

On the relation between descriptive content and reference and its implications for computational modeling

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Take-home message

- ▶ There is lots of evidence that meaning composition in language works in (at least) two fundamentally different ways: mediated by reference, and unmediated by reference.
- ▶ While this may be widely acknowledged, few steps have been taken to build a syntax/semantics interface that really forces one to treat these processes as distinct.

Take-home message

- ▶ Using non-symbolic methods to model meaning composition unmediated by reference, while retaining symbolic methods to model the rest, is extremely helpful as a methodology for getting at these two kinds of meaning construction and how they connect.
- ▶ It could also help to reestablish the increasing disconnect between symbolic and non-symbolic communities in computational linguistics, or at least help them to coexist more productively.
- ▶ A proper division of labor between methodologies can also improve the disconnect between the formal semantics community and large sectors of the syntax community.

Plan for this talk

- ▶ Brief overview of some of the diverse evidence for two types of meaning composition.
- ▶ A preliminary proposal for managing these two types of composition in a particularly illuminating case: partially compositional idioms (Gehrke & McNally, submitted).
 - ▶ Generalizes an independently motivated proposal in Farkas & de Swart 2003.
 - ▶ Facilitates bringing in distributional semantic analysis (see, e.g., Baroni, Bernardi & Zamparelli 2014 for a recent overview) for the composition of descriptive contents.

Idioms: A compositional puzzle

Non-idiomatic material can intervene between the components of an idiomatic expression:

- (1)
 - a. pull strings
 - b. pull some strings
 - c. pull political strings
 - d. pull all the strings I can

- (2) [... [VP pull [DP some [NP strings]] ...]]

The compositionally-puzzling view from syntax

Sportiche 2005, Cecchetto & Donati 2015 and others: The verb in V-O idioms combines directly with the noun inside its complement; the determiner is introduced higher up in the syntax or late-adjoined.

- ▶ Hard to fathom if one wants an analysis that captures the surface constituency of determiners and nominals, and also preserves compositionality.
- ▶ But point to an important and underappreciated issue in the modeling of semantic composition involving descriptive contents vs. “reference-managing” expressions:

The two are partially independently of each other.

HSPG (Sailer 2004, Bargmann & Sailer 2015)

Rich HPSG representations permit fine compositional distinctions:

- ▶ **Local semantics:** Encodes basic lexical information, manages sortal and pragmatic selectional restrictions.
- ▶ **Compositional semantics:** Regulates the combination of larger constituents, including quantifier scope.

Benefit: Once separated in the representation, the interactions between local (descriptive) contents can be managed independently of compositional (referential) contents.

Problem: No explicit technique for combining the local contents in a way that would produce idiomatic meanings.

Diesing's (1992) Mapping Hypothesis

- ▶ Clauses have two levels: VP and IP/CP.
- ▶ Referential/quantificational nominals must vacate the VP to be interpreted (in the restrictor of an overt or covert quantifier); property-type nominals (e.g. certain bare plurals) stay in VP.
- ▶ Diesing & Jelinek 1995: Finite verbs move out of their base position.
 - ▶ Though not addressed directly, entails that V and NP combine at a lower level (VP), without taking into account the referential properties of determiners or finiteness (relevant for event reference).
 - ▶ Both then move out of VP for reasons that one can tie to referentiality.

Diesing's (1992) Mapping Hypothesis

Illustration with nominals

- (3) ... weil Elly immer Lieder singt.
... since Elly always songs sings
'since Elly is always singing songs.'
- (4) **ALWAYS** $t[\text{time}(t)]\exists x[\text{song}(x) \wedge \text{sings}(\text{Elly}, x, t)]$
- (5) ... weil Elly Lieder immer singt.
... since Elly songs always sings
'since always, if something is a song, Elly sings it.'
- (6) **ALWAYS** $x[\text{song}(x)][\text{sings}(\text{Elly}, x)]$

(German, Diesing & Jelinek 1995: 129)

Incorporation

Carlson 2003

(7) stamp collect, bike ride vs. collect stamps, ride a bike

“VP is the domain of a context-free interpretive mechanism specifying an event-type, which is then the input to the usual context-sensitive propositional semantics....[S]omething fundamentally different goes on within the VP that does not go on “above” the VP - it is only information about types/properties that appears there and not information about (contingent) particulars.” (Carlson 2003:198)

(8) VP-level: $[[\text{stamp collect}]] \leq [[\text{collect}]]$

But: How to combine the descriptive content of DP with that of V, ignoring D, and preserve compositionality? Can one form an event-type description with a referential expression in it? If so, how?

