

# Evidence for frames from human language

Sebastian Löbner

DFG Research Unit FOR 600 “Functional Concepts and Frames”

Düsseldorf University

Second International Conference on “Concept Types and Frames”

Düsseldorf, Germany, August 24 -26, 2009

0. Structure of the argument
1. Barsalou frames
2. Grammatical structures
3. The structure of verb and sentence meanings
4. The evolution of abstract vocabulary
5. Conclusions

## 0. Structure of the argument

### Assumptions

- A1 Human cognitive systems [HCS] operate with one general format of representation [GFR].
- A2 Human language is a behavioural system of conventionalized gestures.
- Lexical gestures are represented in HCS in GFR format.
  - Following rules of a grammar, language producers are able to form complex linguistic gestures [CLG] out of lexical gestures,
  - in a way that enables language recipients to recognize their structure.

*Therefore*

Most probably the structure of CLGs (up to sentence level) agrees with GFR.

A3 Conventionalized gestures, lexical or complex, have meanings.

- The meanings of lexical gestures, stored in the HCS, exhibit GFR.
- The meanings of complex gestures are computed by the HCS and hence in GFR. According to the “Principle of Compositionality” and its common interpretation, the structure of the meanings of CLG essentially reproduces the structure of the gestures themselves.

*Therefore, again,*

most probably the structure of CLG agrees with GFR.

A4 The structure of lexical and compositional meanings, as well as the structures of complex linguistic gestures provides evidence for the nature of the GFR of human cognition.

## Discussion

1. Structural description of Barsalou frames
2. Basic structural properties of grammatically complex gestures  
> *The basic structural properties are those of Barsalou frames*
3. Structural properties of compositional and lexical meanings; evolution of vocabulary  
> *The structure of linguistic meanings is Barsalou frames*

## Conclusion

If there is a GFR, it is essentially Barsalou frames.

## 1. Barsalou frames

Barsalou frames represent a referent in terms of its attributes, their values, attributes of these values, their respective values etc. (recursive structure). The aggregate of attributes and their values constitutes the information about the referent. In this sense, B frames are *parameterized descriptions*.

The essential constituents of B frames are **attributes**. Attributes are functions:

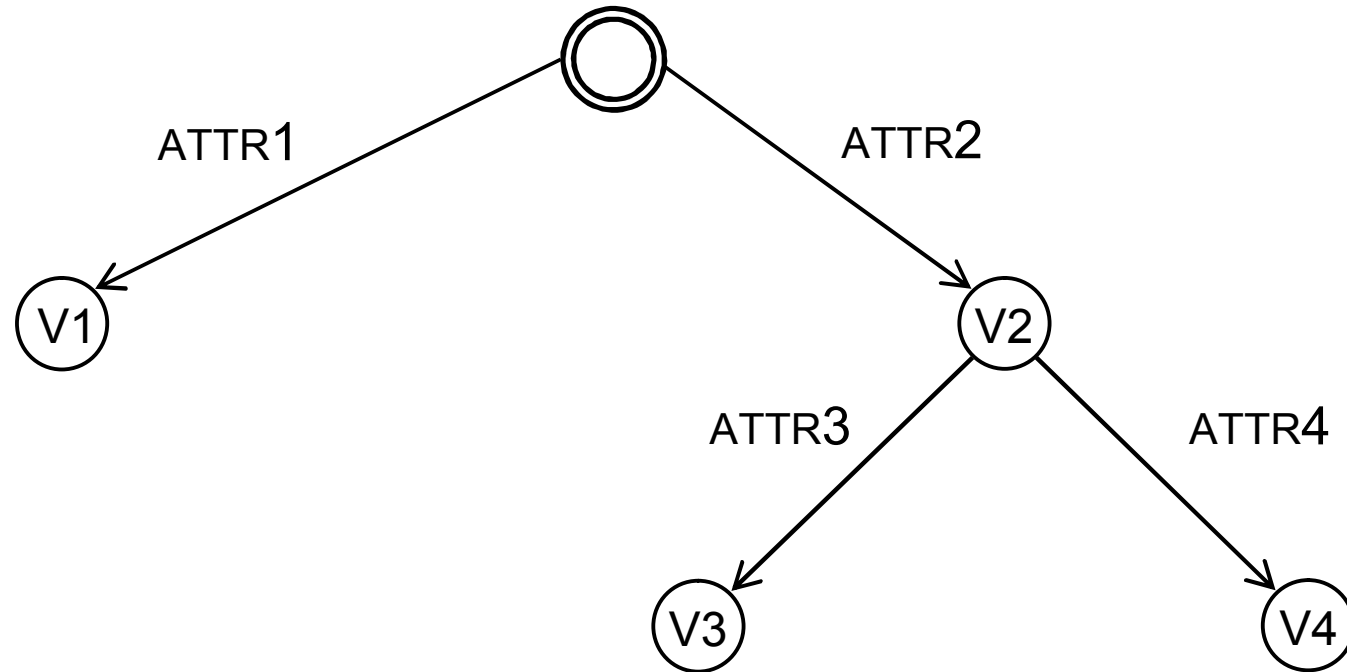
- Defined for a certain type of possessor, attributes assign to every possessor of appropriate type a unique value out of a certain type of values.

*ex.* The attribute COLOUR\_OF assigns possible colour values to the objects of the type “visible [monochrome] object”.

- Value specifications may be more or less specific, but at the most specific level of specification, the value is uniquely determined.
- Attributes and their values are constrained and correlated by various types of constraints (not discussed here).

Graph representation of Barsalou frames (simplified)

central node, attributes, their value, sub-attributes with values



## Crucial uniqueness conditions

### **UR**    *Unique referent*

Ultimately (modulo recursion), all attributes and sub-attributes relate to one and the same referent. (There is exactly one node (the central node) such that every other node can be reached from it via one or more attribute arrows.)

### **UA**    *Unique attributes*

Every attribute is applied to a given possessor at most once. (All attribute arrows originating from one node are mutually different.)

### **UP**    *Unique possessor*

Every attribute assigns a value to one well-defined possessor. (Every attribute arrow originates from one node.)<sup>1</sup>

### **UV**    *Unique values*

Every attribute assigns a unique value to every possible possessor.<sup>2</sup>

---

<sup>1</sup> Notwithstanding n-ary attributes with n simultaneous possessors

<sup>2</sup> Notwithstanding underspecification

## 2. Grammatical structure

Grammatical structure of complex gestures can be universally described in terms of

2.1 Constituent structure

2.2 Dependencies

2.3 Functional features

2.4 Conclusions on grammatical structures

Languages may differ in the grammatical structures they employ, but the structures can invariably be described in combinations of these terms (cf. Van Valin 2002).

