Chapter 2
Evidence for Frames from Human Language

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Abstract The point of departure of this paper is the hypothesis that there is a general format common to all representations in the human cognitive system. There is evidence from cognitive psychology that this might be frames in the sense of Barsalou's. The aim of the paper is an exploration of the consequences of this assumption for natural language. Does natural language provide evidence in favor of Barsalou frames being the general format of representations in human cognition? The paper discusses two levels of representation of linguistic gestures: syntactic structure and meaning. The first part deals with syntactic structure and compositional meaning. It is argued that specific universal uniqueness constraints on the syntactic and semantic structure of complex linguistic gestures provide positive evidence for the assumption. The second part investigates lexical semantics, in particular the emergence of abstract attribute vocabulary. Observations in this field, too, corroborate the hypothesis.

Keywords Frames • Cognition • Natural language • Syntactic structure compositional meaning

2.1 Hypotheses

This paper adopts a strong hypothesis on human cognition:

H1 The human cognitive system operates with a single general format of representations.

Bold as it is, this hypothesis is certainly very attractive. It opens up perspectives for investigating the basic structure of cognitive representations in humans.

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Given the obvious diversity of representations to be dealt with, the hypothesis is certainly controversial. It is, however, a reasonable point of departure. Of course, the assumption is only attractive if it comes with a hypothetical concrete model of this general format. Such a model has to fulfill two requirements: (i) It must be sufficiently expressive to capture the diversity of representations which the human cognitive system is to be assumed to employ. (ii) The model must be sufficiently precise and restrictive in order to be testable.

The hypothesis has fundamental implications for cognitive psychology and neuroscience, for the philosophy of mind, for linguistics, for the philosophy of science, and for information and computer science.

Barsalou (1992a, b, 1999; Barsalou and Hale 1993) assumes that such a general format exists and provides limited experimental evidence.[1] According to Barsalou, the general structure of representations is some version of frames. Barsalou frames are sufficiently restrictive to be testable, and his frame model appears capable of being extended to a wide range of different types of representations. We adopt Barsalou's view as a second hypothesis:

H2 If the human cognitive system operates with one general format of representations, this format is essentially Barsalou frames.

In the following I will refer to Barsalou frames just as 'frames' and to the combination of hypotheses H1 and H2 as the 'Frame Hypothesis'. If the Frame Hypothesis is correct, it applies in particular to cognitive linguistic representations such as lexical entries including lexical meanings, or the grammatical structure and the meaning of complex expressions. Therefore, the investigation of linguistic structures can be used as evidence for testing the Frame Hypothesis. The discussion in this paper will be restricted to syntactic and semantic representations. It will be argued that analysis of the structure of linguistic representations as assumed by linguistic theory essentially supports the hypothesis for the realm of syntactic and semantic representations. Whether or not the hypothesis extends to other levels of linguistic representations or to nonlinguistic representations, is beyond the scope of his paper. The argument is based on the following uncontroversial assumptions:

A1 Human languages are behavioral systems of conventionalized gestures.

a. There is a system of lexical gestures.
b. Following rules of grammar, language producers are able to form complex linguistic gestures out of lexical gestures ...
c. ... in a way that enables language recipients to recognize their structure.

A2 Conventionalized linguistic gestures, lexical or complex, have meanings.

a. The meanings of lexical gestures are stored in the cognitive system.
b. The meanings of complex gestures are computed by the cognitive system.

[1] See Barsalou (1992a) and Barsalou and Hale (1993) for a comparison of the frame approach to other theories of categorization and concept structure.

c. The meanings of complex linguistic gestures can be computed from the structure of the complex gesture and the meanings of the lexical gestures it is composed of.

A2c is a formulation of the principle of compositionality in a very general form (cf. Janssen 1997).

Combining the Frame Hypothesis with these assumptions on human language yields the following conclusions:

C The following linguistic items are represented in the human mind as frames:

a. Lexical linguistic gestures,
b. Meanings of lexical linguistic gestures,
c. Complex linguistic gestures,
d. Meanings of complex linguistic gestures.

Ca and Cb follow from the simple fact that lexical linguistic gestures and their meanings are permanently stored and represented in human cognitive systems. Complex gestures and their meanings are normally not stored permanently, but mental representations of them are generated by the human cognitive system, and hence bound to exhibit the general format of representations. In what follows, we will elaborate on the conclusions Cc (Sect. 2.3), Cd (Sect. 2.4.3), and Cb (Sects. 2.4.1 and 2.5). Elaborating on conclusion Ca would involve going into the phonological and morphological structure of lexical linguistic gestures which will not be done here.

It will be argued that the observable structures of linguistic gestures and meanings actually do provide evidence for a common structure of representation, and that this structure is essentially frames in the sense of Barsalou (1992a, b, 1999).

2.2 Barsalou Frames

2.2.1 The Structure of Frames

In Barsalou (1992a, b), frames are introduced as recursive attribute-value structures with added constraints. A Barsalou frame represents a referent in terms of its attributes, their values, attributes of these values, their respective values, etc. The recursive aggregate of attributes and values constitutes the information about the referent. Barsalou frames are essentially parameterized descriptions. In this article, the notion of frames introduced in Barsalou (1992a, b) is in fact construed in a certain sense which elaborates the original notion in several ways (cf. Petersen 2007; Löbner 2012; Sect. 4). The elaborations include two major points: (1) the attributes are assumed to be strictly functional; (2) Barsalou's approach is extended to different types of concepts. The first assumption is in accordance with all of Barsalou's examples (as well as with his intentions, p.c.). The extension to different

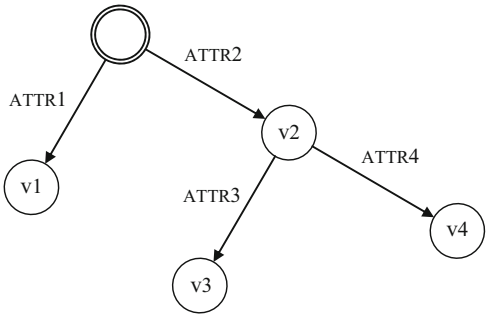


Fig. 2.1 Barsalou frame graph

types of concepts is mandatory if one wants to apply Barsalou's frame model to the lexical meanings of different logical types of expressions such as proper names, relational or functional nouns, or verbs with varying numbers of arguments.[2] The assumption of functional attributes is of central importance for the discussion here; the generalization of the frame approach to different types of concepts matters insofar as functional nouns and concepts will play an important role in Sect. 2.5.3. The essential elements of Barsalou frames are **attributes.** Attributes are functions:

- Attributes assign to every possessor[3] of appropriate type a unique **value** of a certain type; for example, the attribute COLOR_OF[4] assigns possible color 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 description, the value is uniquely determined.
- Attributes and their values are constrained and correlated by various types of **constraints**, such as value restrictions for single attributes, or value covariation of pairs of attributes.

Barsalou frames can be represented in several ways. One mode of representation is recursive attribute-value matrices such as those used in HPSG[5] and other formalisms. We prefer directed graphs. Nodes represent objects and values of attributes; labeled arcs represent attributes. There is a distinguished central node that represents the referent of the frame. For a sortal concept, the central node is a source within the graph: all other nodes can be reached from the central node via an arc or a series of arcs; the central node itself does not have an ingoing node, i.e., it is not the value of an attribute. A simple abstract frame structure is given in Fig. 2.1.

[2] See Löbner (2011: Sect. 2) for the distinction of sortal, individual, relational, and functional nouns and concepts, and Petersen (2007) for the different frame structures applying to the representation of these types of concepts.

[3] The argument of an attribute will be referred to as its 'possessor'.

[4] Attribute terms will be written in small capitals.

[5] Head-Driven Phrase Structure Grammar, initiated by Pollard and Sag (1994).

The topmost node with the double line is the central node. Two attributes, ATTR1 and ATTR2 assign the values v1 and v2 respectively to the referent represented by the central node. The value v2 of the second attribute carries two attributes of its own, ATTR3 and ATTR4, which take the values v3 and v4, respectively. Constraints are not represented in this type of graph.

Barsalou himself uses a different graph notation for frames. In his graphs, attributes, too, are represented by nodes. We prefer the graph representation introduced here because it is less complex and corresponds more directly to the conceptual structure of frames.[6]

2.2.2 *Uniqueness Conditions*

What is essential to a representation in frame format is a set of three uniqueness conditions. These apply independently of the mode of representation chosen for Barsalou frames:

UR ***Unique frame referent***
All attributes and subattributes recursively relate to one and the same referent. (For the graph representation, there is exactly one node, the central node, such that every other node can be reached from it via a chain of one or more attribute arcs.)

UV ***Unique values***
Attributes are partial functions: Every attribute assigns to every possible possessor exactly one value.[7]

UA ***Unique attributes***
Every attribute is applied to a given possessor in a frame structure only once. (All attributes assigned to a given possessor are mutually different.)

UR requires that frames form a coherent whole in a particular way. In terms of the graph representation of frames, UR excludes the possibility that a frame graph may contain subgraphs which are not connected to one another. Rather, frame graphs have a source node. Condition UR is restricted to sortal frames, as opposed to individual, relational, or functional frames. For the latter types of frames,

[6]The graph representation used here implements the principal distinction between attributes and their arguments and values. This distinction is essential; see Petersen (2007) and Löbner (2012: Sect. 4.1) for discussion of this aspect of frame theory and for a comparison of Barsalou's graphs and those used here.

[7]Notwithstanding underspecification. Underspecification leaves room for alternative specifications. For example, the value of the attribute COLOR may be specified not only as, say, 'green', but also as 'warm', 'pleasant', 'sickening', 'stylish', etc. This does not contradict the condition that the attribute takes one particular color as value; rather, these alternative descriptions represent different underspecific predications about the value of the attribute. The values may be complex: for example, a vector of coordinates (see Sect. 2.3.4 on multidimensional spatial case).

UR has to be modified accordingly. These types of frames can be represented by connected graphs, too, but the central node is not a source node (see Petersen 2007 for the structure of nonsortal frames.) For all types of concepts, frames are coherent networks of possessors, attributes, and their values, and have a distinguished node that represents the referent of the whole frame. The discussion of linguistic frames in this article will be confined to sortal frames.

UV is essential. It rules out networks in which (at least some) 'attributes' are nonfunctional relations relating possessors to correlates. For example, UV precludes that in a frame for a person attributes labeled 'CHILD', 'PROPERTY', or 'IS A' would relate children, properties, or superordinates to that person.

UA is a natural consequence of condition UV. If the same attribute were specified more than once for a certain possessor in a frame, its instances would have to return an identical value, resulting in a redundant representation. UA does not preclude multiple occurrences of the same attribute for different possessors in one frame: in a frame graph, arcs with identical label may originate from different nodes.

Obviously, a recursive representation in terms of functional attributes and the values they return represents a frame in Barsalou's sense if and only if these three conditions are met. Therefore these uniqueness conditions will be used in the following argument. We will first turn to syntactic structures, discussing the question as to whether they can be considered to fulfill the three uniqueness conditions (Sect. 2.3). The second part of the paper will deal with the meaning of complex (Sect. 2.4) and lexical (Sect. 2.5) linguistic gestures.

2.3 Syntactic Structure

This section will discuss the basic aspects of syntactic structure, rather than any theoretical frameworks.[8] These aspects are constituent structure (Sect. 2.3.1), dependency structure (Sect. 2.3.2), grammatical functions (Sect. 2.3.3), and grammatical features (Sect. 2.3.4). In this section, the discussion will be restricted to syntactic structure as it can be assessed by purely syntactic means. There seem to be languages for which grammatical structure cannot be settled on the basis of syntactic configurations (constituent structure or dependencies) alone. They have been termed "nonconfigurational".[9] The issue of the autonomy of syntax will be discussed in Sect. 2.4.4.

[8]As this article is not exclusively aimed at linguists, the discussion of syntax and semantics will include the explanation of basic notions in linguistic theory. The discussion is essentially based on Van Valin (2001).

[9]See Pensalfini (2004, p. 362ff) for an overview.

