

Franklin Institute Symposium in Honor of Barbara Partee
The Past, Present, and Future of Formal Semantics

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Channeling Montague, Variable Free Logic(s) and more:
A small puzzles with large implications

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Three main ideas

A. Channeling Montague: Direct Compositionality

- syntax a system of rules proving expressions well-formed ('building' expressions)
often (not always) building larger one from two (or more) smaller ones
- and semantics works in tandem with that
to assign meaning to the output expression in terms of the meanings of the input (smaller) expressions = *compositionality*

meaning: a model-theoretic interpretation ('stuff' build from individuals times, possible worlds, etc. and sets and functions built from these
not a representation)

- HENCE: Direct Compositionality claim:
no mapping between actual pronounced representation
to another level **(Logical Form)**
which is then assigned a model-theoretic interpretation

This basic idea from Montague and maybe others

**but brought into consciousness of linguists especially by
Barbara Partee in 70s and 80s**

**Partee and others: stressed that Direct Compositionality
should be the gold standard - the desiderata**

e.g. Partee and Bach (1984) who take as *initial assumption*:

The semantics is a direct model-theoretic interpretation of the syntax; an intermediate level of translation into intensional logic

[or any other kind of logical representation -PJ]
is dispensable (Cooper (1975)).⁴ This last hypothesis accords with Montague's assertions but runs counter to most earlier and much current work in semantics by linguists, where the usual assumption

current" then was 1984 - but still true!!!!

- Partee and Bach conclude (with a sigh) LF is not dispensable
 - but too hasty!!
but that is for a different talk

B. Also from Montague (PTQ) - adoption of a Categorical Grammar syntax

syntactic categories encode syntactic distribution and the type of meaning an expression has (semantic type)

Thus allowing a tight fit between the syntax and semantics

So take: an ordinary VP or intransitive verb

Semantically: denote functions from individuals to truth values

$\text{Ind} \rightarrow \{1,0\}$ or, usual notation: $\langle e, t \rangle$

equivalently: a set of individuals

Syntactic category parallel

$\text{NP} \rightarrow \text{S}$ or, usual notation: S/NP

Take a transitive verb: functions from individuals to above:

Semantically: denote functions from individuals to "VP" type meanings

$\text{Ind} \rightarrow [\text{Ind} \rightarrow \{1,0\}]$ $\langle e, \langle e, t \rangle \rangle$

in set terms:

chase maps *Porky* to set of Porky chasers

Syntactic category:

$\text{NP} \rightarrow [\text{NP} \rightarrow \text{S}]$ (S/NP)

for notational convenience:

$\text{Obj} \rightarrow [\text{Subj} \rightarrow \text{S}]$ $(\text{S/Subj})/\text{Obj}$

Categories encode their argument 'slots' - i.e., what they can combine with in the syntax

C. Variable Free Semantics - Combinatory Logic (Curry and Feys, 1958), Quine (1960), and much work in Categorical Grammar

semantics makes no use of variables - will elucidate below

Interlude 1:

treatment of quantified NPs (from Montague 1974)
common to most theories with or without variables

every third grade boy is a set of sets -
= set of all sets with 3-grade boy set as subset

every third grade boy sang in the concert: VP set is in the subject set of sets

Interlude II - 'binding' of pronouns in variable-ful treatments

(1) Every third grade boy_i called his_i mother (at lunchtime)

NOTE: Indices here just to indicate intended reading

A standard view:

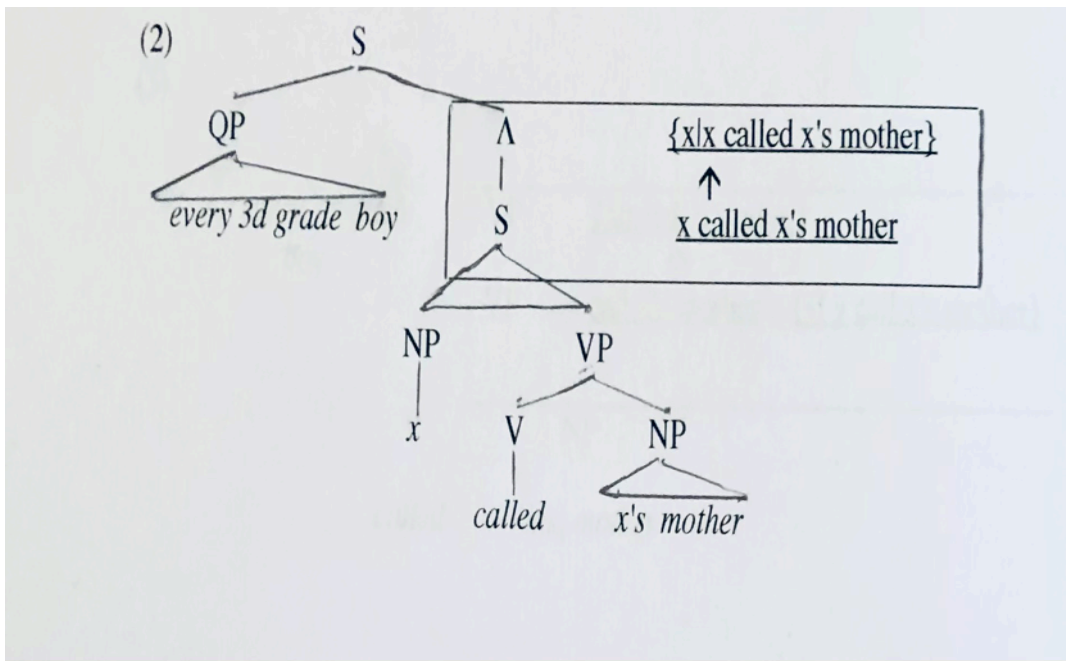
every third grade boy is 'out' of the sentence at level relevant for interpretation

Bach (1968), McCawley (1969) and others

more recent incarnation in May (78) and many since

- hence - crucial use of a level of LF (though see Montague, 1974)
- and crucial use of *variables* -
interpretations are relative to ways to assign values to variables

LF (roughly): (*syntactic expressions in italics*; meanings are underlined)



- main S is x called x's mother
a proposition *relative to assignment of values to variables*
- mapped to $\{x|x \text{ called } x\text{'s mother}\}$ (variable closed off; same on all ways to assign x a value)
- this in the *every 3d grade boy set*
 $\{S \mid \text{set of 3d grade boys} \subseteq S\}$

Key point: "binding" is mapping from S-meaning to Λ -meaning

- Binding domain is S**
- *with a subject in place (and is a variable)*
 - *and the object also in place*
and contains an 'open' variable

B. A variant which still uses variables but compatible with Direct Compositionality

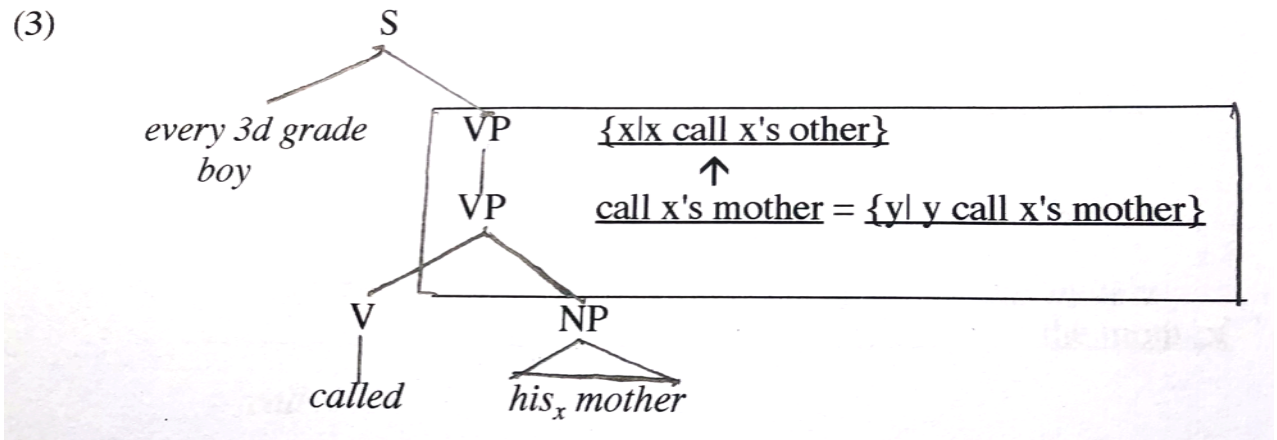
Derived VP Rule Partee (1973), Sag (1976), Partee and Bach (1984)

Similar: but the subject need not be 'pulled out' (so no LF)
as the crucial shift is on the domain of the VP

VP is call x's mother - "open set" - set of callers of x's mother
so that is dependent on value assigned to x

"Derived VP Rule" maps that to $\{x|x \text{ call } x\text{'s mother}\}$
same meaning as in S-level binding view above
no longer depends on assignment of value to x; x is just
in the notation

and rest of the semantics the same: S says this set is in the
every 3d grade boy set



