovici and Prince use for standard OT. There are only finitely many rankings (*n*!) between finitely many constraints (*n*). Even if each of these rankings were to select a unique winner, only a finite number of winners can be selected.

1. The problem: how many possible languages are there?

One of the central tenets of Optimality Theory (Prince & Smolensky, 1993) is that the set of candidates that compete for optimal status is infinite in number. This is an appealing feature of OT. Together with a few other theoretical primitives (such as richness of the base) the infinity of the candidate set safeguards against opting for an easy way out. It forces the theory to express universals through constraint interaction rather than by brute force stipulation.[1] If a certain output is never attested, this must follow from constraint interaction—the same device that is used to decide between possible winners. However, the infinite candidate set also comes at a price. It presents serious computational problems—an infinite number of candidates must be computed by a finite human mind in finite time.[2] But the infinite candidate set may also have other unforeseen implications.

Since the winners, the actual Outputs, are chosen from the infinite candidate set, a question that begs answering is how many possible winners there are for any Input. It seems possible that, given an infinite number of candidates, the number of Outputs for any Input can be infinite. If this were the so then the infinite candidate set would predict an infinite typology—i.e. infinitely many possible languages. On the other hand, not all candidates are actual possible winners—there are many harmonically bounded candidates that can never be an Output (Samek-Lodovici and Prince, 1999). It can thus also be that the number of possible Outputs is finite—i.e. we predict a finite typology.

In this paper I argue, following Samek-Lodovici and Prince (1999), that standard OT (with only Markedness and IO-Correspondence constraints) predicts a finite typology. I then show that under reasonable assumptions, this is also true of OT extended by the addition of OO-Correspondence (Benua, 1997ab, Benua, 2000) and Sympathy Constraints (McCarthy, 1999). I will therefore argue that OT predicts a finite typology.

The rest of this paper is structured as follows: Section §2 sets up the central problem of the paper. I first explain, following Samek-Lodovici and Prince (1999), why standard OT does not predict an infinite typology. Then I show why the addition of OO-Correspondence and Sympathy Constraints poses a potential threat to this result. However, in §3 I show that under standard and reasonable assumptions, OT still predicts a finite typology even with these additional constraints. In §4 I compare this to the situation in rule-based phonological theory, and summarize the results of this paper.

[1] The infinite candidate set in particular implies that candidates with unbounded epenthesis must be ruled out by constraint interaction.

[2] For discussion on the computational problems of the infinite candidate, see the following Eisner (1997), Frank and Satta (1998), Hall (2001), Tesar (1995), Tesar and Smolensky (2000), etc.

2. Standard OT predicts a finite typology

To show that that standard OT predicts a finite typology, two assumptions are made. First, that CON, the universal constraint set, is finite. This assumption is standard in OT, even though it is seldom explicitly stated. The second assumption is that candidates that fare equally well on all constraints are grammatically indistinct. It is conceivable that GEN can emit two candidates that are structurally distinct, but that the structure in terms of which they differ is not linguistically relevant, and therefore not referred to by any constraint. The violation profiles of two such candidates will be identical.

When the candidates under consideration are limited to only grammatically distinct candidates, then every grammar (every total ranking of the constraints)[3] can select only one candidate as optimal for any Input. Since the number of constraints is finite, it follows that the number of possible rankings between the constraints is finite. The number of possible rankings between n constraints is $n!$, and therefore in a system with n constraints, the largest number of distinct Outputs that can be selected is $n!$. This number can be extremely large, but when n is finite, then $n!$ will never be infinite.[4, 5]

