29. Frame Semantics

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Contents

1 Introduction 3

2 Fillmorean frames 6
  2.1 Motivations .............................. 6
  2.2 Basic Tools ............................. 15

3 Related conceptions 24
  3.1 Frames versus relations: profiling and saliency 24
  3.2 Frames versus lexical fields .................. 27
  3.3 Minskian frames ........................... 30

4 Events, profiling, and perspectivalization 33

5 Lexicography 48

6 Discourse understanding 49

7 Conclusion 51

8 References 52
Abstract. Frames are conceptual structures that provide context for elements of interpretation; their primary role in an account of text understanding is to explain how our text interpretations can leap far beyond what the text literally says. The present article explores the role of frames in providing a principled account of the openness and richness of word-meanings, distinguishing a frame-based account from classical approaches, such as accounts based on conceptual primitives, lexical fields, and connotation, and showing how they can play a role in the account of how word meaning interacts with syntactic valence.

For there exists a great chasm between those, on the one side, who relate everything to a single central vision, one system more or less coherent or articulate, in terms of which they understand, think and feel — a single, universal, organizing principle in terms of which alone all that they are and say has significance — and, on the other side, those who pursue many ends, often unrelated and even contradictory, connected, if at all, only in some de facto way, for some psychological or physiological cause, related by no moral or aesthetic principle.

Berlin (1957:1), cited by Minsky (1975)
1 Introduction

Two properties of word meanings contribute mightily to the difficulty of providing a systematic account.

One is the openness of word meanings. The variety of word meanings is the variety of human experience. Consider defining words such as Tuesday, barber, alimony, seminal, amputate, and brittle. One needs to make reference to diverse practices, processes, and objects in the social and physical world: repeatable calendar events, grooming and hair, marriage and divorce, discourse about concepts and theories, and events of breaking. Before this seemingly endless diversity, semanticists have in the past stopped short, excluding it from the semantic enterprise, and attempting to draw a line between a small linguistically significant set of primitive concepts and the openness of the lexicon.

The other problem is the closely related problem of the richness of word meanings. Words are hard to define, not so much because they invoke fine content specific distinctions, but because they invoke vast amounts of background information. The concept of buying presupposes the complex social fact of a commercial transaction. The concept of alimony presupposes the complex social fact of divorce, which in turn presupposes the complex social fact of marriage. Richness, too, has inspired semanticists simply to
stop, to draw a line, saying exact definitions of concepts do not matter for
theoretical purposes.

This boundary-drawing strategy, providing a response if not an answer to
the problems of richness and openness, deserves some comment. As linguistic
semanticists, the story goes, our job is to account for systematic, structurally
significant properties of meaning. This includes:

(1) a. the kinds of syntactic constructions lexical meanings are compat-
ible with.
   i. the kinds of participants that become subjects and objects
   ii. regular semantic patterns of oblique markings and valence al-
ternations

b. Regular patterns of inference licensed by category, syntactic con-
struction or closed class lexical item.

The idea is to carve off that part of semantics necessary for knowing and
using the syntactic patterns of the language. To do this sort of work, we do
not need to pay attention to every conceptually possible distinction. Instead
we need a small set of semantic primitives that make the distinctions that
linguistically matter; what is left over can be dealt with using some open
class of predicates or features whose internal details are not of concern.

Jackendoff (1990) is a good example of this kind of approach. The genera-
tive semantics program, especially as outlined in Lakoff (1972), is another.

Dowty (1979) has many of the same features, but in places expresses doubts that the program can be completely carried out. The kind of analysis I have in mind can be exemplified through Dowty’s generative-semantics-like analysis of causatives like break.tr (transitive break):

(2)  a. John broke the glass.
    b. DO(John, CAUSE(BECOME(broken(glass))))

Here the predicates in capitals (DO, CAUSE, BECOME) are from the inventory of linguistically significant primitives, and the lower case predicates (broken, glass) are from the open class predicates whose internal structure does not matter. At most we need to know that one expresses a state (broken) and the other a kind (glass). The details beyond that are linguistically insignificant.

Of course there are differences in truth-conditions between states like broken and dead, but these have only minor selectional effects on the causative inchoatives created from them (break.tr = DO ... CAUSE BECOME broken’ and kill = DO ... CAUSE BECOME dead’). I will refer to this view of lexical semantics as the classical view.

In this paper I wish to consider a view of semantics in general and lexical semantics in particular that is quite at odds with this classical picture: frame semantics (Fillmore 1975, Fillmore 1978, Fillmore 1977b, Fillmore 1982,
Fillmore 1985). Someone wishing to contest the classical picture has two options: first, contend that the wrong kinds of questions are being asked; second, argue that the program as outlined is not very well-suited to attaining its goals. As we shall see, both kinds of objection motivate frame semantics.

2 Fillmorean frames

2.1 Motivations

The version of frame semantics I will present here is largely the brainchild of Charles J. Fillmore. Although frame semantics has sprouted off in a number of directions and been applied to a number of problems, I will limit the present discussion in two ways: First I will confine myself largely to fleshing out the Fillmorean picture; second, I will confine myself mostly to questions of the lexicon, lexicography, and the lexicon-syntax interface, leaving for other work questions of discourse and text understanding to which frames are also relevant. I will briefly consider the different roles frames play in the account of sign meaning and discourse interpretation.

Although Fillmore has had many interesting things to say about the kinds of problems listed in (1) in early and late works on Case Grammar, the
primary motivations given in Fillmore (1982, 1985) focus on frame semantics as a contribution to a theory of text understanding. Consider for example, the very different scenes evoked by the following pair of sentences, discussed in Fillmore (1985):

(3)  a. I can’t wait to be on the ground again.
    b. I can’t wait to be on land again.

Sentence (3a) evokes a speaker who is in the air (on a plane), sentence (3b) a speaker who is at sea (on a ship). This contrast is tied to some difference between the words land and ground, yet, on the face of it, land and ground denote very similar things. Fillmore would say land is understood within a conceptual frame of sea travel, and within that frame it is opposed to sea, while ground is understood within a conceptual frame of air travel, and within that frame, it is opposed to air. Thus we can explain something that is very difficult to explain in terms what the words in the sentence denote by investigating the conceptual background against which the relevant word senses are defined. That conceptual background is what Fillmore calls a frame.

