

The too-many-solutions problem in OT in a representational perspective

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Ben Hermans; Meertens Institute

ben.hermans@meertens.knaw.nl

II Containment

Goal of this meeting

We will discuss *Containment Theory*, originally proposed in Prince and Smolensky (1993) and revived again in recent work, most notably Van Oostendorp (2005). The following is based on a presentation together with Marc van Oostendorp at the Meertens Institute:

Solving the Too-many-solutions-problem

Talk presented at the Meertens Institute; June 4th, 2007

ben.hermans@meertens.knaw.nl

marc.van.oostendorp@meertens.knaw.nl

Steps in the presentation

- Separation of target and repair; why it is ‘good’; illustrated with Pater (1999)
- Separation of target and repair; why it is ‘bad’; illustrated with Steriade (2001)
- Containment

Separation of target and repair; why it is ‘good’

(1) **Architecture of OT;**

In OT targets and repairs are separated. As a result a given target can be repaired in a variety of ways. This is usually considered to be a major success, because it explains *conspiracies*.

(2) A target:

*NC

A nasal may not be immediately followed by a voiceless obstruent

(3) *Imaginable repairs*

Nasal Substitution,
Post-nasal voicing,
Denasalisation,
Nasal deletion.

(3a) *Nasal Substitution* in Indonesian (for further references cf. Pater’s paper)

/məN+pilih/	[məmilih]	‘to choose, to vote’
/məN+tulis/	[mənulis]	‘to write’
/məN+kasih/	[məŋasih]	‘to give’
/məN+bəli/	[məmbəli]	‘to buy’
/məN+dapat/	[məndapat]	‘to get, to receive’
/məN+ganti/	[məŋganti]	‘to change’

(3b) *Post-nasal voicing* in the Puyo Pungo dialect of Quechua

sinik-pa	‘porcupine’s’	kam-ba	‘yours’
sača-pi	‘in the jungle’	hatum-bi	‘the big one’
wasi-ta	‘the house’	wakin-da	‘the others’

(3c) Denasalisation in Mandar

/maN+dundu/	[mandundu]	‘to drink’
/maN+tunu/	[mattunu]	‘to burn’

(3d) *Nasal Deletion* is attested in the Kelantan dialect of Malay. According to Pater there are no nasals before a voiceless obstruent, although the language does have nasals followed by a voiced obstruent.

(4) Which repair is selected in a given language is determined by the ranking of the relevant markedness constraint and faithfulness constraints.

(4a)

An illustration from Pater (1999);

/məN ₁ +p ₂ ilih/	*[məppilih]	This is a violation of IDENTI→O[NAS]
	*[məmbilih]	This is a violation of IDENT[OBSVCE]
	*[məpilih]	This is a violation of MAX.
	*[məmp ₂ ilih]	This is a violation of *NC
	[məm _{1,2} ilih]	This is a violation of LINEARITY;

(4b) In Indonesian, LINEARITY is the only Faithfulness constraint that is lower ranked than *NC. This explains why in this language *NC is repaired by merging the two underlying segments into one.

(5) Free permutation of ranking should give the right typology (factorial typology). For instance, if all Faithfulness constraints are higher ranked than *NC you get Dutch (cf. a Dutch word like [rentə]).

(6) OT’s separation of Target and Repair is successful to the extent that it yields the following two results:

- a) it generates the right factorial typology;
- b) it explains conspiracies.

(7) An example of a *conspiracy*:

(7a) African languages with nasal substitution often demonstrate a split in behavior between stops and fricatives. The following examples are from Pater (1999).

Kihehe

(7aa) /N+tuma/	[numa]	‘I send’
/N+tabi/	[nabi]	‘I cook’
(7ab) /N+seva/	[seva]	‘I cook’
/N+supa/	[supa]	‘soup’

(7b) In a sequence N+stop substitution applies; in a sequence N+fricative nasal deletion applies. Two different strategies are available within one and the same language. This is a straightforward consequence of OT's fundamental claim that target and repair are separated.

(8) Concluding: OT's separation of target and repair is successful to the extent that the set of imaginable repairs is identical to the set of actually attested repairs. It predicts the right typology and it can account for conspiracies.

Separation of target and repair; why it is 'bad'

(9) The too-many-solutions problem;

Sometimes a specific target is repaired in all languages by the same mechanism. Here the set of imaginable repairs is a proper superset of the set of actually attested repairs. These phenomena are problematic for OT.

(10) An example from Steriade (2001):

A target:

$$\text{FinDev} = *[\text{+voice}] / _]_{\text{word}}$$

(11) *Imaginable repairs:*

- | | | | |
|--------------------|-------|---|--------|
| Devoicing; | /tæb/ | → | [tæp] |
| Nasalisation; | /tæb/ | → | [tæm] |
| Lenition to glide; | /tæb/ | → | [tæw] |
| C-deletion; | /tæb/ | → | [tæ] |
| Segment reversal; | /tæb/ | → | [bæt] |
| Feature reversal; | /tæb/ | → | [dæp] |
| V-insertion; | /tæb/ | → | [tæbə] |

Of all these repairs only the first one, *Devoicing*, actually applies (like in Dutch).

