Compositionality in Formal Semantics
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Chapter 7

Compositionality

7.1 The Principle and its Theory-relativity

7.1.1 Introduction

The compositionality principle, in its most general form, can be expressed as follows:

> The meaning of an expression is a function of the meanings of its parts and of the way they are syntactically combined.

The principle is usually attributed to Frege, and is often called "Frege's principle" (but cf. Janssen 1983 for some problems with this attribution). In its most general form, the principle is nearly uncontroversial; some version of it would appear to be an essential part of any account of how meanings are assigned to novel sentences.

But the principle can be made precise only in conjunction with an explicit theory of meaning and of syntax, together with a fuller specification of what is required by the relation "is a function of". If the syntax is sufficiently unconstrained and meanings are sufficiently rich, there seems no doubt that natural languages can be described compositionally. Challenges to the principle generally involve either explicit or implicit arguments to the effect that it conflicts with other well-motivated constraints on syntax and/or on the mapping from syntax to meaning. Ultimately the question of how strong a form of the principle can reasonably be maintained is a matter of overall theory comparison, so we cannot expect it to be settled very soon or easily.

I have several goals in this chapter. One is to emphasize how many versions of the principle there can be, since I think some arguments about it are clouded by assumptions that it is more clearcut than it is (or that compositionality equals Montague's theory of grammar). The second is to examine a number of

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challenges to various forms of the principle from both broad and narrow perspectives, trying to sort out what real arguments there may be for doubting the principle, particularly Montague's strong version of it. And finally I want to explore some questions about context-dependency, ambiguity, and "invisible variables" that I don't know how to resolve but which have potentially important consequences for how strong a version of the compositionality principle we can reasonably expect to maintain.

7.1.2 Versions of the principle

Given the extreme theory-dependence of the compositionality principle and the diversity of existing (pieces of) theories, it would be hopeless to try to enumerate all its possible versions. In what follows, I will be focusing mainly on the following kinds of differences (not exhaustive): (1) in the nature of "meanings": model-theoretic objects or linguistic representations of some sort? Intensions? Functions from contexts (what are those? do they include assignments to free variables?) to intensions? (2) in assumptions about the syntax: must it be "independently motivated?" or is compositionality itself one of the constraints? Is the relevant part-whole relation "configurational" or "derivational" ("rule-by-rule")? (Cf. Bach 1976.) What kinds of abstractness and invisibilia are allowed? (3) in the construal of "is a function of": how locally must compositionality hold? What kinds of functions are allowed, and are there constraints on what kinds of functions interpret what kinds of syntactic combinations? (Cf. Partee 1979a, 1979b; Landman and Moerdijk 1983; Sag and Klein 1982.) Is compositionality necessarily purely "bottom-up"? Must the functions be single-valued, and if so, how are ambiguity and context-dependence allowed for? Does functionality preclude non-dispensable intermediate levels of representation?

This is just a sample of the kinds of questions to which different answers yield different versions of the principle. In the following section we will review some of Montague's answers, and then turn to considering alternatives and challenges.

7.1.3 Montague's "universal grammar"

An explicit version of the compositionality principle which has fueled a lot of subsequent research is that embodied in Montague (1970) ("UG"; expositions can be found in Halvorsen and Ladusaw 1979, Link 1979, and Dowty, Wall, and Peters 1981, ch. 8.) A brief review will summarize what I will subsequently refer to as "Montague's strong version of the compositionality principle", or MCP.