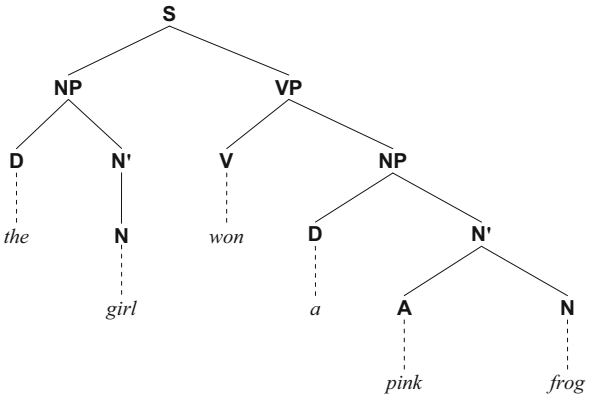


Fig. 2.2 Conventional phrase structure tree diagram of the sentence *the girl won a pink frog*

2.3.1 Constituent Structure

Most approaches to the syntax of natural language – including traditional grammar – are based on constituency: a complex linguistic gesture, specifically a sentence, is analyzed in terms of constituents which may be recursively embedded in one another. Constituents are not just arbitrary substrings of the complex gesture, but constitutive parts with a distinctive function and a certain degree of independence. Van Valin (2001) gives three criteria for constituency. (i) Substitution: "only a constituent can be replaced by another element, usually a pro-form"; (ii) Permutation: "a constituent may occur in different positions in a sentence, while retaining its structural unity". (iii) Coordination: "only constituents may be linked, usually by coordinate conjunction, to form a coordinate structure" (quotes from Van Valin 2001, pp. 111, 112, 113, respectively).

Consider an unsophisticated constituent structure such as the one represented by the phrase structure tree in Fig. 2.2. The sentence S consists of two immediate constituents, NP and VP, the subject and the predicate of the sentence in more traditional terms. These immediate constituents are again analyzed into their immediate constituents, and so on, down to the terminal elements which represent the lexical realizations of the constituents. Expressions and their immediate constituents are traditionally referred to as mothers and their daughters. The representation follows the basic assumptions of X-bar syntax (Jackendoff 1977), a particular framework of constituency theory which is adopted in a large variety of syntactic theories. In X-bar theory, the same types of daughters have to be assigned consistently to the same types of mothers. This is the reason why in the subject NP the article is not immediately attached to the noun N, but to an intermediate N' ('N-bar') constituent. N' is the type of constituent that can, but need not, have an adjective sister, as is the case with the object NP.

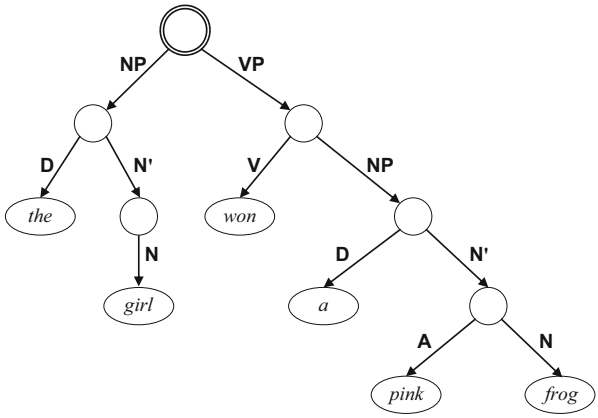


Fig. 2.3 Mereological subframe representing constituent structure

Phrase structure trees and constituency frame graphs. Phrase structure trees can be transformed into directed labeled graphs by applying the following steps:

1. The topmost mother node is marked as the central node.
2. All daughters in the tree, except for the terminal lexical ones, are replaced by nodes.
3. The lines that connect mother nodes to daughter nodes are replaced by arcs which lead from mothers to daughters.
4. Each category label that forms a daughter node in the tree is turned into a label on the arc that leads to the daughter.
5. The terminal nodes of the tree are turned into value specifications of the nodes from which they expand.

The result of applying these transformations to the tree in Fig. 2.2 is given in Fig. 2.3. This is a frame graph. It represents the mereological structure of the complex linguistic gesture. It is to be read as follows. The referent of the constituent structure graph is the whole sentence.[10] It has two parts: the NP *the girl* and the VP *won a pink frog*. NP [OF] and VP [OF] are attributes of sentences, just as HEAD [OF] and STOMACH [OF] are attributes of (bodies) of persons and other creatures. Analogously, the other attributes in the lower parts of the frame are mereological attributes: "D" stands for the attribute DETERMINER [OF] of an NP node, "N'" for the "N' [OF]" attribute, and so on. The terminal nodes of the phrase structure tree are not constituents of their immediate mother nodes; for example, *girl* is not a constituent of N, rather it *is* the N. In the frame graph, they are the values of those mereological attributes which correspond to minimal parts. Thus, *girl* is the value of

[10]The information that the referent is of type "S" is dropped. This is of no detriment since the category label S within the phrase structure is arbitrary and redundant. The fact that the whole complex is a sentence merely follows from its constituent structure.

the N of the N' of the [subject] NP of the sentence, and *pink* is the A of the N' of the [direct object] NP of the VP of the sentence. Since the frame is a mereology, all parts of the same constituent add up to the constituent as a whole. For example, *pink* is the A of *pink frog*, which is the N' of *a pink frog*, which is the NP of *won a pink frog* which is the VP of *the girl won a pink frog*. In this way, the values of those attributes which do not carry a specification entry in their value node are determined. Note that a mere phrase structure frame does not depict the order of its elements. All arcs just denote immediate constituency. Usually, phrase structure trees are arranged, and read, in the way that the terminal nodes appear in their actual order. However, for frame graphs, the spatial arrangement is of no significance, except, of course, for the nodes-and-arcs topology itself.

Uniqueness properties of phrase structures. When phrase structures are construed as constituency frames, the three uniqueness conditions take the following form:

UR_C Unique referent:
There is a unique mother of the whole construction.
UV_C Unique value:
Constituents are unique. Final daughters have unique realizations.
UA_C Unique attributes:
For every mother, all daughters are of mutually different types.

Are these conditions fulfilled in general? Condition UR_C is uncontroversial, though not trivial. It ensures that a constituent structure describes the composition of a complex linguistic gesture as a single coherent whole with a hierarchical structure. The condition excludes structures with two or more independent mothers, for example $\wedge\wedge$ shaped constituent structures with two independent mothers sharing a daughter. It excludes cyclic structures without a source node, and it excludes representations that fall apart into disjoint subgraphs.

Condition UV_C is unproblematic. It rules out the possibility that there is more than one realization for one constituent.

Condition UA_C excludes structures with mothers that have two or more daughters of the same type. There are three types of constructions that, at a first look, might cause trouble: paratactic conjunction,[11] multiple modifiers, and clauses with more than one verb argument in so-called nonconfigurational languages. The analysis of coordination and multiple modification in terms of constituency can be considered settled in syntactic theory. The results comply with UA_C. Constructions with multiple modifiers of the same type, such as [AAAN], can be shown to have a recursively embedded constituent structure [A[A[A N]]] (see Van Valin

[11] Stassen (2000) observes that there are two universal types of languages, which he calls AND-languages and WITH-languages. They differ in the way in which they construct those cases where English would use a conjunction of two NPs. AND-languages combine two NPs in a paratactic coordinating structure, e.g., *Ken and Jo*, while WITH-languages use asymmetric, hypotactic constructions such as *Ken with Jo*. Obviously it is only the AND-languages which provide a potential problem with respect to UA_C.

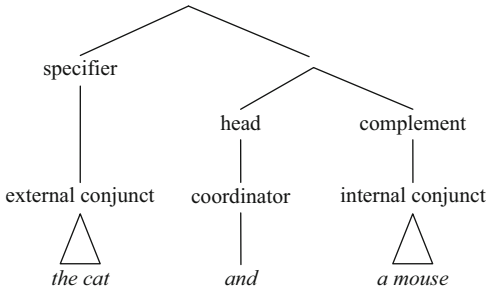


Fig. 2.4 Constituent structure of coordination (Following Zhang 2009, p. 242)

2001, p. 126). As to paratactic conjunctions, the state-of-the-art analysis considers conjunctions as asymmetrical constructions with binary branching. For example, Zhang (2009, p. 242) argues for the general constituent structure in Fig. 2.4.[12]

So-called nonconfigurational languages (Chomsky 1981) lack a VP in the clause. In a simplistic view, in these languages clauses with transitive or ditransitive verbs have two or three NP sisters to the verb: [$_S$ NP NP (NP) V]. This problem in respect to UA_C will be discussed later.

More recent applications of X-bar theory, e.g., Minimalist Syntax (Chomsky 1995), assume a principle of general binary branching: a mother has either one or two daughters, and two daughters are inevitably of different type. Constituents are distinguished in general functional terms such as 'specifier', 'modifier', 'complement', and 'head'. If this principle is recognized, UA_C is obviously fulfilled. Independently, we note that UA_C is by and large achieved by the distinction of types of constituents which differ in function – both within the constituent structure and semantically – such as 'NP' or 'VP'. Thus, syntactic mereology is intrinsically interwoven with functional properties of the parts.

Mereological frames in general. Mereological systems are a very common type of structure in human cognition. One prominent example is the anatomical frame of the human body. We also have mereological concepts for complex artifacts and other objects. The items in a mereology are not just arbitrary portions of the whole, but parts with a constitutive function and a certain degree of independence. Often such mereologies contain what we perceive as multiple parts. Going back to our example of the human body, this would include all those parts of which there are two or more, such as fingers, teeth, or bones. Artifacts, too, may have multiple parts such as the wheels, seats, or doors of a car, the keys of a piano, the leaves of a book, etc. Multiple parts are multiple by virtue of the fact that they share crucial functional and sortal characteristics. Yet their individual function differs. The right ear does not have the same function as the left ear, as each ear perceives a different share of the environmental soundscape, each key of a piano (if properly tuned) produces a different tone, each page of a book may have different content, and so on.

[12]The general constituent structure is quoted from Zhang; the bottom row is added for illustration. Triangles are used in constituent trees as abbreviations for subtrees of unanalyzed phrasal constituents.

Generally, if mereologies are modeled as Barsalou frames, the existence of multiple parts seems to contradict the uniqueness condition UA (all attributes of the same possessor, i.e., parts of the whole, are of different types) or the functional character of attributes (UV). This problem, however, can be dealt with. Part of the solution consists in recognizing that the terms and notions for multiple parts are superordinates of terms and notions for unique parts. The superordinates can, at least in principle, be disambiguated into, say, LEFT EYE, INDEX FINGER, TIBIA, etc. instead of just 'eye', 'finger', 'bone', respectively. Thus, a mereological frame for the human hand would exhibit attributes such as THUMB, INDEX FINGER, MIDDLE FINGER, etc. instead of five equal generalized (pseudo-)attributes 'finger'. In order to comply with condition UA, one has to take care that such generalized terms for mereological attributes are barred from mereological frames. For cognitive representations it appears natural to assume that, despite the naturalness of notions such as 'finger', the cognitive representation of a human body would not represent the five fingers of the hand indiscriminately as just five equal parts.

In addition to employing unique part terms, there is a second method of disambiguation. Multiple parts for which there is a superordinate nonfunctional term may be distinguished by their structural context and/or their relative position. Different bones are placed in a different (and unique) anatomical context, the wheels or doors of a car are in different relative positions, the leaves of a book are numbered sequentially, etc. Accordingly, the mereological frame can be superimposed with a frame for a certain configuration. Barsalou (1999, pp. 590–593) illustrates the integration of frames with relational configurations.

Applied to mereological syntactic frames, we observe the same principles. Constituents are parts of the whole with a certain degree of independence. Also, types of constituents are distinguished and categorized in terms of their function. If, for certain constructions, the syntactic functional distinctions should be insufficient for complying with UA_C, there are other means of distinction. Word order can be used for disambiguation in the same way as relative position in anatomical frames. Further possibilities will be discussed in Sect. 2.4.4.

Summary on constituent structure. At this point, we can fix the following:

- With the preliminary exception of clauses in nonconfigurational languages, 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.

It should be noted that the terms for constituent attributes and for the types of values they take are homonymous: for example, the attribute NP [OF] takes values of the type NP.[13]

[13]The ambivalence is systematic for attribute terms: the functional attribute term *color* [*of*] corresponds to the sortal term [*a*] *color* for possible values of this attribute. See Löbner (2011: Sect. 5.2) with reference to Guarino (1992).