(12) Notes:

- All repairs can be used in other circumstances (at least nasalisation, lenition, deletion and epenthesis are well-attested processes in natural language phonology), but they are never employed to repair $*[\text{+voice}] / _]_{\text{word}}$.
- On the other hand, going back to a rule-based phonology does not really solve the problem: why do we have the rule in (a), but not e.g. the one in (b):

a. $C \rightarrow [-\text{voice}] / _]_{\text{word}}$

b. $C \rightarrow [+nasal] / _]_{\text{word}}$

In other words, some problems seem inextricably linked to exactly one solution. Why is that?

- Steriade proposes that we should essentially abandon the theory of phonological representations, turning to a phonological theory which is informed by the notion of 'perceptual salience' instead (the idea is that devoicing leads to the form which is perceptually most similar to the underlying structure without violating faithfulness). In that sense, there is only one possible repair.
- In this talk, we take a different route to get the same result: instead of abandoning our view of representations, we strengthen it.

Containment

(13) **Faithfulness Theory**

The split between targets and repairs in OT is somehow mirrored by the fact that there are two types of constraints:

- *Well-formedness constraints* (correspond to targets): violation of these can be checked by examining the surface structure (output) only. *NC and FinDev are examples of such constraints.
- *Faithfulness constraints* (correspond to repairs): these check whether certain changes have occurred; therefore, it is necessary to somehow both look at input and output. IDENT[NAS], IDENT[OBSVCE], MAX, LINEARITY are examples of such constraints.

We think that a solution of the TMR problem can be found in the theory of faithfulness. Here, we can largely discern two schools of thought: Correspondence Theory and Containment Theory.

(13a) *Correspondence Theory* (McCarthy & Prince 1995) is the most widely adopted theory. It assumes that there are two representations, an input and an output, and there are ‘correspondence’ relations between the elements of those representations. Suppose we have an input /kluk/, realised as [kuku]. This looks as follows:

input:	k l u k
output:	k u k u

Faithfulness constraints basically talk about correspondence relations:

- Constraints against deletion say: every element in the input needs to have a correspondent in the output.
- Constraints against insertion say: every element in the output needs to have a correspondent in the input.

Correspondence theory is a very powerful (hence not very restrictive) theory of faithfulness: any input can be related to any output. Steriade (2001) is based on this, and we believe that the TMR problem she observes is a consequence of the excessive power of Correspondence Theory. All of the repairs for FinDev correspond to a different faithfulness constraint:

Devoicing;	Ident[Voi]: corresponding segments are identically specified for Voice.
Nasalisation;	Ident[Nas]: corresponding segments are identically specified for Nasal.
Lenition to glide;	Ident[Cons]: corresponding segments are identically specified for Consonantal.
C-deletion;	Max-C: A consonant in the input needs to have a correspondent in the Output.
Segment reversal;	Linear-seg: If segments x,y in the input correspond to a,b in the output, and x precedes y, then a precedes b.

Feature reversal; Linear-F: If features x,y in the input correspond to a,b in the output, and x precedes y, then a precedes b.
V-insertion; Dep-V: A vowel in the output needs to have a correspondent in the input.

Since all of these constraints are independent, they can be independently ranked, and we have a typology with a TMR problem.

(13b) *Containment Theory* was originally proposed in Prince and Smolensky (1993), but it had several severe shortcomings. These have recently been repaired, and this has revived interest (Van Oostendorp 2005, cf. Revithiadou 2006, Uffmann 2006, 2007, Eychenne 2007).

Containment is monostratal; there is only one representation to be evaluated. However, this representation contains both phonological and morphosyntactic information. Furthermore, there is one important restriction on the generative function:

- *Consistency of Exponence* (CoE): No changes may be made to the phonological exponence of morphemes.

CoE means that lexical specifications can never change; phonological material which belongs to a morpheme will always be part of that morpheme in the surface. Inversely, epenthetic segments cannot all of a sudden be part of a stem or affix. Our example above looks as follows in CoE (F is a shorthand for the phonological tree of syllables, feet, etc; M is a shorthand for the morphosyntactic tree of stems, words, phrasal constituents, etc.);



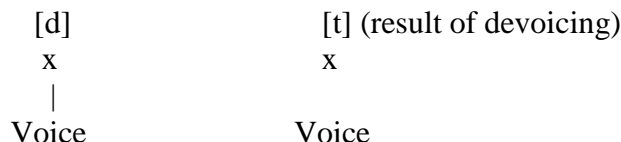
The idea is that the phonetics ultimately will parse only the phonological tree; everything which is not in this tree will be unpronounced, hence deleted.

