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Toward an Explanatory Semantic Representation*

An important part of any semantic description of natural language is a formal analysis of such traditional notions as Agent, Patient, Location, Recipient, Instrument, and so forth. Jackendoff (1972) (henceforth SIGG) briefly sets out such an analysis, based on the work of Gruber (1965). The efficacy of the analysis is demonstrated with several disparate applications in SIGG, Ruwet (1972), and Jackendoff (1974). The present article broadens and deepens the analysis and attempts to show that it forms the basis for a genuinely explanatory theory of semantic representation.

The first two sections of the article lay the groundwork for a fairly detailed restatement of the theory of thematic relations in section 3. Section 4 defines inference rules in terms of the proposed semantic representations. Section 5 extends the analysis to verbs with complements, showing that the inferences of implicative verbs emerge as a consequence of the rules of section 4. A number of more speculative extensions of the theory are discussed in section 6: ethical datives and benefactives, spatial and temporal extent, and verbs of intent. Section 7 discusses the issue of the psychological reality of the proposed representations.

1. Explanation in Semantics

In a linguistic theory, the semantic representation of a sentence[1] is meant to be a formal characterization of the information conveyed by the sentence. This information can be thought of as a set of claims about various individuals, properties, events, and/or states of affairs, and about the relationships among them.

The *truth-conditions* of a sentence are the conditions in the (real) world under which the claims made by the sentence are true claims. A trivial example: one of the claims made by the sentence *Fred is fat* is that the person designated by the name *Fred* is fat; the corresponding truth-condition is that the person is indeed fat. One of the claims of the sentence *The present king of France is bald* is that there is an individual

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[1] Or, more properly, the semantic interpretation of a particular *reading* of a sentence. An *n*-ways ambiguous sentence, I assume, will be associated with *n* distinct semantic representations.

who at present is king of France; the corresponding truth-condition is that there is indeed such an individual.[2]

The semantic representation of a sentence is subject to various well-formedness conditions such as selectional restrictions, conditions on required referentiality and coreference (cf. SIGG sections 5.9, 5.12, and 7.3 for example), and a general condition that every syntactic constituent must be integrated into the semantic representation. Sentences whose semantic representations fail well-formedness conditions are interpreted as anomalous (or even as ungrammatical).

It is at the level of semantic representation that the semantic relations between one sentence and another are ascertained. Relations of synonymy, paraphrase, antonymy, logical and pragmatic inference, and inconsistency are determined by systems of what can informally be called rules of reasoning or natural logic. Likewise, criteria for analyticity, syntheticity, and contradictoriness (if there are such) are also applied at the level of semantic representation. The principles of many of these systems are described adequately for our purposes by Katz (1972), among others, and we need not go into the details here.

The point of having a level of semantic representation in linguistic theory is clear: it is desirable to represent the claims made by a sentence in a canonical form that is independent of the particular lexical items used and (to a certain extent) of language-particular syntactic vagaries. Clearly the surface structure will not do, and neither will the deep structure of the standard *Aspects* theory, because they contain lexical items. Neither will any standard forms of logic, since they lack the expressive power to deal with the kinds of relations among sentences with which this article will be concerned, namely those involving the decomposition of predicates.

Since the level of semantic representation is to be an integral part of a linguistic theory, it must be related by a system of rules to the syntactic form of the language. The theory of generative semantics (as in Lakoff (1971), for example), which in principle provides a level of semantic representation meeting the criteria above, also provides a system of rules of the requisite type relating semantic representation to surface form, namely the transformational component augmented by global rules and transderivational constraints. The difficulties in the generative semantics approach lie principally in its inability to simultaneously express significant semantic and syntactic generalizations, i.e. it fails on grounds of descriptive adequacy. When it does express both kinds of generality, it often fails to show why those generalizations and not others are operative in the language in question or in language in general; i.e. it fails on grounds of explanatory adequacy.[3]

A satisfactory theory of semantic representation, then, must account not only for the information conveyed by a sentence; it must also account for the way in which

[2] Note that I am making no claims about the truth-value of a sentence if not all its truth-conditions are met; in particular, I am not claiming it is thereby false. The theory must of course distinguish between those truth-conditions that render the sentence false if they are not met and those that render it without truth-value.

[3] The most concentrated set of arguments to this effect are in Chomsky (1972). Arguments also appear in SIGG, especially chapters 3, 6, 7, and 8.

the sentence conveys that information, permitting the expression of both the semantic and syntactic generalizations of the language. Neither must be sacrificed for the other's sake.

A theory of semantic representation is *explanatory* when certain linguistically significant generalizations are inherent in the choice of formalism, when the theory claims that the language could not be any other way. Such a theory claims that the language learner does not have to learn these generalizations; rather, they are determined by his innate capability to learn a human language. In particular, we will be concerned that the theory assigns to sentences semantic representations that constrain the choice of syntactic form, i.e. that permit the language learner to infer properties of syntactic distribution on the basis of the meaning.

2. Principles of Semantic Composition

Any semantic analysis that satisfies the desiderata of section 1 must clearly include ways to decompose the meanings of sentences into various semantic elements, identifying the relations by which the elements can be combined. For present purposes, we will use the controversial term "semantic marker" to refer to any of the elements discovered in a semantic decomposition, without necessarily taking a stand on whether they are primitive or amenable to further decomposition. We will represent semantic markers by capitals: for example, the notation "HORSE" will stand for the meaning (or intension) of the word *horse*. If HORSE is further decomposable (which I assume it is), the representation of the decomposed form will have the same reference as HORSE, that is, it also denotes the meaning (or intension) of *horse*. Similarly, BACHELOR and MAN WHO HAS NEVER MARRIED presumably have the same reference, the intension of the word *bachelor*. By choosing this notation, I intend (at least temporarily) to sidestep the tricky issue of exactly what is semantically primitive.

Two different ways of combining semantic markers into semantically more complex expressions appeared as early as Katz and Fodor (1963), and they seem adequate for a great many purposes, though perhaps not all. The first could be called "restrictive modification"; a semantic marker M_2 is added to a semantic marker M_1 to form a new marker M_3 that picks out a more restricted class of referents than does M_1. Perhaps the simplest case of this is adjectival modification: *red horse* describes objects that are both red and equine. Thus the projection rule for the structure $[_{NP} \cdots A - N \cdots]$ must combine the markers for the adjective and noun according to the principle of restrictive modification. We will represent the resulting marker as $\begin{bmatrix} \text{HORSE} \\ \text{RED} \end{bmatrix}$.[4] Another well-known example of restrictive modification is the addition

[4] At this point we could just as well represent such a marker as $\begin{bmatrix} \text{RED} \\ \text{HORSE} \end{bmatrix}$, attaching no significance to the order of the two constituent markers; and many logicians would no doubt approve. However, it is in principle possible to imbue the relation with additional properties distinguishing "modifiers" from "heads",

of a manner adverb to a verb; we will see many such examples below.

Some semantic markers are not constants, but functions of one or more variables $x_1, \ldots, x_n$. These markers enter into the second kind of combination, "functional composition", in which a semantic marker M takes the place of one of the variables x_i of the semantic function $F(x_1, \ldots, x_n)$ to form a new marker $F(x_1, \ldots, x_{i-1}, M, x_{i+1}, \ldots, x_n)$. This new marker can of course be considered a function of $n - 1$ variables, and functional composition can be applied again, iterating until all the variables of the original function are filled in and the resulting marker is a semantic constant. Verbs are the archetypical semantic functions, and the readings of their subjects and objects are combined with them by functional composition. So, for example, we may represent the reading of *see* as SEE (x, y), that of the VP *see the horse* as the one-place function SEE (x, THE HORSE), and that of the sentence *the man sees the horse* as the semantic constant SEE (THE MAN, THE HORSE).

Notice that syntactic embedding of clauses may correspond to either type of semantic composition. Complement clauses are arguments to semantic functions, while restrictive relative clauses are examples of restrictive modification.

As previously mentioned, both types of semantic composition have been discussed in the linguistic literature. There may of course be other types, such as disjunction and nonrestrictive modification, or perhaps all other forms of semantic composition are reducible to these two.[5] Either kind of composition may appear either as a result of combining the readings of two constituents, as we have seen, or alternatively within the representation of a lexical item itself. For example, the verb *smash* means approximately the same as *break violently* or *break in a violent manner*; we can represent this similarity by assigning *smash* a semantic marker such as $\begin{bmatrix}\text{BREAK} & (x, y) \\ \text{VIOLENTLY} & \end{bmatrix}$, which incorporates a restrictive modifier. Similarly, *bachelor* can be decomposed as $\begin{bmatrix}\text{MAN} \\ \text{NEVER MARRIED}\end{bmatrix}$. Functional composition likewise appears in lexical representation: for example, the semantic relation between transitive

with the semantic significance that under certain conditions a modifier may actually change characteristics of the head rather than merely add to them. This move seems empirically justified, since we need a way to express the fact that, for example, a *one-legged man* is considered a man, but a *human monopod* is some more indeterminate sort of creature. Such evidence indicates that the commutative operative of set intersection is not a correct logical characterization of restrictive modification, as has been commonly supposed.

[5] It is notable that in the literature of generative semantics only the second type of semantic composition seems to be countenanced; all other principles, including quantification and logical operations, are reduced to functional composition, represented syntactically as ordinary verbs. Even restrictive modification is thus reduced, by regarding it as a special case of conjunction; for example, relative clauses are taken to be conjoined to their matrix sentence in the underlying "logical form" (cf. Thompson (1971)). The fact that the transformational derivation required by this underlying form violates several well-motivated constraints on transformations (cf. Jackendoff (1975a, section 6)) does not seem to bother anyone very much. In any event, we will retain both types of semantic composition here. The reader may, if he cares to, convert all cases of restrictive modification used here into cases of functional composition and find out for himself how complex and unrewarding the enterprise becomes.

and intransitive *eat* can be represented as EAT (x, y) versus EAT (x, FOOD); KILL (x, y) can be decomposed (roughly) as CAUSE (x, DIE (y)).

3. Five Semantic Functions

This section will restate the system of thematic relations presented in SIGG, chapter 2, shifting the emphasis from the semantic relations of noun phrases to the semantic composition of the verb. The semantic description is based on the analysis in Gruber's *Studies in Lexical Relations*, in which the representation is formalized as a quasi-generative semantics "prelexical" level of syntactic derivation. Here, however, it will be formalized as a purely semantic level related to the syntax by projection rules, i.e. as a standard interpretive theory.

3.1. Motional, Punctual, and Durational Verbs

Consider sentences such as (1).

(1) a. The train traveled from Detroit to Cincinnati.
b. The hawk flew from its nest to the ground.
c. The rock rolled from the hillside into the river.
d. A spark jumped from the anode to the cathode.
e. His hand crept from the book to her lap.
f. An apple fell from the tree to the ground.
g. The coffee filtered from the funnel into the cup.

All of these sentences describe motion of an object or substance from one place to another. For convenience, we will call the phrase describing the moving object the Theme of the sentence. In the sentences (1), the Theme happens to fall in subject position, though this is not always the case, as will be seen shortly. We will call the phrase describing the Theme's initial position the Source. In (1), the Sources all happen to be objects of the preposition *from*. The phrase describing the Theme's final position we will call the Goal; the Goals in (1) happen to be objects of *to* or *into*.

The semantic similarity among these seven sentences can be expressed by assigning them a common element in their semantic representations, a function GO (x, y, z). This function makes the claim that there has taken place an event consisting of the motion of x from y to z. In other words, the first variable of GO corresponds to the Theme, the second to the Source, and the third to the Goal. The corresponding truth-condition, of course, is that there actually have been such an event.

The semantic differences among the seven sentences in (1) are expressed by two distinct means. First, the different Themes, Sources, and Goals are represented by inserting the appropriate semantic markers for the arguments x, y, and z in the function GO. These differences are thus a question of functional composition: (1a) is

represented in part as GO (THE TRAIN, DETROIT, CINCINNATI); (1b) as GO (THE HAWK, ITS NEST, THE GROUND); and so forth.

The other semantic differences among the sentences in (1) concern manner of motion: *flying* involves motion through the air, *rolling* involves motion along a surface with a concomitant circular motion along an axis passing through the object in motion and perpendicular to its path, and so forth. Describing the manner of motion involves adding a semantic marker as a restrictive modifier of the function. Thus we can have the following representations

$$\textit{fly:}\quad \begin{bmatrix}\text{GO (x, y, z)}\\ \text{THROUGH THE AIR}\end{bmatrix}$$

$$\textit{fall:}\quad \begin{bmatrix}\text{GO (x, y, z)}\\ \text{DOWNWARD, BY}\\ \text{FORCE OF GRAVITY,}\\ \text{UNIMPEDED}\end{bmatrix}$$

and so forth. A full explication of the meanings of these words would of course involve further analysis of the claims made by the manner markers; but for present purposes this informal analysis suffices. What is relevant here is that a common element of meaning has been separated out of the seven sentences (1), and that the differences among the sentences can be ascribed to known methods of semantic composition.

Next consider the relationship of (1) to (2).

(2) a. The train traveled to Cincinnati.
b. The hawk flew from its nest.
c. The rock rolled into the river.
d. A spark jumped from the anode.
e. His hand crept into her lap.
f. An apple fell.
g. The coffee filtered into the cup.

These sentences differ from (1) only in that either the Source or Goal or both is not specified. (2a), for example, makes no claim about where the train traveled from, and (2b) makes no claim about where the hawk flew to. We can easily represent this by leaving the relevant variable in the function GO unspecified: (2a) will then be GO (THE TRAIN, y, CINCINNATI); (2b) will be GO (THE HAWK, ITS NEST, z). An unspecified variable is taken to make no claim other than that there is a Source or Goal; this is of course essential to the use of GO.

In all sentences so far, the Theme has appeared in subject position, the Source as object of *from*, and the Goal as object of *to* or *into*. However, this need not always be the case. In *The train left Detroit,* the Source appears as direct object. In *Jill dropped*

the pail into the well, the subject is neither Theme nor Source nor Goal, but Agent, a semantic function we will discuss shortly; the direct object *the pail* is claimed to be undergoing motion, and therefore is Theme; *the well* is of course Goal.

Various ways have been proposed to express the correlation between syntactic positions and functional semantic roles (i.e. thematic relations). The method adopted and defended in SIGG (and in Katz (1972), among other places) uses the strict subcategorization feature of the verb to effect the correlation. For example, the lexical entry for the sense of *fly* in (1) will contain at least the following information:

(3)
$$\left[\begin{array}{l} /\text{fl}\bar{\text{i}}/ \\ +\text{V} \\ +[\text{NP}^1 \text{ \_\_\_\_ (from NP}^2)(\text{to NP}^3)] \\ \left[\begin{array}{l}\text{GO (NP}^1, \text{NP}^2, \text{NP}^3) \\ \text{THROUGH THE AIR}\end{array}\right] \end{array}\right]$$

The first line is the phonological representation; the second line is the syntactic category feature (or feature complex). The third line is the strict subcategorization feature, as described in *Aspects*, except that the subject has been included here, whereas Chomsky excludes it. The NPs in the strict subcategorization feature are indexed so as to be identified with particular arguments in the fourth line, the semantic representation. A projection rule called Argument Substitution examines the deep structure of a sentence containing *fly*, assigns indices to the NPs on the basis of the strict subcategorization feature, and uses these indices to determine which NP readings are to be assigned to which functional arguments of GO (x, y, z). If a particular NP is absent in the deep structure, the corresponding variable is left unspecified by Argument Substitution. This way of correlating grammatical and thematic relations permits a relatively traditional conception of deep structure (i.e. in the spirit of *Aspects* or even *Syntactic Structures*) without sacrificing accuracy of semantic description. It therefore also permits relatively strong constraints on the relationship between deep and surface structure.

Next consider the following sentences.

(4) a. Max is in Africa.
b. The cat lay on the couch.
c. The statue stands on Cambridge Common.
d. The vine clung to the wall.

These sentences differ from those in (1) in precisely the respect in which the sentences in (1) are alike; these sentences do not describe a motion, but rather the location of an object relative to some other object. We will call the phrase describing the object whose location is specified the Theme, and the phrase describing the object in terms of which the Theme's position is specified the Location. In (4), the Theme is in the subject in each case, and the Location is the object of a preposition. The formal

semantic representation of this common element will be a function BE (x, y), where x is the Theme and y is the Location. As with the sentences in (1), the differences in meaning in (4) are expressed by substituting different markers for x and y, and by attaching different manner markers as restrictive modifiers of the function.

A complication arises with verbs of location that does not arise with verbs of motion. Given two objects, either can be located in terms of the other. For example, (5a) and (5b) describe essentially the same physical situation, but (6a) and (6b) do not.

(5) a. The dog is on the left of the cat.
b. The cat is on the right of the dog.

(6) a. The dog moved to the left of the cat.
b. The cat moved to the right of the dog.

That is, in the semantics of English, location is relativistic but motion is not, Einstein notwithstanding. However, the equivalence of (5a) and (5b) does not mean that they necessarily have the same semantic representation. In Gruber's analysis, they do not. (5a) is represented as (7a), (5b) as (7b):

(7) a. BE (THE DOG, LEFT OF (THE CAT))
b. BE (THE CAT, RIGHT OF (THE DOG))

Similarly, (6a,b) are represented as (8a,b) respectively.

(8) a. GO (THE DOG, y, LEFT OF (THE CAT))
b. GO (THE CAT, y, RIGHT OF (THE DOG))

The mutual entailment of (5a,b) is a consequence not of equivalent semantic representations, but of the pragmatic fact that they describe a particular spatial configuration as two different but equivalent states of affairs, one locating object A in terms of object B, the other locating B in terms of A.

In cases like (5), where there are prepositions present, the distinction between the two states of affairs is clear. The situation is more obscure when verbs are chosen that do not require prepositions. For example, consider the pair (9) (discussed in Gruber (1965, section 3.4)), which describe the same spatial configuration.