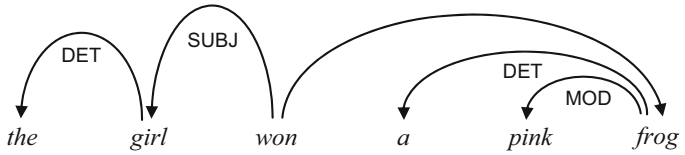
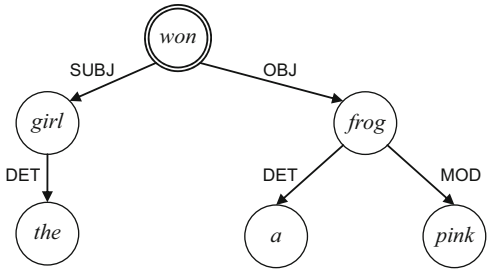


Fig. 2.5 Dependency diagram

Fig. 2.6 Dependency frame



2.3.2 Dependency Structure

A second structural aspect of complex linguistic gestures is dependency relations. A dependency relation holds between two words of which one is the 'head' and the other a 'dependent'. For example, in the English noun phrase *a pink frog*, the noun *frog* is a head with two dependents, the adjective *pink* and the determiner *a*. Heads and dependents are co-occurring expressions, not necessarily adjacent. The head is the "dominant element which is the primary determinant of the properties of the arrangement". Heads "select their dependents and may determine their morphosyntactic and other properties" (both quotes Van Valin 2001, p. 87). Dependencies are usually depicted by means of dependency diagrams such as in Fig. 2.5. The arcs lead from heads to their dependents. Dependency diagrams essentially *are* just frame diagrams, if the highest head is marked as the referent node of the frame (Fig. 2.6); the diagrams in Figs. 2.5 and 2.6 are isomorphic. The dependents are assigned to their heads by functions termed 'subject', 'object', 'modifier', 'determiner', etc. Dependency theory distinguishes different types of dependencies, but this aspect can be neglected here.

The uniqueness issues are parallel to those of constituent structures.

UR_D Unique referent:
There is exactly one element which is a head and not a dependent. All other elements of the structure are ultimately dependent on this element.

UV_D Unique value:
Dependents of a type are unique.

UA_D Unique attributes:
For every head all its dependents are of mutually different types.

Conditions UR_D and UV_D are as unproblematic for dependency structures as they are for constituent structures. Analogous problems arise for UA_D, with the same types of constructions. In the theories of dependency, the treatment of coordinate conjunction and multiple modification is apparently settled as it is in theories of constituent structure. Again, the only type of construction that may provide a problem is that of clauses in nonconfigurational languages.

2.3.3 Grammatical Functions

All theories of syntax agree that basic grammatical functions[14] – such as subject, direct object, indirect object – are of central significance to the syntax of natural language. The classical notions of the grammatical functions are such that a clause can have only one subject, direct object, or indirect object. Thus, the basic understanding is that the following uniqueness conditions hold for grammatical functions:

UV_G Unique value
Grammatical functions receive unique realizations.
UA_G Unique attributes
A clause can contain a grammatical function at most once.

Since grammatical functions are immediately built into dependency structures, the issue of UA for grammatical functions coincides with UA for dependency structures. For constituent structure, the issue is less simple. The problem raises its head for the first time with the question of 'configurationality': is the category of VP universal? Does every clause have a constituent of this type? If a language has a VP in its clause structure, the subject can be syntactically defined as the sister to VP, and direct and indirect object as two different constituents within the VP. But if not, the structural distinction of the basic grammatical functions is less obvious. In terms of constituent structure, one might end up with a flat clause structure with two or three argument NP sisters to the verb with equal status. Thus, the problem of UA for grammatical functions is immediately linked to the problem of UA for constituent structures.

There are two fundamental questions: (i) What are the criteria in terms of constituent structure for determining particular grammatical functions? (ii) Given the typological diversity of languages, are these grammatical functions of universal significance? Do all languages have subjects, direct objects, and indirect objects? If not, are there alternative sets of basic grammatical functions for certain types of languages?

[14] Some scholars, including Van Valin (2001), use the term 'grammatical relations' rather than 'grammatical functions'. I prefer to talk of grammatical functions because notions such as 'subject' are functional concepts.

As to the first question, there are certain clusters of grammatical properties in terms of encoding and syntactic behavior which allow a morphosyntactic definition of the basic grammatical functions (Van Valin 2001: Sect. 2.2). Typically, in a given language, not all properties apply. Thus, the grammatical functions will only be implemented to a certain degree of typicality.[15]

As to the second question, the answer is negative. First, there are languages which lack grammatical functions. Van Valin (2005, p. 89ff) discusses the case of the Indonesian language Acehnese. In this language, the structure of the clause is not defined in terms of 'subject', 'direct object', etc., but consistently in terms of semantic roles like 'actor' and 'undergoer' (see Sect. 2.4.1 below). Those languages that do exhibit a set of grammatical functions differ in which ones they have. According to Van Valin (2001: Sect. 2.3), there are types of languages for which different sets of grammatical functions are relevant, for example, languages with ergative syntax, where the basic syntactic functions are 'absolutive' and 'ergative' rather than subject and direct object.[16]

With respect to grammatical functions, it does not matter for the Frame Hypothesis if all languages have a set of grammatical functions and if all that have share the same set. The Frame Hypothesis does not include the assumption that any particular attributes in syntactic frames are universal. What does, however, matter directly is whether or not particular grammatical functions can occur more than once within a single clause. Van Valin (2001, p. 70ff) discusses examples where this may indeed be considered to apply. One example is the Philippine language Tagalog. Philippine languages provide considerable problems for general grammatical theories and their analysis is highly controversial. One characteristic trait is a system of voices (like the active and passive voice in English) which enables focussing on each of several arguments and adjuncts[17] of the verb. The argument or adjunct which is singled out by voice will be marked with a special case marker *ang*, usually termed 'nominative' in the literature (Schachter and Otanes 1982); all other arguments receive either a case marker *ng* called 'genitive', or a dative case marker, while adjuncts, e.g., locatives, will bear semantically more specific case marking. According to the bundle of syntactic subject criteria, there are two types of NPs in Tagalog sentences

[15]"Even though there do not seem to be universally valid properties which subjects and direct objects each possess exclusively," Van Valin (2001, p. 69) summarizes, "there are enough constructions to provide tests which should enable a linguist to identify these grammatical relations in many languages. Relations which appear to be rather straightforward in familiar Indo-European languages turn out to be much more varied and problematic when a wider range of languages is examined."

[16]The notion of 'ergative' corresponds to the notion of subject, but only for sentences with transitive verbs; subjects of intransitive verbs are subsumed with objects of transitive verbs under the notion 'absolutive'. Van Valin (2001: 77f) discusses the Australian language Mparntwe Arrernte as an example for syntactic ergativity.

[17]The distinction between arguments and adjuncts does not matter much in this paper. Usually, arguments of a verb are those participants which are necessary components of the verb concept. Adjuncts are optional components such as instruments, location of the action, aims, etc. See Van Valin (2001, pp. 92–95) for criteria and problems of the distinction.

which qualify for subjects: NPs marked with nominative and NPs denoting the 'actor' argument (roughly what would be the subject argument for English verbs in active voice.) For example, only the actor argument can be the antecedent of reflexives, independently of the voice of the verb which may single out a different NP as nominative. The nominative NP, on the other hand, is the only NP which can be the head of a relative clause. Plus it is the NP the verb agrees with, by virtue of its voice. This situation leads to the possibility of sentences which have one subject with respect to one set of criteria in addition to another subject with respect to other criteria. Clearly, however, the two "subjects" in such cases do not play the same role in the sentence, as they denote different arguments of the verb. These cases do not invalidate the UA_G condition for Philippine languages. Rather they provide evidence that for languages like Tagalog the basic grammatical functions must be defined differently.

2.3.4 Grammatical Features

Grammatical features play an important part in indicating syntactic structure. It is a striking fact that grammatical features such as gender, number, person, case, tense, aspect, or mood can be assigned to a constituent only once. If feature markings are organized in inflectional paradigms, their once-only quality is immediately grammaticalized. Paradigms such as a case paradigm for nouns or a person paradigm for verbs consist of a closed set of alternative forms. Usually these alternative forms are formed by a particular set of morphemes in a unique morphological position. The unique position allows for exactly one marking of the feature value: one morpheme that specifies person, one for tense, one for case, etc. In rare cases, feature markings can be complex, or stacked; see below.

Most grammatical features have a semantic function such as indicating the number of cases which an NP refers to (grammatical number), being a member of a certain class out of mutually exclusive classes (gender or nominal classifiers), reference to a period of time out of a set of separate time intervals (tense), and analogously for other features. For such features, the values they take are usually incompatible alternatives: reference is to either one or two or more cases; time reference relates either to the past or to the present or to the future; grammatical person indicates either the speaker or the addressee or neither, and so on. As a consequence, there are not only no morphological positions for multiple value assignments of these features, but also the result would be semantically contradictory. All this indicates that grammatical features are in fact attributes in the frame of the linguistic gestures they belong to:

UV_F Unique value
Values of grammatical features are unique.

UA_F Unique attributes
A linguistic gesture carries a grammatical feature only once.

There are some grammatical features for which the semantic argument does not apply. These include grammatical case, and grammatical gender in languages with obligatory gender distinction such as French, Russian, or German. Grammatical gender in these languages usually coincides with natural sex if the referent of the noun carries sex and the noun meaning specifies it, but in all other cases gender assignment is by and large semantically void. Thus, semantics would not bar double gender marking. As it happens, the languages mentioned all have inherent gender for nouns; there is no way of explicitly marking gender, gender is just lexicalized (uniquely, apart from a few exceptions of nonsystematic variation). But even if gender were marked explicitly as in many cases in Spanish or Italian, there will never be double markings of gender.

UA_F does not exclude that a feature of a linguistic gesture be marked more than once for the same value. In fact, the realization of feature markings is a complex morphosyntactic phenomenon. For example in the German NP *ein schöner Garten* ('a beautiful garden', nominative), the noun is inherently masculine, but does not carry a gender marker, while gender is marked by the forms of the article and the adjective; case and number are relevant for the forms of all three NP constituents.[18] UV_F does not exclude underspecification and syncretism.

The uniqueness conditions for grammatical features provide significant constraints on grammars of human languages. The constraints will be briefly illustrated for the features number, tense, and case.

Number. From a semantic point of view, explicit specification of a grammatical feature in many cases indicates a semantic operation on the meaning of the carrier, e.g., a shift in time reference (tense) or a change in the number of instances a predication is to be applied to (grammatical number). For certain communicative ends one might want to be able to express an iteration of such semantic operations. For example, explicit plural can be analyzed roughly as serving the expression of reference to a group of instances rather than to a single instance. Condition UA_F restricts the expression of plurality by the means of grammatical feature marking to one level of group formation. Explicit expression of reference to a group of groups is beyond the functional scope of grammar. Consider the following examples:

(1) a. *The students gathered in their classroom.*
b. *The students gathered in their classrooms.*

The collective plural in (1a) indicates that the predication 'gathered in their classroom' applies to a multitude of students as a whole. The singular form of *classroom* forces the reading that there is one group of students all of whom gathered in one classroom. In (1b), *classrooms* is plural, yielding a predication about a group of groups of students, each group gathering in one out of a group of classrooms. Thus, both *students* and *their* in (1b) have a group-of-groups, or double plural,

[18]For one recent theory of morphosyntactic rules of feature markings, see the framework of Distributed Morphology (Halle and Marantz 1993).

reading.[19] However, there is no way of morphologically indicating double plural on the noun (**studentses*) and there is no double-plural third person pronoun. Corbett (2000, p. 36f) reports very rare cases of 'composed', i.e., stacked number plurals, e.g., in Breton, but these seem to be extremely rare and restricted to very few exceptions.[20] Thus, as a very strong tendency, grammatical number cannot be functionally stacked.[21]

Tense. Similarly, it is easy to conceive of situations where semantically stacked tenses such as past of past, past of future, future of past, or future of future are involved. While such situations can be explicitly expressed in many cases, they are not expressed by double tense marking on verbs or other tense-marked predicators. Options like those in (2) for past of past expression by double tense marking do not seem to exist:

(2)	a. English	*went-*	**ed*		vs.	*had*	*gone*	
		go.PAST-	PAST			have.PAST	go.PARTICIPLE	
	b. Japanese	*tabe-*	*ta-*	**ta*	vs.	*tabe-*	*te i-*	*ta*
		eat-	PAST-	PAST		eat-	PERFECT	PAST

The available means of expressing stacked time reference, such as pluperfects, future 2, or future in the past, seem to never involve double tense marking on the same stem. Note that the correct forms in (2) contain only one tense marking; the form glossed PERFECT is not a tense marker, but an aspect form.

Case. Grammatical case clearly displays the same picture if case morphology forms a closed paradigm as in Russian, Latin, or German. Languages with agglutinative case marking may allow for more than one case morpheme on one noun. Multiple case morphemes are of two types: complex case and stacked case. Complex case consists in marking one case by a series of more than one case morpheme. For example, in Northeast Caucasian Daghestanian languages, there is a set of basic local case affixes (expressing 'in', 'on', 'at', 'behind', 'under', etc.) which can be optionally combined with an affix that specifies a direction. This gives rise to a triad of case variants: essive (absence of motion), allative (motion towards), and

[19] See Löbner (2000, p. 247ff.) for a discussion of such level-2 plural predications, also called 'superplurals' cf. e.g., Linnebo and Nicolas (2008).