Frames are conceptual structures that provide context for elements of interpretation; their primary role in an account of text understanding is to explain how our text interpretations can (validly) leap far beyond what the
Frames can be introduced into interpretation in a variety of ways. They may be directly tied to word senses as in the example of *land* and *ground* or they may be introduced by patterns among the facts the text establishes. To use another example of Fillmore’s (1985), 232:

(4) We never open our presents until morning.

This sentence *evokes* the Christmas frame by describing a situation that matches salient facts of Christmas practice, even though no word in it is specific to Christmas. If in fact the Christmas frame is the right one, that evocation makes a significant contribution to the understanding of the surrounding text.

Frames are motivated not just by words, then, but by stereotypes about customs, practices, institutions, and games. Moreover, the kinds of cognitive structures Fillmore has in mind have been proposed by a variety of researchers for a variety of purposes. Fillmore has adopted the terminology of AI researcher Minsky (1975) in calling them frames, but *schemata* in psychology (Bartlett 1932, Rumelhart 1980) are getting at something very similar, as are *scripts* (Schank and Abelson 1977), *cognitive models* (Lakoff 1983), *experiential gestalts* (Lakoff and Johnson 1980), *the base* (as opposed to the profile) (Langacker 1984), and Fillmore’s own notion of *scene* (Fillmore 1976, Fillmore 1977a). More recently, in articulating a *simulation view* of concep-
tual processing, Barsalou (Barsalou 1992, Barsalou 1999) has proposed that
object conceptualization is processed through simulators of objects linked
to components of a variety of situation memories; one consequence is that
objects may activate components from different situations in different per-
ceptual contexts. In this theory, too, then, conceptualization is framed
against a background with components that help provide an interpretation
for scenes or objects. For more discussion, see Article 120 Conceptual knowl-
edge, categorization, and meaning representation.

As an approach to word meanings specifically, the starting point for
frame semantics is that the lexical semantics “problems” of openness and
richness are connected. Openness depends on richness. Openness does not
mean lack of structure. In fact, it presupposes structure. Most concepts are
interpretable or understandable or definable only against the background
of other concepts. Many backgrounds are rich enough to define a cluster
of concepts, in particular, a cluster of words. These backgrounds are the
frames. Thus because words are networked together through their shared
backgrounds, frames can provide an organizing principle for the openness of
the lexicon.

Consider one of the examples already discussed, discussed in Fillmore
(1982). The concept of alimony depends on the concept of divorce. The
concept of divorce in turn depends on the concept of marriage. The dependency is definition. Unless you define what a marriage is, you can’t define what a divorce is. Unless you define what a divorce is, you can’t define what alimony is. Thus there is a very real sense in which the dependencies we are describing move us toward *simpler* concepts. Notice, however, that the dependency is leading in a different direction than an analysis that decomposes meanings into a small set of primitives like *cause* and *become*. Instead of leading to concepts of increasing generality and abstractness, we are being led to define the situations or circumstances which provide the necessary *background* for the concepts we are describing. The concepts of marriage and divorce are equally specific, but the institution of marriage provides the necessary background for the institution of divorce.

Or consider the complex subject of Tuesdays (Fillmore 1985). We live in a world of cyclic events. Seasons come and go and then return. This leads to a cyclic calendar which divides time up into repeating intervals, which are divided up further. Years are divided into months, which are divided into weeks, which are divided into days, which have cyclic names. Each week has a Sunday, a Monday, a Tuesday, and so on. Defining Tuesday entails defining the notion of a cyclic calendar. Knowing the word *Tuesday* may not entail knowing the word *Sunday*, but it does entail understanding at least
the concept of a week and a day and their relation, and that each week has
exactly one Tuesday.

We thus have words and background concepts. We will call the back-
ground concept the frame. Now the idea of a frame begins to have some
lexical semantic bite with the observation that a single concept may provide
the background for a set of words. Thus the concept of marriage provides
the background for words/suffixes/phrases such as bride, groom, marriage,
wedding, divorce, -in-law, elope, fiancee, best man, maid-of-honor, honey-
moon, husband, and wife, as well as a variety of basic kinship terms omitted
here for reasons of space. The concept of calendar cycle provides the
frame for lexical items such as week, month, year, season, Sunday, ..., Sat-
urday, January, ..., December, day, night, morning, and afternoon. Notice
that a concept once defined may provide the background frame for further
concepts. Thus, divorce itself provides the background frame for lexical
items such as alimony, divorce, divorce court, divorce attorney, ex-husband,
and ex-wife.

In sum, a frame may organize a vocabulary domain:

Borrowing from the language of gestalt psychology we could say
that the assumed background of knowledge and practices — the
complex frame behind this vocabulary domain — stands as a
common ground to the figure representable by any of the individual words.

[Words belonging to a frame] are lexical representatives of some single coherent schematization of experience or knowledge.

Fillmore (1985:223)

Now a premise of frame semantics is that the relation between lexical items and frames is open ended. Thus one way in which the openness of the lexicon manifests itself is in building concepts in unpredictable ways against the backdrop of other concepts. The concept of marriage seems to be universal or near-universal in human culture. The concept of alimony is not. No doubt concepts sometimes pop into the lexicon along with their defining frames (perhaps *satellite* is an example), but the usual case is to try to build them up out of some existing frame (Thus *horseless carriage* leading to *car* is the more usual model).

Summing up: openness does not mean structurelessness. Concepts and their related words have certain unidirectional backgrounding relations that frames capture
<table>
<thead>
<tr>
<th>Words</th>
<th>Frames</th>
</tr>
</thead>
<tbody>
<tr>
<td>bride, groom, marriage, wedding, divorce,</td>
<td>MARRIAGE</td>
</tr>
<tr>
<td>-in-law, elope, fiancee, best man, maid-of-honor,</td>
<td></td>
</tr>
<tr>
<td>honeymoon, husband, wife</td>
<td></td>
</tr>
<tr>
<td>alimony, divorce court, divorce attorney,</td>
<td>DIVORCE</td>
</tr>
<tr>
<td>ex-husband, and ex-wife</td>
<td></td>
</tr>
<tr>
<td>week, month, year, Sunday, ..., Saturday,</td>
<td>CALENDAR CYCLE</td>
</tr>
<tr>
<td>January, ..., December, morning, afternoon</td>
<td></td>
</tr>
<tr>
<td>freezing, cold, cool, tepid, lukewarm,</td>
<td>TEMPERATURE</td>
</tr>
<tr>
<td>warm, hot, temperature, thermometer</td>
<td></td>
</tr>
</tbody>
</table>

All of this obviously points in exactly the opposite direction from the classical view, a few salient primitives, a hard distinction between linguistic and encyclopedic, and a large uninvestigated class of open class predicates.

