

Sub-compositionality

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1. The Principle of Compositionality

1.1 The Principle

Principle of Compositionality

The meaning of a complex expression is a function of the lexical meanings of its components and the syntactic structure of the whole.

Regularity of semantic composition

The meaning of a syntactically regular expression derives from the meanings of its components in a regular way.

1.2 Syntactic composition and semantic composition

Syntactic composition (in terms of constituency or in terms of dependency, or both) follows grammatical rules.

- The rules of syntactic composition are in terms of **syntactic types** (“syntactic categories”) of expressions to be composed, and of the results.
- The rules are constrained by principles which, at least partly, may be assumed to apply to syntactic composition only: constraints due to the requirements such as linearization, parsability, syntactic interpretability. (Other constraints, such as economy and faithfulness apply more generally.)

Semantic composition follows semantic (interpretation) rules.

- The rules of semantic composition are in terms of **semantic types** of expressions to be composed, and of the results.
- The rules are constrained by principles which, at least partly, may be assumed to apply to semantic composition only: for example, constraints on the representation of objects and situations, logical consistency, plausibility, etc. (Other constraints, such as economy and faithfulness apply here, too.)

1.3 Do syntactic and semantic types match?

Probably, syntactic and semantic types match for the core set of grammatically and semantically basic constructions of first-order predication.¹

More elaborate grammars will most probably develop mismatches of syntactic and semantic types, such as:

- **harboring different semantic types of expressions in the same syntactic construction**, e.g.,
 - intensional predication (*temperature rises*) in the construction for extensional predication
 - “concealed questions” (*determine the origin*)
 - quantifiers in determiner positions (*every dog*)
 - non-predicative adjectives in attributive position (*behavioral psychologist*)
- **distinguishing the semantically equal**, e.g.
 - asymmetric conjunction constructions, due to inevitable linearization
 - asymmetric case marking for reciprocal arguments, due to theta criterion

¹ Cf. theories of semantic and/or syntactic bootstrapping, Pinker 1984

2. The doctrine

2.1 The doctrine of homomorphism

For every syntactic formation rule FR_i , there is a (semantic) composition rule CR_i that defines in a uniform way the meaning of regular expressions formed according to FR_j . The resulting meaning assignment β is a **homomorphism**:

If the output of FR_j for the input $\langle e_1, \dots, e_n \rangle$ with $e_1 \in \text{Cat}_1, \dots, e_n \in \text{Cat}_n$ is $\sigma(e_1, \dots, e_n) = e$ then, according to CR , $\beta(e) = \beta_k(\beta(e_1), \dots, \beta(e_n))$, for some semantic operation β_k .²

- † Each semantic composition rule defines some semantic operation to be applied to the complex input expressions for the rule.
It is tacitly understood that **the semantic operation is uniform** for all input expressions.
- † For each semantic composition rule, the **input is defined in terms of syntactic rules and types**:
all input expressions of a certain syntactic constitution (usually: constituent structure) undergo the same interpretation.

² Cf. Montague 1970, Janssen 1997

2.2 Problems with the doctrine (1): The “proper” treatment of quantification³

[[*every* N VPs]] = [[*every* N]]_{ett}([[VP]]_{et}) second order property of first order property:
 > the property to ‘VP’ is among the properties
 which every ‘N’ has <

[[*the* N_{sg} VPs]] = [[*the* N_{sg}]]_{ett}([[VP]]_{et}) > the property to ‘VP’ is among the properties
 which the ‘N’ has <

instead of: = [[VP]]_{et}([[*the* N]]_e) > the ‘N’ has the property to ‘VP’ <

syntactic inadequacy *The dog, dogs, every dog, my three dogs, etc.*
 differ in constituent structure and syntactic properties (e.g. scope).

semantic inadequacy Neither simple definites, nor simple indefinites involve second-order
 predication (i.e. quantification proper).⁴

cognitive inadequacy Children would start out with a nonquantificational interpretation of
 simple definite and indefinite NPs and won’t revise semantics later.

³ Montague 1973, Barwise & Cooper 1981: Generalized Quantifier Theory

⁴ Kamp & Reyle 1993, Löbner 1987, Löbner 2000

2.2 Problems with the doctrine (2): uniform treatment of extensional and intensional verbs ⁵

- (1) *the sun is rising*
the DAX is rising

extensional predication of type $\langle e,t \rangle$
intensional predication of type $\langle \langle s,e \rangle, t \rangle$

PTQ solution:

generalization to the worst case:

- (a) analyse all predications as intensional.
- (b) add an individual meaning postulate for every extensional verb; the meaning postulate permits reduction to extensional predication

- (2) *she's seeking a handbag*
she's seeking a handbag

extensional predication of type $\langle e,e,t \rangle$
intensional predication of type $\langle \langle s, \langle \langle e,t \rangle, t \rangle \rangle, e,t \rangle$

PTQ solution:

generalization to the worst case: + individual meaning postulates for all non-intensional verbs

⁵ Montague 1973 (PTQ)

Problem 1

Using meaning postulates for individual verbs makes the final semantic description extremely **irregular**: this violates the principle of compositionality (see below). One might as well posit an individual interpretation rule for (almost) each single verb.