## 2.1 Constituent structure

Given that the lexical elements that constitute a given CLG are recognizable parts of the whole, a constituent structure is a mereological structure (a structure in terms of part-whole relations). As such natural language constituent structures fulfil the 4 U:

UR *Unique referent*

There is a unique “mother” of the whole construction.

UA *Unique attributes*

For every mother, all her daughters are of mutually different type.

UP *Unique possessor*

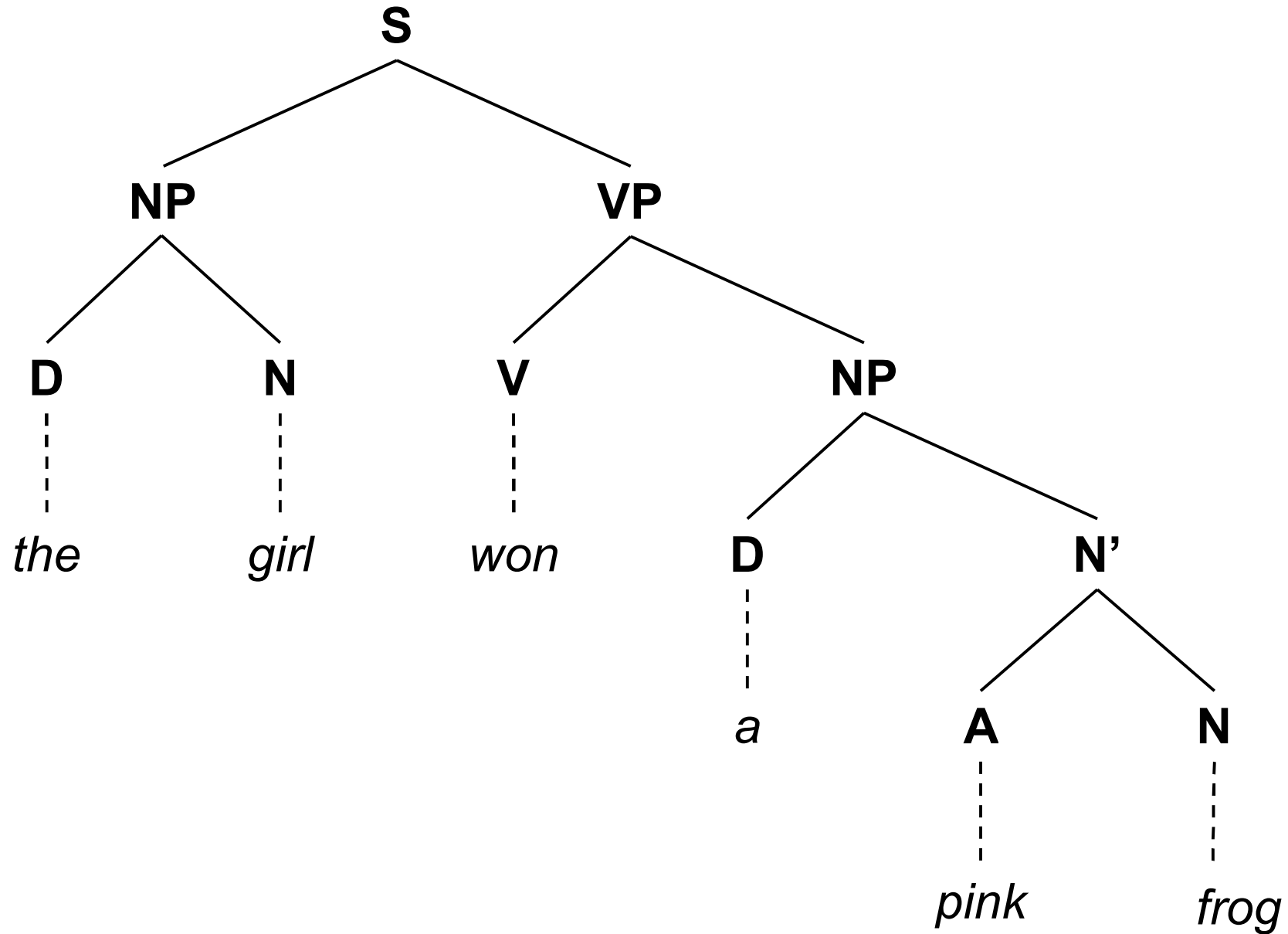
Daughters have unique mothers.

UV *Unique value*

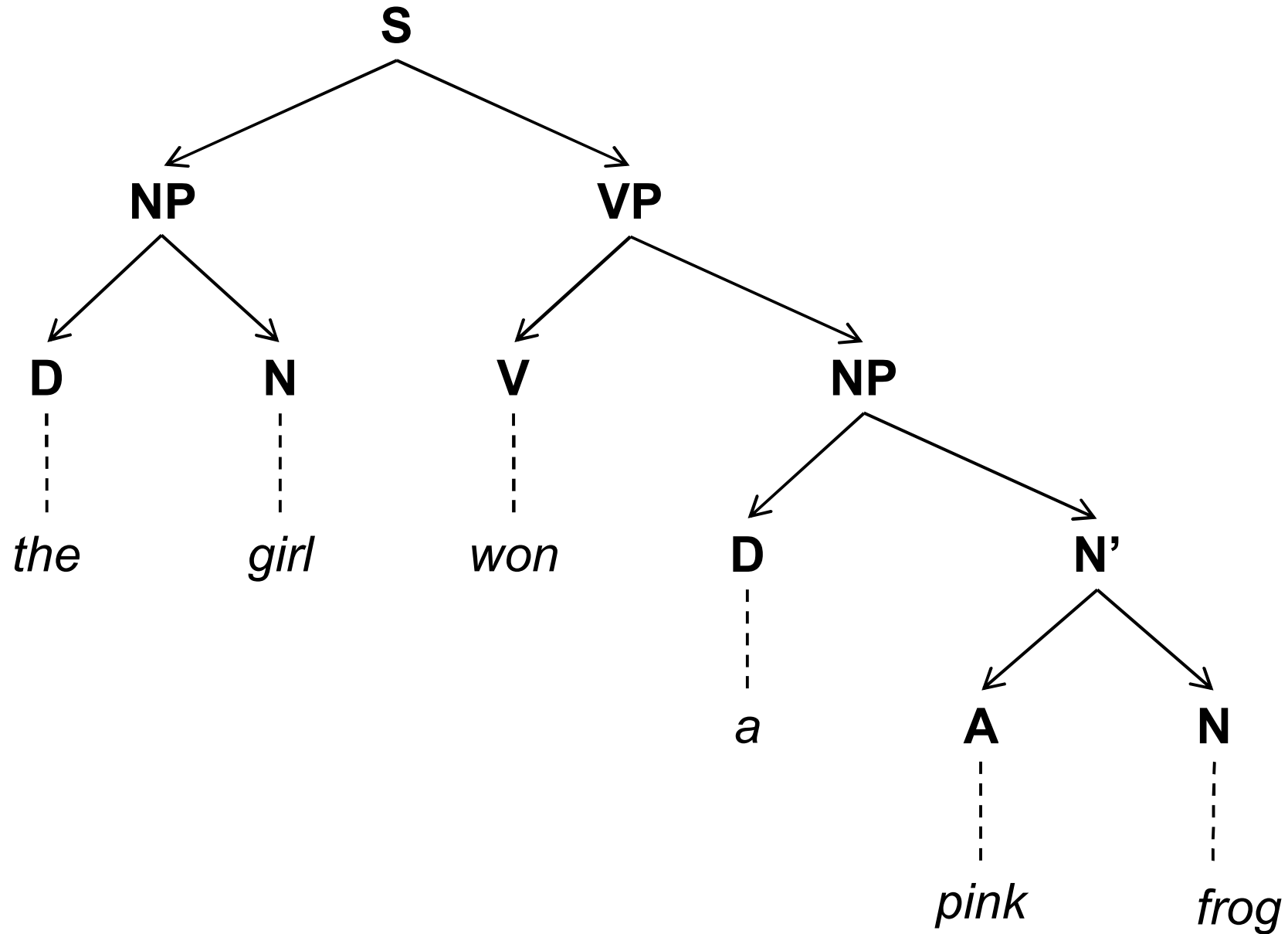
Daughters have unique realizations.