(9) a. The circle contains the dot.
b. The circle surrounds the dot.

There is no overt evidence in these sentences as to which NP is Theme and which is Location. One might be tempted to claim that the sentences are not represented by the function BE (x, y) at all, but are rather realizations of some perfectly symmetrical function. However, Gruber presents evidence that the two sentences do not have the same semantic representation.

First, we observe that there is a sentence (10a) related to (9a) for which there is no parallel like (10b).

(10) a. The dot is contained in the circle.
b. *The dot is surrounded in the circle.

(There is of course a passive, with *by* in both cases, but this is not relevant.) The preposition *in* is an unmistakable marker of a Location phrase; hence *the dot* is Theme of (10a) and *the circle* is Location. In the most favorable lexicon, morphologically related words have related semantic representations. Since the adjective *contained* apparently assigns a Theme and Location, i.e. employs the function BE (x, y), the best account of the lexicon will also assign the verb *contain* a representation incorporating BE (x, y), with the Location appearing in subject position and the Theme in object position. However, we still lack evidence about *surround*, since there is no morphologically related adjective *surrounded*.

The next step of the argument concerns the relation between *wh*-questions and their answers. Observe the contrast in felicity between (11b) and (11c) as answers to (11a), and (12b) and (12c) as answers to (12a). (# indicates my judgment of relative infelicity.)

(11) a. Where is the dog?
b. It is on the left of the cat.
c. #The cat is on the right of it.

(12) a. What is $\left\{\begin{matrix}\text{near}\\ \text{in the neighborhood of}\end{matrix}\right\}$ the dog?
b. #It is on the left of the cat.
c. The cat is on the right of it.

One might guess that these differences have to do with a preference for the grammatical relations of coreferential items to be parallel in the question and answer. Though this is part of the story, it is not all of it, as can be seen from the following examples, where four possible responses to the (a) questions appear in order of decreasing felicity.

(13) a. Where is the dot?
b. It is contained in the circle.
c. ?#The circle contains it.
d. ?#It is surrounded by the circle.
e. #The circle surrounds it.

(14) a. Where is the circle?
b. It surrounds the dot.
c. ?#The dot is surrounded by it.
d. ?#It contains the dot.
e. #The dot is contained by it.

(15) a. What is in the neighborhood of the dot?
b. The circle surrounds it.
c. ?#It is surrounded by the circle.
d. ?#The circle contains it.
e. #It is contained in the circle.

(16) a. What is in the neighborhood of the circle?
b. The dot is contained in it.
c. ?#It contains the dot.
d. ?#The dot is surrounded by it.
e. #It surrounds the dot.

The preference for parallel grammatical relations explains in each case why the (b) and (d) responses are more felicitous than the (c) and (e) responses respectively, but it does not explain why (b) is better than (d) and (c) better than (e).

One possible answer is that question–answer pairs preferably have parallel semantic structures as well as parallel grammatical structures. Question (13a), for example, requests a Location for a given Theme. (13b,c), which use *contain*, adhere to this format, since (as we established above) *the circle* is Location and *the dot* is Theme. (13c) is less felicitous because the grammatical relations do not correspond to those of the question. Now suppose *surround* has the opposite thematic relations, i.e. its subject is Theme and its object is Location. Then responses (13d,e) would violate the preference for parallel thematic relations. The gradation observed in (13) would result from (13b) observing both grammatical and thematic parallelisms, (13c,d) each violating one, and (13e) violating both.

To verify this hypothesis about the thematic relations of *surround*, consider (14). In (14a), *the circle* is Theme and its Location is requested. (14d,e), with *contain*, in which *the circle* is Location and *the dot* Theme, are infelicitous in exactly the same way as (13d,e), and there is here a clear violation of thematic parallelism. If the thematic relations of *surround* are as proposed, however, it will produce the desired thematic parallelism with (14a); and in fact (14b) is the most felicitous response, as predicted.

(15) and (16) are further demonstrations of the hypothesis. Here the questions ask for a Theme corresponding to a given Location. The best response in this case is provided by the verb in which the item specified in the question is Location: *surround* in (15) and *contain* in (16).

This argument shows, then, that there may be two verbs of location that describe precisely the same spatial configuration using parallel grammatical relations, but which are not synonymous. *x surrounds y* means essentially "x is around y"; *x contains y* means essentially "y is inside of x." The two relations are inverses in the same sense as *x is to the left of y* and *y is to the right of x*.

I have gone through this argument in detail because many critics of Gruber have failed to see the relevance of thematic relations in describing verbs of location,

claiming that there is no inherent way to distinguish Theme from Location. We have shown here that although the thematic relations of verbs of location are not as immediately accessible to intuition as those of verbs of motion, a more considered analysis supports Gruber's theory.[6]

In addition to the verbs of location we have discussed, there is a second, smaller, class of locational verbs with significantly different semantic properties:

(17) a. The bacteria stayed in his body.
b. Stanley remained in Africa.
c. Bill kept the book on the shelf.

Again there are NPs whose locations are asserted: the subjects of (17a,b) and the direct object of (17c). There is also a clear instance of a Location phrase. However, unlike the locational verbs mentioned previously, sentences using these verbs cannot refer to a point in time, but rather must refer to an interval of time.[7]

(18) a. {*At 6:00 / For two days}, the bacteria stayed in his body.
b. {*At 6:00 / From 1871 to 1894}, Stanley remained in Africa.
c. {*At 6:00 / Between Sunday and Wednesday}, Bill kept the book on the shelf.

Note that the previous locational verbs are congenial to either kind of time expression.

(19) a. {At 6:00 / For two days}, the cat lay on the couch.
b. {At 6:00 / From 1871 to 1894}, the statue stood on Cambridge Common.

Accordingly, we will distinguish the verbs in (17) as *durational*, by contrast with the *punctual* verbs in (4) (bearing in mind that punctual verbs can be used durationally

[6] Rosenberg (1975) seems to argue against the theory of thematic relations on the grounds that neither Gruber nor I have provided a discovery procedure for the thematic relations of any given verb. To him, this invalidates the theory's account of functional structure. While I agree with him that certain analyses in Gruber and SIGG are by no means obvious and even quite dubious, I take this only as an indication that the full consequences of the theory are as yet poorly understood. It should be clear just from the argument above that determining the thematic relations of verbs is hardly simple, and that sensitivity to the interaction of many factors is necessary.

Similarly, the fact that the Thematic Hierarchy Condition on passive proposed in SIGG (section 2.5) is problematic, as argued in Gee (1974), means only that some other unknown factors account for the inability of certain verbs to undergo passive, not that thematic relations are invalid. Furthermore, Gee argues against the THC as a *sufficient* condition for passivization and reflexivization; since it was clearly meant only to be a *necessary* condition, certain aspects of his argument are irrelevant. Incidentally, his example (30e), **By me, myself was hurt*, is excluded by the condition that a reflexive must be dominated by $\bar{X}$ or PP. Hence it is not a counterexample to the theory, as he claims.

[7] I have used *at 6:00* in each case rather than, say, *on Tuesday* because the latter may be construed as the duration *during Tuesday*.

as well). Gruber uses the term "nondescript" instead of "punctual", standing for "non-temporally-descriptive".

Punctual and durational verbs also differ in that only the latter may be used nonagentively as a copula to *what happened was*:

(20) a. ?*What happened was that {the statue stood on Cambridge Common / the cat lay on the couch / the circle surrounded the dot}.

b. What happened was that {the cat stayed on the couch / Stanley remained in Africa}.

In other words, durational verbs describe *events*, and in this way are like motional verbs. Punctual verbs, on the other hand, describe *states of affairs*. As will be seen in section 3.3, this difference has consequences for their behavior with Agents.

We note further that the dualities observed with punctual verbs do not obtain for durational verbs. For example, (21a,b) are not equivalent.

(21) a. The dog stayed on the left of the cat.
b. The cat stayed on the right of the dog.

We will represent the common element of durational verbs as a semantic function STAY (x, y), where x is the argument corresponding to the Theme and y the argument for the Location.

3.2. The Locational Modes: Position, Possession, and Identification

So far we have given a semantic description of three types of verbs, each of which involves a Theme and one or two positions occupied by the Theme. What seems to me the most important aspect of Gruber's analysis is that he extends this description to a wide variety of examples where the "position" of the Theme is not described in physical terms (as it is in all the examples above). Consider these sentences:

(22) a. Harry gave the book to the library.
b. Charlie bought the lamp from Max.
c. Will inherited a million dollars.

(23) a. The book belonged to the library.
b. Max owned an iguana.
c. Bill had no money.

(24) a. The library kept the book.
b. The iguana stayed in Max's possession.
c. The leopard retained its spots.

In (22), in each case the object described by the direct object is undergoing a change in who it belongs to. By analogy with the physical motion case, we can call the NP

denoting the object in transit the Theme, the NP denoting the initial possessor the Source, and the NP denoting the final possessor the Goal. In (22a), *Harry* is Source and *the library* is Goal; in (22b), *Max* is Source and *Charlie* is Goal; in (22c), the Source is unspecified and *Will* is Goal.

Like (22), the sentences in (23) describe situations of possession, but by contrast do not describe *change* in possession. Rather, they simply express a state of possession. By analogy with verbs of physical location, we will call the object possessed the Theme, and the possessor the Location. In (23a), *the book* is Theme and *the library* is Location; in (23b) *an iguana* is Theme and *Max* is Location; in (23c), *no money* is Theme and *Bill* Location.

Next, we observe that (24), like (23), expresses a single unchanging possessor. The contrast between (23) and (24) is quite similar to the contrast between punctual and durational verbs of physical location. *At 6:00* may be prefixed only to (23), not to (24), but expressions of duration such as *for two years* may be prefixed to either. Only (24) can serve as complement to *what happened was that. . . .*

Thus there is an important parallel between the three classes of verbs in (22)–(24) and the three classes Motional, Punctual, and Durational. Gruber chooses to represent this parallel by claiming that the three classes in (22)–(24) *are* Motional, Punctual, and Durational. The difference between these verbs and those of section 3.1 is represented by means of a restrictive modifier on the semantic function. For physical motion, the modifier is *Positional*; for verbs of possession, the modifier is *Possessional*. According to this description, some previous examples are represented as follows:

(1) a′. The train traveled from Detroit to Cincinnati.
$$\begin{bmatrix}\text{GO (THE TRAIN, DETROIT, CINCINNATI)}\\ \text{POSIT}\end{bmatrix}$$

(22) a′. Harry gave the book to the library.
$$\begin{bmatrix}\text{GO (THE BOOK, HARRY, THE LIBRARY)}\\ \text{POSS}\end{bmatrix}$$

(4) a′. Max is in Africa.
$$\begin{bmatrix}\text{BE (MAX, AFRICA)}\\ \text{POSIT}\end{bmatrix}$$

(23) a′. The book belonged to the library.
$$\begin{bmatrix}\text{BE (THE BOOK, THE LIBRARY)}\\ \text{POSS}\end{bmatrix}$$

(17) a′. The bacteria stayed in his body.
$$\begin{bmatrix}\text{STAY (THE BACTERIA, HIS BODY)}\\ \text{POSIT}\end{bmatrix}$$

(24) a′. The library kept the book.
$$\begin{bmatrix}\text{STAY (THE BOOK, THE LIBRARY)}\\ \text{POSS}\end{bmatrix}$$

The marker *Positional* affixed to a semantic function therefore indicates that the Location or Source and Goal of that function specify claims about *where* the Theme is; the marker *Possessional* indicates that they specify claims about *whose* the Theme is. For typographical convenience, we will henceforth represent this type of modifier with a subscript, e.g. (1a)′ will be $\text{GO}_{\text{Posit}}(\ldots)$.

Next consider sentences like these:

(25) a. The coach changed from a handsome young man into a pumpkin.
b. The metal turned red.
c. The metal melted.

(26) a. The coach was a pumpkin.
b. The metal was red.
c. The pumpkin seemed tasty.

(27) a. The poor coach stayed a pumpkin.
b. The metal remained red.
c. The redness persisted.

The same three-way contrast obtains. (25) describes changes in state; (26) describes a state; (27) describes the persistence of a state. *At 6:00* may be added only to (25) and (26), the motional and punctual sentences; *what happened was that* may be prefixed only to (25) and (27), the motional and durational sentences. Gruber proposes a parameter *Identificational*, which indicates that the Location or Source and Goal of the function to which it is affixed specify claims about *what* the Theme is.

Thus (25)–(27) have the following semantic representations:

(25)′ a. $\text{GO}_{\text{Ident}}(\text{THE COACH, A}\begin{bmatrix}\text{MAN}\\ \text{HANDSOME}\\ \text{YOUNG}\end{bmatrix}\text{, A PUMPKIN})$
b. $\text{GO}_{\text{Ident}}(\text{THE METAL, y, RED})$
c. $\text{GO}_{\text{Ident}}(\text{THE METAL, SOLID, LIQUID})$

(26)′ a. $\text{BE}_{\text{Ident}}(\text{THE COACH, A PUMPKIN})$
b. $\text{BE}_{\text{Ident}}(\text{THE METAL, RED})$
c. $\text{BE}_{\text{Ident}}(\text{THE PUMPKIN, TASTY})$

(27)′ a. $\text{STAY}_{\text{Ident}}(\text{THE POOR COACH, A PUMPKIN})$
b. $\text{STAY}_{\text{Ident}}(\text{THE METAL, RED})$
c. $\text{STAY}_{\text{Ident}}(\text{THE REDNESS, }\left\{\begin{matrix}\text{EXISTENT}\\ \text{PERCEIVABLE}\end{matrix}\right\})$

The (c) cases here are worth discussion. Since the verb *melt* means 'change from solid to liquid', it can be represented as a function whose Source and Goal are already specified:

(28) $$\begin{bmatrix} /\text{melt}/ \\ +\text{V} \\ +[\text{NP}^1 \_\_\_\_] \\ \text{GO}_{\text{Ident}}(\text{NP}^1, \text{SOLID}, \text{LIQUID}) \end{bmatrix}$$

In (26c), I have represented the verb *seem* only in part, leaving out the role of the perceiver. In (27c), the verb *persist* means roughly 'stay in existence' or 'stay perceivable'. As with *melt*, then, the arguments of the semantic function are partially specified by the verb.

What evidence is there that there is any generalization to be captured by adopting the "locational modes" Positional, Possessional, and Identificational as restrictive markers on the functions GO, BE, and STAY? We have already pointed out that there are important semantic distinctions to be drawn: the combination of the three modes with each of the three functions yields a particular class of verbs, and this description accounts for the similarities and differences among the classes in a natural way. As further evidence, recall that we claimed that morphologically related forms have related semantic interpretations, and observe parallels such as these:

(29) a. The coach turned into the driveway. (Positional)
b. The coach turned into a pumpkin. (Identificational)

(30) a. The train went to Texas. (Positional)
b. The inheritance went to Philip. (Possessional)

(31) a. Max is in Africa. (Positional)
b. Max is a doctor. (Identificational)

(32) a. Bill kept the book on the shelf. (Positional)
b. Bill kept the book. (Possessional)

(33) a. The coach {stayed / remained} in the driveway. (Positional)
b. The coach {stayed / remained} a pumpkin. (Identificational)

In each pair, the same verb is used with two different locational modes. Since these uses are not a priori related, it is a significant generalization that a sizable number of verbs do occur in more than one mode. In the present formalism the relationship between the uses is clear and nonaccidental: in the simplest case, the verb stays fundamentally the same, changing only the restrictive modifier from one locational

mode to another. Only in a formalization essentially similar to this one can the generalization be stated naturally. With respect to this sort of semantic data, then, the present formalism attains descriptive adequacy.

The formalism becomes potentially explanatory if we claim that it is not simply a description for English, but rather a part of universal grammar, a fragment of a theory of universal semantic representation. Under this claim, the semantic functions GO, BE, and STAY and the markers Positional, Possessional, and Identificational are semantic primitives common to all languages; representations such as discussed here are the only way the language has to describe physical motion, possession, and predicates describing properties. The fundamental concept of such a representation is giving the location(s) of an object at a particular time or during a particular interval. If this is the means of expression available to natural language for the claims about the world inherent in the examples we have discussed, the observed generalizations follow directly from the formalism, and the theory purports to achieve explanatory adequacy.

One might well ask if the three locational modes mentioned here are the only ones available to the theory; the answer is quite clearly negative. One extremely important extension, Circumstantial location, will be discussed extensively in section 5; more modes will appear in section 6. For now, let us just mention one amusing mode of location, musical pitch, which can be described by the same kinds of verbs:

(34) a. The oboe went from B♭ to C♯.
b. The horn was on D.
c. The contrabass sarrusophone stayed on F♯.
d. The kazoo rose rapidly through a diminished seventh arpeggio to a high A♭.

Pitch is obviously not physical location, and there is no a priori logical relation between them. The language nonetheless imports the expressions of physical location en masse. Clearly the locational parameter can be and should be extended to the case where the Location or Source and Goal specify claims about what pitch the Theme has.

3.3. Causative and Permissive Agency

Consider the semantic relationship among these examples.

(35) a. The rock fell from the roof to the ground.
b. Linda lowered the rock from the roof to the ground.
c. Linda dropped the rock from the roof to the ground.

All three sentences describe physical motion of the rock. The latter two claim that the rock's motion was caused by Linda; she is thus termed an Agent. In turn, these

two differ in the kind of causation performed by the subject: the first might be paraphrased roughly as (36a), the second as (36b).

(36) a. Linda {made the rock / caused the rock to} go from the roof to the ground.
b. Linda let the rock go from the roof to the ground.

Causing is bringing about an event; *letting* is ceasing to prevent an event. Gruber distinguishes these two kinds of Agency by calling the former a Causative Agent (C-Agent) and the latter a Permissive Agent (P-Agent).