(1) Meanings can be anything you like, as long as they form an algebra homomorphic to the syntactic algebra. ("Intermediate levels" must therefore be in principle dispensable.[1]) For the more restricted notion of "Fregean

interpretations" (part of the "theory of reference" for Montague), meanings are functions from possible worlds *and context of use* to possible denotations based on the familiar typed domains with primitive types *e* and *t*. (2) The syntax is given as an algebraic characterization of a disambiguated language plus an "ambiguating relation", with no constraints on the substance of the syntactic operations. The compositionality principle is a fundamental constraint on grammar construction; Montague was not interested in syntax "except as a preliminary to semantics", and believed that syntactic evidence alone was unlikely to determine a unique syntax. (UG, the (in)famous footnote 2.) The relevant part–whole relation is given by the syntactic derivation in the syntax of the disambiguated language ("rule-by-rule interpretation"). "Parts" must be "immediate parts" (derivationally), but they need not be "visible parts" of the resulting expression – the syntactic operations can delete or replace things, and the ambiguating relation can effect further deletions after the derivation of an expression in the disambiguated language is complete. (3) "is a function of" is interpreted as the requirement of a homomorphism from the syntactic algebra to the semantic algebra. There are no further constraints on the nature of this function. Interpretation is purely "bottom-up". Ambiguity arises only via the ambiguating relation; there is no ambiguity within the disambiguated language. Context-dependence is treated entirely as indexicality and built into the notion of meanings as functions from possible worlds *and context of use*; there is no provision for dependence on context effects between parts of a single sentence.

Since the issue of compositionality *vis-à-vis* context-dependence is a major concern in this chapter, I will quote what Montague said about it in UG:

> Thus *meanings* are functions of two arguments – a possible world and a context of use. The second argument is introduced in order to permit a treatment, in the manner of [Montague (1968)], of such indexical locutions as demonstratives, first- and second-person singular pronouns, and free variables (which are treated in Section 6 below as a kind of demonstrative). *Senses* on the other hand . . . are functions of only one argument, regarded as a possible world. The intuitive distinction is this: meanings are those entities that serve as interpretations of expressions (and hence, if the interpretation of a compound is always to be a function of the interpretations of its components, cannot be identified with functions of possible worlds alone), while senses are those intensional entities that are sometimes *denoted* by expressions. No such distinction was necessary in [Frege (1892)], because there consideration of indexical locutions was deliberately avoided. (UG, p. 228)

It is clear from this passage that Montague took compositionality as a guiding principle in determining what sorts of things meanings should be and not as an independently falsifiable claim. Janssen (1983) gives a number of detailed illustrations of how *prima facie* challenges to the compositionality principle can be met by suitably enriching the entities that are to serve as meanings, following the methodological principle articulated by Montague in the passage just quoted.

7.1.4 Theoretical alternatives

In some approaches to semantics, meanings are identified with expressions of some sort – "semantic representations" (Katz and Fodor 1963; Katz 1972; Jackendoff 1972) or "logical forms".[2] The compositionality principle can still be formulated for such systems, but it then becomes a much more syntactic notion, basically a constraint on the translation rules which map syntactic representations on to semantic ones. It is difficult to compare such systems straightforwardly with model-theoretic semantics, although one can probably say that Jackendoff's theory was less locally compositional (given that some parts of semantic interpretation were to be determined at deep structure, others at surface structure) than that of Fodor and Katz (an early model of "rule-by-rule" interpretation). It seems to me that one of the biggest open issues in semantics is the status of a possible linguistic level of semantic representation of some sort; Montague's theory allows such a level but requires that it be in principle dispensable, but one serious alternative is to posit an intermediate level of representation such that its own semantics is compositional (which might justify calling it "logical form") while the rules mapping syntactic representations on to it are not compositional or only weakly so – or vice versa.[3]

Even within the tradition of Montague grammar not all analyses have adhered to MCP. Cooper (1975) proposed the mechanism now known as "Cooper storage" as a means of generating multiple interpretations, differing with respect to quantifier scope, corresponding to a single syntactic structure; Bach and Partee (1980), extending Cooper's mechanism still further, suggested that a limited weakening of the compositionality constraint was a reasonable tradeoff for the strong syntactic constraints of a phrase structure grammar obeying the well-formedness constraint (Partee 1979a). Landman and Moerdijk (1983) have shown how results corresponding to those of Bach and Partee can be achieved in a system which preserves MCP but reinstates quantifying-in rules in the syntax; one of the major points at issue is the need for a level of translation or "logical form", particularly with respect to the indexing of pronouns – if quantifier scope and pronoun indexing are not represented in the syntax, then it appears that an additional level is needed where they are represented. It appears then that MCP is closely bound up with the possibility (and desirability) of giving a direct model-theoretic interpretation for natural languages.[4] This is a crucial issue, but one for which I have no resolution to offer. It will recur at various points below, and is likely to be a major issue for some time to come.