- > Constituent structures can be considered frames in terms of mereological attributes.
- > Parts of speech and complex form classes are value types of particular mereological attributes.
- > The 4 U provide non-trivial constraints on constituent structures.

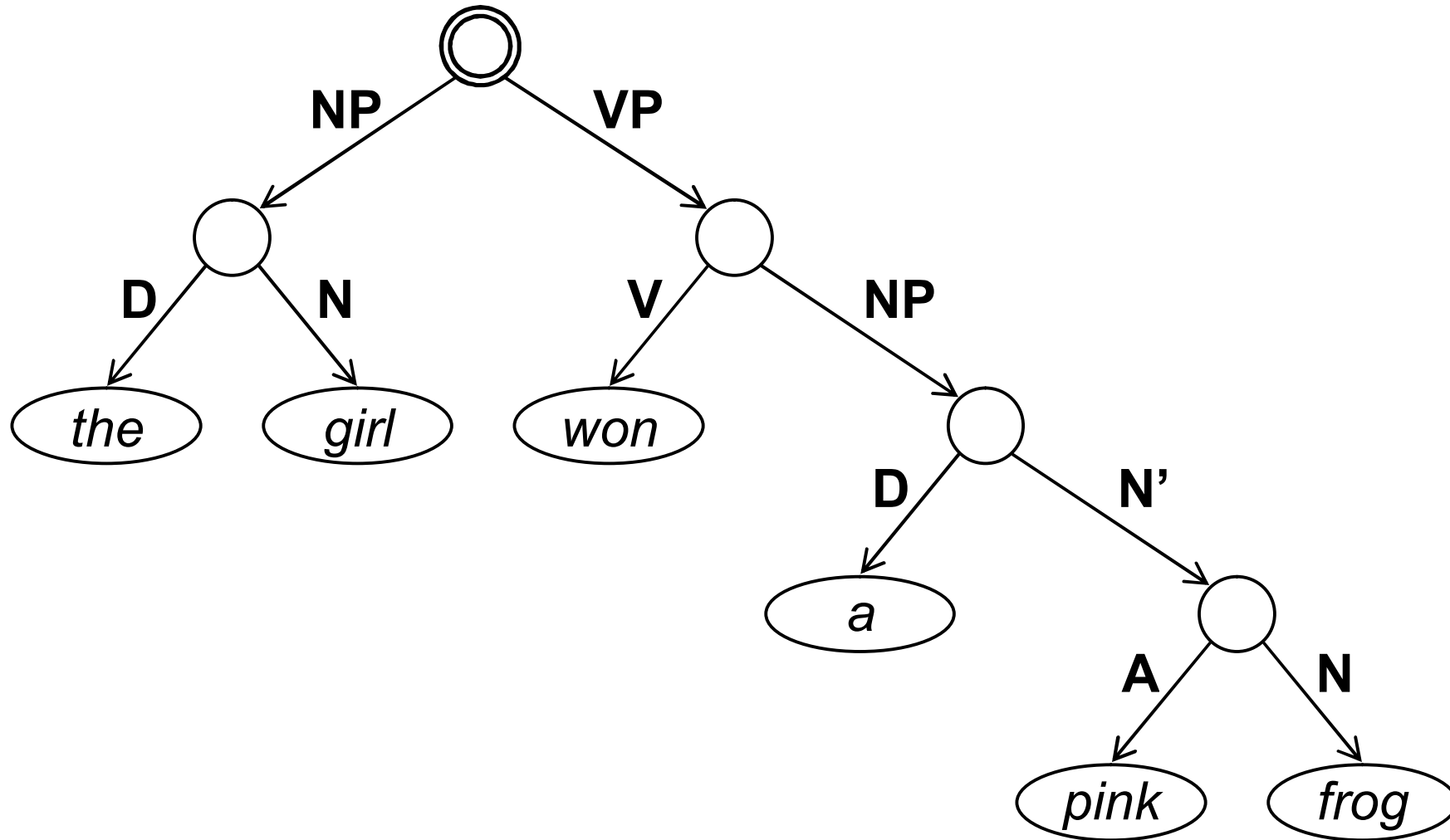
conventional constituent structure tree diagram