[20] Interestingly, Corbett (2000, p. 36) does mention a case of stacked number marking of the kind ruled out here: a double plural marking on Breton 'child' indicating a reference to a group of groups of children: *bugal-e-où* = child-PL-PL; "The first formation," he remarks, "is highly irregular, and the second is a common one. The possibility of composing plural on plural is not freely available."

[21] Cases of functional plural-of-plural and similar stacking must be distinguished from double morphological feature marking with the functional effect of simple plural. For instance the irregular Dutch plural form *kinderen* of *kind* ('child') is based on a former plural *kind-er* (the same form as in the German cognate *Kind*, plural *Kind-er*) to which the general regular Dutch plural suffix *-en* is added. Semantically, the form just functions as a simple plural.

ablative (motion away from).[22] Such complex case markings are not instances of multiple specifications of the same feature, but rather complex specifications of one multidimensional spatial case that consists of a component specifying a spatial region of an object of reference plus a relative direction towards or away from it.[23]

Case stacking occurs as so-called 'Suffixaufnahme' (Plank 1995; Moravcsik 1995). A typical example is the following from the Australian language Gumbaynggir, quoted from Moravcsik (1995, p. 458).

(3) *ba:ba- gu junyu- gundi- yu*
father- ERG child- GEN- ERG
'the child's father (ergative)'

The NP *junyu-gundi-yu* carries an internal case marker that marks it as the possessor phrase for the relational noun *ba:ba*; in addition, both nouns carry ergative case marking. Such structures do not violate condition UA for the attribute CASE: the genitive case morpheme *-gundi* marks *junyu___* as genitive, while the two ergative morphemes mark the whole NP *ba:ba-___junyu-gundi___* as ergative – both on the head *ba:ba* and the possessor NP. Thus the CASE attribute that takes the value 'genitive' is an attribute of the possessor NP only, while the CASE attribute that takes the value 'ergative' is an attribute of the latter's mother.

Summary on grammatical features. Given these observations, we are entitled to conclude that grammatical features can be construed as attributes in structural frames. These attributes can be added to phrase structure frames or to dependency frames. Figure 2.7 illustrates the latter option by adding the attributes NUMBER and TENSE to appropriate nodes in the dependency frame of Fig. 2.6. From this point of view, it appears problematic to treat grammatical features and their expression as constituents as is done in Government-Binding Theory (Chomsky 1981) or Minimalist Syntax (Chomsky 1995). Rather a treatment appears adequate along the lines adopted in LFG[24] or HPSG, where features are treated as attributes.

2.3.5 Conclusion on Grammatical Structure

Among the aspects of grammar discussed in this section, it is grammatical features that provide the strongest evidence for a cognitive representation of grammatical structure in the form of frames. The Frame Hypothesis explains severe restrictions imposed on the expressiveness of grammatical feature markings. For constituency,

[22] Comrie and Polinsky (1998) discuss the complex case systems of the Daghestanian languages Tabasaran and Tsez.

[23] Spatial case may exhibit up to four dimensions; see Creissels (2011) for a survey of multidimensional spatial case systems.

[24] Lexical-Functional Grammar, see Bresnan (2000).

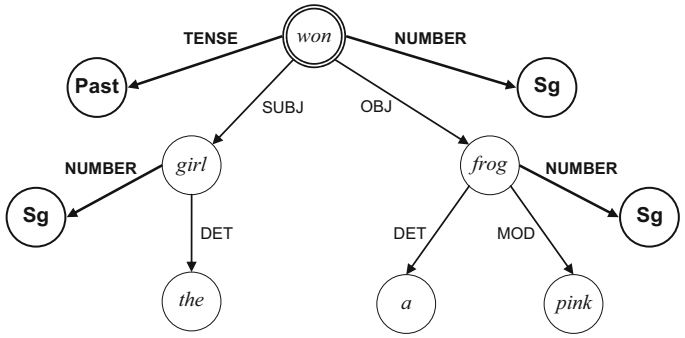


Fig. 2.7 Dependency frame with grammatical features

dependency structure, and grammatical functions the conclusion is this: the Frame Hypothesis is in agreement with basic grammatical structures both in terms of constituent structure and of dependencies. It is also in agreement with the assumption that syntactic functions are unique within a clause – if they are properly defined. The only problematic cases are provided by the clause structure of nonconfigurational languages. Still, there are two ways of reconciling that which we know about constituency, dependency, and grammatical functions with the Frame Hypothesis:

I. Impose UA as a general restriction on constituent structures, dependency structures, and sets of basic grammatical functions, and gain a strong structural constraint which is externally motivated by the Frame Hypothesis. Similar accounts do exist in several versions. For constituent structure, syntactic approaches adopting X-bar theory with binary branching apply this constraint in an even stronger version by admitting at most two daughters for one mother, and necessarily different types of daughters for the same mother. This constraint, however, was never externally motivated, except for, maybe, general principles such as simplicity and uniformity.

II. Alternatively, one can keep to those variants of analysis which for certain constructions prefer flat structures with more than one daughter, or dependent, of the same type. Still, there are two ways to comply with the Frame Hypothesis.

   (a) One may read the corresponding quasiframe structures such as [$_S$ NP NP V] as containing generalized attribute labels to be properly disambiguated. The corresponding structures would then actually be frames, although with underspecified, or generalized, attribute labels. They could be turned into proper frames by using more specific, functional attributes, sacrificing certain generalizations.

   (b) One might recognize that these framelike structures actually are incomplete frames. Neither constituent structure nor dependency structure alone is all there is to grammatical structure. This would mean acknowledging that purely syntactic criteria do not fully determine the grammatical structure of a sentence. Nonfunctional attributes, i.e., nonunique elements in constituent

or dependency structure, would have to be disambiguated by adding further, nonsyntactic attributes in order to comply with UA. From the point of view of the cognitive representation of complex linguistic gestures, this step is harmless. Full representations will not be restricted to abstract constituent or dependency structure, but will necessarily also capture the semantic properties of its constituents. In order to comply with the Frame Hypothesis, one only has to verify that the total representation of grammatical structure is a Barsalou frame. We will return to this option in Sect. 2.4.4.

2.4 Frames and Meaning

2.4.1 Verb Case Frames and Semantic Roles

The most "framish" elements of language are certainly verbs with their case frames. A one-place or more-place verb opens a case frame in terms of its arguments and their respective semantic, or 'thematic', roles. Optional adjunct roles can be added. Case frames have a central element, representing the situation expressed, and a certain number of case roles corresponding to the arguments and adjuncts of the verb (Fillmore 1968). The cases are functional: they assign to each instance of the situation expressed by the verb a unique agent, theme, goal, etc. Each role can occur at most once in a case frame. Thus, Fillmorean case frames clearly fulfill the three uniqueness conditions. Note that UR here is even stronger than the general condition, since case frames are usually conceived of as flat, nonrecursive structures.[25]

UR_{CF} Unique referent:
All case attributes immediately relate to the referent of the frame.
UV_{CF} Unique value:
Case attributes take unique participants as values.
UA_{CF} Unique attributes:
All case attributes are different.[26]

[25]For a theory with recursive case frame embedding see the Localist Case Grammar in Anderson (1977) and Ostler (1980).

[26]Chomky's 'theta criterion' explicitly states UA for case frames; using the term 'θ-role' for Fillmorean case: "Each argument bears one and only one θ-role, and each θ-role is assigned to one and only one argument." (Chomsky 1981, p. 36) Arguments are values of case attributes; an argument is assigned a θ-role if it is the value of the corresponding θ-attribute. The first conjunct of the θ-criterion states a different condition. In terms of the frame approach it means that different attributes of the same verb cannot share their value. This would constitute a fourth uniqueness condition: if x is the value of some attribute of a possessor p, then there is exactly one attribute of p such that x is the value of that attribute. The condition seems plausible for constituents and dependents – one and the same expression apparently cannot be two constituents or dependents of the same mother or head. Whether it holds for frames in general, is a question far beyond the scope

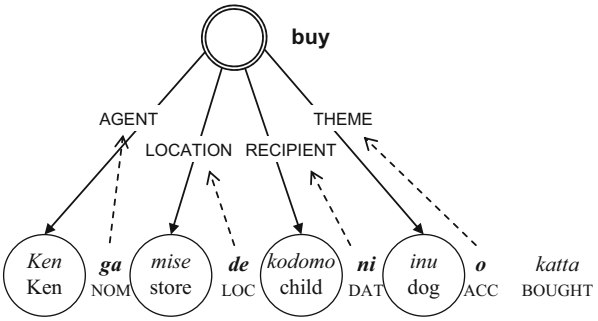


Fig. 2.8 Case frame and linking of the sentence in (4)

Linking theories describe how case frames are related to syntactic structures.[27] The relation is particularly direct for languages such as Japanese which mark every possible argument and adjunct of a verb with a different case marker:

(4) Japanese

Ken	*ga*	*mise*	*de*	*kodomo*	*ni*	*inu*	*o*	*katta*
Ken	NOM	shop	LOC	child	DAT	dog	ACC	bought.PST

'Ken bought the child a dog at the shop'

In this sentence, the verb *kau* 'buy' is used for a four-place predication with the arguments and adjuncts agent, recipient, theme, location marked by the case particles *ga* (nominative), *ni* (dative), *o* (accusative), and *de* (locative), respectively. The grammar of Japanese immediately indicates the different arguments in the case frame by particular case markers. Not only does the case frame provide a set of mutually different argument roles, but in addition to this, two arguments are (almost) never marked with the same case particle in Japanese.[28] Figure 2.8 has the case frame for this four-place use of *kau* 'buy' superimposed on the sentence in (4).

The interaction of case frames with syntax takes us back to the UA issue for constituent and dependency structures. Japanese has been considered a

of this paper. Note that UR the uniqueness conditions do not rule out that a node in a frame may be the value of more than one attribute. This is perfectly admissible if we are talking about attributes of different nodes. For example, attributes can be composed: HAIR is an attribute of people, COLOR is an attribute of the hair of people, whence HAIR COLOR is an attribute of people. The color of the hair of a person is thus, even necessarily, at the same time the value of the attribute COLOR of the hair of the person and the value of the attribute HAIR COLOR of the person.

[27] See Van Valin (2005) for a linking theory in the framework of Role and Reference Grammar.

[28] There are very few exceptions: *ni* may mark dative case as well as a location; the accusative marker *o* can also be used to mark the path argument of a verb of locomotion.

nonconfigurational language (Chomsky 1981, p. 128f).[29] From this point of view, the clause structure of the sentence in (4) would have more than one NP sister to the verb. The locative NP can be exempted as an adjunct, but still three argument NPs would remain. Japanese allows a disambiguation of the three constituents as NP_{ga}, NP_{o}, and NP_{ni}, in order to comply with UA_C. This is possible as a general solution for Japanese because basic clauses, with very few systematic exceptions, cannot have more than one occurrence of the same case particle. For other nonconfigurational languages, this solution for the UA_C problem is not available. For example, in Tagalog more than one argument of a verb can be marked with the default case genitive (Schachter and Otanes 1982). Consider the Tagalog equivalent of (4). In Tagalog, case particles precede the noun; BV marks benefactive voice. Due to the choice of benefactive voice, the recipient NP receives nominative case. The genitive marking is different for NPs denoting persons, but both *ni* and *ng* are genitive case markers.

(5) Tagalog (Anja Latrouite, p.c.)

i-	*b<in>*	*i∼*	*bili*	*ni*	*Ken*	*ng*	*aso*	*ang*	*bata*	*sa*	*tindahan.*
BV-	<Realis>	IPFV	buy	GEN	Ken	GEN	dog	NOM	child	DAT	shop
				AGENT		THEME		RECIPIENT		LOCATION	

Semantically the three roles of agent, theme, and recipient are different, but they may receive identical case marking. They differ grammatically in corresponding to different voices, but the applicability of a particular voice, again depends on the semantic role. Thus, in order to disambiguate argument NPs in Tagalog, one would have to make use of semantic properties of the NPs.