7.2 Broad Challenges to Montague's Version of Compositionality

In addition to the fact that not all current theoretical approaches to syntax and semantics are as strictly compositional as Montague's, there have been a number

of explicit challenges to MCP. In this section I will discuss some which involve challenges to Montague's whole framework.

Chomsky's skepticism towards the compositionality principle, expressed in Chomsky (1975) and elsewhere, seems to stem from two convictions: the "autonomy of syntax" thesis and the idea that the organization of grammar is best viewed as involving a number of relatively independent subsystems, each with its own principles and constraints, which interact to jointly constrain the final output – a view of grammar very different from Montague's, which when extended to phonology as in Bach and Wheeler (1981) presents a grammar as a simultaneous recursive definition of well-formed, phonologically and semantically interpreted, expressions of the language – starting from the smallest units and building up larger ones with phonological, syntactic, and semantic rules working hand in hand to construct and interpret complex expressions compositionally from their parts. Filters, for example, play a large role in Chomsky's theories but have virtually no place in Montague's: given the requirement of a homomorphism from the syntax to the semantics, if an expression is generated by the syntax, it must be interpretable by the semantics.[5] The "autonomy of syntax" thesis is a complex issue which I have discussed elsewhere (Partee 1975b); at the level of description, Montague's theory does include an autonomous syntax. But if the thesis is taken to assert that the syntax of a language should be learnable in isolation from the semantics, then while Montague's theory takes no direct stand on the question, MCP makes such a thesis quite implausible. In a compositionally organized grammar any information about either syntax or semantics would provide some evidence about the other, and an optimal learning mechanism would presumably exploit all available evidence. These tenets of Chomsky's are, like the compositionality principle itself, too global to be straightforwardly evaluated; and the resulting theories differ in too many ways for grammars constructed within them to be directly comparable. As Landman and Moerdijk (1983) point out, Chomsky's particular arguments against compositionality (as in Chomsky 1975) consist of non-compositional analyses of certain phenomena, and while such cases can provide valuable challenges (which may reasonably sway opinions if unmet), they neither settle the issue nor provide an alternative account of what the limits are on the relation of semantics to syntax.

Bresnan's Lexical-functional Grammar (Bresnan 1978; Kaplan and Bresnan 1982) provides challenges to compositionality which are in a sense more interesting because the theories are more nearly comparable. From the perspective of Montague grammar, her arguments for the level of functional structure can be seen as arguments against direct model-theoretic interpretation of syntactic structure and for the value of an intermediate level of representation. Halvorsen (1983) has provided rules for mapping Bresnan's functional structures onto formulas of intensional logic, making the system model-theoretically interpretable; but since the functional structures are apparently not homomorphically related to either the syntactic algebra or the model-theoretic interpretation, the resulting system violates MCP.

Of particular interest is Bresnan's treatment of idioms and dummy *there*, and their interaction with passives, Raising structures, and the like. On her treatment, an NP which is part of an idiom, such as *tabs* in *keep tabs on*, has no meaning of its own; only the complete idiom has a meaning. Within the Montague framework the fact that such "meaningless" elements appear as NPs presents a problem, since they then should have NP-type meanings, at least if they are independently generated in their surface positions. It is possible to maintain compositionality for such cases by providing special meanings for the "meaningless" pieces (see Sag 1982; Sag and Klein 1982). But one should also consider the possibility that a less compositional but more natural treatment (analogous to Bresnan's) might be achieved in a Montague grammar with a non-dispensable level of translation containing "dummy constants" with no fixed interpretations of their own but subject to meaning postulates specifying the meanings of the relevant larger units that contain them.