But from the other direction, support for the classical view has been eroding even among those whose concerns have primarily departed from the problems in (1) such as Levin (1993) or from classic lexical semantic problems like polysemy (Pustejovsky 1995).

Consider the kind of problem Levin (1993) discusses in her seminal study of of English verb classes. A theory that does not posit a systematic difference between the *broken* state of the verb *break* in (2) and the *dead* state in...
the decomposition of kill cannot account for the following contrast:

(6) a. John broke the glass against the wall.
   b. # John killed the cockroach against the wall.

Nor can it account for the fact that verbs in some sense close in meaning to break (shatter, smash, crack, flatten) will follow pattern (a), while verbs in some sense close to kill will follow pattern (b) (strangle, murder, smother, and drown). The generalization at issue is (roughly) that state change or directed action verbs whose effect is commonly achieved by moving one object against another will allow pattern (a) when the object whose state is changed or potentially changed is direct object. Other examples are hit, knock, rap, bang, and slam. None of the kill-type verbs fit the bill.

Thus if valence patterns are part of what is to be explained, then a language like English, with its rich inventory of prepositions and situationally specific constructions (see for example the pattern lists in Levin 1993), will require reference to a large inventory of concepts. It is difficult to see how a principled line between open class and closed class concepts can be drawn in carrying out this program. It is clear for example, that Levin’s verbs of contact, which include the verbs like hit and slap discussed above, overlap significantly with the verbs list for the IMPACT frame in FrameNet, a large computational instantiation of the ideas of frame semantics (Fillmore and Atkins...
1994, Baker et al. 1998, Fillmore and Atkins 1998, Baker and Fillmore 2001, Boas 2001, Boas 2005, Chang et al. 2002a, Chang et al. 2002b). At last count the NSF Framenet project (Fillmore and Baker 2000) which is building a frame lexicon for English had over 800 frames for about 4500 words. Thus the problems of openness and richness arise whether one starts from text understanding or from syntax/semantics interface.

2.2 Basic Tools

We have thus far focused on the role of frames in a theory of word meanings. Note that nothing in particular hangs on the notion word. Frames may also have a conventional connection to a simple syntactic constructions or idiom; *give someone the slip* probably belongs to the same frame as *elude*. Or they may be tied to more complex constructions such as the Comparative Correlative (cf. Article 97 *Constructional meaning and compositionality*)

(7) The more I drink the better you look.

This construction has two “slots” requiring properties of quantity or degree. The same issues of background situation and profiled participants arise whether the linguistic exponent is a word or construction. The term *sign*, used in exactly the same sense as it is used by construction grammarians, will serve here as well.
As a theory of the conventional association of schematized situations and linguistic exponents, then, frame semantics makes the assumption that there is always some background knowledge relative to which linguistic elements do some profiling, and relative to which they are defined. Two ideas are central:

1. a background concept
2. a set of *signs* including all the words and constructions that utilize this conceptual background.

Two other important frame theoretic concepts are *frame elements* and *profiling*.

Thus far in introducing frames I have emphasized what might be called the modularity of knowledge. Our knowledge of the the world can usefully be divided up into concrete chunks. Equally important to the Fillmorian conception of frames is the integrating function of frames. That is, frames provide us with the means to integrate with other frames in context to produce coherent wholes. For this function, the crucial concept is the notion of a *frame element* (Fillmore and Baker 2000). A frame element is simply a regular participant, feature, or attribute of the kind of situation described by a frame. Thus, frame elements of the wedding frame will include the
husband, wife, wedding ceremony, wedding date, best man and maid of
honor, for example. Frame elements need not be obligatory; one may have a
wedding without a best man; but they need to be regular recurring features.

Thus, frames have slots, replaceable elements. This means that frames
can be linked to to other frames by sharing participants or even by being
participants in other frames. They can be components of an interpretation.

In frame semantics, all word meanings are relativized to frames. But
different words select different aspects of the background to profile (we use
the terminology in Langacker 1984). Sometimes aspects profiled by different
words are mutually exclusive parts of the circumstances, such as the husband
and wife in the marriage frame, but sometimes word meanings differ not in
what they profile, but in how they profile it. In such cases, I will say words
differ in perspective (Fillmore 1977a). I will use Fillmore’s much-discussed
commercial event example (Fillmore 1976) to illustrate:

(8)  a. John sold the book to Mary for $100.
    b. Mary bought the book from John for $100.
    c. Mary paid John $100 for the book.

Verbs like buy, sell, pay, have as background the concept of a commercial
transaction, an event in which a buyer, gives money to a seller in exchange for
some goods. Now because the transaction is an exchange it can be thought of
as containing what Fillmore calls two subscenes: a goods transfer, in which the goods is transferred from the seller to the buyer, and a money transfer, in which the money is transferred from the buyer to the seller. Here it is natural to say that English has as a valence realization option for transfers of possession one in which the object being transferred from one possessor to another is realized as direct object. Thus verbs profiling the money transfer will make the money the direct object (pay and collect) and verbs profiling the goods transfer will make the goods the direct object (buy and sell). Then the difference between these verb pairs can be chalked up to what is profiled.

But what about the difference between buy and sell? By hypothesis, both verbs profile a goods transfer, but in one case the buyer is subject and in another the seller is. Perhaps this is just an arbitrary choice. This is in some sense what the thematic role theory of Dowty (1991) says: Since (8a) and (8b) are mutually entailing, there can be no semantic account of the choice of subject.

In frame semantics, however, we may attempt to describe the facts as follows: in the case of buy the buyer is viewed as (perspectivalized as) agent, in the case of sell, the seller is. There are two advantages to this description. First, it allows us to preserve a principle assumed by a number of linguists, that cross-linguistically agents must be subjects. Second, it allows
us to interpret certain adjuncts that enter into special relations with agents: instrumentals, benefactives, and purpose clauses.