To represent the semantic notion of causation, we will use two semantic functions CAUSE (x, e) and LET (x, e). In the former, *x* is a C-Agent and *e* is an event; in the latter *x* is a P-Agent and *e* is an event. Thus (35a–c) are to be represented in part by (37a–c) respectively.

(37) a. GO_{Posit} (THE ROCK, THE ROOF, THE GROUND)
b. CAUSE (LINDA, GO_{Posit} (THE ROCK, THE ROOF, THE GROUND))
c. LET (LINDA, GO_{Posit} (THE ROCK, THE ROOF, THE GROUND))

The semantic function CAUSE (x, e) is quite familiar from the literature, but LET (x, e) is less so. Some more contrasts like (35) are these:

(38) a. Dick received the money.
GO_{Poss} (THE MONEY, y, DICK)
b. Dick acquired the money.
CAUSE (DICK, GO_{Poss} (THE MONEY, y, DICK))
c. Dick accepted the money.
LET (DICK, GO_{Poss} (THE MONEY, y, DICK))

(39) a. The bird left the cage.
GO_{Posit} (THE BIRD, THE CAGE, z)
b. Laura took the bird from the cage.
CAUSE (LAURA, GO_{Posit} (THE BIRD, THE CAGE, z))
c. Laura released the bird from the cage.
LET (LAURA, GO_{Posit} (THE BIRD, THE CAGE, z))

(40) a. The bird stayed in the cage.
$STAY_{Posit}$ (THE BIRD, THE CAGE)
b. David kept the bird in the cage.
CAUSE (DAVID, $STAY_{Posit}$ (THE BIRD, THE CAGE))
c. David left the bird in the cage.
LET (DAVID, $\{STAY_{Posit} / BE_{Posit}\}$ (THE BIRD, THE CAGE))

(41) a. Noga stayed sick.
$\text{STAY}_{\text{Ident}}$ (NOGA, SICK)
b. Henry kept Noga sick.
CAUSE (HENRY, $\text{STAY}_{\text{Ident}}$ (NOGA, SICK))
c. Henry left Noga sick.
LET (HENRY, $\left\{\begin{matrix}\text{STAY}_{\text{Ident}} \\ \text{BE}_{\text{Ident}}\end{matrix}\right\}$ (NOGA, SICK))

CAUSE (x, e) often permits a *with*-phrase in the VP that expresses an Instrument.

(42) a. Linda lowered the rock with a cable.
b. Dave broke the window with a hammer.
c. Laura took the bird from the cage with a coat hanger.
d. Elliott opened the door with a key.
e. Michael kept the bird in the cage with a lock on the door.
f. Dick bought the book with a $5 bill.

The use of an Instrument is associated with the causation of the event and not with the event itself:

(43) a. The rock went down to the ground with a cable.
b. ?The window broke with a hammer.
c. ?The bird left its cage with a coat hanger.
d. ?The door opened with a key.
e. The bird stayed in the cage with a lock on the door.
f. Dick received the book with a $5 bill.

(43a,c,e,f) use the *with*-phrase only in the accompaniment sense, not as instrument: e.g. in (43a) both the cable and the rock went down. (43b,d) imply causation of the event, whereas they do not if the *with*-phrase is absent: we can conclude that the Instrumental use of the *with*-phrase is intimately associated with the use of the function CAUSE (x, e). We can provisionally express this association in our system by making available a restrictive modifier *Inst* in the representation of CAUSE.[8]

For those verbs such as *open* that permit an Instrument in the subject (*the key opened the door*), the strict subcategorization feature must be set up so as to substitute the interpretation of the subject for either the Agent or the Instrument, either by setting up separate but related lexical entries or by generalizations within a single lexical entry, as in (44).

[8] Gruber argues that in fact Instrument and Accompaniment are the same kind of restrictive modifier, the former added to CAUSE and the latter to GO, thereby capturing the generalization that both use the preposition *with*.

(44) $$\left[\begin{array}{l} \text{/open/} \\ +\text{V} \\ +\left[\left\{\begin{array}{l}\text{NP}^1\\ \text{NP}^2\end{array}\right\} \text{—— NP}^3\right] \\ \left[\begin{array}{l}\text{CAUSE (NP}^1\text{, GO}_{\text{Posit}}\text{ (NP}^3\text{, y, OPEN))} \\ \text{Inst: NP}^2\end{array}\right] \end{array}\right]$$

The transitive verb *break* allows both Agent and Instrument subjects, and because of its particular selectional restrictions, *a rock broke the window* is consequently ambiguous. On one reading, the window broke because a rock went through it; on the other, a rock was an appropriate tool for breaking the window.

Unlike CAUSE, LET does not seem to permit Instrumental phrases.

(45) a. Linda dropped the rock with a cable.
b. Dick accepted the book with a $5 bill.
c. David left the bird in the cage with a lock on the door.

Here the *with*-phrase can be interpreted only as accompaniment: the rock and cable drop together, the book comes with $5, the lock is on the cage. Hence such a restrictive modifier must be unavailable (or anomalous) for the function LET.

An apparent counterexample to this claim is (46).

(46) David released the bird from the cage with a coat hanger.

Here the coat hanger is a genuine Instrument, since David is using it; yet *release* seems to mean 'let go', i.e. the relevant semantic function is LET. However, observe that the cage, not the bird, is manipulated by the coat hanger: contrast (46) with (47), where the bird is probably being touched by the coat hanger:

(47) David took the bird from the cage with a coat hanger.

In (47), David is of course a Causative Agent, and the semantic representation is accordingly (48).

(48) $$\left[\begin{array}{l}\text{CAUSE (DAVID, GO}_{\text{Posit}}\text{ (THE BIRD, THE CAGE, z))} \\ \text{Inst: A COAT HANGER}\end{array}\right]$$

A more complete analysis of *release* might be 'let go from an enclosure by opening the enclosure'. The means phrase *by opening the enclosure* is a Causative function, and in (46) the Instrument in fact is being applied to the Theme of the means phrase. As evidence, observe that when the means phrase is spelled out, the Instrument must go with it rather than with the main clause:

(49) a. David released the bird from the cage by opening the cage with a coat hanger.
b. ??David released the bird from the cage with a coat hanger by opening the cage.

We can claim, then, that a means phrase involving opening is part of the lexical reading of *release*, providing a possible semantic position for the Instrument. Representing the means phrase as a restrictive modifier of LET, thus expressing how the P-Agent carries out his action, we get (50) as the semantic representation of (46).

(50) $\left[\begin{array}{l}\text{LET (DAVID, GO}_{\text{Posit}}\text{ (THE BIRD, THE CAGE, z))} \\ \text{Means: }\left[\begin{array}{l}\text{CAUSE (DAVID, GO}_{\text{Posit}}\text{ (THE CAGE, y, OPEN))} \\ \text{Inst: A COAT HANGER}\end{array}\right]\end{array}\right]$

That is, the Instrumental phrase is not incorporated as an Instrument of LET, but as an Instrument of CAUSE after all. The rather complicated expression (50) can be derived by the usual Argument Substitution by assigning *release* the lexical entry (51), which formalizes the intuitive sense of *release* noted above.

(51) $\left[\begin{array}{l}\text{/re = lēs/} \\ \text{+V} \\ \text{+[NP}^1\text{ \_\_\_\_ NP}^2\text{ (from NP}^3\text{)}\left(\left\{\begin{array}{l}\text{to} \\ \text{into}\end{array}\right\}\text{ NP}^4\right)\text{(with NP}^5\text{)]} \\ \left[\begin{array}{l}\text{LET (NP}^1\text{, GO}_{\text{Posit}}\text{ (NP}^2\text{, NP}^3\text{, NP}^4\text{)} \\ \text{Means: }\left[\begin{array}{l}\text{CAUSE (NP}^1\text{, GO}_{\text{Posit}}\text{ (NP}^3\text{, y, OPEN))} \\ \text{Inst: NP}^5\end{array}\right]\end{array}\right]\end{array}\right]$

This analysis of (46), then, permits us to express the apparent use of an Instrument with a P-Agent and the difference in the use of the Instrument in (46) and (47); at the same time it preserves the generalization that only CAUSE takes an Instrument phrase.[9]

There is a further difference between CAUSE and LET. The final argument of LET may be either an event or a state of affairs; contrast the following sentences.

(52) a. David let Laura $\left\{\begin{array}{l}\text{in(to)} \\ \text{out of}\end{array}\right\}$ the room.

b. David allowed Laura $\left\{\begin{array}{l}\text{in} \\ \text{out of}\end{array}\right\}$ the room.

(52a) must be interpreted as David permitting Laura to *go* in or out of the room; (52b) does not say anything about Laura's movement. Notice that *outside of*, a purely nonmotional preposition, can be substituted only into (52b). The semantic difference in (52) can be expressed by the representations (53a,b) respectively.

(53) a. LET (DAVID, GO_{Posit} (LAURA, y, $\left\{\begin{array}{l}\text{INTO} \\ \text{OUT OF}\end{array}\right\}$ THE ROOM))

b. LET (DAVID, BE_{Posit} (LAURA, $\left\{\begin{array}{l}\text{IN} \\ \text{OUT OF}\end{array}\right\}$ THE ROOM))

[9] R. Carter has pointed out to me that *drop* also appears to have a component of C-Agency in its reading in addition to the P-Agency discussed here. This intuition can be expressed by assigning *drop* a reading incorporating a means phrase, such as 'let *x* fall by ungrasping (opening what is holding) *x*'.

It is not clear to me whether there are any verbs of the form LET (x, STAY (. . .)).

On the other hand, CAUSE requires its final argument to be an *event* and not a state of affairs. All of the causative locational verbs such as *hold*, *keep*, and *retain* are of the form CAUSE (x, y, STAY (. . .)) rather than CAUSE (x, y, BE (. . .)).

An apparent counterexample to this claim is (54), since the verb *be* is embedded as a complement to the verb *cause*.

(54) Dollie caused Martin to be happy.

I have just claimed that the semantic representation of (54) cannot be the most obvious possibility, (55).

(55) CAUSE (DOLLIE, BE_{Ident} (MARTIN, HAPPY))

In (55) the third argument of CAUSE is not an event. But in fact intuition requires that (55) not be the representation of (54) anyway, since (54) claims that Martin *became* happy. A representation such as (56) accords better with intuition and with the restriction on the argument of CAUSE.

(56) CAUSE (DOLLIE, GO_{Ident} (MARTIN, y, HAPPY))

But in order to derive (56) by Argument Substitution, one would have to assign the verb *be* a semantic representation incorporating the function GO. This seems implausible, since *be* never means *become* in isolation. Alternatively, one could propose a rule changing BE to GO just in case it is embedded as an argument of CAUSE. This again entails a loss of generality, since a semantic rule of a hitherto unknown sort must be added to the grammar. Hence (54) creates an apparent paradox for the theory proposed here. In section 5, however, we will show that (56) is not the correct representation for (54) either, and that there is a highly motivated representation that makes the correct claims and preserves both the interpretation of *be* and the restriction on the final argument of CAUSE.

3.4. Summary

Before going on, we will sum up the system of semantic functions developed in this section by presenting a table (on page 110) of the possible combinations of functions in the three locational modes, giving examples of verbs of each type.

The absence of the configuration CAUSE (BE . . .) I take to be a principled gap, excluded by the condition that the final argument of a causative must be an event. I know of no instances of the configuration LET (STAY . . .), but do not know whether the gap is principled or accidental. I take the absence of verbs of the form LET (GO_{Ident} . . .) to be accidental: both Identification verbs and P-Agent verbs are relatively rare, hence it is not surprising to find nothing in the intersection of the two categories.

	Positional	Possessional	Identificational
GO	go	receive	become
(motional)	fall	inherit	change
BE	be	have	be
(punctual)	contain	own	seem(?)
STAY	stay	keep	stay
(durational)	remain		remain
CAUSE (GO . . .)	bring	obtain	make (e.g. *make it red*)
	take	give	elect
		buy	
CAUSE (STAY . . .)	keep	keep	keep
	hold	retain	
LET (GO . . .)	drop	accept	
	release	fritter away	
LET (BE . . .)	leave	permit	leave (e.g. *leave it red*)
	allow	(e.g. *permit him* $5)	

This system of semantic functions enables us to express a rich range of semantic information with a rather small set of primitives. The strongest claim one could make is that the five functions presented here are the only functions in semantic theory that when used alone represent verbs; i.e. one of these five must be the outermost function in the representation of any verb. All further enrichment of the expressive power of the theory would then have to come in via restrictive modifiers, logical operators, and more elaborate ways to express locations (such as *to the left of*). Such a substantive universal in semantic theory would be highly significant, and I do not find it implausible.

4. Rules of Inference

As mentioned in section 1, one of the requisites of an adequate semantic theory is that it provide an account of entailment between sentences. In the present theory, rules of inference will be stated in terms of semantic representations, and the general principle for determining entailment relations is (57).

(57) A sentence S^1 entails a sentence S^2 if the semantic representation of S^2 can be derived from the semantic representation of S^1 by means of a sequence of inference rules.

The inference rules themselves will be of the form (58).

(58) $SR^1 \Rightarrow SR^2$ under conditions $C_1, \ldots, C_n$.

The conditions $C_1, \ldots, C_n$ are elements of fact, not necessarily expressed as sentences. One could add the restriction that the conditions be sentential; but as will be seen, such a move would exclude various kinds of partially pragmatic inference that are of interest.

Familiar rules of logical inference can be stated in this framework without difficulty, for example (59).

(59) a. P AND Q ⇒ P
b. P ⇒ P OR Q

We will be concerned here, though, with stating rules of inference involving the semantic functions developed in section 3.

4.1. Inferences about Causation

An obvious candidate for a rule of inference is the principle that if an event is caused, it takes place. This can be formalized as (60).

(60) $\begin{bmatrix}\text{CAUSE (X, E)} \\ \text{Z}\end{bmatrix} \Rightarrow \text{E}$

(60) enables us to derive entailments such as these:

(61) a. Max shoved Joe out of the room.
CAUSE (MAX, GO_{Posit} (JOE, z, OUTSIDE OF THE ROOM))
⇒ Joe went out of the room.
GO_{Posit} (JOE, z, OUTSIDE OF THE ROOM)

b. Max gave Joe the money.
CAUSE (MAX, GO_{Poss} (THE MONEY, MAX, JOE))
⇒ Joe received the money from Max.
GO_{Poss} (THE MONEY, MAX, JOE)

c. Max killed Joe with a revolver.
$\begin{bmatrix}\text{CAUSE (MAX, } \text{GO}_{\text{Ident}} \text{ (JOE, y, DEAD))} \\ \text{Inst: A REVOLVER}\end{bmatrix}$
⇒ Joe died.
GO_{Ident} (JOE, y, DEAD)

d. Max kept Joe in the closet.
CAUSE (MAX, $\text{STAY}_{\text{Posit}}$ (JOE, THE CLOSET))
⇒ Joe remained in the closet. (nonAgentive reading)
$\text{STAY}_{\text{Posit}}$ (JOE, THE CLOSET)

e. Max kept Joe sick.
CAUSE (MAX, $\text{STAY}_{\text{Ident}}$ (JOE, SICK))
⇒ Joe stayed sick.
$\text{STAY}_{\text{Ident}}$ (JOE, SICK)

A similar clear case is the principle that if someone does not let an event happen, it doesn't happen. If E represents the claim that some event took place, we can use the notation NOT E to represent the claim that the event did not take place; similarly NOT prefixed to an expression for a state of affairs represents the claim that the state of affairs did not obtain. Then we can express this second principle of inference as (62).

(62) $\text{NOT} \begin{bmatrix} \text{LET (X, E)} \\ \text{Z} \end{bmatrix} \Rightarrow \text{NOT E}$

Since this sense of NOT is rendered in English by sentence negation, (62) enables us to make inferences such as these:[10]

(63) a. Max didn't drop the pancake on the floor.
NOT LET (MAX, GO_{Posit} (THE PANCAKE, y, THE FLOOR))
⇒ The pancake didn't fall on the floor.
NOT GO_{Posit} (THE PANCAKE, y, THE FLOOR)

b. Joe didn't leave the pancake on the table.
NOT LET (JOE, $\text{STAY}_{\text{Posit}}$ (THE PANCAKE, THE TABLE))
⇒ The pancake didn't remain on the table.
NOT $\text{STAY}_{\text{Posit}}$ (THE PANCAKE, THE TABLE)

c. Joe didn't accept the money from Max.
NOT LET (JOE, GO_{Poss} (THE MONEY, MAX, JOE))
⇒ Joe didn't get the money from Max.
NOT GO_{Poss} (THE MONEY, MAX, JOE)

d. The doctor didn't leave Alice sick.
NOT LET (THE DOCTOR, $\text{STAY}_{\text{Ident}}$ (ALICE, SICK))
⇒ Alice didn't stay sick.
NOT $\text{STAY}_{\text{Ident}}$ (ALICE, SICK)

The converses of (60) and (62) are (64a) and (64b) respectively. They are not valid rules of inference.

(64) a. $\text{NOT} \begin{bmatrix} \text{CAUSE (X, E)} \\ \text{Z} \end{bmatrix} \Rightarrow \text{NOT E}$

b. $\begin{bmatrix} \text{LET (X, E)} \\ \text{Z} \end{bmatrix} \Rightarrow \text{E}$

(64a) is falsified by examples like (65).

(65) Joe died, but Max didn't kill him.

[10] Note that the negation in these sentences must be read as sentence negation for the entailment to hold. If it is associated with a focus (e.g. Joe didn't get the money from *Max*, but from *George*), a different semantic interpretation is derived, which does not meet the structural description of (62). Cf. SIGG, sections 6.6, 6.7, and 8.6.

Obviously, something may happen even if no particular thing one can name is its cause. (64b) is falsified by examples like (66).

(66) Joe wasn't in the room, even though the FBI still allowed Joe in the room.