Key point: "binding" is mapping from VP (set) meanings to VP (set) meanings

Binding domain is VP

- *pronoun containing object is already in place*
- *and meaning contains an 'open' variable*
- *subject need not 'be there'*

Variable Free semantics

- no variables (except for convenience in notation)
 - **no linguistic expression has a meaning relative to ways to assign values to variables**
 - still need a 'binding' step: even more local
- a. pronouns denote identity function from individuals to individuals
(tracked in syntactic category also)
- c. expressions containing pronouns which are (informally speaking)
'unbound' within them:
function from individuals to something else
NOT from ways to assign values to the variable to something
- she, he, his,...* NP^{NP} $\text{ind} \rightarrow \text{ind}$ - in particular identity function $\langle e, e \rangle$
- d. pronouns (and expressions containing 'unbound' pronouns combine with
others (roughly) by function composition
- his mother;* NP^{NP} $\text{ind} \rightarrow \text{ind}$ - in particular 'the mother-of' function
 $\langle e, e \rangle$

But how do we get 'bound' readings???

- A very local 'shift' rule:

*maps an ordinary 2-place relation between individuals
to a relation which holds between
an individual and a function from indivs to indivs*

call that mapping z

in function terms:

some function h which is $\text{ind} \rightarrow [\text{ind} \rightarrow \{1,0\}]$ i.e. $\langle e, \langle e, t \rangle \rangle$
 maps to a function $z(h)$ which is $[\text{ind} \rightarrow \text{ind}] \rightarrow [\text{ind} \rightarrow \{1,0\}]$
 i.e., $\langle \langle e, e \rangle, \langle e, t \rangle \rangle$

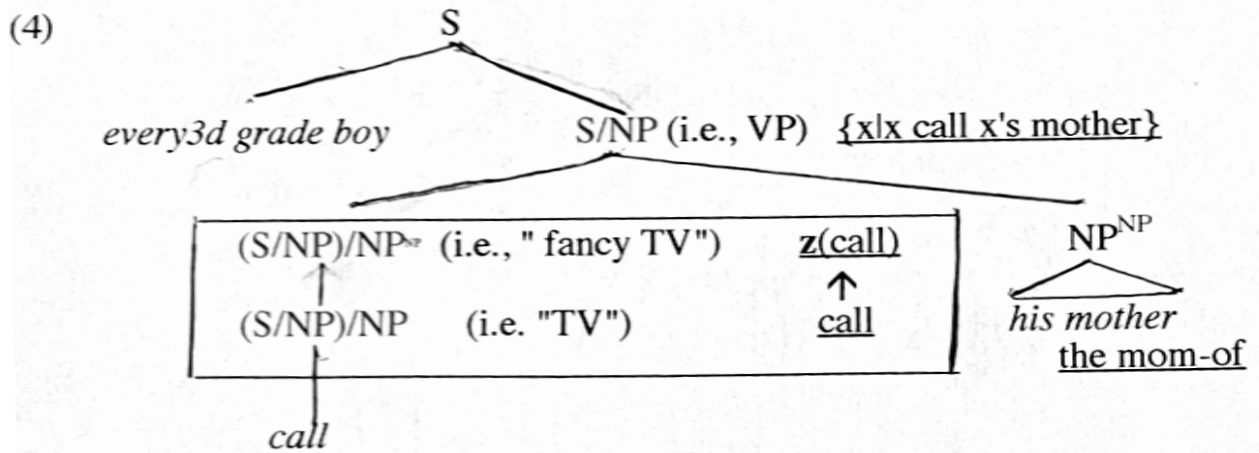
what is this mapping? easiest to just illustrate by example:

$[[\text{call}]]$ is of right type to input the rule

$z[[\text{call}]]$ takes any function f from individuals to individuals,
and returns $\{x \mid \text{ordinary-calls } f(x)\}$

to $z(\text{love})$ some function f is to be an x who loves $f(x)$

Every 3d grade boy called his mother



- *call* shifts to *z-call* - then combines with *his mother* (the-mother-of function)
- *called his mother* = $z\text{-call}(\text{the mother-function}) = \{x|x \text{ call } x's \text{ mother}\}$
- *every 3d grade boy called his mother* - above in the *every 3d grade boy* set

So: last step just like the other two, but the 'binding' shift even more local

Binding domain is transitive verb - maps to fancier meaning

- *subject is not in place*
- *object containing the pronoun is not in place*
- *no use of expressions whose meaning depends on assignments of values to variables*

Payoff: Meeting an apparent challenge to Direct Compositionality

Interlude: Direct Compositional Analysis of "Right Node Raising"
 (based on work by Steedman, 1987, Dowty, 1988)

- (5) Every semantics student loved and every phonology student hated the course on model-theoretic semantics.

no need to posit a level of LF at which hiddenly these are 2 sentences

Given CG syntax plus standard view of semantic types:

- can function compose *every semantic student loved* to give set of things that every semantics student loves
- similarly for *every phonology student hated* composes to give set thigs that every phonology student hates
- these intersect
- rest says that *the course on m-t semantics* is in that

But: we get similar facts with 'binding'!!!