UA_{CF} imposes nontrivial restrictions on natural languages. There are certain verbs which have two arguments that logically play the same role in the verb concept: symmetric, or reciprocal, verbs such as *meet*, *struggle (with)*, *marry*, *differ (from)*, etc. The UA condition on case frames forces these verbs to be constructed either with two arguments of different types or with one complex argument:

(6) a. $Lucy_{\text{AGENT}}$ *married* Joe_{PATIENT} equivalently: Joe_{AGENT} *married* $Lucy_{\text{PATIENT}}$
b. $(Lucy\ and\ Joe)_{\text{AGENT}}$ *married*

2.4.2 Verb Meanings and Case Frames

Case frames cannot be equated with lexical frames for verbs. Rather they constitute an interface between lexical verb meanings and grammar. A language may have

[29] Chomsky's (1981) claim has been successfully challenged by various authors (cf. references in Farmer 1989, p. 249); Japanese is now considered a configurational language with comparatively free word order resulting from the possibility of so-called scrambling (Pensalfini 2004, p. 362). Independently of the discussion within the generativist camp, the cases of Japanese, and Tagalog (see below), are discussed here in order to deal with a possible argument against the assumption of UA in syntax.

hundreds, if not thousands, of verbs with the same case frame. Therefore, case frames obviously do not exhaust verb meanings. Also case frames do not represent aspectual characteristics of the situation expressed as they lack any representation of temporal or causal characteristics of the situation. So far, we know little about the composition of verb meanings beyond comparatively general structures like those introduced in Dowty (1979), Jackendoff (1990), or Pustejovsky (1995).

It must be assumed that verb meanings, if they are frames, are not just enriched case frames. Let me illustrate the problem with just one example. A verb expressing movement of x from A to B would have a flat case frame with three argument roles, THEME (or AGENT) x, SOURCE A, and GOAL B. These three ingredients of the moving event are, however, not on a par and independent of each other as the flat structure of the corresponding case frame suggests. Rather they are linked by the event of moving as follows: the source of the movement is the location of the theme of the movement before the event, and the goal of the movement is the location of the theme of the movement after the event (t_1 is the time when the movement starts, t_2 when it ends):

(7) Dependencies of the roles in a case frame of a verb of movement

SOURCE(e) = LOCATION(AGENT(e), t_1)

GOAL(e) = LOCATION(AGENT(e), t_2)

Thus, a frame for this type of event requires a recursive attribute structure. In addition, the concept will have to represent a change in time of the value of the location attribute of the theme argument: this change constitutes the event expressed.

For the following it will be assumed that for verbs and other predicate expressions there is some regular mapping of the lexical meaning frames ('lexical frames' for short) to the corresponding case frames. It will be assumed that the lexical frames of one-place or more-place predicate expressions (such as verbs, nouns, and adjectives) contain certain nodes marked as empty arguments. The mapping renders the empty nodes in the lexical frame as open arguments in the case frame, where these arguments are distinguished as different semantic roles. Thus, there is not only a linking mechanism that maps case frames to syntactic structures, but also, preceding it, a mechanism that maps lexical frames to case frames.

2.4.3 Sentence Meaning

Due to the principle of compositionality, the meanings of basic clauses can be constructed as frames based on frame-format syntactic structure, where syntactic structure can be defined either in terms of constituency or in terms of dependency. The constitutive parts of both types of structure will be referred to just as 'elements' of the sentence. A regular complex linguistic gesture and its elements are assigned meanings, from the lexical elements up to the whole complex. The frame representation of meaning requires just one attribute: MEANING. The uniqueness conditions

yield the following requirements for frames representing syntactic structures with their compositional meaning:

UR_M Unique referent:
There is a meaning assignment for the highest element.
UA_M Unique attributes:
There is only one meaning assignment for each element.
UV_M Unique value:
A meaning assignment assigns only one meaning.

Compositional meaning and constituent structure. Common theories of composition such as those deriving from Montague Grammar (Montague 1970) are essentially based on constituent structure. Lexical constituents are assigned a meaning in their lexical entry. We will not bother here with the problem of lexical polysemy. Rather, it is assumed that polysemy gives rise to multiple lexical entries with different meaning specifications yet identical form. Thus, UA_M is secured for lexical meaning. Syntax defines the rules for combining constituents into more complex gestures, while corresponding rules of semantic composition specify the way in which the meaning of the whole is computed from the meanings of the constituents. If we adopt the Frame Hypothesis, cognitive representations of lexemes contain an attribute MEANING (along with several other attributes such as PHONOLOGICAL FORM, PART OF SPEECH, GENDER, etc.). Complex expressions are assigned a value of their meaning attribute as the result of compositional interpretation.

Let me illustrate the mechanism of semantic composition in terms of frames, based on constituent structure, with a very simple example. Of course, a frame-based theory of semantic composition requires more than this. A meaning attribute, represented by the dotted arcs, is added to each constituent in Fig. 2.9. To enhance readability, the attribute label 'MEANING' is omitted on these arcs. For the sake of simplicity we treat the lowest constituents as lexical, disregarding possible specifiers and modifiers of the NPs and the V. They are simply assigned their lexical meanings as values of their meaning attributes. In accordance with the Frame Hypothesis, it is assumed that the lexical meanings are themselves frames. The little arrows spreading from the three central nodes of the lexical frames symbolize individual attributes in these frames, i.e., attributes of the subject argument, the object argument, and the event referred to. These attributes may be elaborated recursively. The lexical verb frame contains empty values for the agent and theme arguments of the verb, represented by smaller black nodes. Let us assume that the interface between lexicon and syntax produces these two argument attributes in order to enable the verb frame to figure in the clause. Although these two nodes are empty, they carry type information since the case attributes for the given type of event impose selectional restrictions on the respective possible values, i.e., the arguments of the verb. For example, the THEME attribute of *drink* would define a different type of value than the THEME attribute of *eat*.

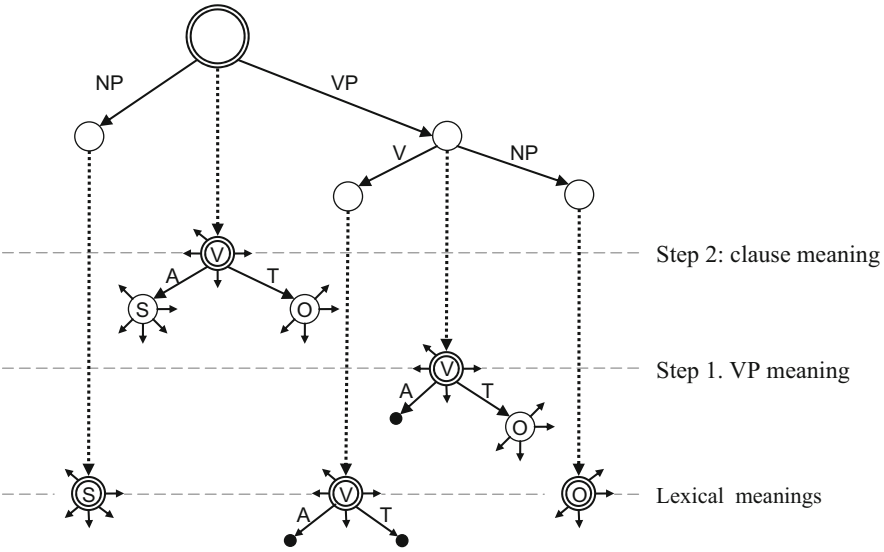


Fig. 2.9 Constituent frame with meaning attributes and values for lexical meanings

The VP and the clause receive meanings in the next two steps. The composition rules require combining the V meaning and the object NP meaning into one, as the constituents themselves combine to form one complex constituent. One of the basic ways of combining meanings is functional application, or argument saturation. This is what applies to the verb meaning and the object NP meaning by unifying the central node of the object NP meaning with the value of the attribute T(HEME) in the verb meaning frame. The resulting meaning frame retains the central node of the verb meaning frame, while the central node of the object NP meaning frame loses its status. Thereby, the resulting meaning frame complies with UR. This VP meaning frame is the value of the meaning attribute of the VP constituent. In the second step, the VP meaning frame combines by unification with the subject NP meaning frame, yielding the value of the meaning assignment of the whole clause. The meaning of a clause is a complex frame that integrates the lexical meanings of the three lexical elements of the sentence into a single frame.

In the total frame in Fig. 2.9, each constituent of the sentence has a meaning assigned to it. The whole structure is a well-formed frame. It contains the phrase structure frame and five meaning frames as subframes. Of course, this representation is redundant. When the human brain processes such a clause, it will certainly "forget" all meaning assignments except the one for the whole clause. Any model of semantic processing would probably understand the three levels of meaning assignment indicated here as subsequent phases of frame formation.

Compositional meaning and dependency structures. Alternatively, semantic composition can be built on the dependency structure of a clause, and this alternative

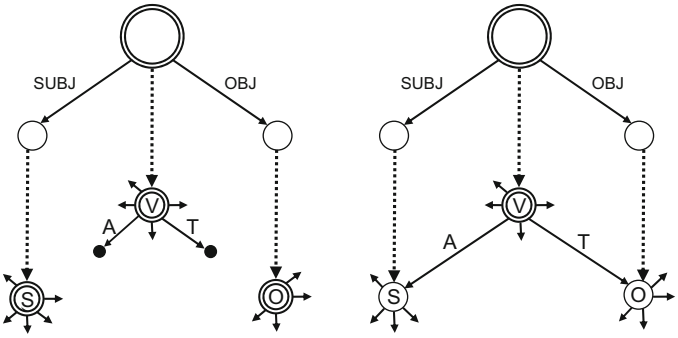


Fig. 2.10 Dependency structure with meanings

is in fact simpler and more elegant than the one just illustrated. The same basic type of clause has the dependency structure displayed in the left part of Fig. 2.10, with the same lexical frames assigned as meanings to its elements, the verb, the subject, and the object. Composition rules for dependencies can be generally described as requiring that the meaning frame of the dependent is to be incorporated into the meaning frame of the head, where rules of linking specify where and how the dependent is to be incorporated into the frame of the head. Incorporation of the dependent frame into the head frame does not change the central node of the head and makes the central node of the dependent lose its status.

In one step, the object NP meaning frame is incorporated into the verb meaning frame by inserting it as the value node of the THEME attribute of the verb meaning frame; in another step, the subject NP meaning frame is integrated. The result is a frame that is composed of two isomorphic subframes that represent the dependency structure and the structured meaning of the clause. The elements of the clause are each related to their respective meanings. However, these meanings are now meanings in the clausal context: the meaning of the subject is modified by the additional condition that it is the value of the AGENT attribute of the event referred to with the verb, and analogously for the meaning of the object NP. The right frame in Fig. 2.10 is free of the redundancies of the resulting frame in Fig. 2.9. From this perspective, it appears more attractive to base composition on dependency rather than constituency.

2.4.4 Configurationality and the Autonomy of Syntactic Structure

The issue of compositional meaning takes us back to the UA problem with syntactic structure. Assume that, for some reason or other, in a certain language different NP arguments, i.e., different grammatical functions cannot be distinguished on

merely syntactic grounds. How can a sentence be assigned a structure in accordance with UA? The problem can be solved easily if the language is like Japanese in that different semantic roles are consistently marked with specific morphological markers. All it takes is a theory of linking which describes the regularities of marking semantic roles with certain case affixes or by other means, for example word order. While such a theory is possible for every language, linking still might not provide enough evidence for determining semantic roles because different roles might be linked in the same way. This is illustrated by the example of Tagalog where, for example, agent and patient may receive the same case marking if the verb is neither in actor nor in undergoer voice.[30] A similar case arises in languages without case marking and with a certain degree of free word order. Consider the following examples from Lakhota (Robert D. Van Valin, p.c.). Lakhota has no case marking on the NP argument terms, rather there are infixes within the verb stem that indicate person, number and semantic role (in this case actor and undergoer) of the external NPs; the infixes for 3rd person singular actor and undergoer are morphologically zero, i.e., equal. Articles are postponed.

(8) a. *hokšíla ki wíŋyaŋ ki waŋ-Ø-Ø-yáŋke*
boy the woman the see < 3sgA-3sgU>
'the boy saw the woman' *or* 'the woman saw the boy'
b. *hokšíla ki thípi ki waŋ-Ø-Ø-yáŋke*
boy the house the see < 3sgA-3sgU>
'the boy saw the house'
c. *thípi ki hokšíla ki waŋ-Ø-Ø-yáŋke*
house the boy the see < 3sgA-3sgU>
'the boy saw the house'

Lakhota allows for both word orders, actor–undergoer (which is unmarked) and undergoer– actor. The case of (8b, 8c) shows that the question as to who sees what cannot be settled syntactically. What makes disambiguation possible in certain cases are the selectional restrictions of the verb 'see' which rule out that the see-er be a house (unless *thípi ki* is shifted by metonymy or metaphor to refer to a person). In the case of (8a) even this is impossible; the sentence does not allow the distinction of actor and undergoer. However – and this is a crucial observation – the sentence will not be construed as merely indifferent as to who sees whom. It would not be taken to mean "there was some seeing event that involved a woman and a boy, one seeing and the other being seen". Rather the sentence will always be interpreted as referring to a seeing event with one unique see-er and one unique object seen (not excluding, but also not expressing, a situation of two persons mutually seeing each other). It is construed as ambiguous, not as neutral. This can only be explained if one assumes that the interpretation of such a sentence forces the construction of a structural representation which complies with UA for the two NPs. When

[30] 'Actor' and 'undergoer' are more general semantic 'macroroles' comprising 'agent' and 'patient', respectively (see Van Valin 2001, pp. 22–33).

there is no grammatical or semantic indication available for the distinction of the two NPs, one will look for contextual or world knowledge for disambiguation, because of UA_M for the sentence. And if this, too, fails one will be stuck with two alternative structural representations of the sentence – each of which complies with the uniqueness conditions.