tree diagram with arrows



mereological subframe representing constituent structure



## 2.2 Dependency structure

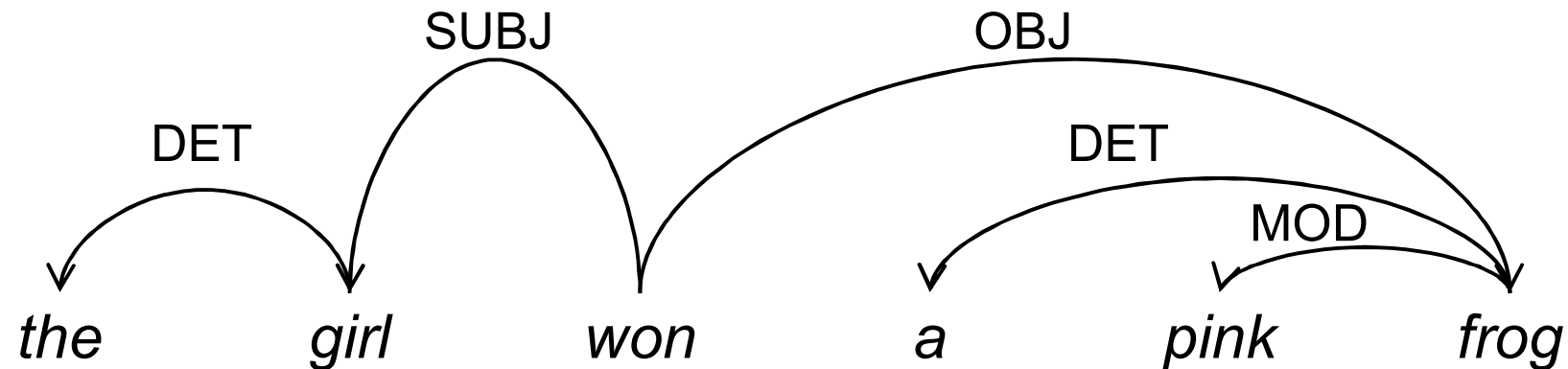
A depends on B if the existence of B requires the existence of A.

UR There is a primary “head” of all dependents and sub-dependents.

UA Dependents of the same head are of mutually different type.

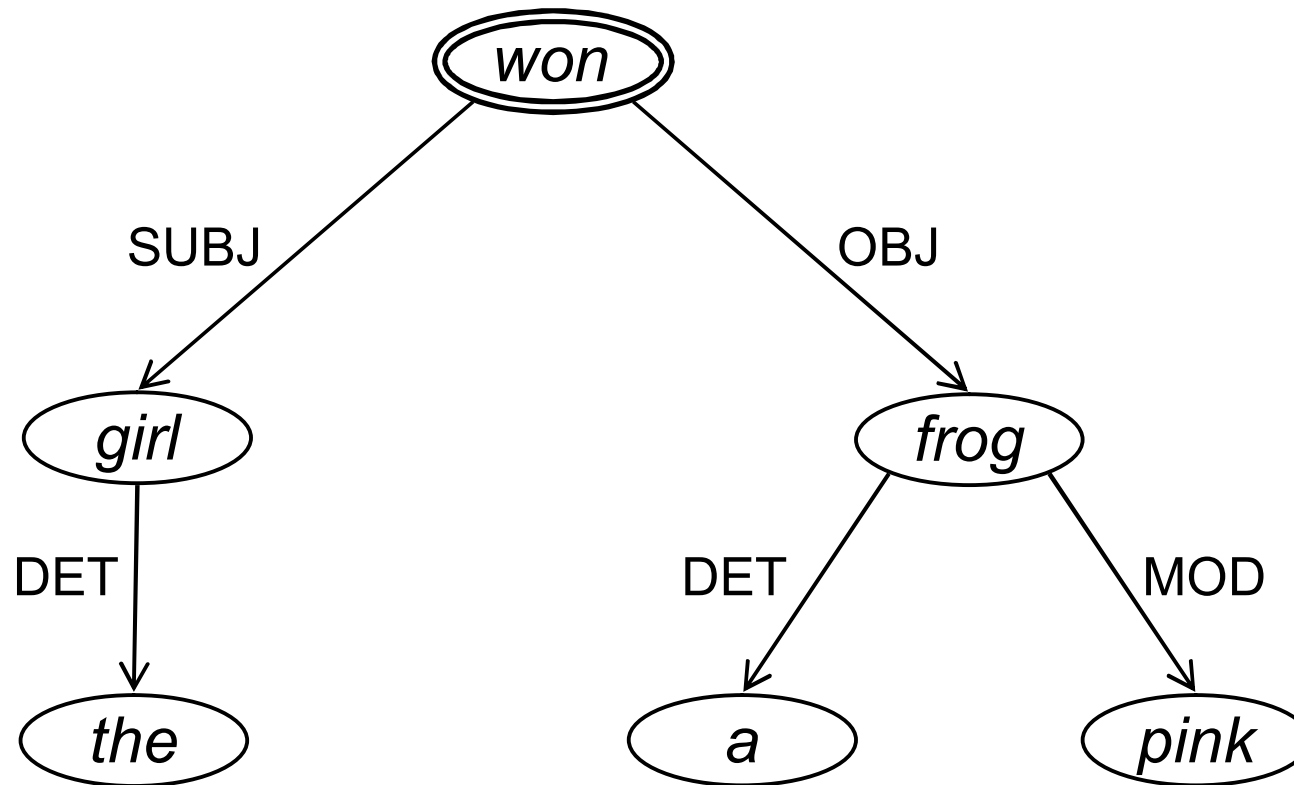
UP Dependents have unique heads.

UV Dependents have unique realizations.



Dependency diagrams can be read directly as frames.

Dependency frame with functional attributes



## 2.3 Grammatical features

Features such as **gender, number, case, tense, aspect, mood** etc.

UA Grammatical features have unique “carriers”.  
(feature inheritance notwithstanding)

UP Any linguistic item carries a feature at most once.

UV Grammatical features of a given carrier take unique values.  
(underspecification possible)

The specification of one feature for one carrier can not be repeated or iterated:

> No double past, double plural, double gender etc.