However, the inference is sometimes valid; for example, if something is *dropped*, it *falls*. Apparently a more limited form of (64b) is valid, the limitation having to do with the form of the expression E. I will not try to deal with the modification here. However, in section 4.5, rules (64a,b) will reappear as rules of "invited inference".

4.2. Inferences from STAY and GO to BE

The next set of inference rules relates the motional and durational functions to the punctual. First, there is the obvious principle that if something *stays* someplace for a period of time, it *is* in that place at any instant during that period. To express this rule we need reference to time, which has not yet been formalized here. I will adopt an obvious notation, using it in a way that I hope will be neutral to the eventual formulation of the semantics of time.[11] Note that the rule includes an extralinguistic condition.

(67) $\begin{bmatrix}\text{STAY (X, Y) FROM } t_1 \text{ TO } t_2 \\ \text{Z}\end{bmatrix} \Rightarrow \begin{bmatrix}\text{BE (X, Y) AT } t_3 \\ \text{Z}\end{bmatrix}$
Condition: $t_1 \leqslant t_3 \leqslant t_2$

(67) permits us to derive entailments such as (68).

(68) a. Carl remained in the room from Tuesday to Friday.
$\text{STAY}_{\text{Posit}}$ (CARL, THE ROOM) FROM TUESDAY TO FRIDAY
⇒ Carl was in the room on Wednesday.
BE_{Posit} (CARL, THE ROOM) AT WEDNESDAY

b. Margo kept the book from 1970 to 1972.
$\text{STAY}_{\text{Poss}}$ (THE BOOK, MARGO) FROM 1970 TO 1972
⇒ Margo had the book on June 22, 1971.
BE_{Poss} (THE BOOK, MARGO) AT JUNE 22, 1971

c. Fred stayed a doctor from when he was 19 to when he was 41.
$\text{STAY}_{\text{Ident}}$ (FRED, A DOCTOR) FROM $\begin{bmatrix}\text{X} \\ \text{BE}_{\text{Ident}}\text{ (FRED, 19) AT X}\end{bmatrix}$ TO $\begin{bmatrix}\text{Y} \\ \text{BE}_{\text{Ident}}\text{ (FRED, 41) AT Y}\end{bmatrix}$
⇒ Fred was a doctor when he was 37.
BE_{Ident} (FRED, A DOCTOR) AT $\begin{bmatrix}\text{X} \\ \text{BE}_{\text{Ident}}\text{ (FRED, 37) AT X}\end{bmatrix}$

[11] In particular, I will avoid standard expressions of quantification in order to keep it clear that the issue of formalization is being left quite open.

Alternatively, (67) could be divided into two parts, used successively ((69a) is probably biconditional):

(69) a. $\begin{bmatrix}\text{STAY (X, Y) FROM } t_1 \text{ TO } t_2\\ \text{Z}\end{bmatrix} \Leftrightarrow \begin{bmatrix}\text{BE (X, Y) FROM } t_1 \text{ TO } t_2\\ \text{Z}\end{bmatrix}$

b. $\begin{bmatrix}\text{BE (X, Y) FROM } t_1 \text{ TO } t_2\\ \text{Z}\end{bmatrix} \Rightarrow \begin{bmatrix}\text{BE (X, Y) AT } t_3\\ \text{Z}\end{bmatrix}$

Condition: $t_1 \leqslant t_3 \leqslant t_2$

Then the inference in (68a), for example, would go by way of the intermediate step *Carl was in the room from Tuesday to Friday*, also a valid inference from the premise, and a further class of inferences would follow.

Observe that the condition in (67) or (69b) does not require the existence of a sentence or even a semantic representation. I take it, rather, that this condition is a truth-condition, i.e. it involves matters of fact and its truth may well be determined pragmatically. Tightening this condition to require the existence of an actual sentence conveying the information $t_1 \leqslant t_3 \leqslant t_2$ is a move that some might find more palatable. However, it is not the sentence *Wednesday is between Tuesday and Friday* that makes (68a) a valid inference—it is the *fact* that Wednesday is between Tuesday and Friday. Therefore, at least for the present theory's notion of valid inference, the condition may be nonlinguistic.

There is a similar entailment following from the principle that if someone does not stay someplace during an interval, there is a time during the interval when he is not there:

(70) $\text{NOT} \begin{bmatrix}\text{STAY (X, Y) FROM } t_1 \text{ TO } t_2\\ \text{Z}\end{bmatrix}$

$\Rightarrow$ (for some time t_3) $\text{NOT} \begin{bmatrix}\text{BE (X, Y) AT } t_3\\ \text{Z}\end{bmatrix}$

Condition: $t_1 \leqslant t_3 \leqslant t_2$

This inference rule is involved in an inference like (71). Because of the difficulties of quantification here, I will not work out the entailment formally.

(71) Ann didn't stay in the room from 5 to 6.
$\Rightarrow$ Ann wasn't in the room all the time from 5 to 6.

The parallel entailment for GO is slightly more complex. The principle is that if something goes from one place to another, it must have been at the first place at some time and at the second place sometime, and it was at the first place first.

(72) $\begin{bmatrix}\text{GO (X, Y, Z) AT } t_1\\ \text{W}\end{bmatrix} \Rightarrow$ for some times t_2 and t_3 such that $t_2 < t_1 < t_3$,

$\begin{bmatrix}\text{BE (X, Y) AT } t_2\\ \text{W}\end{bmatrix}$ AND $\begin{bmatrix}\text{BE (X, Z) AT } t_3\\ \text{W}\end{bmatrix}$

(72) derives entailments such as (73).

(73) a. The train went from Kankakee to Mattoon.
GO_{Posit} (THE TRAIN, KANKAKEE, MATTOON)
⇒ At some time, the train was in Kankakee, and at some time, the train was in Mattoon.
BE_{Posit} (THE TRAIN, KANKAKEE) AT SOME TIME AND BE_{Posit} (THE TRAIN, MATTOON) AT SOME TIME

b. Phil gave the bill to Cathy.
CAUSE (PHIL, GO_{Poss} (THE BILL, PHIL, CATHY))
$\xrightarrow{(60)}$ GO_{Poss} (THE BILL, PHIL, CATHY)
$\xrightarrow{(72)}$ Phil had the bill, and then Cathy had it.
BE_{Poss} (THE BILL, PHIL) AT t_1 AND BE_{Poss} (THE BILL, CATHY) AT t_2, such that $t_1 < t_2$

c. Things went from bad to worse.
GO_{Ident} (THINGS, BAD, WORSE)
⇒ Things were bad, and then they were worse.
BE_{Ident} (THINGS, BAD) AT t_1 AND BE_{Ident} (THINGS, WORSE) AT t_2, such that $t_1 < t_2$

4.3. Inferences Involving Set Inclusion

We would like to make an inference such as that if Bill is in Kenya, Bill is in Africa. The necessary inference rule is easy to state.

(74) $\begin{bmatrix}\text{BE (X, Y)} \\ \text{Z}\end{bmatrix} \Rightarrow \begin{bmatrix}\text{BE (X, W)} \\ \text{Z}\end{bmatrix}$
Condition: $W \supset Y$

Note that the condition is again pragmatic and not linguistic in nature. One does not, in natural language, need to *say* that Kenya is in Africa; it need only be a *fact* in order for one to draw the inference.

(74) generalizes to Identificational location, for in that domain it enables us to ascertain that Socrates is mortal from the assertion that Socrates is a man and the fact (stated or unstated) that men are mortal. However, it apparently does not generalize to Possessional location, since we are not entitled to infer that John has a million dollars from the fact that John has a friend Sue and that *she* has a million dollars.

There seem to be two ways to deal with this problem. The first and less interesting way is to restrict the parameter Z in (74) so as to exclude the marker *Possessional*. A more interesting way is to seek a more precise and motivated statement of the condition $W \supset Y$. For Positional location, it clearly must be interpreted as spatial

inclusion. But for Identificational location, it must be interpreted as property inclusion and not spatial: we do not want to infer that Africa is_{Ident} small from the fact that Kenya is_{Ident} small and Kenya is_{Posit} in Africa. Perhaps it is the case that no relevant notion of inclusion is available for Possessional location. I will not speculate at this point on how to formulate a satisfying solution; but the problem is clearly not insoluble within this framework.

4.4. Inferences with Negated Locations

The next kind of inference we would like to make is that if John is not inside the house, he must be outside the house. Part of this inference is based on the pragmatic relation between *inside* and *outside*, namely that *inside x* and *outside x* together exhaust all the possible places one could be. This relation does not hold of other pairs such as *to the left of* and *to the right of*, for example.

However, there is another part of the inference that is perfectly general: the principle that if something is not in a particular place, it is somewhere else. So far we have no way to express the notion "somewhere else" within the formal system. To represent "someplace other than X", we will introduce the notation NOT X. As will be seen in section 5, this choice of notation is not totally ingenuous; we will make crucial use of the identity of the NOT denoting "somewhere else" and the NOT of sentence negation. We have now given an interpretation to NOT prefixed to functions and to Locations, Sources, and Goals; we have not given any meaning to NOT prefixed to a Theme.

Using the new notation, the desired principle is formalized as (75a); a related principle is the converse (75b), the principle that if something is someplace, it is not someplace else. Both appear to be biconditionals.[12]

(75) a. $\text{NOT} \begin{bmatrix} \text{BE (X, Y)} \\ \text{Z} \end{bmatrix} \Leftrightarrow \begin{bmatrix} \text{BE (X, NOT Y)} \\ \text{Z} \end{bmatrix}$

b. $\begin{bmatrix} \text{BE (X, Y)} \\ \text{Z} \end{bmatrix} \Leftrightarrow \text{NOT} \begin{bmatrix} \text{BE (X, NOT Y)} \\ \text{Z} \end{bmatrix}$

So, for example, from (76a) can be derived the inference (76b); from (76c), (76d).

(76) a. John was not inside of the house.
NOT BE_{Posit} (JOHN, INSIDE OF THE HOUSE)

b. BE_{Posit} (JOHN, NOT INSIDE OF THE HOUSE)

c. John was inside of the house.
BE_{Posit} (JOHN, INSIDE OF THE HOUSE)

d. NOT BE_{Posit} (JOHN, NOT INSIDE OF THE HOUSE)

[12] Actually, the inferences from BE to NOT BE in both rules require pragmatic conditions, as was pointed out to me by Noam Chomsky. The conditions have to do with the spatial extent of the Theme: for example, the atmosphere is both inside and outside the house. Also, there must be boundary conditions: is John inside or outside when he stands in the doorway?

To complete the desired inference we must appeal to the (unformalized) fact that *not inside of x* and *outside of x* define coextensive areas (ignoring boundaries, as is pragmatically possible in this particular case, though not in general). We can then appeal to inference rule (74) to get from (76b) to (77).

(77) John was outside of the house.
BE_{Posit} (JOHN, OUTSIDE OF THE HOUSE)

To reach a conclusion from (76d) we must appeal to inference rule (78), equivalent to (74) and derivable from it and (75) by substituting U for NOT Y and T for NOT W.

(78) $\text{NOT} \begin{bmatrix} \text{BE (X, U)} \\ \text{Z} \end{bmatrix} \Rightarrow \text{NOT} \begin{bmatrix} \text{BE (X, T)} \\ \text{Z} \end{bmatrix}$
Condition: $\text{U} \supset \text{T}$

This enables us to infer (79) from (76d).

(79) John was not outside of the house.
NOT BE_{Posit} (JOHN, OUTSIDE OF THE HOUSE)

Notice that since *not to the left of x* includes *to the right of x* but not vice versa (as in the previous case), only one of the parallel inferences goes through. From (80a) can be derived the intermediate stage (80b), and from (80c), (80d).

(80) a. The duck is not left of the cat.
NOT BE_{Posit} (THE DUCK, LEFT OF THE CAT)
b. BE_{Posit} (THE DUCK, NOT LEFT OF THE CAT)
c. The duck is left of the cat.
BE_{Posit} (THE DUCK, LEFT OF THE CAT)
d. NOT BE_{Posit} (THE DUCK, NOT LEFT OF THE CAT)

In the case of (80b), there is no further inference involving *right of*, since the condition of (74) is not met. But since NOT LEFT OF THE CAT $\supset$ RIGHT OF THE CAT, (78) can be applied to (80d) to derive (81), as desired.

(81) The duck is not right of the cat.
NOT BE_{Posit} (THE DUCK, RIGHT OF THE CAT)

With Identificational location, similar inferences can be drawn. Under the assumption that *sick* and *healthy* are exhaustive and mutually exclusive, we can construct inferences like (82).

(82) a. Hal is sick.
BE_{Ident} (HAL, SICK) $\xRightarrow{(75b)}$ NOT BE_{Ident} (HAL, NOT SICK)
$\xRightarrow{(78)}$ Hal is not healthy.
NOT BE_{Ident} (HAL, HEALTHY)

b. Hal is not sick.

$$\text{NOT BE}_{\text{Ident}}\text{ (HAL, SICK)} \xrightarrow{(75a)} \text{BE}_{\text{Ident}}\text{ (HAL, NOT SICK)}$$
$$\xrightarrow{(74)} \text{Hal is healthy.}$$
$$\text{BE}_{\text{Ident}}\text{ (HAL, HEALTHY)}$$

But since *tiny* and *big* do not exhaust a scale but are only mutually exclusive, only one of the parallel inferences goes through in (83).

(83) a. Pliny is tiny.

$$\text{BE}_{\text{Ident}}\text{ (PLINY, TINY)} \xrightarrow{(75b)} \text{NOT BE}_{\text{Ident}}\text{ (PLINY, NOT TINY)}$$
$$\xrightarrow{(78)} \text{Pliny is not big.}$$
$$\text{NOT BE}_{\text{Ident}}\text{ (PLINY, BIG)}$$

b. Pliny is not tiny.

$$\text{NOT BE}_{\text{Ident}}\text{ (PLINY, TINY)} \xrightarrow{(75a)} \text{BE}_{\text{Ident}}\text{ (PLINY, NOT TINY)}$$
$$\not\rightarrow \text{Pliny is big.}$$
$$\text{BE}_{\text{Ident}}\text{ (PLINY, BIG)}$$

Parallel to inference rules (75) for BE, there is a pair relating GO and STAY, expressing the principle that if someone goes from one place to another, he has not stayed in either of those places, and (contrapositively) if someone stays somewhere, he has not gone anyplace from there.

(84) a. $$\begin{bmatrix}\text{GO (X, Y, W)}\\ \text{Z}\end{bmatrix} \Rightarrow \begin{Bmatrix}\text{NOT}\begin{bmatrix}\text{STAY (X, Y)}\\ \text{Z}\end{bmatrix}\\ \text{NOT}\begin{bmatrix}\text{STAY (X, W)}\\ \text{Z}\end{bmatrix}\end{Bmatrix}$$

b. $$\begin{bmatrix}\text{STAY (X, Y)}\\ \text{Z}\end{bmatrix} \Rightarrow \text{NOT}\begin{bmatrix}\text{GO (X, Y, W)}\\ \text{Z}\end{bmatrix}$$

(These rules obviously must be supplied with time-dependencies, which I omit, pleading the reader's indulgence.) By now the kinds of relevant examples should be clear. Notice that the converses of these rules are not valid: not going somewhere in particular does not imply staying somewhere, and not staying somewhere in particular does not imply going somewhere.

One further principle needs to be mentioned, namely that if one goes from Y to W, Y and W are distinct places. We need this principle to exclude sentences like (85).

(85) a. *The train went from Chicago to Illinois.
b. *Algernon received a flower from himself.
c. *The light changed from crimson to red.

The principle in question can be stated as (86).

$$(86)\quad \begin{bmatrix}\text{GO (X, Y, W)}\\ \text{Z}\end{bmatrix} \Rightarrow \begin{cases}\text{W} \subset \text{NOT Y}\\ \text{Y} \subset \text{NOT W}\end{cases}$$

Notice that this rule is not stated in purely linguistic terms, but rather yields a pragmatic inference. (86), incidentally, is what entitles us to leave either the Source or Goal of GO unspecified and still infer that a change has taken place.[13]

4.5. Rules of Invited Inference

All the inferences we have been concerned with so far have been logical inferences. However, we will mention briefly another kind of inference that has been of interest, "invited inference" or "implicature" (in the sense of Grice (1975)). Such an inference is not a foregone conclusion, but a guess made on the basis of the given sentence. As such it can be incorrect.

One of the ways an invited inference can be overridden is with *but*. Compare the following examples:

(87) a. Sue killed Bill, $\left\{\begin{matrix}\text{*and}\\ \text{*but}\end{matrix}\right\}$ $\left\{\begin{matrix}\text{he died. (redundant)}\\ \text{he didn't die. (anomalous)}\end{matrix}\right\}$

b. Sue didn't kill Bill, $\left\{\begin{matrix}\text{and}\\ \text{?but}\end{matrix}\right\}$ he didn't die.

c. Sue didn't kill Bill, $\left\{\begin{matrix}\text{?and}\\ \text{but}\end{matrix}\right\}$ he died (anyway).

In (87a) there is a logical inference in the first clause to *Bill died*, and so there is no way of adding the second clause. But there is no logical inference from *didn't kill*, since there is no inference rule whose antecedent is NOT CAUSE. Why is *and* more felicitous in (87b) and *but* in (87c)? One possibility is that the rule we rejected as a logical inference should appear as a rule of invited inference (the symbol $\overset{?}{\Rightarrow}$ indicates invited inference):

$$(88)\quad \text{NOT CAUSE (X, E)} \overset{?}{\Rightarrow} \text{NOT E}$$

That is, one is led to guess from a statement that some event was not caused (presuppositions aside—see footnote 10) that the event did not take place. Thus in (87b,c) the first clause has the invited inference that Bill didn't die. *And* is appropriate in (87b) because it confirms the invited inference; *but* is appropriate in (87c) because it contradicts the invited inference.