- (6) Every third grade boy loves and every fourth grade boy hates his homeroom teacher.

- one *his* - 'bound' by two different things? how can that be?
- And note that under either of the variable-ful view of binding - need 2 Ss and hence need an LF
 - S-level binding: no single S containing the subject and pronoun-containing object
 - VP-level binding: no single VP containing the subject and pronoun-containing object
- But very local binding: just z-loves and z-hates

every third grade boy composes with z-loves to give
 set of functions f such that every third grade boy is an x who loves f(x)
every fourth grade boy similarly:
 set of functions f such that every fourth-grade boy is an x who hates f(x)

- these intersect as in above
- *his homeroom teacher* function mapping each boy to his homeroom teacher;
 - S says this function is in that intersection

Back to z - its expected syntax under CG program

- Semantically: input to **z**-rule is a (Curry'ed) 2-place function
some function h which is $\text{ind} \rightarrow [\text{ind} \rightarrow \{1,0\}]$ i.e. $\langle e, \langle e, t \rangle \rangle$
- would expect syntax to be parallel - i.e. input must be an expression of category

$$\begin{array}{l} \text{NP} \rightarrow [\text{NP} \rightarrow \text{S}] \\ \text{Obj} \quad \text{Subj} \end{array} \quad \text{i.e.} \quad (\text{S/NP})/\text{NP}$$

That is: it must be something that can get a subject even though neither subject nor object is 'there' when the shift happens

Prediction: even if the semantic type is right, if an item doesn't have a subject 'slot' it cannot undergo **z**

Is this true?

An apparent puzzle

I go to a small party. Besides me, there are three married couples:

Alice and Abe

Betty and Bert

Cathy and Christine

Betty and Bert were childhood sweethearts. The others all met their spouse within just the last few years.

I really enjoyed talking to Betty. You ask me how I liked the party:

(7) It was interesting. I especially enjoyed talking to Betty.

Suppose: I don't remember her name, though I do remember Bert's name and that she is married to Bert:

(8) It was interesting. I especially enjoyed talking to - oh, what's her name -
 a. the woman married to Bert.
 b. the wife of Bert (or, Bert's wife)

Suppose: I don't remember Bert's name either - but I do remember that they were childhood sweethearts:

(9) It was interesting. I especially enjoyed talking to - oh what's her name, you know
 a. the woman married to her childhood sweetheart

BUT:

b. *the wife of her childhood sweetheart

But why? doesn't *the woman married to* have same meaning (at least roughly) as *the wife of*? i.e., *married to* = *spouse of* (*wife just also encodes gender*)

Additionally:

Add in a few more people at the party

You ask me if you learned anything interesting about the people at the party:

- (10) Well, maybe - I learned that Betty is the only woman married to her childhood sweetheart. .

two readings:

- (a) pragmatically salient one: the only x [x married to x's childhood sweetheart]
'covarying' reading
- (b) the only x [x married to Betty's childhood sweetheart]
i.e., Bert is not polygamous (not exactly an interesting thing to learn!)
hereafter: the *non polygamy reading*

But - despite the fact that the (b) reading pragmatically less salient, it's only reading for (5):

- (12) Well, maybe - I learned Betty is the only wife of her childhood sweetheart.

This a general fact about **relational nouns** - those denoting 2-place relations:

- (13) Sarah is the only friend of her mother's boss.

- the boss is a very lonely person
- no covarying reading (= the only one [out of some contextually given set] who is a friend of her mom's boss)

Known in literature as *i-within-i* effects (a misleading term)

So why the difference between *(woman) married to* and *wife of* (or *spouse of*)?
both denote 2 place relations:

$\text{ind} \rightarrow [\text{ind} \rightarrow \{1,0\}]$ i.e. $\langle e, \langle e, t \rangle \rangle$

married to - 2 place relation between indivs and indivs

wife of - same

Follows from the syntax of *z* as necessitated in the CG program

Combined with an odd fact about nouns and **hence relational nouns**

Ordinary nouns - generally thought to have same type as, e.g., VPs

$\text{ind} \rightarrow \{1,0\}$ or $\langle e, t \rangle$

i.e., sets of individuals

But: they don't have syntactic subject slots - never combine with subjects

Relational nouns as above - but combine with *of-NP* but never with subjects

- Key difference between *married to* and *wife of* (other than encoding of gender)

married to syntactically encodes that it can take a subject!