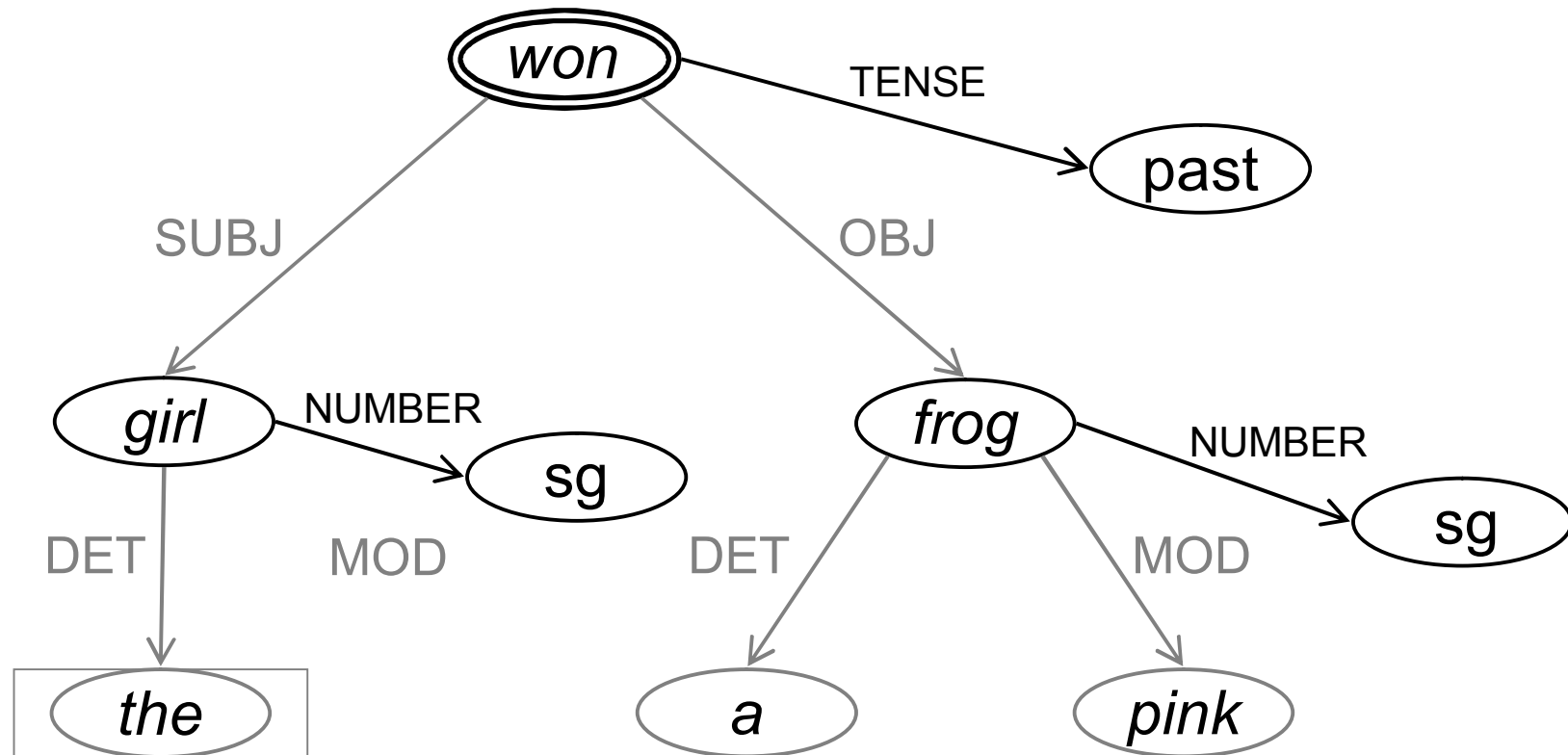
A (logical) case for double plural (1b) or double past (2):

ex. a. *the students gathered in their classroom*

b. *the students\*es gathered in their classrooms*

> Grammatical features constitute direct attributes of their carriers.

dependency frame with functional and grammatical attributes



## 2.4 Conclusions on grammatical structures

- ▶ Complex linguistic gestures (up to sentence level) exhibit the structure of Barsalou frames. The frames are composed of three kinds of attributes
  - C Mereological attributes: their values are constituents
  - D Dependency attributes: their values are dependents of heads
  - F Grammatical features: their values are alternatives out of a small limited choice
  
- ▶ As for the structure of CLG, the GFR of human cognition may be Barsalou frames. If so,
  - we can learn about the architecture of the GFR, i.e. Barsalou frames and frame systems, from the investigation of universal traits of grammatical structures
  - language-specificity of human grammars does not extend to the nature of grammatical structure itself, which is just an instance of GFR. Rather language-specificity would be limited to the choice and combination of attributes in grammatical frames. Are these attributes language-specific or are they just instances of more general attributes which are also used in non-linguistic frames?

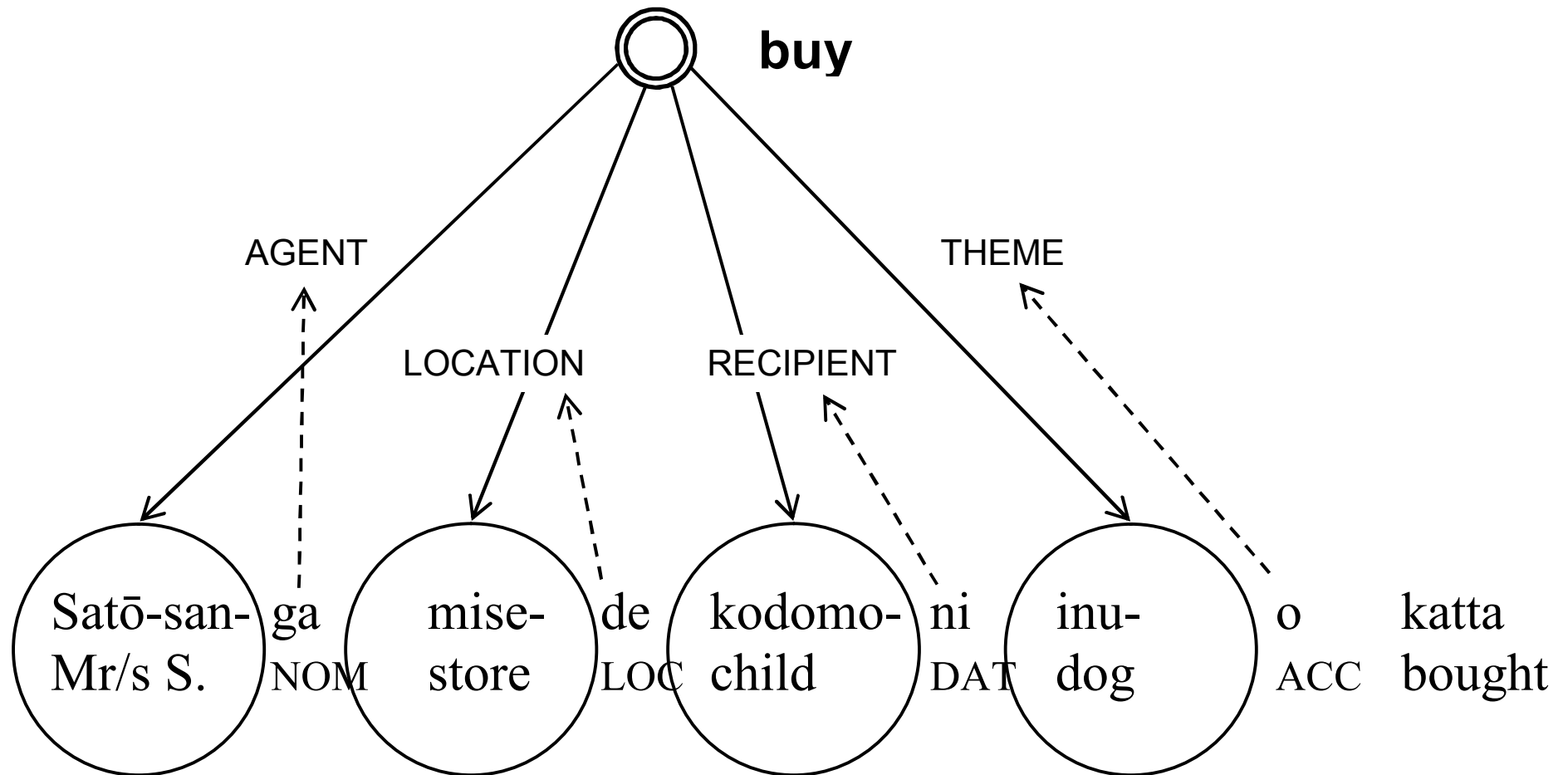
### 3. The structure of verb and sentence meanings