(9) a. John bought the book from Mary with/for his last pay check. [both with and for allow the reading on which the pay check provides the funds for the purchase.]

b. Mary sold the book to John with/for his last paycheck. [Only for allows the reading on which the pay check provides the funds.]

c. John bought the house from Sue for Mary. [allows reading on which Mary is ultimate owner, disallows the reading on which Mary is seller and Sue is seller’s agent]

d. Sue sold the house to John for Mary. [allows reading on which Mary is seller and Sue is seller’s agent; disallows reading on which Mary is ultimate owner.]

e. John bought the house from Sue to evade taxes/as a tax dodge. [tax benefit is John’s]

f. Sue sold the house to John to evade taxes/as a tax dodge. [tax benefit is Sue’s]

But what does it mean to say that a verb takes a perspective which “views” a particular participant as an agent? The facts are, after all, that both the buyer and the seller are agents; they have all the entailment prop-
erties that characterize what we typically call agents; and this, Dowty’s
theory of thematic roles tells us, is why verbs like *buy* and *sell* can co-exist.

I will have more to say on this point in Section 4; for the moment I will
confine myself to the following general observation on what frame semantics
allows: What is profiled and what is left out is not determined by the en-
tailment facts of its frame. Complex variations are possible. For example,
as Fillmore observes, the *commercial transaction* frame is associated
with verbs that have no natural way of realizing the seller:

(10) John spent $100 on that book.

Nothing in the valence marking of the verb *spend* suggests that what is being
profiled here is a possession transfer; neither the double object construction,
nor *from* nor *to* is possible for marking a core *commercial transaction*
participant. Rather the pattern seems to be the one available for what one
might call *resource consumption* verbs like *waste, lose, use (up),* and *blow.*

In this profiling, there is no room for a seller. Given that such variation
in what is profiled is allowed, the idea that the agenthood of a participant
might be part of what’s included or left out does not seem so far-fetched.

As I will argue in Section 4, the inclusion of events into the semantics can
help us make semantic sense of what abstractions like this might mean.
These considerations argue that there can be more than one frame back-grounding a single word meaning; for example, concepts of commercial event, possession transfer, and agentivity simultaneously define buy. A somewhat different but related issue is the issue of event structure. There is strong ev-

evidence cross-linguistically at least in the form of productive word-formation processes that some verbs — for example, causatives — represent complex events that can only be expressed through a combination of two frames with a very specific semantics. Article 119 Mental Lexicon examines additional psycholinguistic evidence for complex events. So it appears that a word meaning can simultaneously invoke a configuration of frames, with parti-

culars of the configuration sometimes spelled out morphologically.

The idea that any word meaning exploits a background is of use in the account of polysemy. Different senses will in general involve relativization to different frames. As a very simple example, consider the use of spend in the following sentence:

(11) John spent 10 minutes fixing his watch.

How are we to describe the relationship of the use of spend in this example, which basically describes a watch fixing event, with that in (10), which describes a commercial transaction? One way is to say that one sense involves the commercial transaction, and another involves a frame we
might call ACTION DURATION which relates actions to their duration, a frame that would also be invoked by durative uses of for. A counter-proposal is that there is one sense here, which involves an actor using up a resource. But such a proposal runs up against the problem that spend really has rather odd disjunctive selection restrictions:

(12) John spent 30 packs of cigarettes that afternoon.

Sentence (12) is odd except perhaps in a context (such as a prison or boarding school) where cigarette packs have become a fungible medium of exchange; what it cannot mean is that John simply used up the cigarettes (by smoking them, for example). The point is that a single general resource consumption meaning ought to freely allow resources other than time and money, so a single resource consumption sense does not correctly describe the readings available for (12); however, a sense invoking a COMMERCIAL TRANSACTION frame constrained to very specific circumstances does. Note also, that the fact that 30 packs of cigarettes can be the money participant in the right context is naturally accommodated. The right constraint on the money participant is not that it be cash (for which Visa and Mastercard can be thankful), but that it be a fungible medium of exchange.

Summarizing:
1. Frames are motivated primarily by issues of understanding and converge with various schema-like conceptions advanced by cognitive psychologists, AI researchers, and cognitive linguists. They are experientially coherent backgrounds with variable components that allow us to organize families of concepts.

2. The concept of frames has far reaching consequences when applied to lexical semantics, because a single frame can provide the organizing background for a set of words. Thus frames can provide an organizing principle for a rich open lexicon. FrameNet is an embodiment of these ideas.

3. In proposing an account of lexical semantics rich enough for a theory of understanding, frame semantics converges with other lexical semantic research which has been bringing to bear a richer set of concepts on problems of the syntax semantics interface.

Having sketched the basic idea, I want in the next two sections to briefly contrast the notion frame with two other ideas that have played a major role in semantics, the idea of a relation, as incorporated via set theory and predicate logic into semantics, and the idea of a lexical field.
3 Related conceptions

In this section I compare the idea of frames with two other concepts of major
importance in theories of lexical semantics, relations and lexical fields. The
comparison offers the opportunity to develop some other key ideas of frame
semantics, including profiling and saliency.

3.1 Frames versus relations: profiling and saliency

Words (most verbs, some nouns, arguably all degreeable adjectives) describe
relations in the world. Love and hate are relations between animate experi-
encers and objects. The verb believe describes a relation between an animate
experiencer and a proposition. These are commonplace views among philoso-
phers of language, semanticists, and syntacticians, and they have provided
the basis for much fruitful work. Where do frames fit in?

For Fillmore, frames describe the factual basis for relations. In this
sense they are “pre-”relational. To illustrate, Fillmore (1985) cites Mill’s
(1847) discussion of the words father and son. Although there is a single
history of events which establishes both the father- and the son- relation,
the words father and son pick out different entities in the world. In Mill’s
terminology, the words denote different things, but connote a single thing,
the shared history. This history, which Mill calls the fundamentum relatio-
nis (the foundation of the relation), determines that the two relations bear
a fixed structural relation to each other. It is the idea of a determinate
structure for a set relations that Fillmore likens to the idea of a frame.

Thus, a frame defines not a single relation but, minimally, a structured
set of relations.

This conception allows for a natural description not just of pairs of words
like father and son, but also of single words which do not in fact settle on
a particular relation. Consider the verb risk, discussed in Fillmore and
Atkins (1998), which seems to allow a range of participants into a single
grammatical “slot”. For example,

(13) Joan risked
    \begin{align*}
    & \text{a. censure.} \\
    & \text{b. her car.} \\
    & \text{c. a trip down the advanced ski slope.}
    \end{align*}

The risk frame has at least 3 distinct participants, (a) the bad thing that
may happen, (b) the valued thing that may be lost, and (c) the activity
that may cause the bad thing to happen. All can be realized in the direct
object position, as (13) shows. Since there are three distinct relations here, a
theory that identifies lexical meanings with relations needs to say there are 3
meanings as well. Frame semantics would describe this as one frame allowing
3 distinct profilings. It is the structure of the frame together with the
profiling options the language makes available which makes the 3 alternatives possible.

