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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 re-statement 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 sentence¹ 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, that is, it also denotes the meaning (or intension) of *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...A - N...] must combine the markers for the adjective and noun according to the principle of restrictive modification. We will represent the resulting marker as [HORSE] RED].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 [RED] HORSE], 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",

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

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, \dots, 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 $F(x_1, \dots, x_n)$ to form a new marker $F(x_1, \dots, x_{i-1}, M, x_{i+1}, \dots, x_n)$. 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

[BREAK (*x, y*)], which incorporates a restrictive modifier. Similarly, *bachelor*

can be decomposed as [MAN [NEVER MARRIED]]. 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 monophed* 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 commensured; 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.

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

fly: $\left[\begin{array}{l} \text{GO } (x, y, z) \\ \text{THROUGH THE AIR} \end{array} \right]$
fall: $\left[\begin{array}{l} \text{GO } (x, y, z) \\ \text{DOWNWARD, BY} \\ \text{FORCE OF GRAVITY,} \\ \text{UNIMPEDED} \end{array} \right]$

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 *Bill dropped*

the ball 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 ball* 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) $\left[\begin{array}{l} /fli/ \\ +V \\ +[NP^1 \text{ — (from NP}^2\text{) (to NP}^3\text{)}] \\ [GO (NP^1, NP^2, NP^3) \\ \text{THROUGH THE AIR}] \end{array} \right]$

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

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

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

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 Rosenber (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 (30c), *By me, myself was hurt, is excluded by the condition that a reflexive must be dominated by X or PP. Hence it is not a counter-example 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. $\left\{ \begin{array}{l} \text{the statue stood on Cambridge Common} \\ \text{the cat lay on the couch} \end{array} \right\}$
 ?*What happened was that
 b. $\left\{ \begin{array}{l} \text{the circle surrounded the dot} \\ \text{the cat stayed on the couch} \\ \text{Stanley remained in Africa} \end{array} \right\}$.

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.
 [GO (THE TRAIN, DETROIT, CINCINNATI)]
 [POSIT]
 (22) a'. Harry gave the book to the library.
 [GO (THE BOOK, HARRY, THE LIBRARY)]
 [POSS]
 (4) a'. Max is in Africa.
 [BE (MAX, AFRICA)]
 [POSIT]
 (23) a'. The book belonged to the library.
 [BE (THE BOOK, THE LIBRARY)]
 [POSS]
 (17) a'. The bacteria stayed in his body.
 [STAY (THE BACTERIA, HIS BODY)]
 [POSIT]

- (24) a'. The library kept the book.
 [STAY (THE BOOK, THE LIBRARY)]
 [POSS]

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 GO_{Ident}(...).

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 motion and punctual sentences; *what happened was that* may be prefixed only to (25) and (27), the motion 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. GO_{Ident}(THE COACH, A [MAN
HANDSOME], A PUMPKIN)
 YOUNG
- b. GO_{Ident}(THE METAL, γ, RED)
- c. GO_{Ident}(THE METAL, SOLID, LIQUID)
- (26)' a. BE_{Ident}(THE COACH, A PUMPKIN)
- b. BE_{Ident}(THE METAL, RED)
- c. BE_{Ident}(THE PUMPKIN, TASTY)
- (27)' a. STAY_{Ident}(THE POOR COACH, A PUMPKIN)
- b. STAY_{Ident}(THE METAL, RED)
- c. STAY_{Ident}(THE REDNESS, {EXISTENT
PERCEIVABLE})

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)
$$\left[\begin{array}{l} /melt/ \\ + V \\ + [NP^1 \text{---}] \\ GO_{Ident}(NP^1, SOLID, LIQUID) \end{array} \right]$$

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 saxophone 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 $\left\{ \begin{array}{l} \text{made the rock} \\ \text{caused the rock to} \end{array} \right\}$ 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_{Pass} (THE MONEY, y , DICK)
 b. Dick acquired the money.
 CAUSE (DICK, GO_{Pass} (THE MONEY, y , DICK))
 c. Dick accepted the money.
 LET (DICK, GO_{Pass} (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}} (THE BIRD, THE CAGE))
 {BE_{Posit}}

- (41) a. Noga stayed sick.
 STAY_{Ident} (NOGA, SICK)
 b. Henry kept Noga sick.
 CAUSE (HENRY, STAY_{Ident} (NOGA, SICK))
 c. Henry left Noga sick.
 LET (HENRY, {STAY_{Ident}} (NOGA, SICK))
 BE_{Ident}

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.⁹

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).

⁹ 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)
$$\left[\begin{array}{l} /open/ \\ +V \\ + \left[\begin{array}{l} \{NP^1\} \\ \{NP^2\} \end{array} \right] - NP^3 \\ \left[\begin{array}{l} CAUSE (NP^1, GO_{\text{Pstts}} (NP^3, Y, OPEN)) \\ Inst: NP^2 \end{array} \right] \end{array} \right]$$

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

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) LET (DAVID, GO_{Post} (THE BIRD, THE CAGE, z))
 Means: [CAUSE (DAVID, GO_{Post} (THE CAGE, y, OPEN))]
 [Inst: A COAT HANGER]

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) [/re = lēs/
 + V
 + [NP¹ — NP² (from NP³) ({ to } NP⁴) (with NP⁵)]
 [LET (NP¹, GO_{Post} (NP², NP³, NP⁴)
 Means: [CAUSE (NP¹, GO_{Post} (NP³, y, OPEN))]
 [Inst: NP⁵]]]]

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 { in (to) } the room.
 b. David allowed Laura { in } the room.
 { out of }

(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 nonnominal 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_{Post} (LAURA, y, { INTO } THE ROOM))
 b. LET (DAVID, BE_{Post} (LAURA, { IN } THE ROOM))
 { OUT OF }

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_{Event} (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_{Event} (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_{Event} ...) 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.