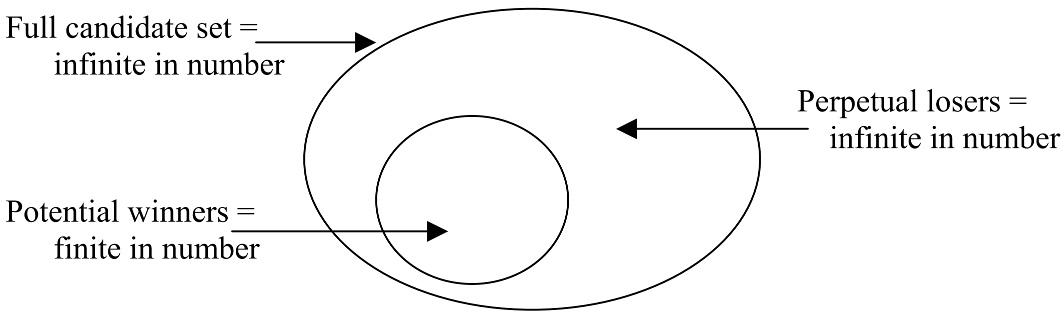
Based on this result, we can divide the candidate set into two disjoint sets, the potential winners and the perpetual losers. The set of potential winners is the set that we have just shown to be finite. This means that the majority of the candidates are members of the infinite set of perpetual losers. These candidates are the harmonically bounded candidates—those candidates that will never be chosen as optimal under any ranking. This situation can be represented graphically as follows:

[3] This makes the standard assumption that any grammar is a total ranking of the constraints in CON. In practice, the grammar of a language is often represented as a stratified hierarchy, where there can be several constraints in one stratum. However, when the grammar of a language is represented with a stratum of unranked or equally ranked constraints, what is implied is that for that specific language, the ranking between those constraints is not relevant. A stratified constraint hierarchy should therefore be seen as shorthand for several possible grammars for a single language. In fact, Tesar and Smolensky show that it is desirable that a grammar be viewed as total ranking instead of a stratified hierarchy, since all totally ranked hierarchies are learnable by their Recursive Constraint Demotion learning algorithm, while not all stratified hierarchies are (Tesar & Smolensky, 1998:49-50).

[4] It is in fact the case that there will very seldom actually be $n!$ distinct possible winners. Prince (2002:11) shows that the conditions that must be met for every ranking to select a distinct winner are very strict and that these conditions will seldom be met in real life. Usually several different rankings select the same winner. Also, it not all logically possible rankings are actually attested—some constraints are in a fixed ranking relationship. The actual number of possible outputs will therefore always be much smaller than the maximum possible $n!$.

[5] The same result can be achieved even if stratified rankings of CON are allowed as possible grammars. If the number of constraints n is finite, then the number of stratified hierarchies of the n constraints is still finite—even though it will be much larger than $n!$ (Tesar and Smolensky, 1998:49).

(2) Divisions in the candidate set



Since standard OT predicts only a finite number of possible Outputs for every Input, it follows that standard OT also predicts a finite typology. But what happens when OO-Correspondence and Sympathy constraints are added? Both OO-Correspondence and Sympathy can promote candidates from the set of perpetual losers to the set of potential winners. These additions to standard OT do therefore result in an increase in the cardinality of the set of potential winners. A question that needs to be answered is whether the new, larger set of potential winners is still finite. Before I address this question, I will show that OO-Correspondence and Sympathy can indeed promote candidates from the set of perpetual losers to the set of potential winners.

For Sympathy Theory this is trivial. Sympathy Theory was developed *inter alia* to explain how a candidate that is harmonically bounded under standard OT can be chosen as winner. Even so, an example is discussed here. Tswana (a Bantu language spoken in Southern Africa) does not allow the sequence [nasal + voiced stop]. Whenever this sequence results from morphological concatenation, the voiced stop devoices (see Hyman 1998). All Tswana data are taken from Cole (1955) and Krüger (1998):

(3) Post-nasal devoicing in Tswana

Root	Singular		Plural		
bu	lo + bu →	lobu	diN + bu →	dimpu	*brack soil*
di	lo + di →	lodi	diN + di →	dinti	*twine*