Other verbs with a similar indeterminacy of participant are *copy, collide*, and *mix*:

(14) a. Sue copied her costume (from a film poster).
    b. Sue copied the film poster.
    c. The truck and the car collided.
    d. The truck collided with the car.
    e. John mixed the soup.
    f. John mixed the paste into the soup.
    g. John mixed the paste and the flour.

In each of these cases the natural frame semantics account would be to say the frame remains constant while the profilings or perspective changes. Thus, under a frame semantics approach, verbal valence alternations are to be expected, and the possibility of such alternations provides motivation for the idea of a background frame with a range of participants and a range of profiling options.

Now on a theory in which senses are relations, all the verbs in (14) must have different senses. This is, for example, because the arguments in (14a) and (14b) fill different roles. Frame semantics allows another option. We
can say the same verb sense is used in both cases. The differences in interpretation arise because of differences in profiling and perspectivalization.

3.2 Frames versus lexical fields

Because frames define lexical sets, it is useful to contrast the concept of frames with an earlier body of lexical semantic work which takes as central the identification of lexical sets. This work develops the idea of *lexical fields* (Weisgerber 1962, Coseriu 1967, Trier 1971, Geckeler 1971, Lehrer and Kittay 1992). Lexical fields define sets of lexical items in mutually defining relations, in other words, lexical semantic paradigms. The classic example of a lexical field is the set of German labels used for evaluating student performance (Weisgerber 1962:99):

(15) *sehr gut*, *gut*, *genügend* and *mangelhaft*

The terms are mutually defining because the significance of a single evaluation obviously depends on knowing the entire set and the relations of the terms in the set. Thus *gut* means one thing in a school system with the 4 possibilities in (15) and quite another if the possibilities are:

(16) *sehr gut*, *gut*, *befriedigend ausreichend*, *mangelhaft* and *ungewichtig*

Fillmore also cites the example of the tourist industry use of the term *first class* in their categorization of hotels; to many travelers, *first class* sounds
pretty good; in fact, the top ranked class of hotels is luxury and first class is fourth from the top. The misunderstanding here seems exactly like a case of applying the wrong frame in the process of understanding.

Domains in which lexical fields have provided fruitful analyses include color, temperature, furniture and artifacts, kinship relations, intelligence, livestock, and terrain features (Fillmore 1985:227).

The general hypothesis of lexical field theory is that the lexicon can be carved up into a number of (sometimes overlapping) lexical sets, each of which functions as a closed system. To this extent, there is agreement with the conception of frames, and in fact, the lexical sets associated with frames can include lexemes in paradigmatic, mutually defining relations.

For example, we identified the temperature frame in Section 2, and this includes the lexical field of temperature words like cold, cool, lukewarm, warm, and hot.

However, the idea of a frame is distinct from the idea of a lexical field. To start with, the idea of a one-word lexical field is incoherent: How can a word have a function in a field in which there is nothing for it to be opposed to? However, there is no inherent difficulty with the idea of a one-word frame. Fillmore (1985) cites the example of hypotenuse, which requires for its background the concept of a right triangle. There appear to be no
other English lexical items specific to right triangles (the term *leg* in the relevant sense seems to apply to triangle sides in general); and that is neither surprising nor problematic. The notion mutually defining is not necessary for lexical frame sets because words in frames are defined in contrast to or in terms of the frame alone. The frame, not its lexical instantiations, provides the background necessary to identify a semantic function. The primitive notion is not *defined in opposition to* but *profiled from the background of*.

A second way in which frames differ from lexical fields is that, even when there is more than one word, there is no requirement that words in the set function in paradigmatic opposition to one another. Thus the *temperature* frame cited above also contains the noun *temperature*, just as the *height* frame containing polar adjectives like *tall* and *short* will contain the noun *height*.

Thirdly, because of the notion of mutual definition, lexical fields come with strict criteria of individuation. In contrast, as we saw in Section 2, frames of arbitrary specificity make sense. Thus, we have very general frames of *temperature* and *height*. But we also have a set of specific frames that recover the traditional mutually defining sets that preoccupied lexical field theorists, a specialization of *height* that includes just the polar adjectives, a specialization of *temperature* that includes just the set *cold*,

29
cool, warm, hot, and so on. This level of specificity in fact roughly describes the granularity of FrameNet.

### 3.3 Minskian frames

As described in Fillmore (1982), the term *frame* is borrowed from Marvin Minsky. It will be useful before tackling the question of how profiling and perspectivalization work to take a closer look at this precursor.

In Minsky’s original frames paper (Minsky 1975), frames were put forth as a solution to the problem of *scene interpretation* in vision. Minsky’s proposal was in reaction to those who, like the Gestalt theorists (Koffka 1963), viewed scene perception as a single holistic process governed by principles similar to those at work in electric fields. Minsky thought scenes were assembled in independent chunks, constituent by constituent, in a series of steps involving interpretation and integration. To describe this process, a model factoring the visual field into a number of discrete chunks, each with its own model of change with its own discrete phases, was needed.

A frame was thus a dynamic model of some specific kind object with specific participants and parameters. The model had built-in expectations about ways in which the object could change, either in time or as a viewer’s perspective on it changed, formalized as operations mapping old frame states
Figure 1: View of cube together with simplified cube frame representing that view. Links marked “fg” lead to foregrounded slots; slots marked “invis” are backgrounded. Faces D and C are out of view.

to new frame states. A frame also included a set of participants whose status changed under these operations; those moving into certain distinguished slots are foregrounded. Thus, for example, in the simplified version of Minsky’s cube frame, shown before and after a rotation in Figures 1 and 2, a frame state encodes a particular view of a cube and the participants are cube faces. One possible operation is a rotation of the cube, defined to place new faces in certain view-slots, and move old faces out and possibly out of view. The faces that end up in view are the foregrounded participants of the resulting frame state. Thus the cube frame offers the tools for representing particular views or perspectives on a cube, together with the operations that
Figure 2: Cube frame after counterclockwise rotation. Faces D and A are now foregrounded, B has moved out of view.