Problem 2

“Generalization to the worst case” is principally inadequate:

The method **deliberately disregards semantic differences** between the worst and the less than worse cases, e.g. between quantificational NPs and nonquantificational NPs, between intensional predications and extensional interpretations, and so on.

3. Sub-compositionality

Claim: A theory of semantic composition has to consider the possibility of sub-compositionality

A syntactic construction is **sub-compositional** iff there is no semantic composition rule that applies to all instances of the construction.
(alternatively: ... iff different rules of semantic composition apply to this type of construction) ⁶

† For sub-compositional constructions, semantic composition rules apply to **semantic** subtypes of the construction (such as constructions containing a certain semantic class of verbs, of adjectives, of nouns etc.)

⁶ Löbner (2012)

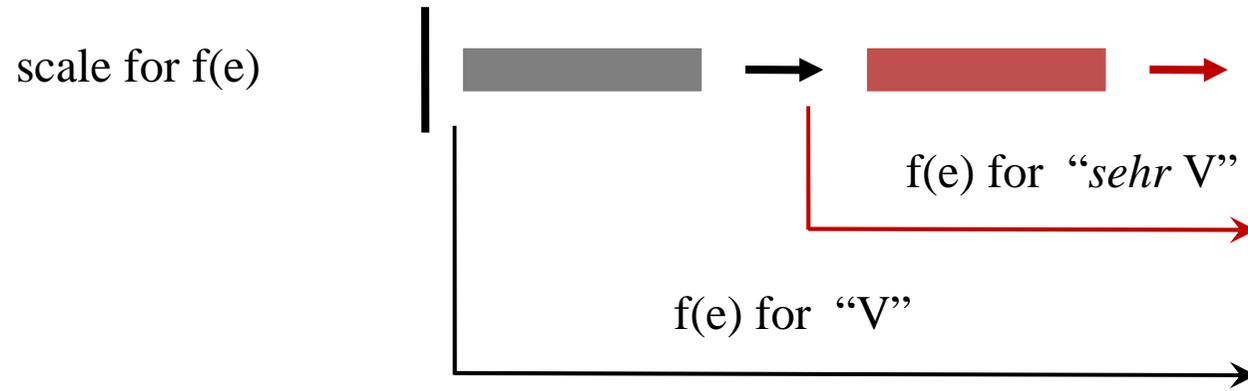
4. A case study: German verb gradation: *bleeding, suffering, cursing, limping, ...*⁷

- | | | |
|-----|---|---|
| (1) | <i>Romeo blutet sehr</i>
'Romeo is bleeding <u>very</u> ' | rate of loss of blood of actor of bleeding event
intransitive verb of substance emission |
| (2) | <i>das Bein schwillt sehr</i>
'the leg is swelling <u>very</u> ' | degree of increase in diameter of undergoer of swelling event
intransitive degree achievement |
| (3) | <i>er leidet sehr</i>
'he is suffering <u>very</u> ' | degree of suffering felt by experiencer of suffering event
intransitive verb of emotion |
| (4) | <i>er flucht sehr</i>
'he is cursing <u>very</u> ' | severity (?) of curses uttered by actor of cursing event
intransitive verb of emotional utterance |
| (5) | <i>er hinkt sehr</i>
'he is limping <u>very</u> ' | degree of unevenness of walking of the walking of the actor
of the limping event
intransitive verb of marked behavior |
| (6) | <i>er hat sich sehr verschätzt</i>
'he has misjudged <u>very</u> ' | degree of deviation from reality of judgment of actor
of misjudging event
intransitive verb of wrong action |
| (7) | <i>das entmutigt ihn sehr</i>
'this discourages him <u>very</u> ' | degree of loss of courage of undergoer of discouragement event
transitive psych verb |

⁷ Fleischhauer (2012)

(1)	<i>blut-en</i> 'bleed'	event	ACTOR —→	a	BLOOD —→	b	LOSS —→	l	RATE —→	dl/dt
(2)	<i>schwell-en</i> 'swell'	event	UNDERG. —→	u	DIAMETER —→	d	INCREASE —→		$\Delta d/\Delta t$	
(3)	<i>leid-en</i> 'suffer'	event	EXPER. —→	e	SUFFERING —→	s	INTENSITY —→	i		
(4)	<i>fluch-en</i> 'curse'	event	ACTOR —→	a	CURSE —→	c	SEVERITY —→	s		
(5)	<i>hink-en</i> 'limp'	event	ACTOR —→	a	WALKING —→	w	UNEVENNESS —→		$\Delta(w,u)$	
(6)	<i>sich verschätz-en</i> 'misjudge'	event	ACTOR/EXP —→	a	JUDGMENT —→	j	DEVIATION —→		$\Delta(j,r)$	
(7)	<i>entmutig-en</i> 'discourage'	event	UNDERG. —→	u	COURAGE —→	c	DECREASE —→		$\Delta c/\Delta t$	