Parallel to (88), there is a rule of invited inference for LET:

$$(89)\quad \text{LET (X, E)} \overset{?}{\Rightarrow} \text{E}$$

[13] The way (86) is stated may conceivably cause difficulty in the analysis of examples like *Bill went from sick to sicker*, since *sicker* is not included in *not sick*. It is not clear to me how to deal with this problem, but it does not appear especially crucial to the main issues here.

This produces a paradigm like (90).

(90) a. David didn't release the bird from the cage, {*and / *but}

{it left. (anomalous) / it didn't leave. (redundant)}

b. David released the bird from the cage, {and / ?but} it left.

c. David released the bird from the cage, {?and / but} it didn't leave.

This is exactly the mirror image of (87) with respect to negation. This follows from the fact that the rules of inference and invited inference for CAUSE and LET are also mirror images with respect to negation.

These observations are obviously only the barest beginning of an analysis of invited inferences. However, we have shown that such an analysis is in principle compatible with the theory presented here.

4.6. Excursus #1

In this section I have proposed a number of rules of inference that permit sentences to be related via their functional representation and (in some cases) certain pragmatic conditions. It is perhaps useful to point out two things that these rules are *not* before discussing what they might be.

First, rules of inference are not rules of grammar. They do not play a role in relating phonetic representation to semantic representation. Second, they do not constitute the meanings of the functions CAUSE, LET, GO, STAY, and BE; that is, the meanings of these functions are not to be determined solely in terms of what inferences can be drawn from them. Rather, I take it that these functions are cognitive primitives of some sort, and that the way in which they make claims about the real world is more a problem in cognitive psychology than one in linguistics.

Under this view, rules of inference not surprisingly must be regarded as universal, expressing the cognitive relationships among the functions. In fact, the rules have perhaps been stated in terms too immediately dependent on semantic representation; they are in fact principles of much wider pragmatic application. For example, (75a), the principle that if something is not in one place, it is someplace else, is really a principle of identity or conservation of objects. I will have more to say about this in section 7.

The idea of inference rules formalized in terms of semantic representations is not new. For example, Katz (1972) writes such an inference rule to deal with inferences about property inclusion; rules very much like those proposed here are developed rather extensively within a generative semantics theory by Lakoff (1972). What makes the particular rules proposed here of interest is the way they provide evidence for the explanatory power of the present theory of semantic description.

For in this system, a rule of inference is simpler if it generalizes over all modes of location, i.e. Positional, Possessional, and Identificational. In other words, the theory claims that it is not an accident that rules of inference generalize in the way they do, but an essential property of the semantic description that could not be otherwise.

I consider it a striking property of the present system that simple principles, framed in terms of physical space, can be stated formally in such a way as to generalize to domains that bear no a priori relation to physical space. It is in the very nature of the expressive power of the semantic representation to result in inference rules of such generality. Thus the theory can lay claim to a degree of explanatory adequacy not present in previous semantic theories.

For convenience, I will end this section with a compilation of the inference rules devised here. The list is obviously not exhaustive.

(60) $\begin{bmatrix}\text{CAUSE (X, E)}\\ \text{Z}\end{bmatrix} \Rightarrow \text{E}$

(62) $\text{NOT} \begin{bmatrix}\text{LET (X, E)}\\ \text{Z}\end{bmatrix} \Rightarrow \text{NOT E}$

(69) a. $\begin{bmatrix}\text{STAY (X, Y) FROM } t_1 \text{ TO } t_2\\ \text{Z}\end{bmatrix} \Leftrightarrow \begin{bmatrix}\text{BE (X, Y) FROM } t_1 \text{ TO } t_2\\ \text{Z}\end{bmatrix}$

b. $\begin{bmatrix}\text{BE (X, Y) FROM } t_1 \text{ TO } t_2\\ \text{Z}\end{bmatrix} \Rightarrow \begin{bmatrix}\text{BE (X, Y) AT } t_3\\ \text{Z}\end{bmatrix}$

Condition: $t_1 \leqslant t_3 \leqslant t_2$

(70) $\text{NOT} \begin{bmatrix}\text{STAY (X, Y) FROM } t_1 \text{ TO } t_2\\ \text{Z}\end{bmatrix} \Rightarrow$ for some t_3, $\text{NOT} \begin{bmatrix}\text{BE (X, Y) AT } t_3\\ \text{Z}\end{bmatrix}$

Condition: $t_1 \leqslant t_3 \leqslant t_2$

(72) $\begin{bmatrix}\text{GO (X, Y, Z) AT } t_1\\ \text{W}\end{bmatrix} \Rightarrow$ for some times t_2 and t_3 such that $t_2 < t_1 < t_3$, $\begin{bmatrix}\text{BE (X, Y) AT } t_2\\ \text{W}\end{bmatrix} \text{ AND } \begin{bmatrix}\text{BE (X, Z) AT } t_3\\ \text{W}\end{bmatrix}$

(74) $\begin{bmatrix}\text{BE (X, Y)}\\ \text{Z}\end{bmatrix} \Rightarrow \begin{bmatrix}\text{BE (X, W)}\\ \text{Z}\end{bmatrix}$

Condition: $\text{W} \supset \text{Y}$

(78) $\text{NOT} \begin{bmatrix}\text{BE (X, U)}\\ \text{Z}\end{bmatrix} \Rightarrow \text{NOT} \begin{bmatrix}\text{BE (X, T)}\\ \text{Z}\end{bmatrix}$

Condition: $\text{U} \supset \text{T}$

(75) a. $\text{NOT} \begin{bmatrix}\text{BE (X, Y)}\\ \text{Z}\end{bmatrix} \Leftrightarrow \begin{bmatrix}\text{BE (X, NOT Y)}\\ \text{Z}\end{bmatrix}$

b. $\begin{bmatrix}\text{BE (X, Y)}\\ \text{Z}\end{bmatrix} \Leftrightarrow \text{NOT} \begin{bmatrix}\text{BE (X, NOT Y)}\\ \text{Z}\end{bmatrix}$

(84) a. $\begin{bmatrix}\text{GO (X, Y, W)} \\ \text{Z}\end{bmatrix} \Rightarrow \begin{Bmatrix}\text{NOT} \begin{bmatrix}\text{STAY (X, Y)} \\ \text{Z}\end{bmatrix} \\ \text{NOT} \begin{bmatrix}\text{STAY (X, W)} \\ \text{Z}\end{bmatrix}\end{Bmatrix}$

b. $\begin{bmatrix}\text{STAY (X, Y)} \\ \text{Z}\end{bmatrix} \Rightarrow \text{NOT} \begin{bmatrix}\text{GO (X, Y, W)} \\ \text{Z}\end{bmatrix}$

(86) $\begin{bmatrix}\text{GO (X, Y, W)} \\ \text{Z}\end{bmatrix} \Rightarrow \begin{Bmatrix}\text{W} \subset \text{NOT Y} \\ \text{Y} \subset \text{NOT W}\end{Bmatrix}$

5. Implicative Verbs

5.1. Circumstantial STAY

Consider the interpretations of these sentences:

(91) a. Laura kept David in the room.
b. Laura kept David working.

We know the interpretation of (91a):

(92) CAUSE (LAURA, $\text{STAY}_{\text{Posit}}$ (DAVID, THE ROOM))

Simplicity suggests that we assign (91b) an interpretation as close to (91a) as possible, of the basic form CAUSE (. . . STAY (. . .)). Clearly none of the modes of location we have discussed will provide such an interpretation, since in (91b) *working* describes neither David's physical location, nor whom he belongs to, nor what kind of object he is.

Gruber (1965, section 8.4) alludes to, but does not define, a mode of location called *Circumstantial*, which he uses for certain complement verbs such as *coerce*. Suppose we take an assertion that an individual is in a "circumstantial" location, where the location is an event or state of affairs, to mean that the individual is involved as a participant in that event or state of affairs. Then we can use this mode of location in a straightforward representation for (91b):

(93) CAUSE (LAURA, $\text{STAY}_{\text{Circ}}$ (DAVID, DAVID WORK))

Here the second argument of STAY is the circumstance described by the gerundive *David's working*, from which the subject has been removed by Equi.[14] (93) claims thus that Laura caused David to continue to be involved in the situation of working, precisely the desired interpretation, and furthermore of precisely parallel form to

[14] In an interpretive theory of Equi (cf. SIGG, chapter 5), the subject is a pronoun anaphoric to *David*. In such a theory, DAVID will appear only once in (93), its subject relation to WORK being established indirectly through rules of anaphora.

its Positional analogue (92). According to this analysis, the verb *keep* is essentially the same in (91a,b), changing only the mode of location.

Extending the parallel, compare (94a) and (94b).

(94) a. Linda kept Laura (away) from the cookie jar.
b. Linda kept Laura from screaming.

Although we have not considered the interpretation of the preposition *from*, it is plausible to interpret it in this case as meaning 'at someplace other than'. Gruber proposes such an interpretation (section 4.1), though with somewhat different consequences within his system. Formalizing this interpretation, we get (95) as the representation of (94a).

(95) CAUSE (LINDA, $\text{STAY}_{\text{Posit}}$ (LAURA, NOT THE COOKIE JAR))

This generalizes immediately to the representation (96) for (94b).

(96) CAUSE (LINDA, $\text{STAY}_{\text{Circ}}$ (LAURA, NOT (LAURA SCREAM)))

In (96), the NOT meaning 'other than' can be reinterpreted as sentence negation over the subordinate clause. To keep things perfectly honest, one might want to use two separate negative terms for these two purposes. It seems, though, that in fact the language fully identifies the two uses of negation. As we will see, no adverse results accrue from treating the NOT in (96) as sentence negation.

One way to verify that (93) and (96) are correct representations for (91b) and (94b) is to check what inferences are possible. From (93), by inference rule (60), we infer the event being caused:

(97) $\text{STAY}_{\text{Circ}}$ (DAVID, DAVID WORK)

In turn, by inference rule (69), we get (98).

(98) BE_{Circ} (DAVID, DAVID WORK) (at some time)

We have as yet no sentence that has (98) as its representation. We might conjecture that (98) represents the progressive *David was working*, nicely filling a gap both in the syntactic and in the semantic paradigm.[15] Whether or not this is the case, we need a special inference rule for Circumstantial location, (99).

(99) BE_{Circ} (X, Y) $\Rightarrow$ Y

(99) is the principle that if one is involved in a circumstance, the circumstance must be taking place. Notice that (99) would be senseless with any mode of location other than Circumstantial, since the location would not be an event or state of affairs. Using (99), we can infer (100) from (98).

(100) DAVID WORK
David worked.

[15] For the syntactic generality of this analysis, see Emonds (1970, section II.2.2).

By a similar process, we get the following inferences from (96). The step from (101b) to (101c) involves the aforementioned identity of the two interpretations of NOT.

(101) a. $\text{STAY}_{\text{Circ}}$ (LAURA, NOT (LAURA SCREAM))
(This is not *Laura kept from screaming*, which is Agentive.)
b. BE_{Circ} (LAURA, NOT (LAURA SCREAM)) (at some time)
c. NOT (LAURA SCREAM)
Laura didn't scream.

Also, from (101b), by inference rule (75a), we derive (102), which (if the above conjecture about the progressive is correct) is the representation of *Laura wasn't screaming*.

(102) NOT BE_{Circ} (LAURA, LAURA SCREAM)

Next consider the possible inferences from the negatives of (91b) and (94b).

(103) a. Laura didn't keep David working.
NOT CAUSE (LAURA, $\text{STAY}_{\text{Circ}}$ (DAVID, DAVID WORK))
b. Linda didn't keep Laura from screaming.
NOT CAUSE (LINDA, $\text{STAY}_{\text{Circ}}$ (LAURA, NOT (LAURA SCREAM)))

Since there is no inference rule whose antecedent is NOT CAUSE, no inferences about the complement clause follow.

These inferences from *keep* and *keep from* appear to be correct: from *keep* one can infer a claim that the complement is true; from *keep from* one can infer that the complement does not take place; from *not keep* and *not keep from* one can derive no inferences about the complement. Such behavior has been described by Karttunen (1971), in whose terms *keep* is a "one-way implicative verb" and *keep from* is a "one-way negative implicative verb". Karttunen accounts for such behavior with meaning postulates either attached idiosyncratically to the verb or referenced by idiosyncratic classificatory features on the verb. He makes no attempt to relate implicative behavior to a general system of semantic representation, though he conjectures that such a relationship should exist. The present study confirms his conjecture: the implicative behavior of *keep* is a direct consequence of its functional semantic representation, and the inferences are derived by much more general rules of inference. Hence the present analysis is potentially more explanatory than Karttunen's, if it can be extended to cover all the cases he discusses.

Many of Karttunen's cases involve verbs of psychological import such as *know* and *remember*. Since we have as yet not introduced a formal representation for mental states and intentions, we will not attempt to deal with such verbs, leaving their analysis for future research. We will however deal with a range of verbs for which

our present descriptive apparatus is sufficient, showing that different classes of implicative verbs emerge from different functional analyses.

First consider *prevent*. This occurs in two frames:

(104) a. Dick prevented Bob from yelling.

b. Dick prevented $\left\{\begin{matrix}\text{the fire}\\ \text{Bob's yelling}\end{matrix}\right\}$.

The analysis of (104a) is just like (94b) with *keep from*, except that *prevent* does not permit the form that takes a positive location. We can assign (104a) the semantic representation (105).

(105) CAUSE (DICK, $\text{STAY}_{\text{Circ}}$ (BOB, NOT (BOB YELLING)))

This has the same inference properties as *keep from*, i.e. it is a one-way negative implicative.

(104b) lacks the complement and has only a direct object (which may, however, be a gerund). The selectional restriction on this direct object is approximately that it must be something that can *occur* or *take place*. The representation most closely related to (105) that expresses this property is (106).

(106) CAUSE (DICK, $\text{STAY}_{\text{Circ}}$ ($\left\{\begin{matrix}\text{THE FIRE}\\ \text{BOB'S YELLING}\end{matrix}\right\}$,
NOT ($\left\{\begin{matrix}\text{THE FIRE}\\ \text{BOB'S YELLING}\end{matrix}\right\}$ OCCUR)))

In other words, in the absence of the *from*-phrase, *prevent* fills in the location of STAY in a specified way. This is precisely parallel to the behavior of *eat*, which in the absence of a direct object fills in the interpretation FOOD. Hence the two subcategorizations of *prevent* are semantically related in quite an ordinary way.

The positive form of *keep* has the nonAgentive counterpart *continue*:

(107) a. Laura continued screaming.

b. $\left\{\begin{matrix}\text{Laura's screaming}\\ \text{The noise}\end{matrix}\right\}$ continued.[16]

(107a) has the representation (108a); (107b) has the Circumstantial location specified by the verb, yielding (108b), parallel to (106).

(108) a. $\text{STAY}_{\text{Circ}}$ (LAURA, LAURA SCREAM)

b. $\text{STAY}_{\text{Circ}}$ ($\left\{\begin{matrix}\text{LAURA'S SCREAMING}\\ \text{THE NOISE}\end{matrix}\right\}$,
($\left\{\begin{matrix}\text{LAURA'S SCREAMING}\\ \text{THE NOISE}\end{matrix}\right\}$ OCCUR))

[16] *Laura continued to scream* may be an instance of either case, depending on whether it is derived by Raising or Equi.

(108a) leads by (69) to the inference (109a), which by (99) leads to (109b).

(109) a. BE_{Circ} (LAURA, LAURA SCREAM)
Laura was screaming. (?)
b. LAURA SCREAM
Laura screamed.

The negation of (107a), *Laura didn't continue screaming*, leads to the chain of inference (110).

(110) a. Laura didn't continue screaming.
NOT $STAY_{Circ}$ (LAURA, LAURA SCREAM) $\xrightarrow{(70)}$
b. (at some time in the relevant interval)
NOT BE_{Circ} (LAURA, LAURA SCREAM) $\xrightarrow{(75a)}$
Laura wasn't screaming. (?)
c. (at some time)
BE_{Circ} (LAURA, NOT (LAURA SCREAM)) $\xrightarrow{(99)}$
d. (at some time)
NOT (LAURA SCREAM)
Laura didn't scream.

In other words, inferences can be drawn from both the positive and negative instances of *continue*: if *continue* is asserted, its complement is asserted for some time; if *continue* is denied, its complement is denied for some time. This is thus an example of a two-way positive implicative verb.

Avoid is apparently a negative counterpart of *continue*. Unlike *continue*, it has only a transitive form; to our advantage, it also has a Positional usage.

(111) a. David avoided the beach.
b. David avoided playing checkers.

Avoid means essentially 'stay away from', or in our terms, STAY AT NOT. So (111a,b) have (112a,b) as their respective representations.

(112) a. $STAY_{Posit}$ (DAVID, NOT THE BEACH)
b. $STAY_{Circ}$ (DAVID, NOT (DAVID PLAY CHECKERS))

By the usual inference rules, we can derive the sentences (113a,b):

(113) a. David wasn't at the beach.
b. David didn't play checkers.

The negations of (111a,b), by inference rules (70) and (75b), imply (114a,b) respectively.

(114) a. David was at the beach. (at some time)
b. David played checkers. (at some time)

Hence *avoid* is a two-way negative implicative.[17]

5.2. Circumstantial GO

We motivated Circumstantial STAY by means of the verb *keep*, for which the Positional case provided an analogue. We then extended the use of Circumstantial STAY to other verbs that had the same complement structure but which did not necessarily have a Positional use. We will now do the same for Circumstantial GO. Compare these three uses of *force*.

(115) a. Jim forced the ball into the hole.
b. Jim forced Phil into leaving the room.
c. Jim forced Phil to leave the room.

(115a) has the representation (116) (in part—we briefly mention the markers of manner in section 5.4):

(116) CAUSE (JIM, GO_{Posit} (THE BALL, y, THE HOLE))

If we choose analysis (117) for (115b,c), we can claim that the two uses of *force* are fundamentally the same.