Really? After all *Betty married to Bert* is not a main clause sentence!

True - but *married to* can occur with subjects in so-called Small Clauses
just think of those as special kinds of sentence-like things that
can't be root clauses

- (14) a. With [_{SC}Betty married to Bert] she might be able to convince him
to move to Providence.
b. With [_{SC}Betty married to her childhood sweetheart], she is probably
sick of celebrating when they first met.

so *married to* is NP → [NP → SC] i.e. (SC/NP)/NP

this doesn't mean it always gets a subject

the woman married to Bert

married to Bert is "VP-like" and denotes a set

woman N and denotes a set

the two intersect

compare to *wife (of)*

- (15) *With Betty wife of Bert, she might be able to convince him to move to Providence.

similarly for ordinary nouns:

- (16) *With Nora linguist, she'll make a lot of money.

So N is a primitive category - even though is same type as VPs (sets)

And so relational nouns (oversimplifying with respect to the preposition):
in syntax: say - give me an NP and I'll give you a N

of-NP → N i.e. N/NP-of

can't undergo z because syntax is not right

hence: *the only woman married to her childhood sweetheart* (covarying)
the only wife of her childhood sweetheart (no covarying)

But wait!!! This doesn't really give evidence for the variable-free view over the others!

Derived VP Rule: if binding requires a subject slot - same exact prediction
if cast into Categorical Grammar - same exact prediction

Standard S-level binding rule: since no small clause with relational nouns
hence: no subject slot
hence: no S-like thing to supply the domain of binding
hence: no binding

But - more complex analysis in the case of participial
the only woman married to her childhood sweetheart

need to posit silent subject of the participle

But a test case which gives evidence for the very local treatment

Constructing the test:

imagine cases where an item is listed in lexicon with a subject slot
e.g., an ordinary transitive verb

with a productive morphological rule mapping this to a relational noun

e.g., *chase* (*Corey ardently chases rabbits*)
chaser (*Corey is an ardent chaser of rabbits*)

very roughly: (S/NP)/of-NP maps to: N/of-NP

$NP \rightarrow [NP \rightarrow S]$ maps to $of-NP \rightarrow N$
where the resulting N has the morphology "N-er"

**transitive verb in lexicon - has object and subject slot
maps to a relational noun (with -er suffix) (no more subject slot)**

But suppose that the input to the above morphological rule could also be
the **z**-version of the transitive verb

For at least some speakers it can be!

Hence: predict: contrast between relational nouns that are
transparent agentive nouns derived by rule vs. those in lexicon

lover: - usual lexical meaning (the Romeo-meaning) which is not derived productively from *love*
 - or marginally: a transparent agentive relational noun
 "one who loves"

- (17) a. Sally is the only lover of her mother's taste in wine.
 b. Sally is the only lover of her mother's tax accountant.

Best shown with odd agentive nouns that don't exist for good reason -
 because when we force these, we can be sure that these are not
 already sitting in the lexicon

befriending on Facebook

Imagine that we don't just 'friend' someone on facebook but refer to it as
 "befriending" them.

- (18) a. Bert is the only befriender of his mother's boss. (covarying possible)
 b. Bert is the only friend of his mother's boss. (lonely boss only)

assassin vs. assassinator

assassinator -strange - it is more or less blocked by *assassin*
 but if forced:

Context: a group of rebels from different countries - each bragging about
 having assassinated some government official from the government of
 their county:

- (19) a. Lee is the only assassinator of his country's secretary of state.
 (covarying possible)
 b. Lee is the only assassin of his country's sec'y of state.
 (only one person involved in the assassination)

MORALS

- a nice piece of evidence for the very local 'binding' of variable-free semantics
- as wedded to a Categorical Grammar syntax
- More importantly - this all compatible with Direct Compositionality
no 'pulling things out' (LF) to get binding
so the hope in, e.g., Partee and Bach - channeling Montague -
(and other places) should not be abandoned
- in a totally vein: odd little corners of the language can be quite illuminating
-- a lesson learned from all of the many many "Partee sentences"
- we should continue to keep our eyes on this type of subtle and complex data as
we move ahead