Incorporation

Chung & Ladusaw 2004

“Doubling” of incorporated nominals supports distinction between *restriction* of verbal participant roles and their *saturation*:

- (9) Găi-ga’ (un ga’lagu) ennao na patgun.
agr.have-pet a dog that L child
‘That child has a pet dog.’

(Chamorro, Chung & Ladusaw 2004: 89, ex. (29a))

Incorporation

Chung & Ladusaw 2004

- ▶ Dissociate the notion of syntactic complement from semantic argument, and adjunct from modifier: The doubling nominal is an *adjunct* that *saturates* V; cp. Cecchetto & Donati's 2015 “late adjunction” of D.
- ▶ Yet their logic does not make this dissociation transparent: the same lambda-bound variables are used both to glue together verbal and nominal descriptive contents and to manage (reference-related) saturation.

$$(10) \quad \textbf{Restrict}(\lambda y \lambda x [\textbf{have}(x, y)], \textbf{pet}) = \\ \lambda y \lambda x [\textbf{have}(x, y) \wedge \textbf{pet}(y)]$$

$$(11) \quad \textbf{FA}(\lambda y \lambda x [\textbf{have}(x, y) \wedge \textbf{pet}(y)], f(\textbf{dog})) = \\ \lambda x [\textbf{have}(x, f(\textbf{dog})) \wedge \textbf{pet}(f(\textbf{dog}))]$$

Incorporation

Farkas & de Swart 2003

Incorporation of bare singulars vs. bare plurals in Hungarian (p. 135, slightly adapted):

- (12) János **beteget_i** vizsgált ??ő_i...
Janos patient.ACC examine.PAST him
'Janos patient_i-examined ??him_i...'
- (13) János **betegeket_i** vizsgált őket_i...
Janos patient.PL.ACC examine.PAST them
'Janos patients_i-examined in the office them_i...'
- (14) János **egy beteget_i** vizsgált őt_i...
Janos a patient.ACC examine.PAST the him
'Janos examined a patient_i him_i...'

Incorporation

Farkas & de Swart 2003

- ▶ DRT-based analysis.
- ▶ Variables for discourse referents, which instantiate the arguments of a predicate, are distinguished from variables for so-called Thematic Arguments (cf. Koenig & Mauner 1999).
- ▶ Two different kinds of semantic composition rules:
 - ▶ Unification of thematic arguments.
 - ▶ A(rgument)-Instantiation by the discourse referent *contributed by the fully interpreted nominal argument*.

Incorporation

Farkas & de Swart 2003

Two ways to associate a nominal with a discourse referent:

- ▶ **D(eterminer)-Instantiation:** Instantiate the thematic argument z of the NP by the discourse referent u contributed by material under D, and subscript u with the index x , writing u_x . (p. 35)
- ▶ **Secondary Instantiation** (for bare plurals): Instantiate the thematic argument x of a nominal with a discourse referent a_x that it is co-indexed with. (p. 49)

Secondary instantiation

“Secondary Instantiation, unlike D-Instantiation, is driven by the presuppositional semantics of the plural rather than by the lexical input of the syntactic configuration. Unlike D-Instantiation, Secondary Instantiation is not triggered by a reduction rule, and **therefore its application is not tied to a particular point in the derivation** [emphasis ours]. It is a last resort strategy that allows a discourse referent contributed by the plural feature to connect to the thematic argument of the nominal in the absence of a proper binder.” (p. 48-49)

- ▶ Dissociates the point at which discourse referents are instantiated from the point at which thematic arguments are unified.
- ▶ No strong reason not to do this with DPs in general.

Reanalysis of Chamorro incorporation

Option 1: Perform D-Instantiation on *un ga'lagu*, then A-Instantiation with the (unified) *gäi-ga'*.