Another sort of challenge to MCP concerns "bottom-up" vs. "top-down" interpretations; this is discussed in Hintikka (1980) (as "inside-out" vs. "outside-in") and arises also in connection with recent work of Kamp (1981) and Heim (1982) as well as some of the proposals of Barwise and Perry. Kamp and Heim both provide explicit treatments of syntax as well as semantics, so I will focus on where their theories depart from Montague's. Simplifying considerably and selecting a single feature for comparison, both of their theories (let me call them jointly in this respect the K–H theory) introduce an intermediate level of representation ("discourse representations" (Kamp) or "file cards" (Heim)) such that occurrences of certain kinds of noun phrases in the syntactic structure affect global properties of the intermediate representations. Indefinite noun phrases, for instance, are interpreted "in the long run" as existentially quantified, but what the scope of the existential quantifier is is not determined locally, "bottom-up" but by properties of the larger configuration in which the corresponding variable ("discourse referent") appears at the intermediate level; the scope may end up over a whole discourse, and in the case of the treatment of "donkey-sentences", the operation of the rules for determining the truth-conditions for intermediate representations do not yield a standard "scope" interpretation at all (although they are well-defined). In the K–H theory, *every* and *if* are more alike than *every* and *a*; not only does this depart from Montague's category-to-type correspondences, but the *if* in effect introduces an "unselective" or variably polyadic universal quantifier which binds everything which occurs within a certain configuration at the intermediate level; what this configuration will be is not a simple function of the syntactic structure, but depends as well on what sorts of noun phrases occur within the *if*-clause (*a*-type or *every*-type). The fact that these treatments do not conform to MCP does not prove, of course, that no MCP-compatible treatment is possible; but the novel solution to the *donkey*-sentence problem provided in the new frameworks does not appear to be expressible in a pure Montague grammar and it poses a serious challenge to the thesis of direct compositional model-theoretic interpretability, since it seems (to me at least) to be superior to any of the

many analyses of *donkey*-sentences proposed within Montague's (or any other) framework.[6]

7.3 Context-dependence, Ambiguity, and Challenges to Local, Deterministic Compositionality

In addition to challenges to compositionality which concern Montague's whole framework, there have also been many challenges directed more specifically at the combination of strict rule-by-rule ("bottom-up") compositionality with particular views about the optimal syntactic treatment of various constructions.

7.3.1 Cases which can be treated as ambiguity resolution by selection

7.3.1.1 *Generic vs. non-generic interpretation of NPs* Before the work of Carlson (1980) it was frequently held that "genericness" was a property of whole sentences, and that the interpretation of a noun phrase as generic or not might be dependent on the interpretation of other parts of the sentence, as would seem to be the case for *the horse* in sentence (1)–(3) below. In (1) we must interpret *the horse* generically, in (2) non-generically, and (3) is ambiguous since either a whole species or an individual can grow stronger. But in the light of Carlson's work we can see this straightforwardly as ambiguity resolution by selection, i.e. as a result of the incompatibility of an individual-level subject with a kind-level predicate or vice versa.

(1) The horse is widespread

(2) The horse is in the barn

(3) The horse is growing stronger

The noun phrase *the horse* can be viewed as having two interpretations;[7] the fact that a sentence can contain a mixture of generic and non-generic NPs, as in one interpretation of (4), shows that genericness cannot be reasonably regarded as a sentence-wide property, and the ambiguity of (3) and (4) shows that the posited NP ambiguity is indeed attested.

(4) The teacher was explaining the diesel engine

This case illustrates a general methodological point: apparent counter-examples to bottom-up compositionality that are claimed to involve determination of meaning of parts by other parts (where the latter are not subparts of the former) can often be analyzed as cases of local ambiguity, with incompatibilities between certain local choices reducing the ambiguity of the containing whole. The next two cases are similar.