Containment is more restrictive because of CoE. Certain things which can be stated in Correspondence cannot be stated in Containment. The basic faithfulness constraints are the following:

- Constraints against deletion say: every element needs to be parsed in the phonological tree.
- Constraints against insertion say: every element needs to be parsed in the morphological tree.

(14) Final Devoicing in Containment Theory

Let us see what the effects are of a high-ranking constraint FinDev in Containment Theory. The preferred choice always is a devoiced segment, i.e. a segment which leaves the final [voice] unparsed. This will violate the faithfulness constraint Parse-Voice:

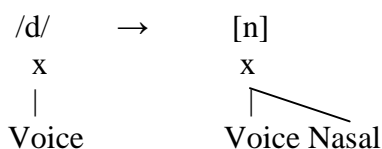


ParseF-Voice: The feature Voice needs to be parsed into the phonological tree.

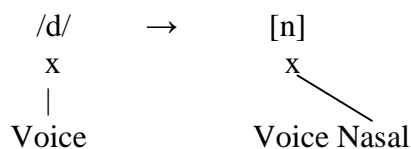
(14a)

/kwa:d/ ‘angry’	FinDev	Parse-Voice
kwa:d	*!	
☞ kwa:t		*

We now turn to the other ‘solutions’. First, nasalisation. Suppose we turn a /d/ into a nasal [n] by adding a feature Nasal:



This structure in itself still does not satisfy FinDev, since the final segment of the word still counts as voiced. So we would need to make an extra change and leave Voice unparsed. We can do this, because Voice is non-contrastive on nasals in Dutch (there is no phonological difference between an *n* which is voiced and one which is not).



Now look at the following tableau:

ParseM-Nasal: Parse Nasal into the morphosyntactic tree.

(14b)

/kwa:d/ ‘angry’	FinDev	ParseM-Nasal	Parse-Voice
kwa:d	*!		
☞ kwa:t			*
kwa:n		*	*

The forms /kwa:t/ and /kwa:n/ stand in a special relation: /kwa:n/ violates all the constraints which /kwa:t/ does, plus more. This means that no matter how we rank our constraints, /kwa:n/ can never win: /kwa:t/ will always do better. Since all variation is due to constraint ranking only, this means we predict that nasalisation is *never* a repair for FinDev. This is called *harmonic bounding* in the literature ([kwa:t] harmonically bounds [kwa:n]).

Something similar can be shown to hold for lenition. Here we have to change the consonantality of the /d/ and lose voicing, resulting in:

ParseF-Cons: Parse Consonantal into the phonological tree.

(14c)

/kwa:d/ 'angry'	FinDev	ParseF-Cons	ParseF-Voice
kwa:d	*!		
☞ kwa:t			*
kwa:j		*	*

[kwa:t] thus also harmonically bounds [kwa:j].

Now consider deleting the whole offending consonant. Again, this will result in a situation of harmonic bounding: if the segment is not parsed into the tree, neither will any of its features:

ParseF-C: Parse a consonant into the phonological tree.

(14d)

/kwa:d/ 'angry'	FinDev	ParseF-C	ParseF-Voice
kwa:d	*!		
☞ kwa:t			*
kwa:		*	*

[kwa:t] thus also harmonically bounds [kwa:].

The following two possibilities involve metathesis. While Correspondence Theory allows for this process freely, this is not true for Containment. Under the latter theory, the input has to be contained in the output, so that metathesis involves a rather complicated machinery:

Metathesis Correspondence Style

input: t a b
 X
 output b a t

Violation profile: One violation of Linearity

Metathesis Containment Style

 F
 /|\
 b a t a b
 \ | /
 M

(14e) Violation profile: Violation of Parse-constraints for /a/, for /b/, and for all features dominated by these. Again, because of the excessive violation profile, we get harmonic bounding (similar to the situation in which /b/ would be deleted).

This leaves us with only two possible repairs: devoicing, and vowel epenthesis. These have different violation profiles, so that ranking can give two different results:

ParseM-vowel: Parse a vowel into the morphosyntactic tree.

(14f)

/kwa:d/ 'angry'	FinDev	ParseM-V	ParseF-Voice
kwa:d	*!		
☞ kwa:t			*
kwa:de		*	

It has been argued (Itô and Mester 2003) that indeed vowel epenthesis might be a repair to FinDev. In the first place, it is sometimes chosen as a repair in L2 acquisition (in particular of speakers of final devoicing languages learning a language without final devoicing). Furthermore, in the history of German there was a rule of schwa loss *süsse* > *süss*, which was blocked after voiced obstruents (*böse*, *leise*, *träge*). Although blocking of acope is not the same as epenthesis, the situation is very similar. Our task now is to find real cases of epenthesis as a repair of FinDev. In any case, we have spectacularly restricted the number of possible 'repairs' already.