In any event, if a syntactic structure receives its semantic interpretation, on whatever grounds, its elements are linked to the case attributes in the verb meaning frame. For example, for the structures in Figs. 2.9 and 2.10, the following relations result for the two NPs[31]:

(9) a. Constituent structure: MEANING(NP(clause)) = AGENT(MEANING(clause))
MEANING(NP(VP(clause)))=
THEME(MEANING(clause))

b. Dependency structure: MEANING(SUBJ(verb)) = AGENT(MEANING(verb))
MEANING(OBJ(verb)) = THEME(MEANING(verb))

The problem with equal elements in flat structures for nonconfigurational languages can then be resolved by using these relations to the semantic structure for disambiguation. Due to UA for case frames, no verb has equal cases in its frame. Therefore, any NP in a clause will be associated with a different case role. Thus, UA can be ensured for basic constituency and dependency structure of clauses, although possibly at the price of the autonomy of syntax.

2.4.5 Frame Semantics Versus Model-Theoretic Semantics

A frame approach to natural language semantics has two advantages over model-theoretic semantics, the dominant paradigm in sentence semantics. First, according to the frame approach, compositional meanings of complex gestures preserve, accumulate, and configure all the information given by the meanings of the elements of the complex. In this respect it differs fundamentally from the truth-functional approach taken in model-theoretic semantics. There, composition is basically modeled as the application of functions to appropriate arguments. Looking merely at the result, there is no way of knowing where it was computed from; the meanings of the parts are not recoverable from the meaning of the whole. Consequently, model-theoretic semantics does not capture meaning differences between logically equivalent expressions with different meanings, such as *the bottle is half empty* vs. *the bottle is half full*, or *today is Tuesday* vs. *yesterday was Monday*.[32]

[31] Note that due to the isomorphic structure of dependencies and meanings in the clause, the relation in the case of dependency structure is more straightforward. See Debusmann and Kuhlmann (2009) on this and other general aspects of dependency grammars.

[32] See Löbner (2013, Sects. 7.6 and 13.5) for discussion.

This problem with model-theoretic semantics has been addressed by constructing 'structured' meanings and propositions in various ways (see King 2008 for a survey). One type of solutions (e.g., Cresswell 1985; Soames 1987) defines meanings of complex linguistic expressions as tuples of their component meanings, just keeping the component meanings apart instead of letting them operate on each other. This type of approach fails to provide an explicit explanation of how the semantic constituents combine to form the compositional meaning of the complex expression. King (1996) proposes considering compositional meanings as a complex of component meanings related to each other by the syntactic relations among their respective expressions. The former approach is obviously deficient, while the latter fails to properly distinguish the levels of expression and meaning. The frame approach sketched here obviously solves these problems.

The second advantage of the frame semantics approach is its potential of linking linguistic semantics to cognitive psychology. Model-theoretic semantics does not provide a link to cognition. By modeling meanings in terms of reference and truth conditions, model-theoretical semantics abstracts away from the cognitive level of concepts. This type of approach captures the logical properties of sentences, but not the way in which these properties result from the meanings of linguistic expressions.

2.5 Meanings of Argument Terms and the Evolution of Abstract Attribute Vocabulary

2.5.1 A Simplified Model of Reference and Linguistic Communication

The discussion of the meanings of argument terms[33] will be restricted to argument terms in basic clauses; these are NPs or PPs, i.e., essentially nominal. Argument types such as propositions would require embedding of clauses. Let us start the discussion from a consideration of a simplified model of reference and communication when a typical argument term is used. The model is depicted in Fig. 2.11. Assume a person P (the eventual producer of an utterance) has seen a tiger and wants to refer to the tiger in an utterance which she addresses to some other person R, the recipient, who speaks the same language. Let us assume that the expression for tigers is phonetically [hu]. Perceiving the tiger, P's cognitive system produces a cognitive representation of the animal. According to the Frame Hypothesis, the representation of this individual tiger is some frame. Whatever the representation of the meaning of the word [hu] in P's mind, it may be a much leaner representation of a tiger than the representation of the individual tiger P saw; the lexical meaning may lack a lot of details of the individual tiger's representation. Wanting to communicate reference to

[33] In this section, 'argument term' is to be understood as also including adjunct terms.

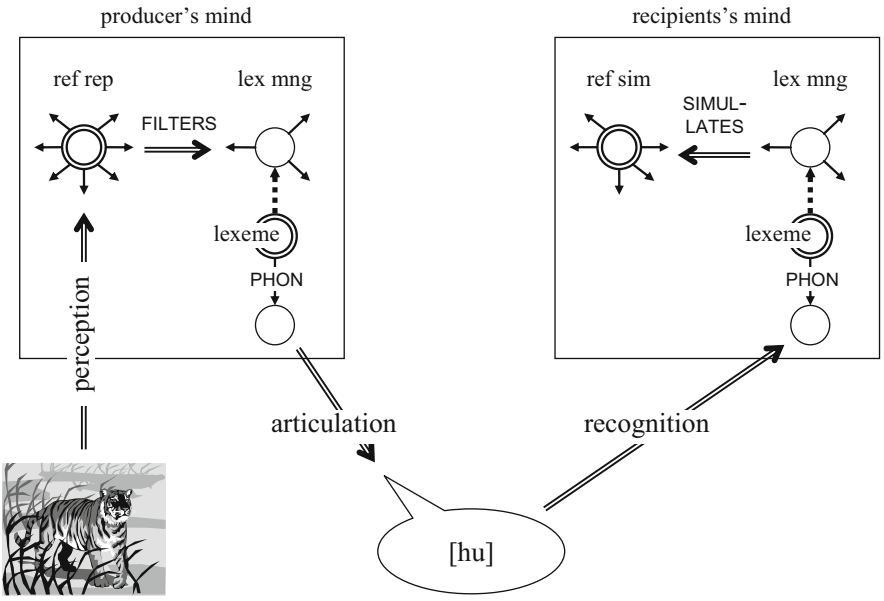


Fig. 2.11 A simplified model of reference and communication (*ref rep* = referent representation, *lex mng* lexical meaning, *ref sim* referent simulation)

that tiger, P will strip the representation of the individual tiger she saw from context-bound details and will search in her mental lexicon for an appropriate entry. An entry will be appropriate if its meaning is compatible with the representation of the tiger she saw and sufficiently specific as to convey enough information. Let us assume that the word [hu] satisfies the communicational needs of P. In Fig. 2.11 the lexical entry is incompletely represented with two attributes, MEANING (indicated by the dotted arc) and PHON[ETIC FORM]. P proceeds from the meaning of the lexical entry to its phonetic form and produces an utterance addressed to R which contains an articulation of the phonetic form [hu]. R, hearing the utterance, recognizes the phonetic form as that of her lexical 'tiger' entry and activates its meaning. The communication is semantically successful, as regards the reference to a tiger, if this is what happens in the mind of R. Based on this meaning and on additional contextual and experiential knowledge, R will construct an individual simulation of a tiger.[34] This is the communicative result of P's utterance. The simulation in R's mind need not match P's original impression. However, what is required to match, at least roughly, are the cognitive representations of the phonetic form [hu] and of its meaning 'tiger'.

[34]Cf. Barsalou (1999) on simulations, Barsalou (2003) on the cognitive interaction of language and simulation.

2.5.2 *Meanings of Argument Terms*

The most common types of argument terms have no arguments themselves. Therefore, the defining attributes in their meaning frames and the specification of their values remains implicit in verbal communication. (When dealing with, say, transitive verbs we at least know that they have two specific participant attributes.)

In order to secure successful common reference, the meanings of the lexical gestures need to be synchronized in the speech community. There are basically three strategies facilitating shared reference for nominal argument terms:

- **Concrete common nouns**
  Terms with rich meanings where the *exact* match of all meaning components does not matter,
- **Proper names**
  Terms that refer to individual, fixed objects by virtue of some convention in the speech community,
- **Indexicals**
  Terms for which reference in a given context of utterance is fixed by demonstration.

Indexical terms are primarily used for unique (definite) reference to objects which are given with the context of utterance, such as the speech participants, the location where the utterance takes place, objects present at the location, or the time of the utterance and related times. The meanings of indexicals are conceptually lean, for example, 'the producer of this utterance' for first person singular pronouns. The conceptual information about the referent in a given context is drawn from contextual, extralinguistic knowledge. Indexicals provide positive evidence for the Frame Hypothesis insofar as their reference can be considered to be based on a frame model of utterances: speaker, addressee, time of utterance, or location of utterance all constitute the values of functional attributes of utterances, in fact case frames in a frame for speaking to someone.

Proper names do not have much conceptual content either. They are used for fixed reference to entities which are established in a wider, permanent context, such as individual persons, animals, geographical landmarks, etc. The lexical meaning of a proper name like *Liz* is a lean concept, approximately, 'the object with NAME ›Liz‹'.[35] The meaning of a proper name is not to be confused with the general knowledge about the object so named. Proper names, if analyzed in this way, provide evidence for the significance of a NAME attribute in frames for certain types of individual objects.

In the following, we will focus on the strategy of common nouns. Synchronization of the meanings of common nouns takes place in the course of language acquisition as well as in verbal communication in general. The acquisition of the

[35] See Löbner (2011, Sect. 2.3) for a discussion of the meaning of proper names.

meanings of common nouns is either based on ostension or on verbal explanation. Ostension is by no means deterministic. If I point to a cat and tell a child: "This is a cat," the child has to recognize what it is that my pointing aims to single out. If the child manages to realize that it is the cat which I meant to refer to, it is left with the problem of determining the intended categorization. According to the findings of developmental psychology, several assumptions and predispositions constrain and underlie the successful process of meaning induction from reference (Markman 1989). One such constraint is the preference of 'basic level' categorization[36] which fixes a certain, medium level of concept formation that is tied to human action and behavior. Hypothesizing the basic level of categorization when shown a cat, the child will not categorize it as just an animal, or a furry thing, nor as a particular breed of cats, a cat with exactly this pattern of stripes in its fur, etc. It will categorize it in a way which is specific enough to exclude other animal categories of the same level for which the child already knows the linguistic terms. But even so, the concept which the child is going to assign as a lexical meaning to the phonetic string heard is far from precisely determined.

Further restrictions that will guide the learner are the 'whole object assumption' and the 'taxonomic assumption'. The language learner will assume that the referent of the ostension is the whole object rather than parts or properties of it; and he or she will assume that the word to be learned is a term for objects of a particular *kind* (Markman 1989: Sect. 2). Even given these constraints, much room is left for fixing a lexical meaning. The child may include conceptual elements irrelevant for the lexical meaning or may fail to include relevant meaning elements, in particular such that cannot be derived from mere perception.

The method of verbal explanation is not much more precise. Since language users do not consciously know the content of lexical meanings, they can only give explanations in terms of other unexplained expressions the meanings of which may be known to the learner, more or less accurately. Imprecision of the defining concepts will be inherited by the new concept.

Thus, it is obvious that the tradition of lexical meanings of concrete common nouns is not a process that propagates precise concepts. Consequently, the individual lexical concepts of the members of a speech community will vary to some degree. When people in a speech community have experiential knowledge of, say, tigers and communicate about them using a certain lexical expression, they will have individual notions of tigers on the one hand, and theories of the notion of tigers shared in the language community, on the other. Language users know what they themselves know about tigers and they know which part of their knowledge of tigers can be shared by others. Thus, it will be the concept that language users assume is being used by the others which they themselves will assign as the lexical meaning

[36]The basic level theory goes back to experiments reported in Rosch et al. (1976). See Markman (1989: Sect. 4) for the role of basic level categorization in cognitive development.

to an expression.[37] As long as the members of a speech community have roughly similar theories about the commonly used meaning of the tiger word, reference to tigers will function in that community.