However, Tswana also has a regular process that deletes the underlying nasal in the plural prefix when the noun root has more than one syllable. The interesting complication is that Tswana devoices voiced stops even after such deleted nasals:

(4) Post-nasal devoicing in Tswana even after deleted nasals

Root	Singular		Plural		
baka	lo + baka →	lobaka	diN + baka →	dipaka	*time/occasion*
bila	lo + bila →	lobila	diN + bila →	dipila	*path*

The plurals in (4) therefore show devoicing of the stop even though the trigger of this process has been deleted. In these instances, the candidate without devoicing harmonically bounds the actual output candidate with devoicing. The actual output therefore belongs to the set of perpetual losers in standard OT. In the tableau below I use M to stand for whatever markedness constraint (or constraints) drives the nasal deletion:

(5) Tswana in standard OT

/diN + baka/	M	*[nasal + voiced stop]	IDENT(voice)	MAX
a. ☞ dibaka				*
b. ☹ dipaka			*!	*!
c. dinpaka	*!		*	
d. dinbaka	*!	*!		

But if we add Sympathy constraints we can promote the harmonically bounded candidate to winner status. In the tableau below MAX is designated as selector constraint. This results in candidate ❀c being chosen as Sympathetic candidate. This tableau employs ordinary correspondence constraints to mediate the Sympathetic interaction, but the same result can be achieved with cumulativity constraints (McCarthy, 1999, 2003).

(6) Tswana in Sympathy Theoretic OT

/diN + baka/	M	*[nasal + voiced stop]	❀ID(vce)	ID(vce)	✯MAX
a. dibaka			*!		*
b. ☞ dipaka				*¡	*¡
c. ❀ dinpaka	*!			*	✓
d. dinbaka	*!	*!	*!		✓

Sympathy constraints can therefore promote candidates from the set of perpetual losers to the set of potential winners. OO-Correspondence constraints can do the same. An example from Tiberian Hebrew is discussed here. Tiberian Hebrew has a regular process of post-vocalic spirantization: stops are realized as fricatives in post-vocalic position. All Tiberian Hebrew data are from Gesenius *et al.* (1910) and Prince (1975).[6]

(7) Tiberian Hebrew spirantization

After vowels	Elsewhere				
x	k	yi-x̱tov	*he will write*	ḵɔθav	*he wrote*
f	p	yi-f̱qoð	*he will search*	p̱ɔqað	*he searched*
θ	t	kɔθ̱av	*he wrote*	yi-xṯov	*he will write*

However, there is an exception to this generalization. The underlying form of the infinitive in Tiberian Hebrew contains an initial consonant cluster. Tautosyllabic

[6] This analysis of Tiberian Hebrew spirantization is suggested by McCarthy (2003). For alternative analyses of these data see Coetzee (2002) and Idsardi (1998).

consonant clusters are not tolerated, and therefore this cluster is broken up by epenthesis of a *schwa* (/kt̲ob/ → [kəθ̲ov]). When the infinitive is preceded by a vowel final affix, re-syllabification resolves the cluster so that epenthesis is not necessary (/li + k̲tob/ → [lixt̲ov]). Since epenthesis does not happen, the second root consonant is not in post-vocalic position anymore and therefore does not have to spirantize. But when the clitic preposition *bi-* is added to the infinitive, the second root consonants still spirantizes:

(8) The Tiberian Hebrew infinitive

UR	/ktob/	/bi + ktob/
Schwa epenthesis	kətob	-
Spirantization	[kəθov]	[bixθ̲ov]

The form [bixθ̲ov] is harmonically bounded by the competing candidate without spirantization [bixt̲ov]. This is shown in the tableau below:

(9) Harmonic bounding in the Tiberian Hebrew infinitive

/bi +ktob/	IDENT(cont)
a. ☞ bixtov	**
b. ☹ bixθov	***!

