Polarity Items in Type Logical Grammar

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1 Background

Montague Grammar [Mon74]

- *Compositionality*: (i) The meaning of complex expressions is built from the meaning of its parts; (ii) The syntactic structure of a complex expression is obtained by functional applications from its parts.
- Main task: to find the correct *type assignment* for lexical items. Complex structures are built by means of application of (stipulated) rules starting from these type assignments. E.g.

  Lexicon : `John` $\in NP : j$, `walks` $\in NP\backslash S : \lambda x.Walk(x)$. The complex expression `John walks` $\in S : Walk(j)$ by means of $\beta-reduction$ (semantic) and $[\backslash E]$ (syntax).
- The derivation (or function application order) determines the meaning of a complex expression. *Multiple derivations = Multiple meanings.*

The composition of the (syntactic) structure is carried out by a *Categorial Grammar* (CG). The meaning is represented by *lambda terms.*

Type Logical Grammar

- Lambek in [Lam58] shows that CG besides the functional operators $\backslash$ and / "contains" the composition connective $\bullet$. Making this explicit gives a *logic* system, the Lambek calculus (L).
- van Benthem in [vB88] proves that L and the lambda calculus are Curry-Howard isomorphic.
- Moortgat in [Moo96, Moo97] shows that L contains unary operators as well $\Diamond, \Box^{\downarrow}$. Making this explicit we obtain $\mathsf{NL}(\Diamond)$.
- Similarly, Areces and Bernardi in [AB01] show that the same principle which characterizes $\backslash$, / can give their unary counterpart, ${}^{0}(\cdot), (\cdot)^{0}$. The full system is referred to as $\mathsf{NL}(\Diamond, \cdot^{0})$ and studied in Areces, Bernardi and Moortgat [ABM01].

Summing up, in TLG types are seen *as* logical formulas, a logic system works *as* parser, viz. *Parsing as Deduction.*

2 Polarity Items

Anastasia Giannakidou

Thesis: Polarity Items (PI) are sensitive to (non)veridical environments.
Analysis: Expressions of the same syntactic category (e.g. sentences), are of different semantic kinds: eg. episodic (E), veridical (V), non veridical (NV) anti-veridical (AV). Moreover, we have seen that (i) the latter two are related by an inclusion relation, that episodic propositions can become either NV or V; (ii) modal operators, adverbs etc. transform one semantic category to another.

$$\begin{array}{ccc} \mathrm{AV}_{\mathrm{lic}} & \subseteq & \mathrm{NV}_{\mathrm{lic}} \\ \texttt{not} & \texttt{greepos} & \\ \mathrm{E} & \texttt{now} & \mathrm{V} \end{array}$$

Type Logical Account

Ingredients: (i) Relations between syntactic category, (ii) Functional type which lift from one level to the other.

$$\begin{array}{ccc} \mathrm{AV}_{\mathrm{lic}} & \longrightarrow & \mathrm{NV}_{\mathrm{lic}} \\ \uparrow & & \\ \mathrm{E} & \longrightarrow & \mathrm{V} \end{array}$$

$$\frac{\mathrm{AV}_{\mathrm{lic}} \in E/AV \quad \mathrm{NPI} \in AV}{\mathrm{AV}_{\mathrm{lic}} \circ \mathrm{NPI} \in E} \qquad \frac{\mathrm{NV}_{\mathrm{lic}} \in E/NV \quad \mathrm{PI} \in NV}{\mathrm{NV}_{\mathrm{lic}} \circ \mathrm{PI} \in E}$$

$$\frac{\dfrac{\mathrm{AV}_{\mathrm{lic}} \in E/AV}{\mathrm{AV}_{\mathrm{lic}} \in E/NV} \quad \mathrm{PI} \in NV}{\mathrm{AV}_{\mathrm{lic}} \circ \mathrm{PI} \in E} \qquad \frac{\dfrac{\mathrm{NV}_{\mathrm{lic}} \in E/NV}{\mathrm{NV}_{\mathrm{lic}} \in E/AV}[*] \quad \mathrm{NPI} \in AV}{*\mathrm{NV}_{\mathrm{lic}} \circ \mathrm{NPI} \in E}$$