In the course of language development and language evolution, there are factors which will exert pressure towards more precision and more generality of lexical meanings. Language communities may grow, and with them the range and degree of individual variation of lexical meanings. The range of experience will grow, and with it the diversity of samples to be covered by existing lexical terms. Such developments will result in more general meanings for concrete common nouns. The supposed common denominator of lexical meaning will become leaner. In terms of the frame approach to concepts, this means that certain attributes in a lexical frame will receive more general value specifications or will be dropped altogether. By this process, lexical meanings will gradually approximate the bare logical minimum. For example, a child will form a concept for the denotation of the word 'bird' on the basis of encounters with exemplar birds, with pictures of birds, etc. This will result in a concept which ascribes birds certain attributes such as having wings, being able to fly, and maybe further attributes which are accidentally shared by the exemplars she happens to encounter. Later, she will learn that there is a broader variety of birds, in terms of color, size, shape, and behavior. She will remove certain restrictions from her bird frame. Eventually she will have to cope with the fact that there are also atypical birds such as penguins or ostriches. At some stage, there will remain a hard core of necessary attribute-value information and constraints in the ultimate educated adult bird frame.[38]

Another process of language change is the growth and differentiation of the lexicon. A growing number of terms will evolve that are more specific than basic level terms. While basic level concepts differ in a large number of attributes, their subordinates are differentiated by only few additional semantic conditions. For example, 'dog' is a basic level concept comprising a great number of properties that distinguish dogs from the members of other basic level animal categories. The subordinate 'bitch', however, only adds a sex specification, while 'Golden Retriever' would add a handful of other conditions.

The growth of the lexicon and the growth of speech communities, as well as other factors like language contact will eventually lead to the necessity of negotiating meanings more precisely. This can be done implicitly, for example, by way of communicating reference. But eventually it will become necessary to be able to

[37]Therefore, lexical meaning is based on a generalized theory of mind (see Carruthers and Smith 1996) about the mental lexicons of the other members of the speech community.

[38]Two questions will not be discussed in this connection. The first concerns the relation between world knowledge frames and lexical meaning frames. I have argued elsewhere (Löbner 2013: Sect. 11.6) that lexical meaning frames are necessarily leaner than world knowledge frames; for a recent review see Kelter & Kaup (2012), in particular Sect. 6. The second question concerns the relationship of prototypes to world knowledge frames on the one hand and lexical meaning frames on the other; see Barsalou (1992b, pp. 47–50) on world knowledge frames and prototypes, and Löbner (2013: Sect. 11.5) on lexical meanings and prototypes.

communicate about meaning components. If the Frame Hypothesis is correct, these components are attributes. Consequently, what a speech community may develop sooner or later is attribute vocabulary: terms for attributes and terms for the values which attributes take.

Terms for attributes are functional nouns: nouns that are relational (attributes are attributes *of* something) and inherently unique (attributes are functional).[39] This combination is nothing to be expected in an early stage vocabulary. Likely types of argument terms such as common nouns or proper names are not relational. Proper names and indexicals are inherently unique, but this alone does not make up the sort of expression needed for denoting attributes. In what follows, we will first take a look at different semantic types of attribute terms (Sect. 2.5.3) and then discuss developments in which attributes in lexical meanings may get eventually isolated and later named and lexicalized (Sects. 2.5.4 and 2.5.5).

The discussion in this subsection has been mixing observations from language acquisition with aspects of language evolution. It may be assumed that both processes follow similar lines. Children learn concrete nouns, proper names, and somewhat later indexical expressions earlier than more general and abstract vocabulary, in particular abstract attribute vocabulary. For example, they will learn color terms earlier than they will learn the term 'color'. Analogously, languages acquire more general and abstract vocabulary only later in their history. This can be clearly seen from the fact that such vocabulary very often is recruited derivationally from existing vocabulary or borrowed from other languages. Just take a glimpse at abstract attribute terms in English:

(10) a. Native root terms: *name*, *shape*, *speed*
b. Native derivatives: *length*, *height*, *breadth*, *width*, *depth*, *meaning*, *weight*
c. Nonnative terms: *color*, *form*, *size*, *quality*, *quantity*, *temperature*, *price*, *sex*, *age*

It is very hard to find any native root terms at all in English. *Name* appears to be the only genuine original one. The terms s*hape* and *speed* underwent a series of semantic shifts before they took on the modern attribute meanings.

There appear to be languages which lack abstract attribute vocabulary almost completely (e.g., Lakhota, according to Van Valin, p.c.). Even in European languages, the evolution of abstract attribute vocabulary apparently has taken place only in modern times.[40]

[39] See Löbner (2011: Sect. 2) for extensive discussion of types of nouns, Löbner (1998, p. 5; 2012, Sect. 4.2) for the connection between functional nouns and frames.

[40] For example, Middle High German of about 1,200 seems to widely lack abstract functional concepts with inanimate possessors, such as 'value', 'size', or 'quality'. The 100,000 word poem 'Tristan' by Gottfried von Strassburg from around 1200 does not contain a single such noun (personal reading).

The direction of conceptual development is therefore one from structurally complex concepts to simpler ones. This is not as paradoxical as it might seem.[41] Concept formation, including the formation of concrete lexical concepts, is based on perceptual representations (Barsalou 1999). Perception yields very complex representations which are connected with other complex faculties of human cognition such as agency and emotions. Thus, one major type of cognitive achievement is the reduction of the complexity of representations.

2.5.3 Types of Attributes and Attribute Terms

Attributes in Barsalou frames can be distinguished in terms of the types of values they take.[42] Major attribute types are the following:

M Mereological attributes for constitutive parts of the referent, e.g., body parts: HEAD, BODY.
R Role attributes for correlates of the referent, e.g., kin attributes such as MOTHER, HUSBAND, or attributes such as BOSS, OWNER, SUCCESSOR, etc.
D Abstract dimensional attributes such as SHAPE, SIZE, COLOR, TEMPERATURE, WEIGHT, MEANING, FUNCTION, or NAME.

The frames used in Sects. 2.3 and 2.4 illustrate all three kinds of attributes: attributes such as VP in constituent frames are of type M; attributes in dependency frames are of type R; the meaning attribute and attributes for grammatical features are of type D.

Type M attributes in mereological frames of concrete objects have concrete objects as their possessor and take concrete, though not independent, objects as values. The relationship between the possessor and the values of its mereological attributes is bidirectionally one-to-one: a given part can belong to only one whole (notwithstanding transitivity of the belong-to relation), and due to UA a given whole has a given part only once. For concrete objects, at least the external parts can be referred to by ostension. However, their categorization is dispreferred due to the whole-object constraint. The latter corresponds to the cognitive problem that categorization requires cues for individuating the part within the whole, singling it out in order to establish a certain degree of relatively independent existence.

Type R attributes in everyday life also take concrete values. For example, the value of the attribute MOTHER is a concrete person. Unlike mereological attributes, role attributes are not bidirectionally one-to-one (e.g., different persons can have the same mother, but not the same womb). However, although the values of role attributes, i.e., the occupants of the roles, are concrete and of independent existence,

[41] Cf. Werning's notion, and discussion, of what he terms the "complex first paradox" (Werning 2010).

[42] For basic ontological distinctions of types of attributes, see Guarino (1992).

it is impossible to illustrate the meaning of a role term by just pointing to an instance. The notion of 'mother' can only be grasped if some abstract causal or social relation is recognized. The taxonomic assumption mentioned above is a barrier to this type of categorization, since it leads to the induction of a sortal rather than a relational concept.

Type D attributes, or 'D-attributes' for short, have abstract reference. They take values, but the values do not exist independently of the possessors. Different possessors can have equal values for the same D-attribute, e.g. they may be the same size, color, price, or age. Obviously, ostension without further explanation cannot be used for teaching the meaning of a D-attribute term. If I point to a ball, saying "this is red," it is by no means evident that I refer to the color of the ball rather than to its shape, temperature, or weight. Grasping the meaning of a term for a D-attribute or its value requires the isolation of this aspect of categorization, i.e., abstraction from all other attributes which the possessor may exhibit.

Thus, it is increasingly challenging to establish reference and meaning of attribute terms for M, R, and D type attributes, respectively. This is in accordance with the data from language acquisition as well as historical lexicology. As to D-attribute terms, in particular D-attribute nouns, the question arises as to how they emerge at all. Using nouns such as *weight*, *temperature*, or *shape* as referential terms and as argument terms for verbs is far away from the prototypical use of nouns and verbs. In the next subsection I will outline possible steps in the lexical and semantic emergence of D-attribute nouns.

2.5.4 Semantic Isolation of Abstract Attributes

2.5.4.1 Step I: Gross Attribute Isolation

Suppose the nominal lexicon is restricted to concrete sortal nouns (disregarding proper names or indexicals, which do not matter in this connection). A first step of cognitively getting hold of a certain D-attribute might involve establishing pairs of lexical opposites which differ with respect to the value of this attribute. Probably all languages will have different nouns for females and males, such as Japanese *otoko* ('male, man') vs. *onna* ('female, woman'), and maybe not all, but many, may have different terms for adults and children, like Japanese *otona* ('adult') vs. *kodomo* ('child'). Having different terms for females and males, does not necessarily mean that the D-attribute SEX is semantically isolated. There are many concomitant differences between males and females. Therefore the distinction will first be conceived of as relating to a bundle of attributes. The bundle may be eventually reduced to a considerably smaller number of attributes, if and when the distinction is extended to other domains, e.g., by establishing opposing terms for male and female animals. Analogous considerations apply to the adult vs. child opposition. If a language has several pairs of opposites for female vs. male or child vs. adult, it can be considered to have some semantic

grasp of the underlying attributes SEX and DEVELOPMENTAL STAGE, but this grasp is not necessarily very precise. The respective attributes may still be bundled with others.

2.5.4.2 Step II: Value Specification for an Implicit Attribute

In a second step of lexical evolution, expressions might arise for the values that certain D-attributes take. Still, there may be no term for the attribute itself. For any D-attribute there is a whole range of possible values. Therefore, if terms for the values of a certain D-attribute arise, they will not denote the whole range of possible values, but rather certain marked cases. Very often, this will result in lexical fields of two or more terms for the same dimension. Examples are systems of color terms, systems of numerals, quality terms (e.g., for 'good' and 'bad'), size terms, or terms for other D-attributes such as *long/short*, *heavy/light*, *fast/slow*, *high/low,* etc. In his comparative study, Dixon (1977) investigated which terms for properties and dimension values actually do occur as adjectives or other parts of speech in a sample of 17 unrelated languages. Focusing on adjectives, he states that there are many languages with a small closed class of adjectives, from 8 (Igbo, Niger-Congo), 12 (Hausa, Chadic), up to several hundred in Japanese. Adjectives, it appears, are a word class denoting prototypically values of certain attributes. "The AGE, DIMENSION, VALUE, and COLOUR types are likely to belong to the adjective class, however small it is."[43] Such adjectives relate to a single attribute, but the relation is implicit. They do not (yet) serve to denote the attribute as such. The attribute may be implicitly specified with more or less precision. Adjectives for 'good' and 'bad' are very vague with respect to the criterion of evaluation. 'Big' and 'small' may apply to more than one spatial dimension of physical objects. As to color terms, cases are reported where the 'color' term also includes other dimensions such as being glossy or wet.[44] But as a tendency, the degree of conceptual isolation of the underlying attribute is much higher than with opposing common nouns.

2.5.4.3 Step III: Grasping the Range of an Isolated Attribute

The third step will for the first time provide expressions that relate to a dimension as such. In a preparatory stage, a language will have pairs of antonyms relating to the

[43] Dixon (1977, p. 36). The types AGE and COLOUR are obviously related to the respective D-attributes. The type DIMENSION is defined as comprising, for English, the adjectives "*big*, *large*; *little*, *small*; *long*, *short*; *wide*, *narrow*; *thick*, *fat*, *thin*, and just a few more items" (p. 31). These, too, directly relate to specific D-attributes. VALUE adjectives correspond to the D-attributes WORTH, VALUE, QUALITY and include "*good, bad* and a few more items [. . .]" (p. 31).

[44] See the discussion in Levinson (2001).

same dimension such as expressions for ‘big’ and ‘small’ or for ‘good’ and ‘bad’.[45] Pairs of antonyms not only relate to the same dimension, but by denoting two opposite extremes on a scale of possible values, they jointly define the dimension as such by spanning a large range of possible values.[46] The members of such pairs of opposition typically divide the scale in a vague and context-dependent way. As a natural consequence, languages will evolve constructions for comparative predications, such as ‘x is bigger than y’.[47,48] In a comparative construction, the gradable adjectives are stripped of any fixation of the value on the scale. A statement expressing ‘x is bigger than y’ by using a predicative term for being big, may be true independently of whether x is big or small taken for its own. This use of the term ‘big’ is applicable throughout the whole scale. The same holds for other constructions such as superlative or equative. A further important construction of this type is questions of the type ‘how big is x’.

