

# On Constraint Conjunction

Marc van Oostendorp

J.M. van de Weijer Reading Group in Phonology

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## 1 Constraint Conjunction Theory

In the literature we can find two types of constraint conjunction theory:

- (1) ✗ *Bad CCT*: Extending the number of possible constraints (from  $|n|$  to  $|c \times (n^2 - n)|$  or  $|c \times n!|$ ) ( $c$  is the number of domains, such as the syllable, the word, etc.;  $n$  is the number of basic constraints).
- ✓ *Good CCT*: Restricting the theory of constraints. This theory is 'good' because we undeniably badly need a good theory of the syntax of constraints (van Oostendorp & van de Weijer, 2005).

It is easy to be misled by the former and not see the latter, on which we concentrate here. The basic idea:

- (2) Constraints can only be of the following types:
  - a. Basic constraints, which are a small set of very simple constraints (e.g. \*[+voice])
  - b. Derived constraints, which can be formed on the basis of basic constraints with a few very simple logical operations (in particular, of course, conjunction)

The standard example in the CCT literature is final devoicing in German (Itô & Mester, 2003, p. 26-29):

- (3) *Rad* 'wheel NOM' [rat]    *Rades* 'wheel GEN' [radəs]    *Rädchen* 'wheel DIM' [retçən]  
*Rat* 'council NOM' [rat]    *Rates* 'council GEN' [ratəs]    *Rätchen* 'council DIM' [retçən]

Let us assume that CON already contains the following constraints:

- (4) a. NOCODA:  $*C]_{\sigma}$   
 b. NOD:  $*[+voi, -son]$

Note that at least NOD could itself be the result of CC. We can now conjoin these constraints in the following way:

- (5) NOCODA & <sub>$\delta$</sub>  NOD

The  $\delta$  subscript denotes a phonological or morphological domain; this is the segment (no segment may violate NOCODA and NOD at the same time). Itô & Mester (2003) notice that this is an advantage over a more ‘traditional’ formulation of a condition on final devoicing.

- (6) 
$$\begin{array}{c} *C]_{\sigma} \\ | \\ [+voi, -son] \end{array}$$

According to Itô & Mester (2003, p.28), this version “places a new constraint against voiced obstruents in codas alongside (i) an existing constraint against codas and (ii) an existing constraint against voiced obstruents, without relating them in any way. It therefore fails at a very elementary level of theoretical analysis.”

Yet there are problems too. Formally speaking, many other domains could be filled in here, but notice that all other domains give unfortunate results:

- (7) a. NOCODA & <sub>$\sigma$</sub>  NOD: No syllable may contain a voiced obstruent in either coda or onset and dominate a coda (*\*bap, pab, bab, <sup>ok</sup>ba, pa, pap, bap*)  
 b. NOCODA & <sub>$\omega$</sub>  NOD: No word may contain a voiced obstruent in either coda or onset and dominate a coda (*\*bap, pab, bab, bapap, babap, . . ., <sup>ok</sup>ba, pa, pap, bap, bapa, papap, pappap, . . .*)

The theory thus probably heavily overgenerates constraints, arguably because we are lacking a theory of representations; we will return to this below. Itô & Mester (2003, p. 28) argue for an extension of CCT, with *self-conjunction*. In particular, they claim that the OCP can be seen in this way:

- (8) OCP([voice]) = NOD & <sub>$\delta$</sub>  NOD = NOD<sup>2</sup> $\delta$ : No two voiced obstruents in domain  $\delta$ .

It is assumed that (self-)conjoined constraints universally dominate their basic counterparts. An important difference between this account and the one on OCP is, once again, that constraint conjunction does not involve a very

strict notion of locality. In Autosegmental Phonology, locality is usually reduced to adjacency (as in the original definitions of the OCP). Within self-conjunction theory, the definition of locality is much looser, as we have seen, it can be any domain. Itô & Mester (2003, p. 19) see this as an advantage:

The finely articulated geometrical representations of feature structure, configured so as to make the dissimilating properties literally adjacent on some tier(s), might be unnecessary representational baggage, carried over without critical scrutiny from an earlier theory and analysis whose tenets and assumptions are meanwhile eroded.