$$\frac{\mathrm{Now} \in E/V \quad \dfrac{\mathrm{E} \in E}{\mathrm{E} \in V}}{\mathrm{Now} \circ \mathrm{E} \in E} \qquad \frac{\mathrm{GrePo} \in E/NV \quad \dfrac{\mathrm{E} \in E}{\mathrm{E} \in NV}}{\mathrm{Greekp} \circ \mathrm{E} \in E}$$

The unary operators of $\mathsf{NL}(\Diamond, \cdot^{0})$ give a way to express these relations among types:

(i) Type Hierarchy:

$$\begin{array}{ccc}
\text{NV-PI: } {}^{0}((\Diamond\Box^{\downarrow}S)^{0})) & \longrightarrow & \text{AV-NPI: } {}^{0}((S)^{0}) \\
\uparrow & & \\
\text{E: } \Diamond\Box^{\downarrow}S & \longrightarrow & \text{V: } \Box^{\downarrow}\Diamond S
\end{array}$$

The $/, \backslash$ together with the above operators, allows us to express the role of the adverbs etc.

(ii) Lexicon

`Now`: $\Diamond\Box^{\downarrow}S/(\Box^{\downarrow}\Diamond S)$	`greek pos`: $\Diamond\Box^{\downarrow}S/{}^{0}((\Diamond\Box^{\downarrow}S)^{0})$
`not`: $(NP\backslash\Diamond\Box^{\downarrow}S)/(NP\backslash{}^{0}((S)^{0}))$	`anything`: $(({}^{0}((\Diamond\Box^{\downarrow}S)^{0}))/NP)\backslash{}^{0}((\Diamond\Box^{\downarrow}S)^{0})$
`something`: $(\Box^{\downarrow}\Diamond S/NP)\backslash\Box^{\downarrow}\Diamond S$	`If`: $(\Diamond\Box^{\downarrow}S/{}^{0}((\Diamond\Box^{\downarrow}S)^{0}))/{}^{0}((S)^{0})$

Examples

1. I *may* buy any book
2. I have *not* bought any book
3. *If* anybody has left, John has let him out.
4. *I now buy any book
5. I have bought some book
6. *If* somebody has left, John has let him out.

The case of *as soon as*, *when* etc.

Giannakidou: Connectives as *as soon as* and *when* allow for PIs when construed with the habitual operator or the future, but not when they are construed with episodic past. Thesis: these connectives are not ambiguous but their licensing effect arises as the product of embedding under an appropriate operator.

Examples

1. Paul *used to* warn me *as soon as* he saw anything
2. *The children left *as soon as* they discovered anything
3. *Yesterday, Paul warned me *as soon as* he saw anything
4. *Paul *used to* buy anything

We can account for these phenomena by means of a distribution property ie. assigning to *as soon as* a type which licenses a PI in the subordinate clause just in case there is a HAB operator in the main clause.

What can we learn from this formalization

[A] New classes of PIs could be defined; [B] PI licensers seem to be related to the anaphoric one; [C] PIs seem to be related to adverb order.

[A]

New classes of PI

If we complete the type hierarchy picture we find the way to express others relations as well.

$$\begin{tikzcd}
\boxed{NV :^0 ((\Diamond\Box^{\downarrow}S)^0)} \arrow[r] & \boxed{AV :^0 ((S)^0)} \arrow[r] & {}^0((\Box^{\downarrow}\Diamond S)^0) \\
\boxed{E : \Diamond\Box^{\downarrow}S} \arrow[r] \arrow[u] \arrow[d] & S \arrow[r] \arrow[u] \arrow[d] & \boxed{V : \Box^{\downarrow}\Diamond A} \arrow[u] \arrow[d] \\
({}^0(\Diamond\Box^{\downarrow}S))^0 \arrow[r] & ({}^0(S))^0 \arrow[r] & ({}^0(\Box^{\downarrow}\Diamond S))^0
\end{tikzcd}$$