Although in these constructions the predicative expression such as ‘big’ relates to the whole range of possible values of an attribute, it cannot be used as a term for referring to the attribute as such. This requires a noun that denotes the D-attribute.

2.5.4.4 Step IV: Functional Nouns for the Attribute as Such

Functional nouns for D-attributes appear to emerge very late. In German and other languages, numerous D-attribute nouns are derived from adjectives, thus indicating that steps II and III are the historical basis of the development (cf. (10b) for English). There are hardly any historically genuine D-attribute terms. One rare exception is functional nouns for the attribute NAME. Apparently the isolation of the abstract attribute NAME was necessary for metalinguistic communication. A look into the etymology of other abstract functional concepts reveals that they are semantically and/or morphologically derived. For example, the meaning of German *Farbe* (‘color’) derives from the meaning ‘paint’ (which *Farbe* still possesses along

[45] According to Dixon, even very small adjective repertories contain pairs of antonyms. For example, the eight adjectives in Igbo mean ‘large’, ‘small’, ‘new’, ‘old’, ‘black/dark’, ‘white/light’, ‘good’, and ‘bad’ (Dixon 177: 20f).

[46] The discussion will focus on scalar dimensions from now on. Similar considerations apply to terms for values of nonscalar dimensions. For example, the research into color terms (cf. Berlin and Kay 1969 and subsequent work) shows that most languages do not just have isolated color terms, but always systems of color terms that more or less cover the whole space of visible colors.

[47] Bierwisch (1987: 150ff/1989: 123ff), following Sapir (1944: 93f), argues that even the positive use of dimensional adjectives is essentially a comparative. I do not endorse this analysis (Löbner 1990: Ch. 8), but argue similarly that predication with dimensional adjectives involves the comparison of higher with lower degrees on a scale.

[48] Comparative constructions may be grammaticalized to varying degrees. For example, a language might express ‘x is bigger than y’ by two sentences ‘x is big, y is small’ or ‘y is not big, x is big’ (Stassen 1985: 44f). The latter variant shows that all it takes to cognitively span the underlying scale is negation of a scalar adjective.

Table 2.1 Patterns of emergence of abstract attribute terms

	Specific value predicate term	Property term	Value question predication	Attribute term
English	*big*	*bigness*	*how big*	*size*
German	*groß*	*Größe*	*wie groß*	*Größe*
	'big'	'bigness'	'how big'	'size'
Dutch	*veel*	[*veelheid*]	*hoe veel*	*hoeveelheid*
	'much'	'muchhood'	'how much'	'howmuchhood'
Chinese	長 短			長 短
	cháng duǎn			*chángduǎn*
	'long' 'short'			'longshort'

with the abstract meaning). The word *temperature* and its parallels in French, German and other languages acquired the present meaning only in modern times. Its original meaning was the same as that of *temperament*: 'mixture'.

Deadjectival D-attribute terms exhibit crosslinguistic patterns that provide insight into their evolution (Table 2.1). De-adjectival nouns often start out with a meaning denoting the property of being "ADJ", i.e., the property of x if 'x is ADJ' is true. As a rule, for the negative members of antonymy pairs (i.e., *small* out of *big* vs. *small*), the derived noun only has this interpretation (Bierwisch1987, p. 110). In this reading, de-adjectival nouns are not attribute terms. Only readings that can be roughly paraphrased with an interrogative clause 'how ADJ x is' can be used as terms for the attribute as such. The Dutch term *hoeveelheid* 'how-much-hood' is interesting in deriving directly from the question construction. The example shows that the cognitive derivation of the attribute term from this type of question is at least plausible enough to be accepted as a lexicalized derivation.[49]

If a noun is available that denotes an abstract attribute as such, it can be used for predications relating to changes of its value or to the determination of it:

(11) a. *The temperature of the cooling water* is rising
b. *They are not able to* determine *the temperature of the cooling water*

Constructions like these require an adaptation of verb vocabulary or of verb constructions. For example, the intensional use of *rise* in (11a) requires a metaphor, and the predication in (11b) involves a 'concealed question' interpretation of the object NP.[50]

In addition to nouns denoting D-attributes, there is a second option for neutral reference to a D-attribute, namely static dimensional (or attribute) verbs. Instead of

[49]The pattern displayed in *hoeveelheid* is not productive in Dutch. There is only one parallel: *hoedanigheid* ('quality', lit. 'how-done-ness'). Probably both are loan translations of Latin *quantitas* and *qualitas*, respectively. *Quantitas* is a noun derived from an interrogative adjective *quantus* 'how much'; *qualitas* is the same type of derivation from the interrogative adjective *qualis* 'of what kind'.

[50]See Löbner 1979: Ch. 3, 2012: Sect. 3.4, for a discussion of the relevant constructions.

using the attribute noun *price* for specifying the price of something in (12a), one could use the stative verb *cost* (12b).

(12) a. D-attribute noun: *the* price *of the car is 499 Euro*
b. D-attribute verb: *the car* costs *499 Euro*

The functional potential provided by a stative D-attribute verb is, however, much more restricted than that of a corresponding noun. With a stative D-attribute verb, only one type of predication about the attribute becomes available: the specification of its value for a particular object. By contrast, a D-attribute noun opens up the possibility of using it as an argument term for a wide range of predications by verbs. Predications such as those in (11) cannot be equivalently expressed by using a stative D-attribute verb. This is probably the reason why this class of verbs is much less frequent than D-attribute nouns.

2.5.5 Lexical Tinkering with Abstract Attribute Vocabulary

There are two remarkable observations concerning the emergence of abstract attribute vocabulary. The first is that abstract vocabulary comes about at all, against all odds of learnability and grammar. It is far more difficult to teach and acquire attribute vocabulary than concrete common nouns. A look at functional nouns and the constructions they occur in shows that they constitute a special and marked type of nouns. Their lexical recruitment requires several steps of derivation, and even when they are available, an appropriate repertory of verbs and constructions needs to be developed.

The second observation is that there is a remarkable lack of systematic patterns of word formation in the course of the development lined out above. There are, of course, systematic means of forming pairs of expressions in sex opposition or deriving antonyms from given adjectives by adding negative affixes like *un-important*, *in-efficient*, *a-modal*. However, the core cases which represent the original stages are characterized by morphologically unrelated pairs such as *girl* vs. *boy*, *big* vs. *small*, *size* vs. *big*, etc.[51] This appears to indicate that the respective vocabulary was either semantically adjusted to yield the oppositions or, in other cases, recruited from wherever something grossly appropriate was available or derivable. Borrowing a term from evolution theory, the evolution of abstract attribute vocabulary is a case of heavy 'evolutionary tinkering'[52] – innovative use of various *given* material for meeting novel purposes. For an illustration of the point, consider the vocabulary for

[51] See also the antonym pairs for six languages in Dixon (1977, pp. 21–23); there is not a single pair of antonyms which are morphologically related.

[52] The notion goes back to the seminal article Jacob (1977).

dealing with the attribute PRICE in German; the emerging picture in other languages would be very similar. At least four different, and originally unrelated word stems are immediately semantically related to this D-attribute in (13).

(13)

Stem	Meaning	History
teuer$_{A}$	'expensive'	Cognate of English *dear*; original meaning: 'dear', 'precious'
billig$_{A}$	'cheap'	Original meaning: 'adequate', 'appropriate'
kosten$_{V}$	'cost'	Loan from middle French *couster*, *coster* (now *coûter*), from Latin *constare* 'cost'
Preis$_{N}$	'price'	Loan from middle French *prise*, from Latin *pretium* 'price, value, money'; compare English *price*, *prize*, *praise*, *precious* of the same origin

The adjectives relating to the attribute PRICE are originally not only morphologically unrelated, but also semantically not attuned to each other. The original meaning of *teuer* is more generally 'of high value'. The meaning 'expensive' is the result of a restriction to the commercial value of goods. The antonym *billig* originally means 'acceptable', 'appropriate', 'adequate'; the meaning 'cheap' results from a metonymy which transfers the property of being an appropriate price to the possessor, resulting in the property of being *of* an appropriate price. Later on, *billig* acquired a derived meaning 'of low quality, worthless' (as did *cheap* in a parallel development). In order to avoid this interpretation, *billig* is nowadays often replaced by the more recent expression *preiswert* (lit. 'worth its price', from *Preis* 'price' and *wert*$_{A}$ 'worth') which now functions as an antonym of 'expensive'. Note that the original meaning of *billig* 'adequate (in price)' displays the same kind of concept. The verb *kosten* was borrowed from French *coster*, now *coûter*, as late as in medieval times (Grimm). The original meaning and use was more concrete: the construction was [þx_{NOM} *kost-* y_{ACC} z_{ACC}ÿ], where x is the thing to be paid, y is the payer and z the price (e.g., *der Urlaub kostet mich 2000 Euro*, lit. 'the vacation costs me 2000 euros'). This alternant of the verb is less stative and less abstract. Finally, the functional noun *Preis* is another loan from medieval French. Along with the D-attribute meaning 'price' it carries the meaning 'prize' or 'premium' as well as 'praise$_{N}$' (obsolete); the derived verb *preis-en* 'praise' with the same stem is only related to the meaning 'praise'.

The example shows how vocabulary eventually falls in place in the conceptual paradigm of abstract attributes: antonymous adjectives for high and low values on the scale, a functional noun for the attribute as such and a stative dimensional verb for predications about the value the attribute takes. All this, however, is only the result of a long and complex historical process.

Both observations, the fact that D-attribute vocabulary exists at all, and the massive lexical tinkering in the respective vocabulary, show that there must be some driving force behind the development. The cognitive structure in terms of frame attributes is first; the emergence of frame vocabulary results from an a posteriori convergence of cognitive structure and the vocabulary of the languages we use.

2.6 Conclusion

The review of the grammatical structure and meanings of linguistic gestures offers positive evidence for the assumption that cognitive representations of linguistic gestures exhibit the essential structural properties of Barsalou frames described in Sect. 2.2. For the part of language as a subsystem of human cognition, this provides evidence for the Frame Hypothesis: there is a uniform structure of representations in human cognition, and this structure is essentially Barsalou frames.

This corroboration of the Frame Hypothesis opens important perspectives, for linguistics, for cognitive psychology, and for the relationship between both.

Applied to linguistics, the Frame Hypothesis entails that there is a uniform structure of representations for all levels of linguistic description, including phonetics, phonology, morphology, syntax, semantics, and pragmatics. At present, the respective subdisciplines of linguistics all apply representations of different structures. There are only few approaches, among them HPSG, which try to apply a uniform format of representation to syntax, semantics, morphology, and phonology. Not accidentally, it appears, HPSG uses framelike representations. Tree representations are used in many linguistic theories for representing the composition of complex linguistic gestures not only in syntax, but also in morphology and phonology. As was demonstrated in Sect. 2.3.1, such trees are essentially mereological frames. Classical structuralism introduced features for the distinction of sounds, parts of speech, and meanings. Feature sets are not frames (see the discussion in Barsalou and Hale 1993), but features can be considered specifying the value of an implicit attribute. For example, the feature +[FEMALE] implicitly relates to the attribute SEX, or the phonetic feature [–VOICE] to the attribute VOICING.

The assumption that the same structure underlies cognitive representations of linguistic gestures at all levels of description would provide a very strong constraint on linguistic theory. Such a constraint would be extremely productive and innovative, since the subdisciplines of linguistics would have a reason and a common perspective for cooperating to a degree never envisaged before. Applied to linguistic theory, the Frame Hypothesis first of all means that syntax, semantics, morphology, and phonology are not separate modules of the language faculty, at least not in terms of the structure of representations they use. This is not to deny that each level has a *certain* degree of autonomy, resulting from its particular constraints and its connection to other cognitive faculties. For example, syntax is bound to produce linear structures of phonetic strings, phonology is grounded in phonetic articulation and auditory perception, semantics is connected with cognitive faculties such as perception, categorization, reasoning, and memory.

For cognitive psychology, the recognition of the fact that the cognitive representations of form and meaning of linguistic gestures instantiate the general format of representations in human cognition could lead to a much more intensive consideration of the findings of linguistic analysis. No area of cognition has received such an amount of scientific attention and understanding as language has in more than 2,000 years of theories on the structure of language(s). If there

is a uniform structure of human cognitive representations of linguistic gestures, cognitive psychology can learn about the structure of cognitive representations, their potential and their constraints, from linguistic research into grammar(s) and meaning.

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