On closer inspection, there actually does not seem to be a lot of evidence in Itô & Mester (2003) that the restrictions imposed by autosegmentalism have been so much ‘eroded’ that a retreat to a less restrictive position is warranted.

Itô & Mester (2003, p. 32ff) concentrate on the shape of Japanese stems, which is evident both from Lyman’s Law (interacting with Rendaku) and morpheme structure constraints on the native lexicon. Voicing is contrastive:

- (9) a. *asi* ‘leg’, *azi* ‘taste’  
 b. *oko-ru* ‘to be angry at’, *ogo-ru* ‘to treat s.o.’

However, there are no stems in the native lexicon featuring more than one voiced obstruent:

- (10) a. *kak-u* ‘write’, *gake* ‘cliff’, *kago* ‘basket’, \**gake*  
 b. *kasuka* ‘faintly’, *kasegi* ‘earning’, *kabuto* ‘helmet’, *damas-* ‘deceive’, \**gasegi*, \**kazegi*, ...

These facts are accounted for by assuming the following hierarchy:

- (11) a.  $\text{NOD}^2_m \gg \text{IDENT} \gg \text{NOD}$  (m=the ‘morpheme domain’)

b.

/huda/ ‘sign’	$\text{NOD}^2_m$	IDENT	NOD
☞huda			*
huta		*!	

c.

/gage/ (hypothetical)	$\text{NOD}^2_m$	IDENT	NOD
gage	*!		**
☞kage		*	*
☞gake		*	*
kake		**!	

Itô & Mester (2003) give a few other examples of self-conjunction. For instance, in Japanese loanwords, gemination works as a strategy to preserve (partial) coda status (p. 49):

- (12) kukkii 'cookie' hotto 'hot coffee'  
wakkusu 'wax' beddo 'bed'

However, if a word has more than one (illicit) coda in the source language, only one of them is preserved as a geminate (p. 50):

- (13) poketto 'pocket' piketto 'picket'  
papetto 'puppet' ketyappu 'ketchup'

Itô & Mester (2003) analyse this as an instance of a self-conjoined markedness constraint against geminates ( $\text{NOGEM}^2_{stem}$ ).

- (14) a.
- | /pik <sub>μ</sub> oro/ 'piccolo' | $\text{NOGEM}^2_{stem}$ | IDENT[ $\mu$ ] | NOGEM | ALIGN-R( $\mu$ ) |
|----------------------------------|-------------------------|----------------|-------|------------------|
| ☞pikkoro                         |                         |                | *     | **               |
| pikoro                           |                         | *!             |       |                  |
- b.
- | /pok <sub>μ</sub> et <sub>μ</sub> o/ (hypothetical) | $\text{NOGEM}^2_{stem}$ | IDENT[ $\mu$ ] | NOGEM | ALIGN-R( $\mu$ ) |
|---|-------------------------|----------------|-------|------------------|
| pokketto  | *!                      |                | **    | ***/*            |
| ☞poketto  |                         | *              | *     | *                |
| pokketo   |                         | *              | *     | **!              |
| poketo  |                         | **!            |       |                  |

As Itô & Mester (2003) mention explicitly, facts like these are hard to capture within autosegmental accounts (since gemination is not a feature).

## 2 Problems with self-conjunction

There are a few problems with self-conjunction, some of them discussed by Itô & Mester (2003, section 3.3). For instance, an analysis on dissimilation by Alderete (1997) needs to have it established that the 'universal hierarchy' in (15a) needs to replicate at the level of self-conjunction (15b).