#### 3.1 Verb meanings

The most « framish » elements of language are certainly **verbs**. A one-place or more-place verb opens a frame in terms of its arguments. The arguments represent different semantic roles (e.g. for giving: “giver”, “given object”, “recipient”).

- UR There is a central node that represents the situation itself; all other nodes ultimately relate to the central situation node
  - UA More-place verbs never have two arguments of the same semantic role.  
*... although, logically, two arguments may well be involved in the situation denoted in perfectly the same way, cf. symmetrical predications such as “meet”, “fight”, “separate”.*
  - UP Semantic roles are uniquely linked to one verb node.
  - UV Each semantic role of a verb can be occupied by exactly one “participant” (possibly complex).
- Note that verb frames necessarily contain other attributes in addition to semantic roles.

## “Linking” syntax and semantics: Japanese “buy” syntax



### 3.2 Meanings of CLGs

In a constituent of CLGs, each item (node) is assigned a unique semantic interpretation, its meaning.

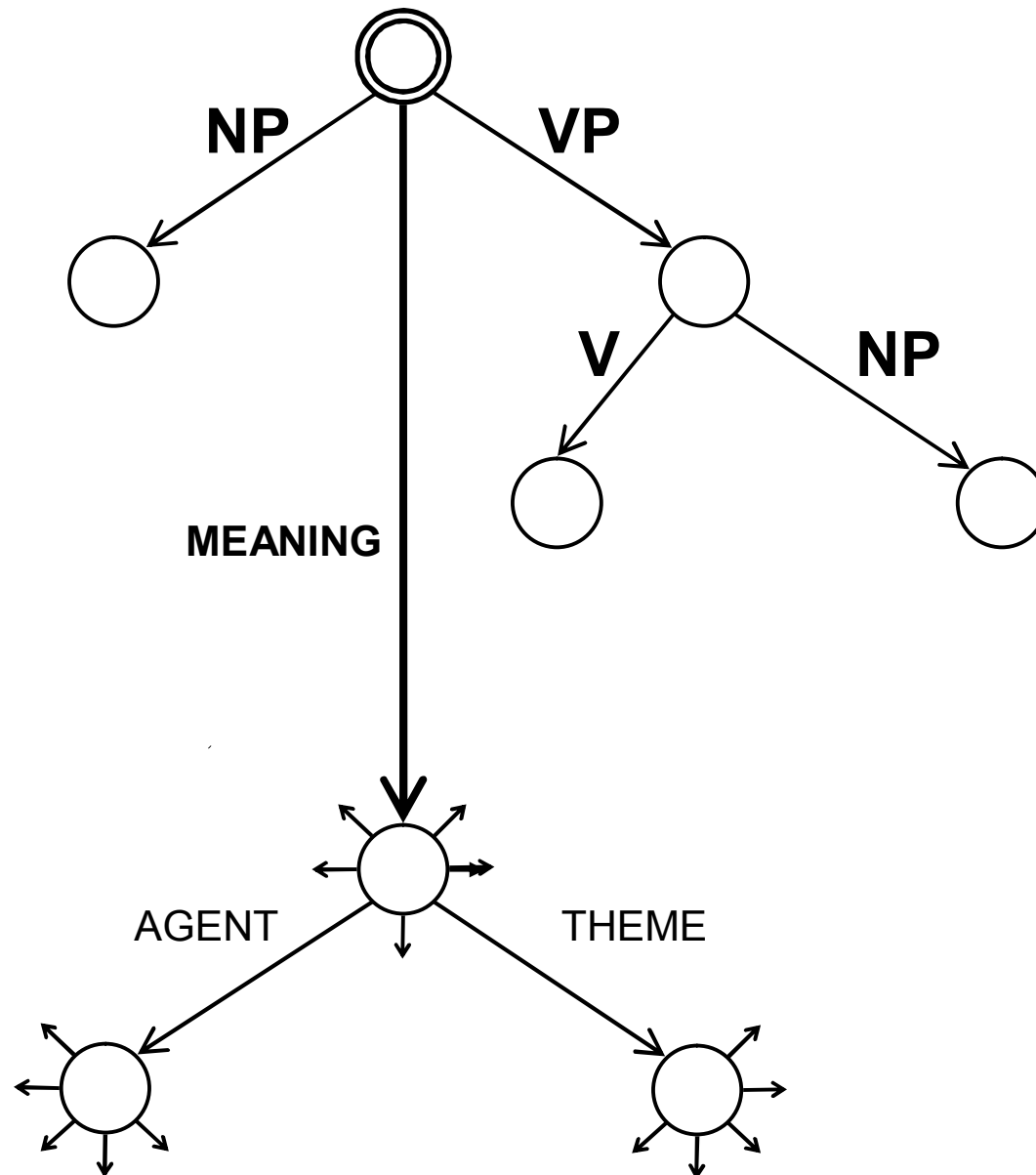
The 4U for the grammatical frame, yield derivative U conditions for the meaning assignment:

- UR There is a meaning assignment for the highest mother constituent (the whole CLG).
- UA There is only one meaning attribute for each constituent.
- UP Meanings are assigned to uniquely determined constituents.
- UV Each constituent is assigned a unique meaning.