7.3.1.2 *Dependent plurals* Chomsky (1975) offered an argument against bottom-up compositionality on the basis of examples like (5) and (6), where the number of the subject seems to affect the interpretation of the plural object *wheels*.

(5) This unicycle has wheels

(6) Unicycles have wheels

De Mey (1981 and elsewhere) has done extensive study of the phenomenon of "dependent plurals" exhibited in (6), and his work supports the view that there are distinct interpretations of bare plurals involved in the two sentences; the "dependent" one, as its name suggests, can only occur within the scope of an appropriate quantifier phrase such as a plural noun phrase or frequency adverb. Again a compositional approach invoking ambiguity resolution seems to be leading to success, and I know of no comparably successful "top-down" analysis along the lines originally suggested by Chomsky.[8]

7.3.1.3 *Any* While the behavior of the word *any* has been a puzzle for linguists regardless of theoretical persuasion for years, it seemed to pose a particular problem for the compositionality principle because of its apparent sentence-internal context-sensitivity. Sentence (8) has two meanings, only one of which appears to come from sentence (7). (That this is not just a scope effect can be seen by substituting "nearly anyone" for "anyone" in (7) and (8); only one reading remains in (8).) And sentence (9) seems to have no coherent meaning on its own, but occurs as part of sentence (10), which is fine (and unambiguous).

(7) Anyone can solve that problem

(8) If anyone can solve that problem, I suppose John can

(9) #Anyone got the answer right

(10) If anyone got the answer right, I suppose John did

While important mysteries and controversies about *any* remain, great progress has been made in the last few years through the work of Fauconnier (1975), Ladusaw (1979), and Carlson (1981). At this point it appears that there are strong arguments for two distinct *any*s, 'affective' *any* and 'free-choice' *any*, with distinct (though overlapping) constraints on the contexts in which their semantic contributions "make sense"; the constraints on affective *any* can be described elegantly in model-theoretic terms (Ladusaw 1979), while those on free-choice *any* are less clearly understood and may be partly pragmatic. The examples in (7)–(10) can therefore be justifiably viewed as involving an

ambiguous *any*, with one or both readings eliminated by incompatibility with the surrounding context.

7.3.2 Further challenges to strictly "bottom-up" compositionality

7.3.2.1 *Keenan's functional principle* Keenan (1974) enunciates the interesting claim that the (form and) interpretation of a function word may depend on the (form and) interpretation of its argument but not vice versa, and uses the principle to help explain a wide range of phenomena. Intuitively the claim seems correct; where function-argument structure is uncontroversial,[9] we find many examples of the sort Keenan discusses. In adjective-noun constructions, where the adjective is generally agreed to be the function word, we find the contrast noted by Quine (1960) between *red apple* (red on the outside) and *pink grapefruit* (pink on the inside), and between the different colors denoted by *red* in *red apple* and *red hair*; Keenan points out cases like *flat tire*, *flat beer*, *flat note*, etc. The interpretation of the nouns in these constructions stays constant, while that of the adjective appears to shift in a context-sensitive way. Even more extreme cases are prepositions and versatile minimal-content verbs like *make*, *do*, and *take*.

But there is a natural explanation of the phenomenon consistent with MCP. As Keenan notes, mathematical functions are often defined disjunctively in the manner illustrated in (11), where the P_i are mutually exclusive properties of possible arguments of the function *f*.

(11)
$$f(x) = \begin{cases} \ldots \text{ if } P_1\ (x) \\ \ldots \text{ if } P_2\ (x) \\ \ldots \\ \ldots \text{ otherwise} \end{cases}$$

What the function *does* to its argument depends on the argument, all right, but that's inherent in the notion of a function. The interpretation of the function symbol *f* in such a case does *not* vary with the argument; it is given by the whole of (11). Similarly we could imagine a description of the meaning of an adjective like *flat* or of a preposition like *to* displayed in a form like (11); that would show how the value obtained by applying the function to its argument varies with the argument, but would not show that the function word has different meanings with different arguments. Dependence of a function on its argument in this sense is perfectly compatible with the independent interpretability of function-expressions and argument-expressions required by compositionality.