(117) CAUSE (JIM, GO_{Circ} (PHIL, y, PHIL LEAVE THE ROOM))

(117) says that Jim brought about Phil's being involved in the circumstance of leaving the room.

Applying inference rules to (117) yields these results:

(118) a. $\xrightarrow{(60)}$ GO_{Circ} (PHIL, y, PHIL LEAVE THE ROOM)
b. $\xrightarrow{(72)}$ for some times t_2 and t_3 such that $t_2 < t_3$, BE_{Circ} (PHIL, y) AT t_2 AND BE_{Circ} (PHIL, PHIL LEAVE THE ROOM) AT t_3
c. 2nd clause of (118b) $\xrightarrow{(99)}$ PHIL LEAVE THE ROOM (at t_3)
d. (118a) $\xrightarrow{(86)}$ y $\subset$ NOT (PHIL LEAVE THE ROOM)

In short, we are entitled to infer from (115b,c) that at some time t_2 Phil was doing something other than leaving the room, and at some later time t_3 Phil left the room.

If we negate (115), *Jim didn't force Phil to leave the room*, there are no inferences about the event described by the complement, since there is no inference rule whose

[17] For some speakers, *avoid* has a preferred Agentive use, CAUSE (NP^1, STAY (NP^1, NOT NP^2)). In this use it is of course a one-way implicative, since there is no inference from NOT CAUSE. An inanimate subject such as *the waves* selects the nonAgentive use, though: both inferences go through for *the waves* $\{$*avoided* / *didn't avoid*$\}$ $\{$*the beach* / *hitting the beach*$\}$.

antecedent is NOT CAUSE. *Force* can thus be considered a kind of one-way implicative: asserting it asserts its complement for a particular time and denies it for an earlier time, but negating it leads to no inference about the complement.

The negative counterpart of *force* is *stop*, in its Agentive sense:

(119) Dick stopped the car from coughing.
CAUSE (DICK, GO_{Circ} (THE CAR, y, NOT (THE CAR COUGH)))[18]

A procedure like (118) will lead to the inference that at some time t_2 the car was doing something other than not coughing (i.e. coughing), and that at a later time t_3 the car was not coughing. Likewise, negating (119) leads to no inference, i.e. the car may or may not have been coughing at any given time. We have thus accounted for the one-way negative implicative property of *stop*.

An alternative analysis of (119) would be CAUSE (DICK, GO_{Circ} (THE CAR, THE CAR COUGH, y)). The inferences are essentially the same. The *from* then is the mark of a Source, not of a negated Goal. The question of whether these are separate uses of *from*, or whether there is a generalization being missed, is left for future research.

The nonAgentive verbs *begin* and *cease* are also represented with Circumstantial GO:

(120) a. The car began sputtering.
GO_{Circ} (THE CAR, y, THE CAR SPUTTER)
b. The car ceased moving.
GO_{Circ} (THE CAR, y, NOT (THE CAR MOVE))

Again, the inference rules lead from (120a) to the claim that at some time the car was doing something other than sputtering, and that at a later time it sputtered; from (120b) to the claim that at some time the car was moving, and that at a later time it was not. Also, by (84a), we can infer that in (120a) the car neither kept sputtering nor kept not sputtering, and in (120b) the car neither kept moving nor kept not moving.

We have no inference rule whose antecedent is NOT GO, and so we derive no inferences from the negations of (120a,b). This seems to be correct, since one can say either (121a) or (121b), for example:

(121) a. The car didn't begin sputtering; it never sputtered at all.
b. The car didn't begin sputtering on Tuesday; it was sputtering all along.

The two possibilities correspond to different stresses, and hence to different foci and presuppositions; the consequences are thus to be explicated in terms of the rules of SIGG, chapter 6, dealing with focus and presupposition.

[18] There are many speakers who use this ambiguously, the other sense synonymous with *Dick prevented the car from coughing*. We will ignore this reading, assuming it has the same analysis as its paraphrase.

Notice that *begin* and *cease*, like *continue*, have intransitive variants:

(122) $\left\{\begin{matrix}\text{The noise}\\ \text{Bill's yelling}\end{matrix}\right\}\left\{\begin{matrix}\text{began}\\ \text{ceased}\end{matrix}\right\}$.

As with *continue*, we can assign these verbs representations in which the circumstance is specified as OCCUR: (123) is *begin*.

(123) $\text{GO}_{\text{Circ}}\left(\left\{\begin{matrix}\text{THE NOISE}\\ \text{BILL YELL}\end{matrix}\right\}, \text{y}, \left\{\begin{matrix}\text{THE NOISE}\\ \text{BILL YELL}\end{matrix}\right\} \text{OCCUR}\right)$

This then is a semantic explication of Perlmutter's (1970) two verbs *begin*.

One might justifiably wonder if some of the representations we have arrived at are somewhat baroque; it is entirely plausible to suggest that the mysterious Circumstantial GO is superfluous in the representation of *force*, and certainly in that of the arch-causative verb *cause*. We have claimed that representations such as (124b) are correct for (124a), yet (124c) appears intuitively correct and is one function simpler.

(124) a. John $\left\{\begin{matrix}\text{forced}\\ \text{caused}\end{matrix}\right\}$ Bill to scream.

b. CAUSE (JOHN, GO_{Circ} (BILL, y, BILL SCREAM))

c. CAUSE (JOHN, BILL SCREAM)

There are three arguments against (124c). First, without a Circumstantial function, *cause* and *keep* cannot be differentiated; both would have to be represented as (124c). Second, (124b) but not (124c) can explain why (54) implies a change of state, even though the complement is punctual.

(54) Dollie caused Martin to be happy.

A representation of (54) parallel to (124c) is (55), which we rejected in section 3.3 on two grounds: it violates the constraint that the final argument of CAUSE must be an event, and it does not represent the understood change of state.

(55) CAUSE (DOLLIE, BE_{Ident} (MARTIN, HAPPY))

A representation parallel to (124b), however, overcomes both objections at once:

(125) CAUSE (DOLLIE, GO_{Circ} (MARTIN, y, BE_{Ident} (MARTIN, HAPPY)))

The third argument for (124b) is that it provides an account of the semantic difference used classically (e.g. by Rosenbaum (1967)) to argue for the presence of an underlying direct object with these verbs:

(126) a. John forced the doctor to examine Bill.

b. John forced Bill to be examined by the doctor.

Since the underlying structure of the complement is *the doctor examine Bill* in both cases, a (124c)-type representation cannot differentiate between the readings of the two sentences. But if GO_{Circ} is included, the difference can be represented quite plausibly as (127).

(127) a. CAUSE (JOHN, GO_{Circ} (THE DOCTOR, y, THE DOCTOR EXAMINE BILL))
b. CAUSE (JOHN, GO_{Circ} (BILL, y, THE DOCTOR EXAMINE BILL))

In other words, the use of GO_{Circ} enables the system to express certain important semantic differences that have crucial effects on syntactic structure. The direct object of *force* is given a real semantic function. Hence the syntax of *force* is directly related to and explained by its semantics: there is a one-to-one correspondence between syntactic and semantic arguments, as there should be.

We see therefore that the concept of Circumstantial location, although intuitively somewhat murky and philosophically quite suspect, leads to a much more general formal semantic system than could be attained without it.

5.3. Permissive Agents

Symmetry requires that we find semantic structures of the form LET GO_{Circ} and LET BE_{Circ}, parallel to the attested CAUSE GO_{Circ} and CAUSE $STAY_{Circ}$. As before, the place to start looking for such verbs is among the Positional verbs of appropriate functional form.

(128) a. John released the bird from the cage.
LET (JOHN, GO_{Posit} (THE BIRD, THE CAGE, z))
b. John released Fred from washing the dishes.
(LET JOHN, GO_{Circ} (FRED, FRED WASH THE DISHES, z))

(129) a. John allowed Fred in the room.
LET (JOHN, BE_{Posit} (FRED, THE ROOM))
b. John allowed Fred to wash the dishes.
LET (JOHN, BE_{Circ} (FRED, FRED WASH THE DISHES))

It is more difficult to test the accuracy of these representations than the corresponding ones with CAUSE, because fewer inferences are possible. Correctly, there is no inference about the truth of the complement from the truth of (128b) and (129b), since there is no inference rule whose antecedent is LET(. . .). There is however an inference from NOT LET, so we will negate these sentences and follow through the inferences.

(130) a. John didn't release Fred from washing the dishes.
NOT LET (JOHN, GO_{Circ} (FRED, FRED WASH THE DISHES, z))

b. $\xrightarrow{(62)}$ Fred didn't stop washing the dishes.
NOT GO_{Circ} (FRED, FRED WASH THE DISHES, z)

(131) a. John didn't allow Fred to wash the dishes.
NOT LET (JOHN, BE_{Circ} (FRED, FRED WASH THE DISHES))

b. $\xrightarrow{(62)}$ Fred wasn't washing the dishes. (?)
NOT BE_{Circ} (FRED, FRED WASH THE DISHES)

c. $\xrightarrow{(75a)}$ BE_{Circ} (FRED, NOT (FRED WASH THE DISHES))

d. $\xrightarrow{(99)}$ Fred didn't wash the dishes.
NOT (FRED WASH THE DISHES)

Again these inferences seem correct, and *release* and *allow* are two further types of one-way implicative.

Here are two more interesting permissive verbs.

(132) a. Jack forbid Jim to fight.
b. Jack exempted Jim from fighting.

These can be assigned representations (133a,b) respectively, incorporating NOT at two different points.

(133) a. NOT LET (JACK, BE_{Circ} (JIM, JIM FIGHT))
b. LET (JACK, BE_{Circ} (JIM, NOT (JIM FIGHT)))

Note again in (133b) how the *from-ing* complement stands for a negative Location, as in many previous examples. From (133a) we can draw the inference that Jim didn't fight, and from its negation there is no inference. From (133b) there is no inference, but from its negation we can draw the inference that Jim fought. Thus *forbid* and *exempt* belong to two additional classes of one-way implicative verbs, and their properties are explicated directly within the theory of thematic relations.

Interestingly, the verb *let* itself appears to be an anomaly. From its Positional use in (134a) we would guess that (134b) contains a GO_{Circ}.

(134) a. John let the bird out of the cage.
LET (JOHN, GO_{Posit} (THE BIRD, y, OUTSIDE OF THE CAGE))

b. John let Fred wash the dishes.
LET (JOHN, GO_{Circ} (FRED, y, FRED WASH THE DISHES))

Since the reading (134b) contains the same functions as *release* in (130), we would expect the same inference, i.e. its negation should entail only that Fred didn't stop washing the dishes. In fact, it seems that *let* permits the same inferences as *allow*, namely, the negation of (134b) entails that Fred didn't wash the dishes.

There are two possible resolutions of this anomaly. One is to say that *let* does not have the optimal relation between its two uses, and that the reading in the complement form (134b) is like *allow*: LET (x, BE_{Circ} (. . .)). Alternatively, the representation of (134b) could be simply LET (JOHN, FRED WASH THE DISHES); the complement, instead of replacing the Location phrase of the Positional use, would replace the entire second argument of LET. Under this assumption, inference rule (62) leads directly from the negation of (134b) to the claim that Fred didn't wash the dishes, as desired.

This second solution is worth dwelling on for a moment. *Let* is unusual syntactically in that it requires a bare infinitive complement rather than the *to*-complement generally associated with the verbs of this class. It is not inconceivable that this syntactic anomaly reflects the observed semantic anomaly. As evidence, note that the verb *make* takes the same type of complement as *let*; it is evidently the causative counterpart.

(135) John made Fred wash the dishes.

If the above conjecture about *let* is correct, (135) should be represented by CAUSE (JOHN, FRED WASH THE DISHES), contrasting with *John caused Fred to wash the dishes*, which contains a Circumstantial GO. Now notice that state-of-affairs complements can be embedded more comfortably under *cause* than under *make*:

(136) a. ?*John made {Bill know the answer / the tree be tall}.

b. John caused {Bill to know the answer / the tree to be tall}.

This difference is explicable, since in (136a), the final argument of CAUSE is the anomalous BE_{Ident}, whereas in (136b) it is the permissible GO_{Circ}. Hence the conjectured structure for the bare infinitive complement explains at least one interesting independent fact. Doubts about the precise syntax of the construction preclude much stronger claims. If this conjecture is correct, however, there is a real deep structure difference from the *to*-infinitive, not merely a trivial *to*-deletion transformation triggered by an exception feature. Again the present semantic analysis reveals an interesting correlation with syntactic structure.

5.4. Excursus #2

By following the general heuristic that a verb means fundamentally the same in all its uses, we were led to discover the notion of Circumstantial location. This is clearly a linguistically significant generalization of the system of thematic relations: it permits the description of a wide range of verbs and their inferences merely by following through mechanically the possibilities provided by the system, and by deriving the inferences by independently motivated inference rules. A set of heretofore classi-

ficatory features, namely those defining implicative verbs, is replaced with a motivated semantic description.

Lest the generalization from Positional to Circumstantial location seem still marginal and unmotivated, we should observe that it is in fact quite pervasive in the language. A few random examples culled from Jespersen, in which the generalization is immediately evident, are *to* COME *to be called Max*, *to* LEAD *someone to believe something*, *to* DRIVE *someone to confess*, *to* BRING *oneself to acknowledge something*, *to* DIRECT *someone to leave*, and, among nominals, the striking example *the* WAY *to find out*. These are not "metaphors" in the usual sense—they are not used for artistic effect, and there is no clash of semantic markers characteristic of true metaphor. Rather, they are generalizations of the meanings of verbs along innately determined lines.

For a more subtle example, consider the meaning of *force*, which we have so far defined up to synonymy with *cause*. *John forced the ball into the hole* can be paraphrased more accurately by *make go* plus a manner phrase: *John made the ball go into the hole by applying pressure against its resistance*. Surprisingly enough, the same manner phrase is exactly right for the circumstantial reading: *John forced Sue to leave* can be paraphrased as *John caused Sue to leave by applying pressure against her resistance*. In other words, the concepts of *pressure*, *applying pressure*, and *resistance* generalize from their physical senses to abstract senses, all in precisely the right way that they can be combined identically in both modes to describe the two senses of *force*. Surely this is no coincidence; it argues that the choice of extensions from Positional to Circumstantial mode is highly predetermined.

We end this section with a summary of the classes of implicative verbs discussed here. Their great variety amply demonstrates the futility of any classificatory system not based directly on semantic structure.

Semantic Structure	Examples	Inferences
$GO_{Circ}(x, y, z)$	begin start	asserted: *z* denied for some time; *z* asserted for some later time denied: no inferences
$GO_{Circ}(x, y, NOT\ z)$	cease stop	asserted: *z* asserted for some time; *z* denied for some later time denied: no inference
$STAY_{Circ}(x, y)$	keep continue	asserted: *y* asserted denied: *y* denied for some time
$STAY_{Circ}(x, NOT\ y)$	avoid refrain	asserted: *y* denied denied: *y* asserted for some time
CAUSE (x, z)	make	asserted: *z* asserted denied: no inference
CAUSE (x, $GO_{Circ}(z, u, w)$)	cause force coerce	asserted: *w* denied for some time; *w* asserted later denied: no inferences

Semantic Structure	Examples	Inferences
CAUSE (x, GO_{Circ}(z, u, NOT w))	stop	asserted: *w* asserted for some time; *w* denied later denied: no inferences
CAUSE (x, $STAY_{Circ}$(z, w))	keep	asserted: *w* asserted denied: no inferences
CAUSE (x, $STAY_{Circ}$(z, NOT w))	keep from prevent restrain	asserted: *w* denied denied: no inferences
LET (x, z)	let	asserted: no inferences denied: *z* denied
LET (x, GO_{Circ}(z, u, w))	release	asserted: no inferences denied: *u* didn't stop
LET (x, BE_{Circ}(z, w))	allow permit	asserted: no inferences denied: *w* denied
LET (x, BE_{Circ}(z, NOT w))	exempt	asserted: no inferences denied: *w* asserted
NOT LET (x, BE_{Circ}(z, w))	forbid	asserted: *w* denied denied: no inferences

6. Pushing the System

We continue with three areas where the theory of thematic relations seems applicable, but for which the results are somewhat more speculative: ethical datives and benefactives, spatial and temporal extent, and verbs of intent.

6.1. Ethical Datives and Benefactives

Gruber observes that there is a sort of converse of Possessive location in the following expressions.

(137) a. Nelson ran out of money.
b. Ari is in the money.
c. Fred came into a lot of money.

By the usual analysis within the present framework, the subjects in these sentences are Themes, and the prepositional phrases are Goals and Locations, though not in any of the locational modes we have discussed. (137c) is related to the ordinary Possessional sentence *Fred got a lot of money* in much the same way as *The circle surrounds the dot* is related to *The circle contains the dot*; that is, the two sentences express the same situation but with different thematic relations. For Positional sentences the locational parameter does not have to be changed, but we must introduce a new

locational mode (call it Poss′) to describe (137), giving these sentences descriptions more or less like (138).

(138) a. $GO_{Poss'}$ (NELSON, y, NOT MONEY)
b. $BE_{Poss'}$ (ARI, MONEY)
c. $GO_{Poss'}$ (FRED, y, MONEY)

Understanding the expressions in (137) amounts to understanding the Poss′ mode of location.

One might wonder whether there are any other "converse" modes in the language. Consider these well-known constructions.

(139) a. A funny thing happened to Bill.
b. What happened to Bill was Mary punched him.
c. Sue did something evil to Harry.
d. What Sue did to Harry was kiss him.

What is the interpretation of the *to*-phrase in these examples? The choice of preposition suggests a Goal phrase, leaving the subject, an event, as Theme in (139a,b). The end result of the motion of the Theme is the Goal's being involved in the event. Hence these sentences represent the converse of Circumstantial motion: instead of an individual moving to an event, an event moves to an individual. The representations of (139a,b) are therefore (140a,b).