Some **function** $f: E \longrightarrow S$, where S is a **scale**, i.e. a set with a linear ordering.



general constraints:

$$(1) \quad \textit{sehr V} \Rightarrow V$$

$$(2) \quad \diamond (V \wedge \neg \textit{sehr V})$$

$$(3) \quad \neg \textit{sehr V}(e_1) \wedge \textit{sehr V}(e_2) \Rightarrow f(e_1) < (e_2)$$

Verb alternation:

- | | |
|---|--|
| (8a) <i>das verbesserte die Situation sehr</i>
'this improved the situation <u>very</u> ' | quality of undergoer of improvement event
causative degree achievement |
| (8b) <i>die Situation verbesserte sich sehr</i>
'the situation improved <u>very</u> ' | quality of undergoer of improvement event
intransitive degree achievement |
| (9a) <i>sie ärgert ihren Bruder sehr</i>
'she is annoying/vexing her brother <u>very</u> ' | degree of anger felt by experiencer
agentive causative psych verb |
| (9b) <i>er ärgert sich sehr</i>
'he is very angry' | degree of anger felt by experiencer
intransitive experiencer psych verb |
| (9b) <i>das ärgert ihn sehr</i>
'this makes him very angry' | degree of anger felt by experiencer
source causative psych verb |

† Same patterns of semantic composition apply across different syntactic types.

† **Different patterns of semantic composition apply for the same syntactic type.**

5. Autonomous semantics

- > The Principle of Compositionality does not entail homomorphy of syntax and compositional semantics. It only requires:
 - that syntactic structure is one potentially relevant input to semantic composition rules
 - that semantic composition follows *rules*, i.e. semantic composition patterns apply equally to semantic types of component expressions. Therefore:
- > A theory of semantic composition has to start out from determining the semantic types that are relevant for semantic composition.
- > It is only a second question, in which way, and in which cases, semantic types match with syntactic types. **Homomorphy of syntactic and semantic composition is an empirical question.** It cannot be adequately settled by doctrine.

- > Traditional Formal Semantics all but disregards the lexical input of the component expressions: the complex information given by the lexical input is reduced to syntactic type and logical type (which somehow have to match).
- > In actual language interpretation, full lexical meanings are given and present. Therefore, a theory of composition that is based on differentiated lexical meanings is cognitively realistic.
- > Any adequate theory of semantic composition needs to be grounded in a theory of lexical meaning which allows for the determination and description of lexical semantic types.

For example: If we knew the structure of the meanings of psych verbs and of degree achievements, we would be able to explain the semantic mechanisms of grading these two types of verbs, and we would know why the mechanisms are different.

6. Cognition

- > A theory of lexical meanings must be grounded in cognitive psychology, because lexical meanings are stored in the cognitive system. Therefore, a necessary framework for a theory of lexical meanings is a theory of cognitive representations.
- > The most explicit, general, advanced, and experimentally tested theory of cognitive representations is **Barsalou's theory of frames**.⁸

Application to verb gradation

Barsalou frames are recursive attribute-value structures with **functional attributes**. A frame representation of verb meanings yields a network of embedded functions: the argument roles as attributes of the event (or situation), attributes of the arguments, attributes of the values of attributes of the arguments, and so on. Functional composition ensures that iterated attributes all are attributes of the event itself.

- > The gradable function $f(e)$ involved in verb gradation can be analyzed as a chain (functional composition) of attributes in the event frame.

⁸ Barsalou 1992, 1999

7. Life (and language, and linguistics)

François Jacob⁹ (1977): Principle of “**Evolutionary tinkering**”

Rather than working like an engineer, evolution works like a tinkerer: genetic material is not systematically designed, but accidentally recombined out of given bits and pieces, which eventually may result in innovations. (cf. Jacob 1977:1163f)

Tinkering in language evolution

- > emergence of innovations out of the given stock of linguistic tools
(cf. various grammaticalization processes)
e.g. basic syntactic constructions come to harbor semantically heterogeneous cases
- > emergence of new lexical items by mechanisms of morphological and semantic derivation and recombination
e.g. expressions of a certain semantic type may be gradually shifted to other types
(cf. intensional verbs of the *rising temperature* type)

⁹ Nobel Prize in Physiology or Medicine 1965

Tinkering in linguistics:

- > Scientific evolution, too, is mainly implemented by tinkering: evolution of innovations by adopting given tools and ideas.
- > For example, formal semantics built a theory of semantic composition out of bits and pieces from syntax and modal logic, but it had to disregard lexical meaning – the most important ingredient of semantic composition – just because this was a missing piece not available

Time has come to tinker with Barsalou's theory of frames, with the insights of logical and syntactic analysis of lexical items, and with the results of all other approaches to lexical meanings from etymology, over structuralism, to cognitive linguistics – to bring about a theory of lexical meaning and a theory of semantic composition based on it.

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