- (15)
- a. *gäi*: $\langle \{\}, \{\text{have}(x, y)\}, \{\} \rangle$
 - b. *gäi-ga'*: $\langle \{\}, \{\text{have}(x, z), \text{pet}(z)\}, \{\} \rangle$
 - c. *un ga'lagu*_[sg]: $\langle \{u_w\}, \{\text{dog}(w)\}, \{u_w\} \rangle$
 - d. *gäi-ga' un ga'lagu*:
 $\langle \{u_w\}, \{\text{have}(x, u_w), \text{pet}(u_w), \text{dog}(u_w)\}, \{u_w\} \rangle$

(Color coding: DRs, conditions, presupposed DRs)

Reanalysis of Chamorro incorporation

Option 2: Ignore D-Instantiation on *un ga'lagu*, perform Unification of thematic arguments on *gäi-ga'* and *un ga'lagu*, then Secondary Instantiation on the thematic argument of *un ga'lagu* and, along with it, the verb:

- (16)
- a. *gäi-ga'*: $\langle \{\}, \{\text{have}(x, z), \text{pet}(z)\}, \{\} \rangle$
 - b. *un ga'lagu*_[sg]: $\langle \{\}, \{\text{dog}(w)\}, \{u_w\} \rangle$
 - c. *gäi-ga' un ga'lagu*:
 $\langle \{\}, \{\text{have}(x, w), \text{pet}(w), \text{dog}(w)\}, \{u_w\} \rangle$
 - d. *gäi-ga' un ga'lagu*:
 $\langle \{u_w\}, \{\text{have}(x, u_w), \text{pet}(u_w), \text{dog}(u_w)\}, \{u_w\} \rangle$

Extension to idioms

Unification for modification: Replace the relevant thematic argument x of a modifier with the thematic argument y contributed by the predicate it modifies. Eliminate any speaker-presupposed discourse referent associated with the modifier.

- (17)
- a. *pull*: $\langle \{\}, \{\text{pull}(x, y)\}, \{\} \rangle$
 - b. *some*: $\langle \{\}, \{\text{some}(w)\}, \{u_w\} \rangle$
 - c. *strings*: $\langle \{\}, \{\text{strings}(z)\}, \{u_z\} \rangle$
 - d. *some strings*: $\langle \{\}, \{\text{strings}(z), \text{some}(z)\}, \{u_z\} \rangle$
 - e. *pull some strings*:
 $\langle \{\}, \{\text{pull}(x, z), \text{strings}(z), \text{some}(z)\}, \{u_z\} \rangle$
 - f. *pull some strings*:
 $\langle \{u_z\}, \{\text{pull}(x, u_z), \text{strings}(u_z), \text{some}(u_z)\}, \{u_z\} \rangle$

Only remaining issue: Dealing with the non-transparency of Unification.

Distributional Semantics for descriptive content

- ▶ Lexical representations are continuous, non-symbolic, and concept-like
- ▶ Learned from text (and possibly accompanying perceptual input)
- ▶ Antecedents: Harris 1954, Firth 1957, vector space models of semantics for information retrieval (see Turney & Pantel 2010), Latent Semantic Analysis (Landauer & Dumais 1997)
- ▶ Representations originally based on “count” models; currently, “prediction” models are more prevalent (see various works by Mikolov and colleagues; Baroni, Dinu & Kruszewski 2014; Pham 2016 for comparison).

Illustration with a count model

because not all boots are red. Similarly, the items for the (or living), number of packed red blood cell units transfused, at the 6 mo before transplant, red blood cells transfused, and possibly by saying, It's round, it's red, it is a fruit; I've Promotion, Ontario, Canada, 2008–2009. red dots, malaria case-protein; and absence of dysmorphic red cells, heavy protein, and indicated by darker shades of red. Map was constructed by using Ikoma Ward in northwest Tanzania. red dots indicate cases of malaria regarding abnormal uterine bleeding. Recognise red flag symptoms: green apple, a red apple, red grapes, and green grapes, family make a guess before the red screen appeared. The instructor asks important to rule out any red flag symptoms for cauda equina

Illustration with a count model

	bright	fiery	grapes	carrot	blood	meal
red	99	55	41	18	100	1
green	75	4	40	37	9	10
hair	39	22	0	51	35	0
wine	6	2	79	12	65	150

From words to phrases

and sturdy, with carrot red hair that matched his temperament
and her bundle of curly red hair is out of control.
Although we both have red hair and freckles, our dispositions a
her glorious, flaming mane of red hair only once before, when a
She had dyed red hair -- that bloody shade -- brutal amounts
The woman with red hair and freckles was crying.
ex-professor with freckles and curly red hair. When I asked how
A strand of copper red hair had escaped her hood and
29 years, a rocket of flaming red hair, drive, defiance, raw po
with her combo of red hair, porcelain skin and fine bones
silence, she let her fiery red hair fall over her shoulders as
school. Iris had wild red hair, green eyes, a strong nose

A count model for phrases

	bright	fiery	grapes	carrot	blood	meal
red hair	148	77	82	69	135	1
red wine	105	57	120	30	165	151

Importantly:

- ▶ Representations for phrases can be composed from representations for words or smaller phrases (see e.g. Baroni, Bernardi & Zamparelli 2014, Pham 2016 for recent overviews).
- ▶ These composition operations typically take into account syntactic information (see Erk & Padó 2008, Lenci 2016 a.m.o.) – typically, **dependency parsing**.