- (15) a.  $\text{NOLAB}, \text{NODORS} \gg \text{NOCOR}$   
b.  $\text{NOLAB}^2_{\delta}, \text{NODORS}^2_{\delta} \gg \text{NOCOR}^2_{\delta}$

This preservation of ranking relations can be derived from the UCCRH of Spaelti (1997):

- (16) *Universal Conjoined Constraint Ranking Hypothesis* (UCCRH): If  $A \gg B$ , then  $A \&_{\delta} Q \gg B \&_{\delta} Q$   
(17) *Ranking preservation under self-conjunction*  
a.  $A \gg B$  (by hypothesis)

- b. If  $A \gg B$ , then  $A \&_{\delta} Q \gg B \&_{\delta} Q$  (UCCRH)
  - c.  $A \&_{\delta} Q \gg B \&_{\delta} Q$  (from (a) and (b))
  - d.  $A \&_{\delta} A \gg B \&_{\delta} A$  (from (c))
  - e.  $A \&_{\delta} B \gg B \&_{\delta} B$  (from (c))
  - f.  $A \&_{\delta} A \gg B \&_{\delta} B$  (from (d) and (e) by commutativity of  $\&$  and transitivity of  $\gg$ )
- 

As elegant as this proof may be (if we accept the UCCRH, which is not self-evident). The problem is that it involves an intermediate step  $A \&_{\delta} A \gg A \&_{\delta} B \gg B \&_{\delta} B$ . Concretely, this implies:

$$(18) \text{ NO LAB}^2_{\delta} \gg \text{ NO LAB} \&_{\delta} \text{ NO COR} \gg \text{ NO COR}^2_{\delta}$$

In other words, we predict that a word with a labial and a coronal will always be more marked (or at least as marked) as an OCP violation at the coronal level.

Itô & Mester (2003) admit that they do not really have an answer to this. They suggest that we can choose a ‘activationist’ interpretation of constraint conjunction, meaning that conjoined constraints are invoked in a grammar only if needed. If we assume that for some (unknown) reason  $\text{NO LAB} \&_{\delta} \text{NO COR}$  is never constructed, we do not run into problems. “Overall, these considerations show that self-conjunction is not the ultimately ideal way of formalizing local markedness thresholds. The link it establishes to other conjunctions, while opening up interesting theoretical and empirical perspectives, is perhaps too close.”

Connecting to this, we may note that the formal definition of self-conjunction is not exactly clear. Here is the definition of local conjunction (p. 23):

- (19) Let  $C_1, C_2$  be constraints, and  $\delta$  be a (phonological or morphological) domain (segment, syllable, foot, prosodic word, ...; root, stem, morphological word, ...). Local conjunction is an operation “ $\&$ ” mapping the triplet  $(C_1, C_2, \delta)$  into the locally conjoined constraint denoted by  $C_1, \&_{\delta} C_2$ .

This actually already is not very precise, but for ‘normal’ conjunction, this means:

- (20)  $C = [C_1 \& C_2]$  is violated iff both  $C_1$  and  $C_2$  are violated in a local domain  $D$ . (Smolensky, 1993)

Filling this in for self-conjunction, we get:

- (21)  $C=[C_1\&C_2]$  is violated iff both  $C_1$  and  $C_1$  are violated in a local domain  $D$ .

But this makes  $C_1 \&_\delta C_1$  exactly equivalent to  $C_1$ ; it is not the required result. We want to say that the two violations have to be *different*, but (i) the formalisation of difference is not straightforward, (ii) we do not have the same restriction in other cases. Take the constraint  $\text{NOCODA} \&_\sigma \text{NOD}$ . This (presumably) never gets the interpretation that a word such as *bap* is out — violations of  $\text{NOCODA}$  and  $\text{NOD}$  are in different loci — whereas *pab* is okay — the constraints are violated in the same place.

### 3 Locality

Most points mentioned above seem to lead in the same direction: in order for CCT to have any hope of success, we need a theory of locality to accompany it. A promising step in this direction has been made by Łubowicz (2005). Her proposal is based on the notion of a *locus function* for constraints, as has been proposed by McCarthy in a number of works (e.g. McCarthy, 2003).