Fillmore’s innovation, then, was to apply this Minskian idea in the domain of word meaning, importing not only the idea of chunked modular knowledge units, but also the idea of operations that take perspectives on such chunks. I used the terms profiling and perpsectivalization to describe such operations in Section 2. Although Fillmore himself does not attempt a formalization of these operations, I believe it is possible to clearly describe what is at issue using some ideas from event semantics (Davidson 1967, Davidson 1980, Parsons 1990), building on the event-based approach to frames in Gawron (1983).
4 Events, profiling, and perspectivalization

To spell out a bit better how word senses might invoke multiple frames, let us return to the case of the commercial transaction frame discussed in Section 2. The following development takes up and extends the ideas of Gawron (1983).

A rather natural account of the interface between frames and compositional semantics becomes available if we make use of neo-Davidsonian event-semantics (Davidson 1967, Davidson 1980, Parsons 1990). On a neo-Davidsonian account, we have, as the schematic semantics for John bought the book on sale:

$$\exists e [\text{buy}(e) \land \text{agent}(e) = j \land \text{patient}(e) = b \land \text{on-sale}(e, b)]$$

We call $e$ in the above representation the lexical event.

I assume that Fillmorean frames classify events. That is, there is such a thing as a commercial transaction event. Further, I assume that lexical predicates like give and buy are predicates true of events. These lexical events cannot be directly identified with Fillmorean frame events. Rather the lexical events are perspectivalizations of Fillmorean frame events. Thus, for example, buying will be associated with three events, one perspectivaliz-
ing event that is directly related to syntactic realization, a second profiling event that is a profiling of a third commercial transaction (or Fillmorean frame event). I will call this latter the circumstance event. Perspective, profiling, and circumstance events will be related by functions.

Borrowing the machinery of sorted logic (Carpenter 1992, Smolka 1992, Rounds 1997), I will assume that all predicates are sorted; that is, it is a property of predicates and relations that in all models, for any given argument position, there is a sort of individuals for which that argument position is defined. I will write sorts in boldface and predicates in roman.

(17) \[ \text{AGENT PATIENT} : \text{agent.patient} \mapsto \text{truth-values} \]

\[ \text{agent} : \text{agent.patient} \mapsto \text{animate} \]

\[ \text{patient} : \text{agent.patient} \mapsto \text{entity} \]

\[ \text{source} : \text{agent.patient} \mapsto (\text{entity}) \]

\[ \text{goal} : \text{agent.patient} \mapsto (\text{entity}) \]

These declarations just say, in roughly standard mathematical notation that agent and patient are functions from one set to another. For example, the first declaration says that AGENT PATIENT is a function from the set (sort) to truth-values; the second says agent is a function from the set (sort) of AGENT PATIENT events to animates; patient from the set of AGENT PATIENT events to the set of things (the domain of entities). The parentheses in
the source and goal role definitions may be taken to mean that the role is
optional (or the function is partial). Not every AGENT PATIENT event has a
source or a goal, but some do.

I assume the declarations (or axioms) in (17) are sufficient to define a very
simple kind of frame. The first axiom defines a predicate AGENT PATIENT
that is true of events of that sort; the rest define a set of roles for that sort of
event. Thus a minimal frame is just an event sort defined for a set of roles.
I will call AGENT PATIENT an argument frame because syntactic arguments
of a verb will need to directly link to the roles of argument frames (such as
agent and patient). We can represent this set of axioms as an attribute-value
matrix (AVM):

\[
\begin{bmatrix}
\text{AGENT PATIENT} \\
\text{agent} & \text{animate} \\
\text{source} & \text{entity} \\
\text{goal} & \text{entity} \\
\text{patient} & \text{entity}
\end{bmatrix}
\]

Henceforth I use AVM notation for readability, but the reader should bear
in mind that it is merely a shorthand for a set of axioms like those in (17),
constraining partial functions and relations on sorts.

I will call AGENT PATIENT an argument frame because syntactic argu-
ments of a verb will need to directly link to the roles of argument frames
(such as agent and patient). The agent patient frame is very general,
too general to be of much semantic use. In order to use it a lexical item
must specify some circumstance frame in which participant roles are further
specified with further constraints.

The connection between an argument frame like agent patient and
simple circumstance frames can be illustrated through the example of the
possession transfer frame (related to verbs like give, get, take, receive,
acquire, bequeath, loan, and so on). Represented as an AVM, this is:

\[
\begin{array}{c}
\text{donor} \quad \text{animate} \\
\text{possession} \quad \text{entity} \\
\text{recipient} \quad \text{animate}
\end{array}
\]

Now both give and acquire will be defined in terms of the possession transfer frame, but give and acquire differ in that with give the donor becomes
subject and with acquire the recipient does. (Compare the difference be-
tween buy and sell discussed in in Section 2.2.)

We will account for this difference by saying that give and acquire have
different mappings from the agent patient frame to their shared circum-
stance frame (possession transfer). This works as follows.
We define the relation between a circumstance and argument frame via a *perspectivalizing function*. Here are the axioms for what we will call the *acquisition* function, on which the recipient is agent:

\[\text{(20) (a) acquisition : possession\_transfer} \rightarrow \text{agent\_patient}\]

\[\text{(b) agent} \circ \text{acquisition} = \text{recipient}\]

\[\text{(c) patient} \circ \text{acquisition} = \text{possession}\]

\[\text{(d) source} \circ \text{acquisition} = \text{donor}\]

The first line defines *acquisition* as a mapping from the sort *possession\_transfer* to the sort *agent\_patient*, that is as a mapping from *possession transfer* eventualities to *agent patient* eventualities. The mapping is total; that is, each *possession transfer* is guaranteed to have an *agent patient* eventuality associated with it. In the second line, the symbol \(\circ\) stands for *function composition*; the composition of the *agent* function with the *acquisition* function (written *agent* \(\circ\) *acquisition*) is the same function (extensionally) as the *recipient* relation. Thus the filler of the *recipient* role in a possession transfer must be the same as the filler of the *agent* role in the associated *agent patient* eventuality. And so on, for the other axioms.

Summing up AVM style:
(21)

<table>
<thead>
<tr>
<th>POSSESSION TRANSFER</th>
<th>AGENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>donor</td>
<td>1</td>
</tr>
<tr>
<td>recipient</td>
<td>2</td>
</tr>
<tr>
<td>possession</td>
<td>3</td>
</tr>
</tbody>
</table>

\[ \text{donor} \xrightarrow{\text{acquisition}} \text{agent} \]

(22)

<table>
<thead>
<tr>
<th>POSSESSION TRANSFER</th>
<th>AGENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>donor</td>
<td>1</td>
</tr>
<tr>
<td>recipient</td>
<td>2</td>
</tr>
<tr>
<td>possession</td>
<td>3</td>
</tr>
</tbody>
</table>

\[ \text{donor} \xrightarrow{\text{acquisition}} \text{agent} \]

I will call the mapping that makes the *donor* agent *donation*.