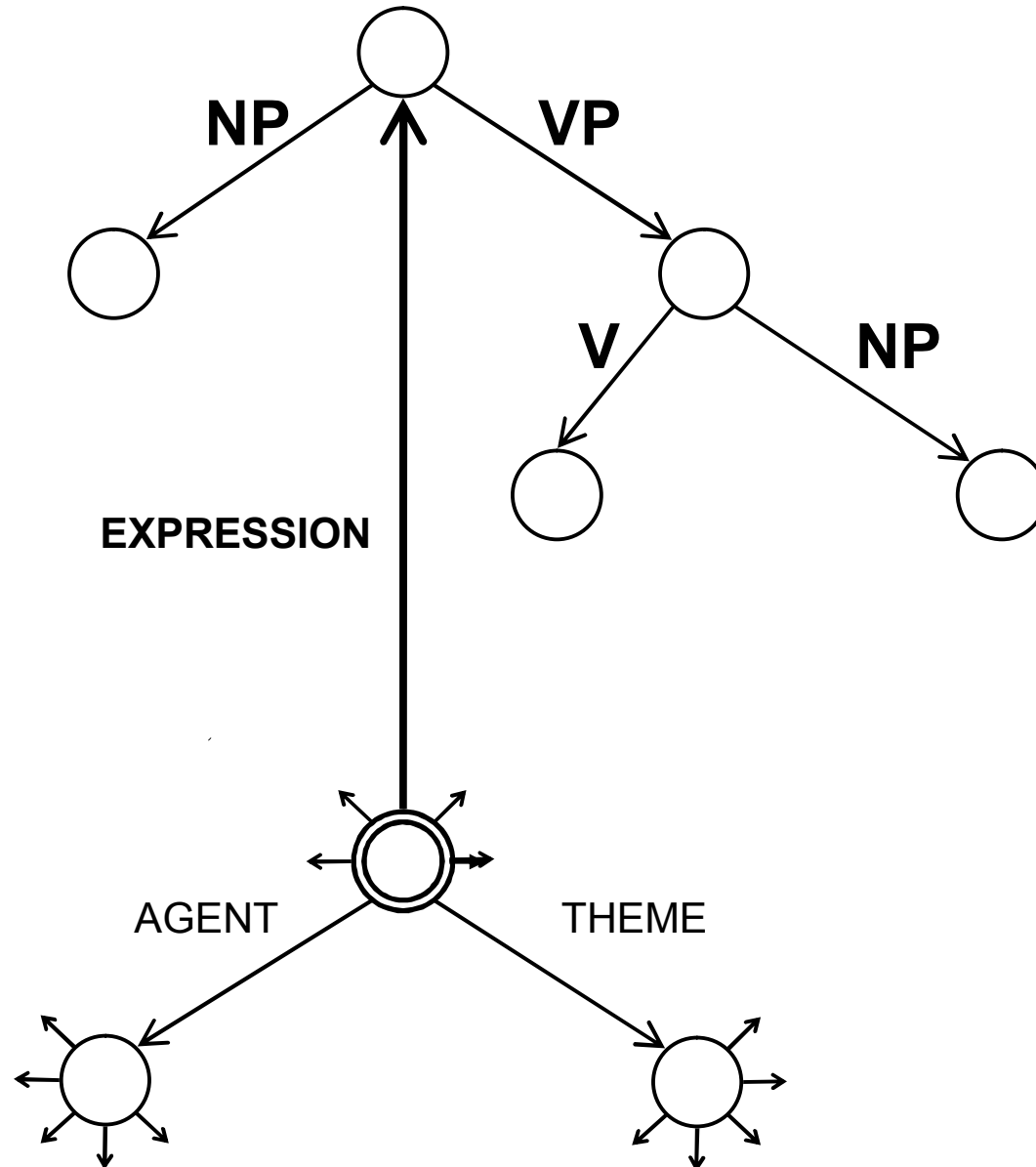
The meanings of lexical gestures are stored in the mental lexicon - in GFR format. Lexical meanings may contain attributes with empty values (argument slots).

The meanings of CLG are constructed by a regular process operating on the given lexical meanings and grammatical structure (Principle of Compositionality).

