A Note on Categorical Grammar, Disharmony and Permutation

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Disharmonious Composition (DishComp) is definable as

$X/Y \ Y/Z \Rightarrow X/Z \quad Y/Z \ X/Y \Rightarrow X/Z$
(and is condemned by Carpenter 1998: 202 and Jacobson 1992: 139ff)

Harmonious Composition (HarmComp) is defined as

$X/Y \ Y/Z \Rightarrow X/Z \quad Y/Z \ X/Y \Rightarrow X/Z$
(and is generally adored)

Lambek Calculus (Lambek) has the following basis:

axiom: $X \Rightarrow X$

rules: if $X \ Y \Rightarrow Z$ then $X \Rightarrow Z/Y$
and $Y \Rightarrow Z \backslash X$
if $X \Rightarrow Z/Y$ then $X \ Y \Rightarrow Z$
if $X \Rightarrow Z \backslash Y$ then $Y \ X \Rightarrow Z$

Permutation Closure of language L (PermL)

$\text{PermL} = \{ s \mid s' \text{ in } L \text{ and } s \text{ is a permutation of } s' \}$ and $L \subseteq \text{PermL}$
(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)

$\Leftrightarrow$

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
X/Y	$(..(Y Z_1)..) Z_n$	$\Rightarrow (..(X Z_1)..) Z_n$
secondary type	primary type	composition
$(..(Y Z_1)..) Z_n$	$X \backslash Y$	$\Rightarrow (..(X Z_1)..) Z_n$

while $|$ is $\backslash$ 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

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

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

Fact 5

Consider the assignment A_b of categories to the lexicon $\{a, b, c\}$ s.t. $A_b(a) = a$, $A_b(c) = c$, $A_b(b) = \{ (s/a)/c, ((s/a)/c)/s, \dots \}$

..., $((s \setminus c) / s) \setminus a$, ... $((s \setminus s) / c) \setminus a$, $(s \setminus c) \setminus a$, i.e. $A_b(b) = \{s|x|y, s|v|w|t \mid \{x,y\} = \{a,b\}, \{v,w,t\} = \{a,c,s\} \text{ and } | \text{ is } \setminus \text{ or } /\}$; 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 *baacbb* and *abaacbbcb* with respect to A_b

Fact 6

Let $A_{bc}(a) = A_b a$, $A_{bc}(b) = A_b(b)$, $A_{bc}(c) = \{ (s/a)/b, ((s/a)/b)/s, \dots, ((s \setminus b)/s) \setminus a, \dots ((s \setminus s) \setminus b) \setminus a, (s \setminus b) \setminus a \}$ (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

$X/Y \ Y \Rightarrow X$ iff Y is primitive

(- in order to be more restrictive - and)

Directed Stacks (example)

$((X \setminus Y) / W) \setminus U / V$ is written as

$X \setminus [U, Y] / [V, W]$

(- in order to be more transparent - and)

Transparent Primary Category (examples)

$X[A]/[Y,B] \ Y[C]/[D] \Rightarrow X[A,C]/[B,D]$ or

$X[A]/[Y,B] \ Y[C]/[D] \Rightarrow X[C,A]/[B,D]$ or

$X[A]/[Y,B] \ Y[C]/[D] \Rightarrow X[A,C]/[D,B]$ or

$X[A]/[Y,B] \ Y[C]/[D] \Rightarrow X[C,A]/[D,B]$

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

Categorical List Grammar (CatListGram)

(Cremers 1993 and at fonetiek-6.leidenuniv.nl/hijzlnr/delilah.html)

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.

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