For example, these new types allow us to express the fact that English *if* allows both PI and PPI in the antecedent clause: $if \in (S/{}^0((\Diamond\Box^{\downarrow}S)^0))/{}^0((\Box^{\downarrow}\Diamond S)^0)$. Moreover, we can express the fact that there are NV expressions which fail to license PI e.g. English *possibly*. *Possibly* is of category $\Diamond\Box^{\downarrow}S/({}^0(\Diamond\Box^{\downarrow}S))^0$.

We would now be able to accomodate PIs which are licensed by *possibly* , but not by *might/may/didn't*, etc..

[B]

Dynamic vs. Static sentence

Non veridical (and therefore also anti-veridical) sentences do not allow anaphoric link. Veridical ones do.

Examples

1. This house **might/could/should** have a bathtub.
   a) *It's green.
   b) It **might/could/should** be green.

2. This house **allegedly/possibly** has a bathtub.
   a) *It's green.
   b) It is **allegedly/possibly** green.

- Whenever an expression is in the scope of $({}^0(\cdot))^0$ it is closed.
- Whenever an expression is in the scope of $\Box^{\downarrow}\Diamond\cdot$ anaphoric links are allowed.

Translating this into Dynamic Montague Grammar terms [GS90],

- $\Box^{\downarrow}\Diamond \quad \rightsquigarrow \quad \uparrow$
- $({}^{0}(\cdot))^{0} \quad \rightsquigarrow \quad \downarrow\uparrow$

[C]

Non-linear Adverb Order
Adverb ordering can also be treated as a sort of polarity phenomenon.

(1) a. Jens kom **muligens ikke**. [Norw]
J came possibly not on.time
b. *Jens kom **ikke muligens**.
J came not possibly on.time

(1-b) is possible only under a so-called 'comma reading' where the *ikke* is interpreted inside the scope of *muligens*. We will not have anything to say about comma readings here.

(2) a. Jens kom **ikke alltid**.
J came not always
b. *Jens kom **alltid ikke**.
J came always not

We have that, in Norwegian, *muligens* must precede *ikke*, and *ikke* must precede *alltid*. By transitivity, we now expect that *muligens* must precede *ikke*. This, however, is not supported by the facts.

(3) a. Jens kommer **muligens alltid** for sent.
J comes possibly always too late.
b. Jens kommer alltid muligens for sent
J comes **always possibly** too late
"It is always possible that he comes too late."

In order to save an account in terms of functional heads [Cin99], we could assume that, in (3-b), *alltid* is modifying *muligens* directly. But this is not necessarily the case, since the subject can intervene between the two adverbs, as seen in (4).

(4) Derfor kommer **alltid** Jens **muligens** for sent.
therefore comes always J possibly too late

The order *ikke muligens* becomes much better if *alltid* intervenes.

(5) Jens kommer **ikke** *(**alltid**) **muligens** for sent
J comes not always possibly too late

The string of adverbs can be broken up by the subject in this case as well, so the adverbs are not necessarily constiuents.

(6)	a.	Derfor	kommer	ikke	**Jens**	alltid	muligens	for	sent.
		therefore	comes	not	J	always	possibly	too	late
	b.	Derfor	kommer	ikke	alltid	**Jens**	muligens	for	sent
		therefore	comes	not	always	J	possibly	too	late

Thus, we appear to have a genuine counterexample to linearity. The pattern can be analyzed in our system of S-types as follows:

	Lexicon
muligens	$S/({}^0(\Diamond\Box^{\downarrow}S))^0$
ikke	$({}^0(\Diamond\Box^{\downarrow}S))^0/{}^0((S)^0)$
alltid	$\Diamond\Box^{\downarrow}S/S$

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