(140) a. $GO_{Circ'}$ (A FUNNY THING, x, BILL)
b. BE_{Ident} ($\left[\begin{matrix}\text{SOMETHING} \\ GO_{Circ'}\text{ (WH-SOMETHING, x, BILL)}\end{matrix}\right]$, MARY PUNCH BILL)

(139c,d) are simply the causative counterparts of (139a,b).

(140) c. CAUSE (SUE, $GO_{Circ'}$ (SOMETHING EVIL, y, HARRY))
d. BE_{Ident} ($\left[\begin{matrix}\text{SOMETHING} \\ \text{CAUSE (SUE, } GO_{Circ'}\text{ (WH-SOMETHING, y, HARRY))}\end{matrix}\right]$, SUE KISS HARRY)

Such an analysis explains two interesting and heretofore mysterious constraints on these constructions. First, the fact that the end result of the motion is that the individual is involved in the event explains the somewhat vague selectional restriction on possible clauses in *what happened to x was . . .* constructions:

(141) a. *What happened to Fred was Transylvania became independent in 1274.
b. *What happened to Fred was the price of bananas went up.

(141b) is acceptable only if there is some connection between Fred's fortunes and the price of bananas, that is, if the event could involve Fred in some way.

Since the event is moving to the person, rather than vice versa, the person can have no control over the event. Hence this construction excludes clauses in which the relevant person is Agent:

(142) a. What happened to Fred is he inherited twenty cents. (*Fred* is Goal of clause)
b. *What happened to Fred is he bought an expensive car. (*Fred* is Agent of clause)
c. What happened to Fred was he fell down the stairs. (*Fred* is Theme of clause)
d. *What happened to Fred was he lowered himself down the stairs. (*Fred* is Agent)

(142b) could be used ironically, implying Fred was victimized by a salesman or has fallen prey to bourgeois instincts, i.e. that his control of the situation was only apparent. The irony lies in the conflicting assertion that Fred was both in control and not.[19]

Hence a grammatically motivated interpretation of (139) leads to a plausible explanation of some unusual constraints on its use. Some cases whose analysis is less clear are those in (143).

(143) a. It remained to Dan to clean up the mess.
b. It fell to Ivanovich to throw the bomb.
c. My car broke down on me.

(143a,b) look similar to (139): the prepositional phrase is the Goal of something, and the Theme is apparently the clause. On the other hand, *Dan* and *Ivanovich* are understood as Agents of their respective clauses, violating the Agency constraint observed in (142). This difference can be explained if we notice that what is going to Dan and Ivanovich is not the event, but an *obligation* to bring the event about, and they have no control over the obligation—it is being imposed from without. The semantic difference between these and (139) is reflected as a syntactic difference in complementizer choice.

(143c) represents a different case. Here the *on* phrase, the so-called "ethical dative", represents the recipient of a misfortune. An obvious semantic representation would be one similar to (139).

[19] Gruber (1965) suggests at one point that an Agent is a kind of Source; in the present formalism, this amounts to claiming that CAUSE (x, e) is to be reanalyzed as $GO_{Circ'}$ (e, x, z). He has pointed out (personal communication) that such an analysis would formally explain the constraint illustrated in (142): it would simply be a special case of the general constraint that Source and Goal are distinct. Fairly clear cases of such Circumstantial' Sources exist, for instance *he died* FROM *cancer*. However, this treatment of CAUSE entails reducing LET (x, e) as well, to something like STAY (e, NOT x), whose intuitive appeal is far less. I therefore leave the question open.

(144) $GO_{Circ'}$ (MY CAR BROKE DOWN, y, ME)

(144) has intuitive appeal semantically, but it presents syntactic problems, in that the superordinate function $GO_{Circ'}$ is not part of the main verb of the sentences, as would be expected. Alternatively, the $GO_{Circ'}$ could be incorporated as a restrictive modifier on the main verb:

(145) $\begin{bmatrix} GO_{Ident} \text{ (MY CAR, x, BROKEN DOWN)} \\ \text{Manner(?): } GO_{Circ'} \text{ (MISFORTUNE, y, ME)} \end{bmatrix}$

But this is not altogether satisfying semantically. The present system at least provides the correct pieces for the interpretation of (143c). It remains to be seen whether the pieces can be put together in a way that preserves the generality of the rules relating syntactic and semantic structures.

A word about the preposition *on* in this construction. It may well seem unmotivated, since the usual preposition for Goals is *to*. However, *on* can be used to express a Goal, suppleting *to*, when the Goal is a surface and the motion is downward from above:

(146) a. The bomb fell on the field.
b. Bill put the flowers on the counter.
c. The plane landed on the roof.

For lack of better analysis, we indulge in metaphorical speculation. One might guess that suffering misfortune is conceived of as like getting hit on the head by a falling object—the object is out of one's control, and its impact hurts (note the parallel use of *impact*—almost a bad pun, and we accept it ruefully). Like a falling object, the course of events cannot be stopped once it is underway. The use of *on* is consistent with this conception. The existence of such expressions as *Don't lay your troubles on me* and the recent colloquial use of *go down* for *happen* confirm the psychological reality of this metaphor. Presumably, if there is any relationship between *fall* and *befall*, it is to be found here. Also note the expressions *have control* OVER *something*, *be* ON TOP OF *the situation*, *be* UNDER *someone's control*.

Contrasting with ethical datives are so-called benefactive expressions, usually containing a *for*-phrase:

(147) a. What Connie did for Bob was $\begin{Bmatrix} \text{bake a cake} \\ \text{??kick him} \end{Bmatrix}$.
b. Bob sang a tune for Connie.
c. Kick a goal for old Phuque U.

Most of the events associated with these phrases are beneficial to the individual denoted by the object of *for*, whereas in the previous examples the object of *to* and *on* was a victim. Other than this difference, the interpretation seems to be the same: the object of the preposition is the Goal of a circumstance.

Here is a very speculative conjecture about how to represent the difference between the ethical dative and the benefactive. We have seen that the preposition *on* of the ethical dative has a strongly Positional connotation. In contrast, the benefactive *for* has Possessional overtones. For example, *Bill painted* $\left\{\begin{matrix}\textit{a picture for Fred}\\ \textit{Fred a picture}\end{matrix}\right\}$ is ambiguous between the picture being painted for Fred's amusement or for Fred to own. Many of the *for*-Dative verbs have similar ambiguities.

Now notice that a Circumstantial Theme moving to an individual as Goal need have no special mode of location such as *Circ'* indicated on the function GO; the mode will be indicated unambiguously by the semantic nature of the Theme. Suppose, then, that the mode can be specified either as Positional or Possessional, and that the former denotes ethical datives and the latter benefactives. This would explain in a rather natural way the observed uses of prepositions, while reducing the stock of locational modes by one.[20]

Section 6.3 will mention further evidence for the affinity between Possessional mode and benefactive interpretations. Though this connection may seem somewhat extreme, pushing the theory beyond presently justifiable limits, it is important to thus investigate how the theory might be extended in a more than mechanical fashion.

6.2. Spatial and Temporal Extent

(148) raises a number of apparent contradictions to the analysis given so far.

(148) The road $\left\{\begin{matrix}\text{extended}\\ \text{reached}\end{matrix}\right\}$ from Altoona to Johnstown.

The *from* and *to* strongly suggest that the semantic representation of (148) should contain GO as its principal function. This conjecture is strengthened by the observation that *goes* can be substituted for the verbs in (148), and both *extend* and *reach* can describe physical motion:

(149) a. John extended his arm over the table.
b. John reached Altoona.

Yet (148) does not express change of any sort, and it fails the test for eventhood that picks out motional verbs:

(150) *What happened was that the road $\left\{\begin{matrix}\text{extended}\\ \text{reached}\end{matrix}\right\}$ from N.Y. to L.A.

Furthermore, the usual inferences for GO are not only invalid, but semantically

[20] Alternatively, one might try to develop a feature system for the locational parameter, in which (for example) Positional was unmarked, Possessional and benefactive were marked for possession, and benefactive and ethical dative were marked for Circumstantial Theme. The analysis of Extensional hypermode in section 6.2 strongly suggests such a treatment.

anomalous: it makes no sense to say that first the road was in Johnstown and then it was in Altoona. An example with similar problems, but in the Identificational mode, is (151).

(151) This theory ranges from the sublime to the ridiculous.

These sentences seem to be serious counterexamples to the theory of thematic relations.

(148) and (151) differ from all the previous examples of motional verbs in one very crucial way: they do not make essential reference to the passage of time. It is because of this that they, like punctual verbs, do not describe events, but states of affairs. Since the use of *happen* implies passage of time, (150) is anomalous; since (72), the inference rule for GO, makes reference to passage of time, it cannot be applied to these examples. Thus the difficulties with (148) and (151) follow from the fact that GO_{Posit} and GO_{Ident} are not correct representations for their principal functions.

When the linguistic form of some example has strongly suggested motion, but the theory could not yet express its sense, we have typically responded by creating a new locational mode. The new mode was then justified by showing that it was necessary for durational and punctual verbs as well as for motional. In the present instance, what is called for is not simply a new mode, since both Positional and Identificational modes are involved in the extension of the system. Rather we seem to need a "hypermode" that cross-categorizes (at least in part) with the previous locational modes.

Let us call the new opposition *Transitional* vs. *Extensional*. All previous examples of GO have been GO_{Trans}, expressing the locations of the Theme over time. (148) and (151), however, are GO_{Ext}, expressing what locations the Theme occupies without reference to time. We will assign them the following representations:

(148′) $GO_{Ext,Posit}$ (THE ROAD, ALTOONA, JOHNSTOWN)

(151′) $GO_{Ext,Ident}$ (THIS THEORY, SUBLIME, RIDICULOUS)

To prevent inference rule (72) from applying to these sentences, it must be restricted to GO_{Trans}:

$$(72') \quad \begin{bmatrix} GO_{Trans}\ (X, Y, Z)\ AT\ t_1 \\ W \end{bmatrix} \Rightarrow \text{for some times } t_2 \text{ and } t_3 \text{ such that } t_2 < t_1 < t_3, \begin{bmatrix} BE_{Trans}\ (X, Y)\ AT\ t_2 \\ W \end{bmatrix} \text{ and } \begin{bmatrix} BE_{Trans}\ (X, Z)\ AT\ t_3 \\ W \end{bmatrix}$$

The corresponding inference rule for GO_{Ext} is that if something $goes_{Ext}$ from y to z, part of it (in particular, one end) is at y and part of it (the other end) is at z:

$$(152) \quad \begin{bmatrix} GO_{Ext}\ (X, Y, Z) \\ W \end{bmatrix} \Rightarrow \text{for some T and U such that } T \subset X \text{ and } U \subset X, \begin{bmatrix} BE_{Ext}\ (T, Y) \\ W \end{bmatrix} \text{ AND } \begin{bmatrix} BE_{Ext}\ (U, Z) \\ W \end{bmatrix}$$

This provides the desired inferences for (148) and (151).

If there is a hypermode of Extension, we would expect to find $STAY_{Ext}$ and BE_{Ext} as well. Notice, however, that since BE never refers to passage of time in any case, there is probably no semantic distinction between BE_{Ext} and BE_{Trans}—the two collapse into one semantic function. There remains STAY. What would be a suitable candidate for a verb represented as $STAY_{Ext}$? To answer this, let us speculate on what possible inferences $STAY_{Ext}$ could have. If something $stays_{Trans}$ someplace during a particular interval of time, there is no part of the interval during which it is not there. The relationship between (72′) and (152) seems to be that part of the Theme in (152) corresponds to part of the time in (72′). Making a corresponding alteration in inference rules (69) and (70) for $STAY_{Trans}$, we get these rules:

(153) $\begin{bmatrix}\text{STAY}_{\text{Ext}}\ (\text{X, Y}) \\ \text{Z}\end{bmatrix} \Rightarrow \begin{bmatrix}\text{BE}\ (\text{W, Y}) \\ \text{Z}\end{bmatrix}$
Condition: W is part of X

(154) $\text{NOT}\ \begin{bmatrix}\text{STAY}_{\text{Ext}}\ (\text{X, Y}) \\ \text{Z}\end{bmatrix} \Rightarrow \text{for some W, NOT}\ \begin{bmatrix}\text{BE}\ (\text{W, Y}) \\ \text{Z}\end{bmatrix}$
Condition: W is part of X

A verb that obeys these inference rules is *contain*, which we previously analyzed as BE_{Posit}. If the circle contains a square, every part of the square is in the circle; if the circle does not contain the square, there is a part of the square that is not in the circle. Thus $STAY_{Ext}$ might be taken to mean approximately 'stay within the boundaries of'; the verb of this paraphrase is of course significant.

The potential ramifications of an Extensional hypermode are vast, and I will mention only two of its possible uses. First, there appears to be a notion of nontemporal (i.e. Extensional) causation that includes the idea of logical connection. *P implies Q*, for example, can be represented as $CAUSE_{Ext}$ (P, Q). There is no standard logical connective expressing LET_{Ext} (P, Q), but this sense seems to be conveyed by *Q is consistent with P*. By filling in the Agent with a specified argument, we can represent *P is (logically) possible* with some such expression as LET_{Ext} (LOGIC, P). The parallel expression $CAUSE_{Ext}$ (LOGIC, P) is then, of course, *P is (logically) necessary*. Other kinds of necessity and possibility can be expressed by substituting other kinds of general laws (e.g. NATURE, MORALITY, THE PRESENT SITUATION, etc.) for LOGIC in these formulas. This gives us essentially the range of readings exhibited by the modals *must* and *may*, which are thus CAUSE and LET respectively. Hence, if this speculation is correct, the theory of thematic relations has as a natural consequence the semantic parallelisms observed by Lakoff (1972, section VIII) among the pairs *require* and *permit*, *necessary* and *possible*, and *must* and *may*.

Oddly enough, time reenters in the Extensional hypermode via a new mode of location:

(155) The conference $\left\{\begin{matrix}\text{went}\\\text{lasted}\\\text{extended}\end{matrix}\right\}$ from Tuesday to Friday.

Since the verb *go* and Source–Goal patterns reappear here, we conclude that we are dealing with a motional sentence again. The Source and Goal are of course times. Now notice that only the Extensional inference rule (152) is applicable: we can infer that part of the conference was on Tuesday and part on Friday; it makes no sense to apply (72) and infer that there was a time at which the conference was on Tuesday and a time at which it was on Friday. Hence the appropriate hypermode seems to be Extensional, and the use of the verb *extend* confirms this. We thus must create a new Extensional mode, *Temporal*, representing (155) this way:

(156) $\text{GO}_{\text{Ext,Temp}}$ (THE CONFERENCE, TUESDAY, FRIDAY)

The existence of the Temporal mode of course renders it possible to express the often-observed relations between the spatial and temporal uses of such words as *precede*, *follow*, *occupy*, *fill*, *before*, *after*, *within*, and of course *at* and *on*. Thus again the theory of thematic relations opens up an important area of semantic description to motivated analysis.

6.3. Verbs of Intent

Observe the contrast in the following pairs.

(157) a. Max sailed toward the harbor.
b. Max sailed for the harbor.

(158) a. Max ran toward home.
b. Max ran for home.

Though both *toward* and *for* seem to express direction, they are not identical in meaning:

(159) a. Max sailed $\left\{\begin{matrix}\text{*toward}\\\text{for}\end{matrix}\right\}$ the harbor by setting his course 30° north of the harbor.

b. Max inadvertently ran $\left\{\begin{matrix}\text{toward}\\\text{*for}\end{matrix}\right\}$ home, thinking he was running away from it.

(159a) is anomalous with *toward* because *toward* expresses a physical direction that conflicts with the direction asserted in the means clause. *For*, however, expresses an *intent*, a "mental direction", so it does not conflict with the physical direction in (159a). Conversely, the subordinate clause in (159b) deals with Max's thoughts; it is compatible with the physical direction expressed by *toward*, but not with the

intent expressed by *for* (unless Max is self-destructively neurotic and the *for* expresses an unconscious intent).

Lacking at present any formalization of direction phrases and of mental constructs, we will provisionally express intent as a restrictive modifier of the function CAUSE, thus:

(160) a. $\left[\begin{array}{l}\text{CAUSE (MAX, } \left[\begin{array}{l}\text{GO}_{\text{Posit}}\text{ (MAX, y, z)}\\ \text{Manner: SAILING}\end{array}\right]\text{)}\\ \text{Intent: GO}_{\text{Posit}}\text{ (MAX, x, THE HARBOR)}\end{array}\right]$

b. $\left[\begin{array}{l}\text{CAUSE (MAX, } \left[\begin{array}{l}\text{GO}_{\text{Posit}}\text{ (MAX, y, z)}\\ \text{Manner: RUNNING}\end{array}\right]\text{)}\\ \text{Intent: GO}_{\text{Posit}}\text{ (MAX, x, HOME)}\end{array}\right]$

Note that we can use the presence of the modifier of intent to distinguish those verbs that require animate Agents from those that permit either an animate or inanimate Agent: verbs that express intent may be ascribed only to sentient Agents (and this will include organizations and higher animals in exactly the appropriate way).

The phrase of intent, marked syntactically by *for* and realized semantically as a motional function modifying CAUSE, appears also in nonphysical cases. Contrast these pairs.

(161) a. Phil tried a new job.
b. Phil tried for a new job.

(162) a. The moderator asked the panelist a question.
b. The moderator asked the panelist for a question.

In (161a), the direct object is probably a Location or Goal (as indicated by the nominal *Phil took a try at it*), and in (162a), the object is a Theme (what came from the moderator's mouth). By contrast, in the (b) sentences, the object of *for* is the Goal of an intention, something that is not necessarily claimed to exist other than in the subject's mind.