However, if the isolation form [kəθov] acts as Base in an OO-Correspondence relation, then this harmonically bounded candidate can be chosen as optimal:

(10) Tiberian Hebrew infinitive with OO-Correspondence

/bi +ktob/ Base: [kəθov]	IDENT(cont)$_{OO}$	IDENT(cont)$_{IO}$
a. bixtov	*!	**
b. ☞ bixθov		***

Therefore, also OO-Correspondence can promote candidates from the set of perpetual losers to the set of potential winners. Although we know that the set of potential winners in standard OT is finite, it is not immediately obvious whether the same is true of OT with Sympathetic and OO-Correspondence constraints. The rest of this paper will show that this is indeed also the case.

3. How many constraints do OO-Correspondence and Sympathy add to CON?

The argument for the finitude of the set of potential winners in OT rests on the cardinality of CON being finite. As long as there is only a finite number of constraints, the number of possible rankings is finite. And if every ranking selects only one grammatically distinct candidate, then set of the potential winners is finite. This result will hold even if some of the constraints are OO-Correspondence or Sympathy constraints. If we can show that each of OO-Correspondence and Sympathy adds only finitely many constraints to CON, it follows that OT with these constraints still predicts a finite typology.

We can think of correspondence constraints generally as a set of constraints demanding identity between two linguistic forms. Since OT is a theory of competition between potential Outputs, one of these two forms is always the Output. This general correspondence relation can then be expressed as *X*O-Correspondence. *X* is a variable that stands for the Comparison form that the Output is compared to—Input, Sympathy Candidate, (morphologically related) Output Base, etc. The set of general correspondence constraints is therefore set of constraints on the Correspondence relation between the Output and some Comparison form represented here by *X*.

To show that the total number of constraints is finite, it first needs to be shown that the set of general correspondence constraints is finite—i.e. that the number of constraints on the general *X*O-Correspondence relation is finite. Then we need to show that there is only a finite number of specific instantiations of this abstract set—i.e. a finite number of sets IO- and OO- and SympathyO-Correspondence constraints. The rest of this section is presented in two parts: In §3.1 I argue that the set of general *X*O-Correspondence constraints is finite. In §3.2 I then show that each of IO-Correspondence, OO-Correspondence and Sympathetic Correspondence, has only a finite number of specific instantiations of the abstract set of *X*O-Correspondence constraints.

3.1 How many general *X*O-Correspondence constraints are there?

The definition of Correspondence below is based on McCarthy and Prince (1999:223):

(11) *Correspondence*
Given two linguistic objects S_1 and S_2, *correspondence* is a relation $\mathfrak{R}$ from the elements in S_1 to those in S_2. Elements $\alpha \in S_1$ and $\beta \in S_2$ are referred to as *correspondents* of one another when $\alpha\mathfrak{R}\beta$.

Correspondence relations can only be established between two structures that stand in correspondence according to (11). Correspondence constraints are then formulated that require identity between two structures in a correspondence relation. The first issue that needs to be addressed when the total number of possible correspondence constraints is considered, is the number of objects that S_1 and S_2, and α and β can stand for. McCarthy and Prince treat S_1 and S_2 as strings of segments, and α and β as individual segments. However, they also state that it is straightforward to generalize this approach to other structures such as features, morae, etc. S_1 can therefore also stand for a segment and α for a feature of the segment, or S_1 for a foot and α for a syllable in this foot, etc.

How many structures can the variables S_1 and S_2, and α and β then stand for? Let us assume that they can stand for any of the linguistically relevant primitives—the basic atomic features or structures that need to be specified as the alphabet from which all linguistic objects are built. For phonology this will include features, prosodic categories, segments, etc. It is reasonable to assume that this alphabet has only finitely many members—there are not infinitely many features or prosodic categories. As long as this alphabet is finite, then the total number of possible Correspondence relations will be finite, even if all possible combinations from this alphabet were allowed to substitute in any order into the definition in (11).[7]