With the *acquisition* and *donation* mappings defined, the predicates *give* and *acquire* can be defined as compositions with *donation* and *acquisition*:

\[
give = \text{POSESSION TRANSFER} \circ \text{donation}^{-1}
\]

\[
acquire = \text{POSESSION TRANSFER} \circ \text{acquisition}^{-1}
\]

*donation*\(^{-1}\) is an inverse of *donation*, a function from AGENT PATIENT eventualities to POSSESSION TRANSFERS defined only for those AGENT PATIENT events related to POSSESSION TRANSFERS. Composing this with the POSSESSION TRANSFER predicate makes *give* a predicate true of those AGENT
PATIENT events related to possession transfers, whose agents are donors and whose patients are possessions. The treatment of *acquire* is parallel but uses the *acquisition* mappings. For more extensive discussion, see Gawron (2008).

Summarizing:

a. an argument frame AGENT PATIENT, with direct consequences for syntactic valence (agents become subject, patients direct object, and so on).

b. a circumstance frame POSSESSION TRANSFER, which captures the circumstances of possession transfer.

c. *perspectivalizing* functions *acquisition* and *donation* which map participants in the circumstances to argument structure.

This is the basic picture of perspectivalization. The picture becomes more interesting with a richer example.

In the discussion that follows, I assume a commercial transaction frame with at least the following frame elements:
This is a declaration that various functions from event sorts to truth values
and entity sorts exist, a rather austere model for the sort of rich back-
grounding function we have assumed for frames. We will see how this model
is enriched below.

Our picture of profiling and perspectivalization can be exte nded to the
more complex cases of commercial transaction predicates with one more
composition. For example, we may define buy as follows:

\[(24) \text{buy} = \text{COMMERCIAL TRANSACTION} \circ (\text{acquisition} \circ \text{goods transfer})^{-1}\]

What this says is that the relation \text{buy} is built in a series of steps, out of 3
functions:

1. \text{acquisition}: the function from possession transfer events to \text{AGENT-PATIENT}
   events already introduced.
2. *goods_transfer*: a new function from commercial events to possession transfers in which the goods is transferred:

\[
\begin{array}{c}
\text{COMMERCIAL TRANSACTION} \\
\text{buyer} \quad 1 \\
\text{seller} \quad 2 \\
\text{money} \quad 3 \\
\text{goods} \quad 4
\end{array}
\rightarrow
\begin{array}{c}
\text{POSSESSION TRANSFER} \\
\text{recipient} \quad 1 \\
\text{donor} \quad 2 \\
\text{possession} \quad 3
\end{array}
\]

3. The inverse of the composition of *goods_transfer* with *acquisition*

\[(acquisition \circ \text{goods}_{\text{transfer}})^{-1}\]

is a function from agent patient events to commercial transactions.

4. **COMMERCIAL TRANSACTION**: a sortal predicate true of commercial transactions.

5. The predicate *buy* is therefore true of AGENT PATIENT events that are related in certain fixed ways to a POSSESSION TRANSFER and a COMMERCIAL TRANSACTION

The novelty in the definition above is the *goods_transfer* function. We will call this the *profiling function* because it selects the parts of the COMMERCIAL TRANSACTION event which the verb highlights. We will call *acquisition* —
the function which determines subject and object — the perspectivalizing function. The role of the perspectivalizing function is to select a syntactic realization.

A profiling function like *goods_transfer* has two independent motivations:

a. It enriches our rather impoverished model of *commercial transaction*. We started out in (23) with little more than the assumption that there were 4 sorted participants we were calling buyer, seller, money, and goods. Now with the assumption of the *goods_transfer* function, a possession transfer \( p \) is entailed (because the function is total) in which the possession is the goods. Thus *goods_transfer* can be viewed as part of an enriched definition of the *commercial transaction* frame. There will be other total functions enriching the definition further, for example, a *money_transfer* function of use in defining verbs like *pay* and *collect*, in which the money is transferred.

b. Both *money_transfer* and *goods_transfer* are projections from commercial events to possession transfers; and possession transfer is a frame for which we have a pre-defined perspectivalization, independently motivated for other verbs like *acquire* and *get*. By composing a commercial event subscene projection with a possession transfer argument projection
we derive an argument projection for commercial transactions.

Thus the *good transfer* function simultaneously serves knowledge representation needs (a) and valence theory needs (b).

There is an analogy between how profiling and perspectivalization work and the way the original Minskyan frames work. A Minskyan frame enables the integration of scene components in view with underlying objects by specifying, for example, how the faces of the cube in view relate to the cube as a whole. A Fillmorian perspective enables the integration of the realized elements of a text with an underlying text interpretation by specifying how syntactically realized frame components relate to frames as a whole. In both cases there are operations that mediate between rich representations and a constrained (perspectivalized) representation that belongs to an external representational system. Minskyan rotation operations mediate between 3D representations and the 2D representations of a scene, ultimately necessary because the human retina is a screen. Fillmorian profilings and perspectivalizations mediate between unlinearized representations in which there is no fixed individuation of participants and linearizable argument structure, ultimately necessary because the syntax of human language forces us to linearize participants.

Now consider a profiling which leaves things out. This is the case of
As discussed in Section 2, the verb *spend* views a commercial transaction as a resource consumption, where resource consumption is the frame used by verbs like *waste, lose, use (up),* and *blow.* The profiling of the verb *spend* includes the seller and goods but leaves the seller out. The profiling of the verb *sell* includes the buyer and the goods, as well as the seller. The two subscenes overlap in participants but choose distinct, incompatible event types, which lead to distinct realization possibilities in the syntactic frame.

The frame-based picture of commercial transactions is schematized in Figure 3.

The picture on the left shows what we might call the *commercial transaction neighborhood* as discussed here. The picture on the right shows that portion of the neighborhood that is activated by *buy;* the functions used in its
Figure 3: Left: Lexical network for COMMERCIAL TRANSACTION.

Right: Same network with the perspectivalization chosen by buy in the boxed area.
definitions are linked by solid lines; the functions left out are in dashes; the
boxed regions contains those frames that are used in the definition. If as is
suggested in Article 120 Conceptual knowledge, categorization, and meaning
representation, concepts and word meanings need to be different knowledge
structures, the picture in Figure 3 may provide one way of thinking about
how they might be related, with the frame nodes playing the role of concepts
and a configuration of links between them the role of a word meaning.