The locus function for markedness constraints is relatively easy to define, viz. as a function mapping a candidate analysis in an OT tableau to a range

- (22) **Definition 1 (Locus Function)** *A Locus Function for a constraint C is a function which takes as its input a candidate and as its output the set of segments which violate that particular constraint.*

Here are a few Locus Functions for well-known markedness constraints:

- (23) a.  $\text{Loc}_{\text{NoVcdObs}} \equiv$  Return every  $C$ , where  $C$  is [-sonorant, +voice].  
 b.  $\text{Loc}_{\text{NoCoda}} \equiv$  Return every  $C$ , where  $C$  is final in some syllable.  
 c.  $\text{Loc}_{\text{Parse-}\sigma} \equiv$  Return every  $V$ , where  $V$  is the head of an unfooted syllable.

The definition of the locus function is a little bit more complicated — in Correspondence Theory, but not in Containment Theory. One way to do it, is assume a subdivision of input and output with empty strings as follows (given an input /ak/ and an output [ta]:

- (24) 1. |  $\emptyset$  - t  
 2. | a - a  
 3. | k -  $\emptyset$

The locus function can now be defined as follows: DEP will return segment 1, and MAX will return segment 3 (notice that this implies that the input

segment is represented in the output, albeit with a  $\emptyset$ ). This is in some sense a resurrection of Containment Theory.

We can now define a restricted form of local conjunction:

(25) The locus function  $LOC_C$  for local conjunction  $C=C_1\&C_2$  is  $LOC_{C_1}\cap LOC_{C_2}$ .

In other words, a locally conjoined constraint is violated if both conjuncts are violated in the same segment. This is an extremely restricted version of locality: only the phonological segment is now declared to be the relevant domain of conjunction.

Conjunctions of markedness and faithfulness constraints can be argued to account for so-called *derived environment effects* (DEE) (Łubowicz, 2000), such as the following well-known case from Polish: underlying post-alveolar affricates /ʃ/ map into [j], but that segment cannot come from /g/; instead, this segment has to move on to /ʒ/:

(26) a. /briʃ+ek/ → brijek  
 b. /rog+ek/ → \*rojek, rožek

Since underlying ʃ does not change, we know that  $IDENT(continuant)\gg *j$ . However,  $*j$  cannot be derived by palatalization, and we assume that the reason for this is a conjoined constraint:  $*j\&IDENT(coronal)$  and a ranking:

(27)  $*j\&IDENT(coronal)\gg IDENT(continuant)\gg *j$

However, giving this particular conjoined constraint a domain bigger than the segment would lead to undesired results, because palatalization elsewhere in the domain may then cause underlying ʃ to map unto \*ž, e.g.:

(28) ʃem+ik+ek → žem+ič+ek

Such patterns are unattested. (Notice, by the way, that many derived environment accounts in derivational terms have the same problem of nonlocality.)

Łubowicz (2005) proposes a further restriction on local conjunction, based on the observation that it can give undesired results even for final devoicing. Instead of with NOD, we could also conjoin NOCODA with a faithfulness constraint  $IDENT(voice)$ . We then get a “markedness reversal” effect: obstruents devoice, except in coda’s:

(29)

/bad/	NOCODA & IDENT(voice)	NOD	IDENT(voice)
pat	*!		**
pad		*	*
bad		**!	

This gives us coda voicing, presumably an undesired effect (though see Blevins, 2004, for a few examples). According to Łubowicz (2005), the reason why we do not get markedness reversal conjunctions is the following. In licit faithfulness-markedness conjunctions such as Polish \*j&IDENT(coronal) it is the violation of the faithfulness relation which leads to the violation of the markedness relation: we violate the latter only because we violate the former. NOCODA&IDENT(voice) share no such relation: violating IDENT(voice) does not lead into a violation of NOCODA.

Łubowicz (2005) therefore imposes the following further restriction on conjoined constraints:

- (30) Restricted Local Conjunction (LC)  
 $C=C_1\&C_2$  is violated iff:
- a.  $LOC_{C_1} \cap LOC_{C_2} \neq \emptyset$
  - b.  $C_1$  results in  $C_2$  if  $C_1$  is faithfulness and  $C_2$  is markedness.