(12) Alphabet of linguistic primitives: {segment, foot, μ, σ, [voice], [coronal], …}
Examples of possible Correspondence relations:
(i) S_1, S_2 = strings of segments, and α, β = segments with $\alpha \in S_1$ and $\beta \in S_2$.
Then it is possible that $\alpha\Re\beta$.
(ii) S_1, S_2 = individual segments, and α, β = features with $\alpha \in S_1$ and $\beta \in S_2$.
Then it is possible that $\alpha\Re\beta$.
(iii) S_1, S_2 = prosodic words, and α, β = feet with $\alpha \in S_1$ and $\beta \in S_2$.
Then it is possible that $\alpha\Re\beta$. etc. …

Once it has been established what all the possible correspondence relations are, we can formulate constraints on the nature of this relation. The next question is then how many different constraints there are on each of these correspondence relations. McCarthy and Prince (1999:293-296) list eight classes of correspondence constraints: MAX, DEP, IDENT, CONTIGUITY, R/L-ANCHOR, LINEARITY, UNIFORMITY and INTEGRITY. If there were to be a correspondence constraint of each type for each of the possible correspondence relations, there will still be only a finite number of correspondence constraints.[8] This is probably not a complete list of possible constraints on the nature of the correspondence relation. However, there cannot be many more than these, and there certainly is not an infinite number. Below are a few examples of these general *X*O-Correspondence constraints:

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[7] In reality, this is not possible. The correspondence relation is defined on the members α and β of S_1 and S_2. Therefore, S_1 and S_2 cannot stand for segments, and α and β for strings of segments. Similarly, since features are elements of segments and not syllables, S_1 and S_2 cannot stand for syllables when α and β stand for features. Also, assuming that features are minimal objects, S_1 and S_2 cannot stand for features—since there will be no objects that α and β can stand for. For the purposes of the point argued in this paper, it does not really matter how or when these unacceptable combinations of S_1 and S_2, and α and β are ruled out. Even if all logically possible combinations were allowed, the total number of combinations will still be finite as long as the alphabet from which they can choose is finite.

[8] Again, not all possible combinations of constraints and correspondence relations are attested. For instance, it is difficult to imagine what an IDENT constraint on feet will demand. Also, UNIFORMITY and INTEGRITY probably cannot apply to features. This does not matter for the point made here. Even if all possible combinations were attested, there will still only be finitely many constraints.

(13) *X*O-Correspondence Constraints =
{*X*O-MAX(segment), *X*O-MAX(coronal) …
*X*O-CONTIGUITY(segment), *X*O-CONTIGUITY(syllable) …
*X*O-IDENT(segment), *X*O-IDENT(foot) …}

3.2 How many sets of IO-Correspondence, OO-Correspondence and Sympathy Correspondence constraints are there?

In the previous section I have argued that the set of *X*O-Correspondence constraints is finite. But now we have to determine that there is only a finite number of IO, OO and Sympathy instantiations of this set. For any Output, how many Inputs, Output Bases and Sympathetic candidates can there be? How many Comparison forms can *X* stand for?

IO-Correspondence. For IO-Correspondence it is trivial that there is only one instantiation of the general set of *X*O-Correspondence constraints. Any candidate set has only one Input, and thus only one Comparison form that *X* can stand for.

OO-Correspondence. In the original version of OO-Correspondence theory, Benua (1997ab) posited different sets of OO-Correspondence constraints for each different affix class. For example, there is a set of OO-Correspondence constraints indexed to the English Class I-affixes, and a different set for the Class II-affixes. There certainly cannot be an infinite number of affixes in any language, and consequently the number of affix classes can also not be infinite. Even if every affix were in a class of its own so that there were a set of OO-Correspondence constraints indexed to every affix, there will still only be a finite number of sets of OO-Correspondence constraints.