7.3.2.2 *Things "in the wrong place"* I will close this subsection with two examples that pose problems for a compositional semantics combined with a highly constrained "surfacy" syntax.

Bolinger (1967) noted the problem raised for compositionality by sentences like (12), where *occasional* appears within the NP but has the effect of a frequency adverbial.

(12) An occasional sailor walked by

(Cases like this, it should be noted, are a problem for any theory, since abandoning compositionality does not immediately lead to an alternative account of how the sentence does get its interpretation.) Stump (1981a) provides a compositional treatment which seems as elegant as the facts allow; it requires an additional *a(n)*, but the restricted distribution of such constructions supports the analysis.

If direct generation of surface structures by context-free rules is pushed to the limit, phonology and morphology pose some serious problems for compositionality. Consider phrase (13).

(13) The king of England's daughter

Phonologically, *'s* is part of the word *England's*, and *England's can* occur as a syntactic and semantic constituent; but in (13) it does not – the suffix belongs with the whole NP *the king of England*. Similar examples abound in other languages; see Carlson (1983), Bach (1983), and Landman and Moerdijk (1983) for a discussion of a number of such cases and their implications for compositionality.

All the authors mentioned above call attention to the importance of a theory of explicit feature-percolation mechanisms that allow features on higher-level phrasal nodes to have their semantic effect take place at that level but their "instantiation" realized in such various ways as affixes on words within the phrase, word order effects, intonation contours, etc. These works suggest that such constructions pose no great problems for local rule-by-rule compositionality unless one tries in addition to constrain the syntax to pure context-free phrase structure rules "all the way down" to the level of inflectional morphology. It will be important for further research to try to determine more precisely the constraints on the additional mechanisms needed for such cases; the works cited are important steps in this direction.

7.3.3 Challenges to the determinacy thesis

What Hintikka (1980) calls the determinacy thesis is the thesis that it is *only* the meanings of the parts and their syntactic mode of combination that matter. There are a number of cases that cast doubt on it.

7.3.3.1 *Constructions with variable "extra meanings"* Frege in "On Sense and Reference" claimed that non-restrictive relative clause constructions often ended

up with components of meaning that could not be traced to any of their parts nor to the construction itself – added meanings such as "because", "in spite of", etc., as in his well-known example (16).

(16) Napoleon, who recognized the danger to his right flank, himself led his guards against the enemy position

In hindsight it is quite easy to see this as a typical case of Gricean conversational implicature; the "added meaning", easily cancellable by an explicit addition to the sentence, can be generated by the maxim of relevance and need not be considered part of the literal meaning of the sentence.

An intricate case of apparent extra meaning neither directly attributable to overt expressions nor easily explained away by Gricean means is the analysis of free adjuncts and absolutes in Stump (1981b). Examples of free adjunct constructions are (14) and (15) (Stump's (26a) and (26b), p. 70).

(14) Being a master of disguise, Bill would fool anyone

(15) Wearing his new outfit, Bill would fool anyone

(Free absolutes are similar but with overt subjects in the preposed phrase; the difference between absolutes and adjuncts is irrelevant to the present discussion.) In (14) the adjunct is understood as outside the scope of the *would* in the main clause, in (15) as inside. (Cases like (15) show that a uniform "and" meaning plus Gricean implicature could not explain the full range and distribution of available readings.)