## Syntax and semantics



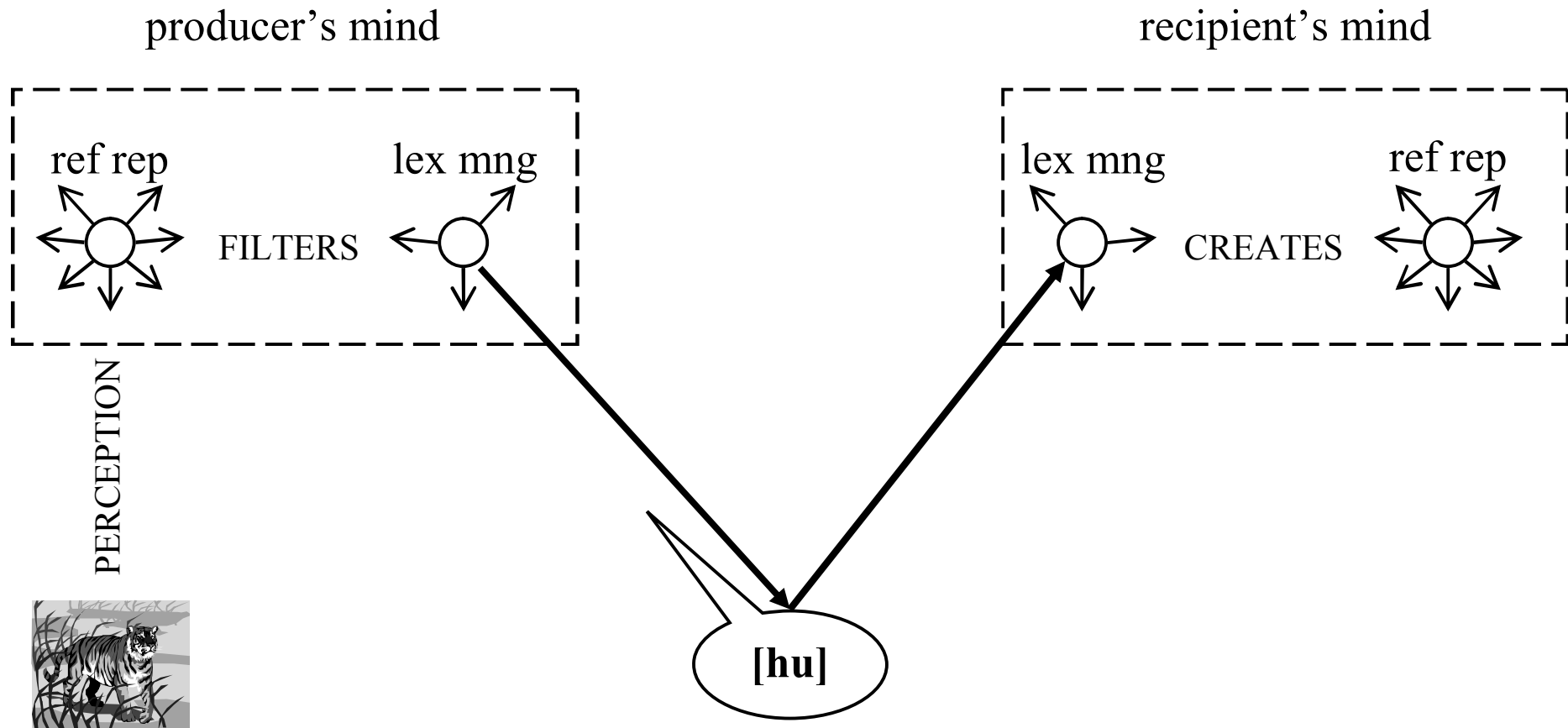
### Semantics and syntax



## **4. The evolution of abstract attribute vocabulary**

- 4.1 A simplified model of reference and linguistic communication
- 4.2 Meanings of argument terms
- 4.3 Types of attribute
- 4.4 Semantic isolation of abstract attributes
- 4.5 Lexical tinkering of abstract attribute vocabulary

### 4.1 A simplified model of reference and linguistic communication



## 4.2 Meanings of argument terms

- Argument terms typically have no arguments themselves. Hence the specification of the values of their defining attributes, or more generally, **meaning components** - and **remain implicit** in verbal communication.
  - In order to ascertain successful common reference, the lexical meanings need to be synchronized. Two strategies facilitate common reference:
    - (1) employing terms with rich meanings where the exact match of all meaning components does not matter: **common nouns**
    - (2) fixing unique reference by convention rather than semantic content: **proper nouns**
  - As language communities grow, as well as the spatial, temporal and sortal range of possible reference, conventionalized meanings are more restricted to a decreasing number of meaning components, i.e. those components which are logically necessary.
  - Eventually, it will become necessary to communicate about single components in order to fix conventional meanings.
- **If the format of lexical meanings is Barsalou frames, languages may eventually develop a vocabulary of frames, their values (and constraints).**

### 4.3 Types of attributes

- M Mereological attributes for constitutive parts of the referent , e.g. body part terms: concrete referents/values, problematic w.r.t. individuation (cf. “whole object constraints”)
  
- R Role attributes for correlates of the referent. e.g. kinship terms *mother, father*, as well as *owner, chief, successor* etc.  
concrete referents/values; criteria of categorization only indirectly by causal chains
  
- D Abstract dimensional attributes such as *size, shape, colour, weight, meaning, function* etc.  
abstract reference/value, requiring abstraction from other features
  
- ▶ **Terms for values and, a fortiori attributes, of these types are increasingly problematic in terms of reference establishment and control.**

## 4.4 Semantic isolation of abstract attributes

### Stage I. Gross attribute isolation

E.g. **oppositions** in terms of one causally primary attribute along with a bundle of interrelated attributes:

*woman vs. man*

primary: SEX

interrelated: biological and social GENDER attributes

*child*

primary: DEVELOPMENTAL STAGE

interrelated: biological and social attributes

Transfer of the opposition to other species will separate/abstract the primary attribute from interrelated attributes.

## Stage II. Precise attribute specification

Precise vocabulary distinguishing between values of single abstract attributes. Probably not by way of lexical oppositions, rather by predicative vocabulary.

- colour terms
- size terms
- quality terms (*good, bad*)
- various dimension terms *long, deep, heavy, fast, old, expensive*

## Stage III. Grasping the range of values of an isolated attribute

antonymies	for opposite values in the same dimension <i>big - small</i>
question constructions	<i>how much, how big, how ...</i>
comparison constructions	comparative, superlative, equative etc.

**Stage IV Functional nouns for the attribute as such: abstraction from values**

## Patterns of emergence

	specified value predicate	corr. property term	open value predicate	abstract attribute term
Ger	<i>groß</i> big	<i>Größe</i> “bigness”	<i>wie groß</i> etc. how big	<i>Größe</i> size
Dutch	<i>veel</i> much	[ <i>veelheid</i> ] “muchhood”	<i>hoe veel</i> how much	<i>hoe-veel-heid</i> “howmuchhood”
Chinese	長      短 <i>cháng</i> <i>duǎn</i> long      short			長短 <i>chángduǎn</i> “longshort”

## 4.5 Lexical tinkering of abstract attribute vocabulary

The vocabulary of abstract attributes is strikingly unsystematic:

- morphologically unrelated antonyms
- branching antonyms, shared antonyms
- attribute nouns not related to adjectives
- occasional abstract dimension verbs not related to adjectives or noun
- meanings shifted to fit

antonyms		noun	verb
<i>big</i>	<i>small</i>	<i>size</i>	-
<i>tall</i>	<i>short</i>	<i>height</i>	-
<i>high</i>	<i>low</i>	<i>height, pitch</i>	-
<i>heavy</i>	<i>light</i>	<i>weight</i>	<i>weigh</i>
<i>long</i>	<i>short</i>	<i>length</i>	-
<i>long</i>	<i>short</i>	<i>duration</i>	<i>last, take</i>
<i>good</i>	<i>bad</i>	<i>quality</i>	-

## Dimension PRICE in German

<i>teuer</i>	expensive	originally “dear” (cognate), “precious”
<i>billig</i>	cheap	originally “proper, just, fair”
<i>Preis</i>	price	loan from Old French <i>pris</i> (now <i>prix</i> ); originally “praise, glory” (inner value) present meaning 15th century
<i>kosten</i>	cost	loan from Old French <i>coster</i> , <i>couster</i> (now <i>coûter</i> ) originally “spend”
<i>preiswert</i>	bargain	“worth its price”

- ▶ **Cognitive attribute concepts are prior to lexicalization.**

## 5. Conclusions

- ▶ Linguistic gestures and linguistic meanings exhibit a complex structure. This structure is a frame structure in the sense of Barsalou's.
- ▶ Provided that Barsalou frames constitute the general format of representation
  - Cognitive psychology might learn about general traits of the GFR from linguistic research into grammatical and other linguistic structures
  - Linguistics might profit from cognitive psychology and frame theory by re-viewing linguistic structures from a frame perspective point of view. Eventually, this might result in a uniform frame-based theory of all linguistic levels of description.