We have called goods transfer and consumption profiling functions. We
might equally well have called them subscene roles, because they are func-
tions from events to entities. Note that subscene roles don’t attribute a
fixed hierarchical structure to a frame the way DO ... CAUSE BECOME .. in
Dowty’s system attributes a fixed structure to causatives of inchoatives. As
these examples show, a frame may have subscene roles which carve up its
constituents in incompatible ways. Now this may seem peculiar. Shouldn’t
the roles of a frame define a fixed relation between disjoint entities? I sub-
mit that the answer is no. The roles associated with each sort of event
are regularities that help us classify an event as of that sort. But such
functions are not guaranteed to carve up each event into non-overlapping,
hierarchically structured parts. Sometimes distinct roles may select over-
lapping constituents of events, particularly when independent individuation
criteria are not decisive, as when the constituents are collectives, or shape-
less globs of stuff, or abstract things such as events or event types. Thus we
get the cases discussed above like *collide*, *mix*, and *risk*, where different ways
of profiling the frames give us distinct, incompatible sets of roles. We may
choose to view the colliders as a single collective entity (X and Y collided),
or as two (X collided with Y). We may choose to separate a figure from a
ground in the mixing event (14f), or lump them together (mix X and Y), or
just view the mixed substance as one (14f). Finally, risks involve an action
(13c) and a potential bad consequence (13a), and for a restricted set of cases
in which that bad consequence is a loss, a lost thing (13b).

What of relations? Formally, in this frame-based picture, we have re-
placed relations with event predicates, each of which is defined through some
composed set of mappings to a set of events that will be defined only for
some fixed set of roles. Clearly, for every lexical predicate, there is a corre-
sponding relation, namely one defined for exactly the same set of roles as the
predicate. Thus in the end the description of the kind of lexical semantic en-
tity which interfaces with the combinatorial semantics is not very different.
However the problems has, I believe, been redefined in an interesting way.
Traditionally, discussion of the lexical-semantic/syntax interface starts with
a relation with a predefined set of roles. This is the picture for example,
that motivates the formulation of Chomsky’s (1981) Θ-Criterion. However, a major point of frame semantics is that, for many purposes, it is useful to look at a set of relations structured in a particular way. This is the domain of frames.

5 Lexicography

A word about the application of frames to lexicography is in order. Any set of frames imposes a certain classificational scheme on the lexicon. Other examples of such a classificational scheme are Roget’s Thesaurus, Longman’s valence classes, and Wordnet (Fellbaum 1998). Frames differ from all three in that they are not primarily oriented either to the task of synonym-classes or syntactic frame classes. One expects to find synonyms and antonyms in the same frame, of course, and many examples of valence similarity, but neither trend will be a rule. As we saw in Section 2, near synonyms like land and ground may belong to different frames, and understanding those frames is critical to proper usage. As we saw in our investigations of profiling and perspective, differences of both kinds may result in very different valence options for verbs from the same frame. The value of the frame idea for lexicography is that it seems the most promising idea if the goal is to organize words according to usage. This of course is a hypothesis. FrameNet
(Fillmore and Baker 2000) is a test of that hypothesis. Accordingly, frame entries are connected with rich sets of examples gleaned from the British National Corpus illustrating frame element realizations in a variety of syntactic contexts. Interested readers will find a tour of the web site far more persuasive than any discussion here.

6 Discourse understanding

In this section I propose to raise the issue of frames in discourse understanding, not to try to give the subject an adequate treatment, for which there is no space, but to talk a bit about how the role of frames in discourse understanding is related to their role in interpreting signs.

Let us return to the example of verbs conventionally connected with effects caused by movement:

(26) a. John broke the glass against the wall.

b. # John killed the cockroach against the wall.

It is at least arguably the case that this contrast can be made without the help of a lexical stipulation. If movement can be a default or at least a highly prototypical way of breaking something, and not a highly prototypical way of killing something, then something like the default logic of Asher
and Lascarides (1995a) or abduction as in Hobbs et al. (1993), both of which have been applied successfully to a number of problems of discourse interpretation, could infer causality in (a) and not in (b). However, this still falls somewhat short of predicting the genuine oddity of (b). Notice, too, that when discourse coherence alone is at issue, both causality inferences go through:

(27)  a. The glass was hurled against the wall and broke.

        b. The cockroach was hurled against the wall and died.

Thus the defaults at play in determining matters of “valence” differ from those in discourse. We can at least describe the contrasts in (26) — not explain it — by saying movement is an optional component of the breaking frame through which the denotation of the verb *break* is defined, and not a component of the killing frame; or in terms of the formal picture of Section 4:

Within the conventional lexical network linking frames in English there is a partial function from breaking events to movement subscenes; there is no such function for killing events.

In contrast Fillmore’s (1985), 232 discussed in Section 2.1:

(28)  We never open our presents until morning.

The point of this example was that it evoked Christmas without containing
a single word specific to Christmas. How might an automatic interpretation
system simulate what is going on for human understanders? Presumably by
a kind of application of Occam’s razor. There is one and only one frame
that explains both the presence of presents and the custom of waiting until
morning, and that is the Christmas frame. Thus the assumption that gets
us the most narrative bang for the buck is Christmas. In this case the frame
has to be evoked by dynamically assembling pieces of information activated
in this piece of discourse.

These two examples show that frames will function differently in a theory
of discourse understanding than they will in a theory of sign-meanings in
at least two ways. They will require a different notion of default, and they
will need to resort to different inferencing strategies, such as inference to the
most economical explanation.

7 Conclusion

The logical notion of a relation, which preserves certain aspects of the lin-
earization syntax forces on us, has at times appeared to offer an attractive
account of what we grasp when we grasp sign meanings. But the data we
have been looking at in this brief excursion into frame semantics has pointed
another way. Lexical senses seem to be tied to the same kind schemata that
organize our perceptions and interpretations of the social and physical world.

In these schemata participants are neither linearized nor uniquely individuated, and the mapping into the linearized regime of syntax is constrained but underdetermined. We see words with options in what their exact participants are and how they are realized. Frames offer a model that is both specific enough and flexible enough to accommodate these facts, while offering the promise of a firm grounding for lexicographic description and an account of text understanding.

8 References


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58


Keywords: semantics, frames, lexicon