However, OO-Correspondence theory has been extended beyond this initial formulation to deal also with effects of *paradigm uniformity* (Kenstowicz, 1996; Burzio, 1998). In these cases an OO-Correspondence relation is induced not by the presence some affix, but by virtue of the relationship that exists between words in a paradigm. Paradigm should be interpreted here in its broadest sense. Kenstowicz (1996:382), for instance, claims that constraints that enforce these paradigm-leveling effects attempt to "minimize the differences in the realization of a lexical item". This therefore applies in the more traditional sense of a paradigm—for instance, the different forms of a specific noun in a language with declensional noun morphology. Under the strictest interpretation of this approach to OO-Correspondence, every morpheme can have its own set of OO-Correspondence constraints.[9]

If we accept that every morpheme in the lexicon can have its own set of OO-Correspondence constraints, then all that we need to assume in order to maintain a finite number of sets of OO-Correspondence constraints, is a finite lexicon. And the assumption

[9] See also De Lacy (1999:12) for a different motivation for this: "'Since haplology is a morpheme-specific process there must be a separate version of MAX for every morpheme …"

of a finite lexicon is reasonable—no language has an infinite number of morphemes that form a part of the active lexicon of the language at a specific time.

However, lexicons are language specific. Under the assumption that every language has a finite lexicon, it only follows that there is no single language that can have an infinite number of OO-Correspondence constraints. But since different languages have different morphemes, they will also have different OO-Correspondence constraints. Can we then make any claim about the total number of OO-Correspondence constraints in Universal Grammar? I suggest that we need to think about the relation between Universal Grammar and language specific OO-Correspondence in the following way:

There is some large but finite universal cap on the number of morphemes in any language. Universal Grammar (i.e. CON) contains as many sets of OO-Correspondence constraints as this universal cap on lexicon size. A specific language *L* then assigns one of these UG sets of OO-Correspondence constraints to each of the morphemes (or morpheme classes) in its lexicon. If the specific language has fewer morphemes than the total number of available sets of OO-Correspondence constraints in UG, there will be some sets of OO-Correspondence constraints from CON that are not indexed to any morpheme of *L*. These OO-Correspondence constraints will then be vacuously satisfied by all candidates of *L*. Thinking about OO-Correspondence constraints in this way has two desirable consequences: (i) the difficult issue of relating language specific constraints to the universal set CON is resolved; (ii) adding together all the OO-Correspondence constraints from all languages still leaves us with a finite CON.

Under the assumption that a language has only finitely many morphemes, there are only finitely many comparison forms that the *X* in *X*O-Correspondence can stand for, and the number of sets of OO-Correspondence constraints will therefore be finite.

Sympathy Theory. In Sympathy Theory the two forms that stand in correspondence, are the Output and the Sympathetic candidate. The Sympathetic candidate is selected by a constraint designated as the selector constraint. It is possible that there can be more than one selector constraint, and therefore more than one Sympathetic candidate. McCarthy (1999) has shown, with an example from Yokuts, that when this happens, the different Sympathetic candidates can enforce different levels of similarity on the Output. That is, Sympathetic Candidate 1 might be able to enforce vowel height agreement, while Sympathetic Candidate 2 is able to enforce agreement in front/back specification of vowels but not agreement in vowel height. This can only be achieved if there are separate constraints on the relationship between the Output and each of the two Sympathetic candidates.

Therefore, we need a different set of Sympathetic constraints for every selector constraint. In order to assure that there are only finitely many sets of Sympathetic correspondence constraints, we therefore only need to show that the number of selector constraints is finite. De Lacy (1998), and Itô and Mester (1998) argue that markedness and IO-Correspondence constraints can act as selectors, while McCarthy (1999) claims that only IO-Correspondence constraints should be allowed as selectors. Whichever of these two options is accepted, it follows that the number of possible selector constraints is finite. Even if there were a set of Sympathetic constraints for every selector constraint, there will still only be a finite number of sets of Sympathetic constraints. [10]

3.3 How many constraints then?

Below is a summary of the argument presented in the previous two sections:

(14) Summary of the argument

<table>
<tr><th>Comparison forms (=X)</th><th>Cardinality</th><th></th><th></th><th></th><th></th></tr>
<tr><td>Input</td><td>Finite (namely 1)</td><td rowspan="3">×</td><td rowspan="3">Finitely many XO-Correspondence constraints</td><td rowspan="3">=</td><td>Finite</td></tr>
<tr><td>OO-Bases</td><td>Finite (maximally as many the number of morphemes in the lexicon)</td><td>Finite</td></tr>
<tr><td>Sympathetic Candidates</td><td>Finite (maximally as many as the selector constraints = IO-Correspondence + Markedness constraints)</td><td>Finite</td></tr>
<tr><td>Total</td><td></td><td></td><td></td><td></td><td>Finite</td></tr>
</table>

Since the general set of *X*O-Correspondence constraints is finite, and since *X* can stand for only a finite number of Comparison forms, it follows that the total number of Correspondence constraints (IO, OO and Sympathetic together), is also finite. And then Samek-Lodovici and Prince's argument can be used again: There is only a finite number of possible rankings between a finite number of constraints. If every one of these rankings were to select a grammatically distinct candidate as winner, then the number of possible outputs for any Input is finite.

[10] Itô and Mester (1997), De Lacy (1998), and Jun (1999) argue that Sympathetic correspondence is indeed mediated by ordinary correspondence constraints. However, McCarthy (1999, 2003) argues that Sympathetic correspondence is mediated by a special set of two correspondence constraints (❀CUMUL and ❀DIFF) or maybe even by only one (❀SYMP). Following McCarthy therefore obviously means that there are only finitely many Sympathetic constraints for any selector constraint. However, for the purposes of this paper, it does not matter whether we follow McCarthy or not. Even if we allow Sympathetic correspondence to be mediated by ordinary *X*O-Correspondence constraints, we still have only finitely many Sympathetic constraints for any selector constraint.

4. Conclusion

The only source of an infinite typology in OT, is an infinite number of constraints. It is desirable not to have an infinite number of constraints. In OT all constraints are assumed to be in the grammar of all languages. If there were an infinite number of constraints, then the language user will have a grammar of infinite size. This would not be a desirable situation. In rule-based phonology the situation is different. There is no claim that rules are universal. Different languages are allowed to have idiosyncratic rules. Even if there were infinitely many possible rules, every language will have to select only a finite number of these. In rule-based phonology an infinite typology is therefore possible without presupposing a grammar of infinite size. The architecture of an OT grammar therefore places a restriction on the size of the typology that OT predicts. However, in rule-based phonology no such a restriction is necessary. OT is therefore the more restrictive theory in this regard.

Which of these two options is the correct one? Should our theory predict an infinite typology or not? This is not an easy question to answer. We cannot rely on empirical data—there certainly is not an infinite number of human languages. But this does not mean that there cannot be. The answer will have to come from a different source. Maybe it is to be found in the evolutionary history of language, or in psychological restrictions on the human mind. Until we know the answer to this question, we should at least be conscious of the implications of the different theories.

References

Benua, Laura. 1997a. Affixes Classes are defined by Faithfulness. In *University of Maryland Working Papers in Linguistics 5. Selected Phonology Papers from Hopkins Optimality Theory Workshop 1997 / University of Maryland Mayfest 1997*, eds. Viola Miglio and Bruce Morén, 1-27.

Benua, Laura. 1997b. *Transderivational Identity: Phonological Relations between Words*, University of Massachusetts, Amherst: Doctoral dissertation.

Benua, Laura. 2000. *Phonological Relations Between Words*. New York: Garland.

Burzio, Luigi. 1998. Multiple correspondence. *Lingua*, 104:79-109.

Coetzee, Andries W. 2002. OO-Correspondence as Cumulativity. In *UMOP 26: Papers in Optimality Theory II*, eds. Angela Carpenter, Andries W. Coetzee and Paul De Lacy, 27-57. Amherst: GLSA.