The notion ‘results in’ at present is not formalized, and Łubowicz (2005) does not discuss it. The general idea should be something along the following lines:

- (31) a faithfulness constraint  $C_1$  results in a markedness constraint  $C_2$  for a segment type  $s$  iff  
 $\forall$  faithfulness constraint  $C_f, C_f \neq C_1: \forall$  candidate  $c, s \in c: [s \notin C_f(c) \wedge s \in C_1(c) \Rightarrow s \in C_2(c)]$

We have restricted the notion ‘results in’ to particular segment types (i.e. combinations of features); in the Polish example above, IDENT(coronal) ‘results in’ \*j only for /g/, not for /t/ or anything else.

$C_1$  ‘results in’  $C_2$  if changing /g/ minimally — only violating  $C_1$  and no other faithfulness requirement — means that  $C_2$  is violated as well by necessity (i.e. in every possible candidate satisfying these requirements). The reason why it is necessary to state that other faithfulness violations should not be violated is that we can of course always repair the damage done by violating  $C_1$  by changing other things as well.

Notice that IDENT(voice) does not ‘result in’ NOCODA for any segment in this sense: there are many candidates where IDENT(voice) is violated, but NOCODA is not.

However all this may be, it should be clear that self-conjunction does not have a place in this story, if only because it is never local in the required way:

The locus proposal does not admit self-conjunction of markedness constraints (Alderete 1997, Itô & Mester 1998). I argue that self-conjunction of markedness is different from other types of



conjunctions. Unlike other conjunctions, the domain for this conjunction is language-specific . . . . My proposal predicts that self-conjunction is different from other types of conjunctions. (Łubowicz, 2005)

There seems to be no escape from this conclusion: ‘self-conjunction’ does not seem to be the proper way of formalizing OCP effects. We can also determine at this point what the properties of a better formalisation should be:

- (32) a. It should be based on strict locality, e.g. adjacency.
- b. Therefore it should take some “representational baggage” on its journey
- c. However, it needs to be able to accomodate for the fact that marked prosodic properties such as gemination may be subject to similar forces.

The following may be one direction to go. Suppose we have the following types of basic constraint:

- (33) a. **\*P**: Return every segment displaying marked property P (\*[labial], NOCODA, NOGEM, etc.)
- b. **SHARE-P**: Return every segment which occurs adjacent to marked property P without sharing that property at some relevant level of representation.

SHARE-P constraints may enforce assimilation if it is appropriately ranked with respect to faithfulness and other markedness constraints. (It is of course not yet completely clear how we should deal with the gemination facts.) The OCP can now be seen as ‘normal’ self-conjunction of markedness:

- (34) \*P & SHARE-P

The following gives the violations for some representative examples:

(35)	A	B	C	D	E
	k a k e	g a k e   [v]	k a g e   [v]	g a g e     [v] [v]	g a g e     [v]
NOD:	✓	*	*	**	*
SHARED:	✓	*	*	**	✓
NOD & SHARED	✓	✓	✓	**	✓

This shows that candidate E is harmonically bounding most other forms, except A. However, in order to get this, we either have to skip the intermediate vowel, or we have to link [voice] to the vowel. Let us assume that there are markedness constraints against both and call these together NOSKIPPING.

We can now replace (11) with the following:

(36) a. NOSKIPPING  $\gg$  NOD & SHARE-D  $\gg$  IDENT  $\gg$  NOD, SHARE-D

b.

/huda/ 'sign'	NOSKIPPING	NOD & SHARE-D	IDENT	NOD
↗huda				*
huta			*!	

c.

/gage/ (hypothetical)	NOSKIPPING	NOD & SHARE-D	IDENT	NOD
gage (D)		*!		**
gage (E)	*!			*
↗kage			*	*
↗gake			*	*
kake			**!	

## 4 Conclusions

- Local conjunction can be a potential tool to get more insight into the structure of the constraint set CON
- It needs a restricted theory of locality and a theory of representations
- Self-conjunction is not an option (under our interpretation of conjunction, self-conjunction is vacuous)
- The OCP can however potentially be described as conjunction of independently needed markedness constraints.

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