# A Note on Categorial Grammar, Disharmony and Permutation

Crit Cremers
Leiden University, Department of General Linguistics
P.O. box 9515, 2300 RA Leiden, The Netherlands
+31 71 5275491
cremers@rullet.leidenuniv.nl

Disharmonious Composition ( DishComp ) is definable as

**X/Y Y\Z ⇒ X\Z** **Y/Z X\Y ⇒ X/Z**

*( and is comdemned by Carpenter 1998: 202 and Jacobson 1992: 139ff )*

Harmonious Composition ( HarmComp ) is defined as

**X/Y Y/Z ⇒ X/Z** **Y\Z X\Y ⇒ X\Z**

*( and is generally adored )*

Lambek Calculus ( Lambek ) has the following basis:

axiom: **X ⇒ X**

rules: ***if* X Y ⇒ Z *then* X ⇒ Z/Y *and* Y ⇒ Z\X**

***if* X ⇒ Z/Y *then* X Y ⇒ Z**

***if* X ⇒ Z\Y *then* Y X ⇒ Z**

Permutation Closure of language L ( PermL )

**PermL = { *s* | *s′* in L and *s* is a permutation of *s′*} and L ⊆ PermL**

*( but nice languages are not PermL for any L )*

*Fact 1* DishComp is not a theorem of Lambek but HarmComp is

*( as you can easily check )*

*Fact 2* DishComp + Lambek = Lambek + Permutation = undirected Lambek ( Moortgat 1988, Van Benthem 1991; Lambek is maximal, but contextfree )

⇔

For any assignment A of categorial types to the atoms of language L, if Lambek recognizes L under A, Lambek + DishComp recognizes PermL under A

*( so disharmony is always too much for Lambek )*

Generalized Composition ( GenComp ) (Joshi *et al.* 1991, Steedman 1990 )

| primary type | secondary type | | composition |
|---|---|---|---|
| $\mathbf{X/Y}$ | $\mathbf{(..(Y\|Z_1)..\|Z_i..)\|Z_n}$ | ⇒ | $\mathbf{(..(X\|Z_1)..\|Z_i..)\|Z_n}$ |
| secondary type | primary type | | composition |
| $\mathbf{(..(Y\|Z_1)..\|Z_i..)\|Z_n}$ | $\mathbf{X\backslash Y}$ | ⇒ | $\mathbf{(..(X\|Z_1)..\|Z_i..)\|Z_n}$ |

while | is \ or / and is conserved under composition.

*( Summarizing combinatory categorial grammar:)*

*Fact 3* GenComp entails DishComp

*( and you need it for the famous crossing dependencies in Dutch, but )*

*Fact 4* It is **not** the case that for any assignment A of categorial types to the atoms of language L, if GenComp recognizes L with respect to A, GenComp recognizes PermL with respect to A

*( as you can see from )*

MIX MIX = PermTRIPLE, where TRIPLE = $\{a^n b^n c^n : n > 0\}$

*( - which is more than mildly context-sensitive; Joshi et al. 1991 - and )*

*Fact 5* Let $A_b(a) = a$, $A_b(c) = c$, $A_b(b) = \{ (s/a)/c, ((s/a)/c)/s, ..., ((s\backslash c)/s)\backslash a, ... ((s\backslash s)\backslash c)\backslash a, (s\backslash c)\backslash a \}$ i.e. $A_b(b) = \{s|x|y, s|v|w|t \mid \{x,y\} = \{a,b\}, \{v,w,t\} = \{a,c,s\}$ and | is \ or / }; b, then, is said to be fully functional, since it has all relevant functional types .

**GenComp does not recognize MIX with respect to assignment $A_b$.**

For example: GenComp does not derive *baaccb* and *abaaccbcb* with respect to $A_b$

*Fact 6* Let $A_{bc}(a) = A_b a$, $A_{bc}(b) = A_b(b)$, $A_{bc}(c) = \{ (s/a)/b, ((s/a)/b)/s, ..., ((s\b)-/s)\a, ... ((s\s)\b)\a, (s\b)\a \}$ ( both b and c are fully functional ).

**GenComp recognizes MIX with respect to assignment $A_{bc}$.**

*( Now consider the grammar exhibiting the following features. )*

Primitive Cancellation Constraint

**X/Y Y ⇒ X iff Y is primitive**

*( - in order to be more restrictive - and )*

Directed Stacks (example)

**(((X\Y)/W)\U)/V** is written as **X\[U,Y]/[V,W]**

*( - in order to be more transparent - and )*

Transparent Primary Category (examples)

**X\[A]/[Y,B] Y\[C]/[D] ⇒ X\[A,C]/[B,D]** or
**X\[A]/[Y,B] Y\[C]/[D] ⇒ X\[C,A]/[B,D]** or
**X\[A]/[Y,B] Y\[C]/[D] ⇒ X\[A,C]/[D,B]** or
**X\[A]/[Y,B] Y\[C]/[D] ⇒ X\[C,A]/[D,B]**

*( - in order to gain expressivity - make GenComp to )*

Categorial List Grammar ( CatListGram ) ( Cremers 1993 )

GenComp + Primitive Cancellation Constraint + Directed Stacks + Transparent Primary Category

*(but nevertheless )*

*Fact 7* Fact 4, Fact 5 and Fact 6 also hold *mutatis mutandis* for CatListGram. In these aspects, CatListGram and GenComp are weakly equivalent.

*CONCLUSIONS*

None of the additional characteristics for CatListGram affects the weak capacity of a categorial grammar; i.e.:

- exclusive cancellation of primitives does not affect recognition capacity
- maintaining more than one argument stack does not affect recognition capacity
- merging argument stacks of primary and secondary category does not affect recognition capacity

and it takes more than disharmony to induce permutation closure

(*) see demo Delilah here or
http://fonetiek-6.leidenuniv.nl/hijzlndr/delilah.html

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