Cole, D.T. 1955. *An Introduction to Tswana Grammar*. London: Longmans, Green &Co.

de Lacy, Paul. 1998. *Sympathetic Stress*. Ms. University of Massachusetts Amherst.

de Lacy, Paul. 1999. *Morphological Haplology and Correspondence.* Ms. University of Massachusetts Amherst.

Eisner, Jason. 1997. *Efficient Generation in Primitive Optimality Theory*. Ms. Philadelphia.

Frank, Robert, and Satta, Giorgio. 1998. Optimality Theory and the computational complexity of constraint violability. *Computational Linguistics* 24:307-315.

Gesenius, W., Kautzsch, E., and Cowley, A.E. 1910. *Hebrew Grammar*. Oxford: Clarendon Press.

Hyman, Larry M. 1998. *The limits of phonetic determinism in phonology: *NC revisited*. Ms. University of California, Berkeley.

Idsardi, William. 1998. Tiberian Hebrew spirantization and phonological derivations. *Linguistic Inquiry*, 29:37-73.

Itô, Junko, and Mester, Armin. 1997. Sympathy theory and German truncations. In *University of Maryland Working Papers in Linguistics 5. Selected Phonology Papers from Hopkins Optimality Theory Workshop 1997 / University of Maryland Mayfest 1997*, eds. Viola Miglio and Bruce Morén, 117-139.

Itô, Junko, and Mester, Armin. 1998. German coda conditions: Sympathy meets freedom of the input. Paper presented at *The Syllable: Typology and Theory*, Tübingen, Germany.

Jun, Jongho. 1999. Generalized sympathy. In *Proceedings of the North East Linguistic Society 29*, eds. Pius N. Tamanji, Mako Hirotani and Nancy Hall, 121-135. Amherst: GLSA.

Kenstowicz, Michael. 1996. Base-Identity and Uniform-Exponence: alternative to cyclicity. In *Current Trends in\ Phonology: Models and Methods*, eds. Jacques Durand and Bernard Laks, 363-393. Paris: CNRS .

Krüger, C.J.H. 1998. *Afrikatale Woordfonologie. Studiegids vir Tswana III.* Potchefstroom: Potchefstroom University for Christian Higher Education.

McCarthy, John J. 1999. Sympathy and phonological opacity. *Phonology* 16:331-399.

McCarthy, John J. 2003. Sympathy, cumulativity, and the Duke-of-York gambit. In *The Optimal Syllable*, eds. Caroline Féry and Ruben van de Vijver, 23-67. Cambridge: Cambridge University Press.

McCarthy, John J., and Prince, Alan. 1999. Faithfulness and identity in Prosodic Morphology. In *The Prosody-Morphology Interface*, eds. Rene Kager, Harry van der Hulst and Wim Zonneveld, 218-309. Cambridge: Cambridge University Press.

Prince, Alan. 1975. *The Phonology and Morphology of Tiberian Hebrew*, MIT: Doctoral dissertation.

Prince, Alan, and Smolensky, Paul. 1993. *Optimality Theory: Constraint Interaction in Generative Grammar*. New Brunswick, NJ: Rutgers University Center for Cognitive Science.

Prince, Alan. 2002. *Anything Goes*. Ms. Department of Linguistics and Center for Cognitive Science, Rutgers University, New Brunswick.

Samek-Lodovici, Vieri, and Prince, Alan. 1999. *Optima*. Ms. London and New Brunswick, NJ.

Tesar, Bruce. 1995. Computing Optimal Forms in Optimality Theory: Basic Syllabification. Ms. Boulder, Co: Department of Computer Science, University of Colorado.

Tesar, Bruce, and Smolensky, Paul. 1998. Learnability in Optimality Theory. *Linguistic Inquiry* 29:229-268.

Tesar, Bruce, and Smolensky, Paul. 2000. *Learnability in Optimality Theory*. Cambridge: MIT Press.

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