A complete formalization of these verbs must be somewhat conjectural, but for the sake of pushing the theory, I will attempt it. Let us deal first with *try*. *Try* can take a gerundive object as in *Phil tried working on the XP–70*, indicating the presence of a Circumstantial function in its representation. *A job* can likewise be considered a Circumstance (but not *an apple*, as in *Phil tried an apple*, of which more shortly). (161a) entails that at some time Phil did not have the job, and at some later time he had it. Such inferences suggest that the desired Circumstantial function is GO. Since *try* is clearly Agentive, there must be a CAUSE as well. So far, then, (161a) has the representation (CAUSE (PHIL, GO_{Circ} (PHIL, y, A NEW JOB))). What distinguishes *try* from other verbs of this functional structure is the marker of intent, which in (161a) is roughly "Phil get into a better situation". The lexical entry for transitive *try* in (161a) must thus be (163).

(163) $$\left[\begin{array}{l}\text{/trī/}\\ +\text{V}\\ +[\text{NP}^1 \text{ \_\_\_\_ } \text{NP}^2]\\ \left[\begin{array}{l}\text{CAUSE (NP}^1\text{, GO}_{\text{Circ}}\text{ (NP}^1\text{, z, NP}^2\text{))}\\ \text{Intent: GO}_{\text{Circ}}\text{ (NP}^1\text{, x, BETTER SITUATION)}\end{array}\right]\end{array}\right]$$

(161b), on the other hand, is read roughly as 'Phil did something with the intent of getting a job'. Here the object of *for* appears within the intent marker, and the actual action taken by Phil is left unspecified. The complement clause in this reading is infinitival: *Phil tried to get a job*. The lexical entry for this sense of *try* could thus be (164).

(164) $$\left[\begin{array}{l}\text{/trī/}\\ +\text{V}\\ +[\text{NP}^1 \text{ \_\_\_\_ for } \left\{\begin{array}{l}\text{NP}^2\\ \text{S}\end{array}\right\}]\\ \left[\begin{array}{l}\text{CAUSE (NP}^1\text{, y, e)}\\ \text{Intent: GO}_{\text{Circ}}\text{ (NP}^1\text{, x, } \left\{\begin{array}{l}\text{NP}^2\\ \text{S}\end{array}\right\}\text{)}\end{array}\right]\end{array}\right]$$

Thus the two senses of *try* differ in which Circumstantial position in the semantic representation is filled in; further, the semantic distinction between the two possible complement types is clearly expressed in the proposed analysis.

Two further related uses of *try* appear when the second NP is not a circumstance:

(165) a. Phil tried an apple.
b. Phil tried for an apple.

The reading of *try* in (165b) is easily assimilated to lexical entry (164), since it can be represented by replacing the GO_{Circ} in (164) with $\text{GO}_{\text{Poss}'}$: the sentence can this way be paraphrased approximately as 'Phil did something with the intent of getting (to the possession of) an apple'. (165a) is closely related to (161a): it can be paraphrased as 'Phil got involved in a situation involving an apple with the intent of getting a better situation'. Note that the exact nature of the situation involving the apple is unspecified: it could be eating, throwing, painting, levitating, looking at, or sitting on an apple. (166) represents this reading of *try*.[21]

(166) $$\left[\begin{array}{l}\text{/trī/}\\ +\text{V}\\ +[\text{NP}^1 \text{ \_\_\_\_ } \text{NP}^2]\\ \left[\begin{array}{l}\text{CAUSE (NP}^1\text{, GO}_{\text{Circ}}\text{ (NP}^1\text{, z, } \left[\begin{array}{l}\text{w}\\ \text{BE}_{\text{Circ}}\text{ (NP}^2\text{, w)}\end{array}\right]\text{))}\\ \text{Intent: GO}_{\text{Circ}}\text{ (NP}^1\text{, x, BETTER SITUATION)}\end{array}\right]\end{array}\right]$$

[21] Note that NP^2 appears in this entry inside a semantic construction that corresponds syntactically to a relative clause. If this entry is correct, it is an example of what many generative semanticists have claimed to be an impossible lexical item, since within their theory its lexicalization would necessarily violate the Complex NP Constraint.

Thus $\begin{bmatrix}\text{CAUSE (NP}^1\text{, GO}_{\text{Circ}}\text{ (NP}^1\text{, z, w))}\\ \text{Intent: GO}_{\text{Circ}}\text{ (NP}^1\text{, u, v)}\end{bmatrix}$ appears to be the theme of which all the uses of *try* are variations. One could easily conceive of a language in which these senses were assigned to different words, yet they are not so different as to be unrelated.

The relation between the two uses of *ask* in (162) is similar. (162) can be paraphrased roughly as 'the moderator said a question with the intent of getting from the panelist a response to the question': (162b) is roughly 'the moderator said something to the panelist with the intent of getting a question from the panelist'. These senses of *ask* can be formalized as (167a,b) respectively. Note that (167b) leaves unspecified what NP[1] says.

(167) a. $\begin{bmatrix}\text{/æsk/}\\ \text{+V}\\ \text{+[NP}^1\text{ \_\_\_\_ (NP}^2\text{) NP}^3\text{]}\\ \begin{bmatrix}\text{CAUSE (NP}^1\text{, GO}_{\text{Poss}}\text{ (NP}^3\text{, NP}^1\text{, NP}^2\text{))}\\ \text{Intent: CAUSE (NP}^2\text{, GO}_{\text{Poss}}\text{ (ANSWER TO NP}^3\text{, NP}^2\text{, NP}^1\text{))}\end{bmatrix}\end{bmatrix}$

b. $\begin{bmatrix}\text{/æsk/}\\ \text{+V}\\ \text{+[NP}^1\text{ \_\_\_\_ (NP}^2\text{) for NP}^3\text{]}\\ \begin{bmatrix}\text{CAUSE (NP}^1\text{, GO}_{\text{Poss}}\text{ (z, NP}^1\text{, NP}^2\text{))}\\ \text{Intent: CAUSE (NP}^2\text{, GO}_{\text{Poss}}\text{ (NP}^3\text{, NP}^2\text{, NP}^1\text{))}\end{bmatrix}\end{bmatrix}$

In these examples, I have represented the communication of information as GO_{Poss}, with a Theme that represents linguistic information. We could again invent a new mode of location to represent linguistic communication, and it may well prove necessary; but the use of normally Possessional verbs is suggestive in examples such as *I have a question* and *He'll give you an answer*. See Gruber (1965, section 7.2) in this regard.

Running the risk of oversimplification, we nevertheless observe that this generalization permits both normal Possessional transfer (as in *ask for a book*) and communication (*ask for an answer*) to be represented by GO_{Poss} in the intent marker of (167b). In (167a), of course, only a linguistic NP[3] is possible, since only questions can serve as arguments of ANSWER TO NP[3] in the intent marker.

Closely related to (162a) is the subcategorization of *ask* with indirect questions, as in *Phil asked Bill who left*. The subordinate clause describes the actual content of the discourse. The communication cannot, however, be represented as GO (WHO LEFT, PHIL, BILL), since WHO LEFT denotes a (partially unspecified) event, not a sentence. A more appropriate representation is GO_{Poss} ($\text{IMAGE}_{\text{verbal}}$ (WHO LEFT), PHIL, BILL), where the operator IMAGE is a mapping from events into their representations, as described in Jackendoff (1975c). This analysis creates the

possibility of referential opacity and of inexact correspondence between direct and indirect discourse, exactly as desired. This sense of *ask* is represented as (167c).

(167) c.
$$\left[\begin{array}{l} /\text{æsk}/ \\ +\text{V} \\ +[\text{NP}^1 \text{ \_\_\_\_ } (\text{NP}^2)\ \textit{wh}\text{-S}] \\ \left[\begin{array}{l} \text{CAUSE } (\text{NP}^1, \text{GO}_{\text{Poss}} (\text{IMAGE}_{\text{verbal}} (\text{S}), \text{NP}^1, \text{NP}^2)) \\ \text{Intent: CAUSE } (\text{NP}^2, \text{GO}_{\text{Poss}} (\text{ANSWER TO} \\ \qquad\qquad \text{IMAGE}_{\text{verbal}} (\text{S}), \text{NP}^2, \text{NP}^1)) \end{array}\right] \end{array}\right]$$

This is exactly like (167a) except that $\text{IMAGE}_{\text{verbal}}$ (S) is substituted for NP^3.

There are two further subcategorizations of *ask*, with subjunctives and with infinitive complements:

(168) a. Phil asked Bill that Fred leave.
b. Phil asked Bill (for Fred) to leave.

The parallel with the infinitival complement of *try* suggests that *ask* in (168b) be analyzed like (167b), with the complement represented only within the intent marker. On admittedly slim evidence, we could differentiate (168a) from this by giving it a reading more like (167a,c), with the complement represented both in the main function and in the intent: this would claim that (168a) represents more closely than (168b) what was actually said. Such an intuition seems accurate.

Here are some possible forms for the intent marker of (168a,b):

(169) a. $\text{CAUSE } (\text{NP}^2, \text{S})$
b. $\left\{\begin{array}{l}\text{CAUSE}\\ \text{LET}\end{array}\right\} (\text{NP}^2, \text{GO}_{\text{Circ}} (\text{NP}^1, \text{z}, \text{S}))$
c. $\text{CAUSE } (\text{NP}^2, \text{GO}_{\text{Poss}} (\text{S}, \text{z}, \text{NP}^1))$

All three of these incorporate the selectional restriction that the S must represent an event over which NP^2 can have control (cf. SIGG, section 5.12). Of the three, (169c) is the closest in form to the intent markers in the other uses of *ask*: the major difference is in the Theme, which is simply S substituted for the NP^3 in (167b). This captures the intuition that, as with *try*, the *for*-complement is most closely related to the *for*-object.

Under the conjecture of section 6.1, the GO_{Poss} in (169c) would represent a benefactive whose benefactor is NP^1. Such a benefactive interpretation is not implausible. Contrast (168b) with *Phil yelled to Bill for Fred to leave* or with *Phil ordered Bill to leave*, both of which seem much more neutral with respect to possible benefits for the subject: saying *Do this for me* is *asking*, whereas saying just *Do this* is *ordering*. The difference could be represented by assigning *order* and *yell* intent markers more like (169a,b), where there is no benefactive connotation, and assigning *ask* the more

complex but also more generalizable intent marker (169c). There are thus two considerations favoring (169c) as the representation of intent in (168).

We have thus analyzed the five subcategorizations of *ask* as variations on a semantic theme, the differences being in the possible interpretations of GO_{Poss}, in whether the direct object or complement appears both in the main function and the intent or only in the intent, and in whether the complement represents a question or an order.

One could easily write off these analyses of *try* and *ask* as legerdemain, mere virtuoso display; many steps along the way have been speculative and unsupported by the solid kind of data that was presented in earlier sections. It is certainly not clear that the descriptive power of the system is not being abused. However, I present these analyses so as to indicate directions in which research might be pursued, and to show the potential power of the theory. Only through such analysis can we ever hope to arrive at any real understanding of the semantics of complementation, one of the most vital problems of current linguistic research.

7. On Psychological Reality

This study has developed a fragment of the semantic description of English in terms of the theory of thematic relations. This fragment is observationally adequate in that it provides sentences with semantic representations that convey the correct information and that have the correct entailments. It meets criteria of descriptive adequacy in a number of ways.

Most important, it expresses the strong intuition that verbs are fundamentally the same in their various uses. The causative–noncausative relationship has long been a staple of linguistic description, but other relationships investigated here are relatively novel. The most significant is the relationship engendered by varying the locational parameter in the functions GO, STAY, and BE among the values Positional, Possessional, Possessional′, Identificational, and Circumstantial. Relationships are also created by substituting fully specified information for strictly subcategorized arguments and by entering strictly subcategorized arguments in different positions (such as the main function and the intent marker).

Further, the theory permits a succinct description of traditional intuitive terms such as *event*, *state of affairs*, *Agent*, and *Goal*. To the extent that these terms represent real generalizations, the theory is descriptively adequate.

The theory also meets criteria of descriptive adequacy with respect to the relationship between semantics and syntax. In particular, the dependence of complement type on semantic structure is an important part of the analysis: the bare infinitive complements of *make* and *let* correspond to direct causation; gerundive complements correspond to Circumstantial Locations, Goals, and possibly Sources; *to*-infinitives correspond to Circumstantial Goals and to intents. The direct object

of *force*-type verbs, previously justified on syntactic grounds and on the basis of semantic intuitions, has been given a semantic justification as the Theme of a Circumstantial function. More speculatively, a place has been found in the system for the relationships between ethical datives and Positional prepositions, and between benefactives and Possessional prepositions.

The most important advance in this analysis, however, is at the level of explanatory adequacy. Any choice of formalism automatically creates a valuation of possible descriptions, based on their relative simplicity within the formalism. A theory is explanatory when the empirically correct description is also most highly valued by the formalism. The crucial aspect of the theory of thematic relations, as has been emphasized, is its generalization of the functions GO, STAY, and BE across several modes of location. The formalism claims that the simplest verbs and the simplest inference rules are those that generalize across all the values of the locational parameter, leaving it maximally unspecified. Thus verbs like *be* and *keep* are claimed to be very simple, not very complex, on account of their wide variety of uses. From the choice of notation comes the proliferation of inferences based on extremely primitive physical principles, extending to Possessional and Identificational verbs in section 4, and most strikingly to Circumstantial verbs in section 5. In this last case, the assumption that being involved in a circumstance is a kind of location led to the automatic and natural account of a large variety of implicative verbs, perhaps the single most important particular result of this study. It can now be claimed that the implicative properties of verbs are not idiosyncratic meaning postulates or classificatory features, but the only possible consequence of the verbs' having the functional structure they do.

There have been other, minor, results in the domain of explanatory adequacy, of which I will mention only two. The analysis of implicative verbs depends on treating sentence negation and the negation meaning 'at a place other than' as identical. The notation has been chosen so that such identification is inevitable. Also, various selectional restrictions have followed automatically from the semantic analysis, for example the requirement of animateness on verbs of intent and the heretofore poorly understood relationship required between ethical datives and their associated clauses.

No matter how much internal coherence a semantic theory may have, of course, the ultimate test is whether it fits coherently into a theory of human psychology. For we are engaged in studying natural language, not abstract formal systems. And I believe that the theory of thematic relations, though it does not immediately imply a particular approach, has suggestive connections to some current trends in psychology.

I have already mentioned my conviction that the inference rules of section 4 are not simply means of formally manipulating semantic representations. Rather, in their Positional manifestations, they are fundamental principles involved in understanding the behavior of the physical world. As such they are certainly of an extralinguistic nature. The work of Piaget (e.g. 1947, 1970) has been concerned with the

development of this sort of understanding: the conservation of objects, their existence independent of perception, their combinatorial properties, and so forth. He emphasizes the nonlinguistic nature of these notions, showing how the child's ability to reason about and describe situations involving these notions develops later than his ability to put the notions to practical use.

Piaget inquires about the nature of logical reasoning, arguing that logic (in the logician's sense) is not the basis of thought, but only the final step in a long sequence of developmental stages of reasoning. The beginning of the sequence is the application of principles of conservation and identity to the perception and manipulation of the physical world; by gradual stages of abstraction, a child develops the ability to understand situations that he does not perceive completely and in which he is not directly involved. Finally, he learns to comprehend situations completely independent of the point of view of the observer and to generalize to abstract situations totally beyond experience, such as logical truths.

According to the theory of thematic relations, one crucial step in moving to abstract reasoning is recognizing a particular phenomenon as an instance of generalized Location. For example, understanding the full generality of complement verbs requires learning the concept of Circumstantial location, realizing that the principles of conservation and identity apply in the new domain. This is exactly the kind of learning process that Piaget describes in connection with other extensions of physical comprehension. In fact, the analysis of language may provide insight into where cognitive extensions of physical principles may be sought: surely the linguistic extensions are physically unmotivated, hence any account of why these and not other generalizations occur must bear on a theory of the structure of cognition.

The generalization of the physical and the abstract also plays an important role in current schools of psychotherapy such as gestalt therapy and bioenergetics. The most elaborate theoretical discussion I am aware of is in Perls (1947) and Perls, Hefferline, and Goodman (1951). At the risk of treating a large and complex work frivolously, I will attempt to describe briefly the germane points of Perls's theory. Perls points out numerous parallels in linguistic description between the process of meeting physical needs and that of meeting emotional and intellectual needs, for instance *digesting an idea*, *biting off more than one can chew*, *spitting out answers*, *feeling empty*, *swallowing a story whole* ("*I can't swallow that!*"), and so forth. More centrally, he discusses characteristic physical reactions to emotional and intellectual processes, in light of which the linguistic parallels are not at all surprising. For example, nonreceptivity toward a situation is often accompanied by clenching of the jaws as if not to let anything in; holding back feelings is accompanied by holding back breathing.

On such grounds, Perls argues that all spheres of human activity are governed by identical gestalt principles, the formation of figure–ground configurations in accordance with organismic needs. The apparently "metaphorical" extensions of

the physical language are in fact absolutely real and unfanciful, proceeding from the holistic nature of the organism. They seem novel and a priori unmotivated only because we are unaccustomed to treating the human being as a whole, insisting on separating "mind" from "body".

Whether or not one is willing to accept all of Perls's theory, it is clear that he has provided strong evidence that generalization from the physical world to abstraction plays a fundamental part in our mental processes. Such evidence supports the psychological reality of a semantic theory like the present one, which depends heavily on the existence of such generalizations.

The present study is complemented by Jackendoff (1975c), in which the semantics of description and belief is assimilated to the semantics of pictures, again a generalization from the physical world to abstractions. The results of these two articles are reinforced by the psychological works we have cited, and a clear message emerges: contrary to current fashion, the semantics of natural language must not be approached by developing alternative versions of formal logic. Insight is to be found rather in the study of the innate conception of the physical world and the way in which conceptual structures generalize to ever wider, more abstract domains. Such an approach seems to me an exciting and promising way of learning about the relations of thought and language.

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