Connecting Distributional Semantics and DRT

- ▶ Interpret content words as vectors. Think of these as alternatives for types or kinds, as used by Carlson 2003 (above) or Zamparelli 1995 (for nouns...another talk).
- ▶ Compose vectors using distributional semantic methods.
- ▶ Functional morphology (e.g. number, determiners, tense) introduces a relation **R** to relate entity tokens to the (possibly composed) vectors they instantiate.
- ▶ Integrate into Farkas & de Swart's version of DRT, including liberal use of Secondary Instantiation.

Core idiomatic expressions

Basic vector composition (+: your favorite distributional composition operation):

$$(18) \quad [\text{VP pull strings}]: +(\overrightarrow{\text{pull}}, \overrightarrow{\text{strings}_{ob}})$$

The inner workings of the composition operation will guarantee that *pull strings* can be interpreted idiomatically.

Adding referential information

- ▶ Representations are quadruples, including the vector contributed by the word or phrase in question.
- ▶ Substitute Unification with vector composition.

- (19)
- a. *pulled*: $\langle \{\}, \{\mathbf{R}(e, \overrightarrow{\text{pull}})\}, \{u_e\}, \{\overrightarrow{\text{pull}}\} \rangle$
 - b. *some*: $\langle \{\}, \{\mathbf{some}(y)\}, \{u_y\}, \{\} \rangle$
 - c. *strings*: $\langle \{\}, \{\mathbf{R}(z, \overrightarrow{\text{strings}})\}, \{u_z\}, \{\overrightarrow{\text{strings}}\} \rangle$
 - d. *some strings*:
 $\langle \{\}, \{\mathbf{R}(z, \overrightarrow{\text{strings}}), \mathbf{some}(z)\}, \{u_z\}, \{\overrightarrow{\text{strings}}\} \rangle$
 - e. *pulled some strings*: $\langle \{\}, \{\mathbf{R}(e, \overrightarrow{\text{pull}}), \mathbf{R}(z, \overrightarrow{\text{strings}}), \mathbf{some}(z)\}, \{u_e, u_z\}, \{+(\overrightarrow{\text{pull}}, \overrightarrow{\text{strings}}_{ob})\} \rangle$
 - f. *pulled some strings*: $\langle \{u_e, u_z\}, \{\mathbf{R}(u_e, \overrightarrow{\text{pull}}), \mathbf{R}(u_z, \overrightarrow{\text{strings}}), \mathbf{some}(u_z)\}, \{u_e, u_z\}, \{+(\overrightarrow{\text{pull}}, \overrightarrow{\text{strings}}_{ob})\} \rangle$

Final comments

- ▶ The syntactic analyses of idioms by Sportiche 2005 and others look odd if we think of tree structures as a reflection of morphosyntactic structure.
- ▶ These proposals reflect a general fact: verbs select for the descriptive content of nouns, whereas determiners are not selected for in the same way.
- ▶ Determiners (and other functional morphology) play a crucial role in supplying verbs with the referents for their participant roles: Saturation. Saturation is looks like a type of selection by the verb.
- ▶ But these two types of selection should not be conflated.

Final comments

- ▶ Nominal descriptive content serves to restrict verbal descriptive content to form complex event (sub)type descriptions, both for idioms and for more or less fixed and non-idiomatic V-N combinations. We proposed using (syntactically-savvy) **distributional semantics** for this part of the composition process.
- ▶ We maintain **symbolic methods** for connecting these to referents, and for reference-management itself.

Final comments

- ▶ It is commonly assumed that the syntax and semantics for a full DP is built before it is introduced as an argument to V.
- ▶ Our analysis is not compositional in this sense, insofar as we take a speaker presupposition to license Secondary Instantiation - which we recast as the introduction of token individuals and events that realize type-level descriptions - and the point at which this presupposition is discharged does not have to respect strict morphosyntactic constituency.
- ▶ We do not consider this a problem, but we leave the justification of this claim for another moment.

Thank you!

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