Stump reduces the bewildering array of apparent semantic indeterminacy of such cases to basically just two discrete constructions, one of which makes the adjunct an argument to a propositional relation expressed overtly in the main clause, the other of which introduces a free higher-order variable over such relations (relations like *because*, *although*, *after*). Stump shows that the different scope possibilities are determined by whether the predicate in the adjunct phrase is "stage-level" or "individual-level" in the sense of Carlson (1980). In the case of (14), the syntactic construction introduces a free variable over propositional relations (plus an operator making the relation factive for both arguments); the choice of a particular value is argued not to be a matter of grammar *per se* (although there are possibly conventional "unmarked cases" and something like "attendant circumstances" is common to most of the normal choices), but depends heavily on inferences that can be drawn from the content of the adjunct and the main clause – this part of the account does have a Gricean flavor.[10] In the case of (15), the adjunct serves as an argument to a propositional relation introduced in the interpretation of the main clause (in connection with *would*; other main clause elements besides modals that can introduce such variables are frequency adverbs and the generic simple present).

Is a compositional semantics which introduces free variables still compositional? Montague, in the passage cited earlier, clearly allowed the possibility:

he took meanings to be functions from both possible worlds and contexts of use (to denotations of appropriate types), with the idea that contexts of use could supply the values for free variables as well as for straightforward indexicals like *I* and *this*. In the case of interpreting non-anaphoric third person pronouns as (expressions containing) free variables, it seems reasonable to think of the context as supplying a value – if a speaker uses a non-anaphoric *he* or *she*, he or she must be able to presuppose that the hearer is already able to identify an appropriate referent, typically someone perceptually salient or mentally salient as a result of past conversation or of shared interests. But are Stump's variables the same kind of case? When we hear (14), even in isolation, we will all probably interpret the propositional relation variable as *because*; the only context we need is the sentence itself. (And having just had a *because* in prior discourse probably would make it only marginally more likely that a subsequent sentence with a free adjunct would be understood to express a *because* relation.)

I can see two ways of evaluating this situation, and I expect the preference for one view or the other will be strongly influenced by one's antecedent attitude toward the compositionality principle.

One possible conclusion is that while Stump's analysis is technically compatible with MCP, it nevertheless provides an argument against it. On Stump's analysis, a sentence like (14) has no truth conditions at all without a value for the free variable over propositional relations; the relevant relation is an essential part of the assertion.[11] But the understood value, most likely *because* in the case of (14), is not determined by any antecedently available context in the manner of indexicals, but from inferences drawn from the content of the two parts of the construction (plus context, including general knowledge). So it would appear that a crucial part of the truth-conditional meaning of the free-adjunct plus main-clause construction is *not* determined directly from the meanings of the immediate parts plus the rule by which they are combined, nor directly by the context, but by carrying out inferences from the content of the parts plus other premises available in the context in order to arrive at a most plausible relevant value for the free variable.

The other possible response is that Stump's analysis is perfectly compositional, and that the interpretation of the crucial variable is not as different from pronoun interpretation as it seems. Prior context does not by itself always determine a most likely referent for a *he* or *she*; the content of the sentence in which it occurs may be instrumental in choosing among a number of potentially available values. Consider a situation in which one spouse comes home at the end of a day, not having seen the other spouse since morning, and opens a conversation with one of (16a–d).

(16)a. Did she get her report card today?
b. She still won't give me a raise
c. Did she call and say when she's arriving?
d. Oh, I see she brought my banjo back

It is not hard to imagine a situation in which any of (16a–d) could be understood unambiguously by the second spouse, with a different value for *she* in each case. Between frequent conversational partners there will generally be a large but finite number of "she's" potentially salient without immediate perceptual or linguistic context, and the rest of the content of an isolated sentence may make one of those the unique most relevant value for the pronoun in that sentence, just as sentence content contributes to ambiguity resolution. All we need to assume to see the Stump cases this way is that there are only a finite number of potential values for the proposition-relation variable. This assumption may be disputable, but I see no argument against it in Stump's work, and the traditional grammarians he cites who studied the construction all attributed to it a discrete number of semantic roles, ranging from three to eight, with fairly high agreement as to what the possibilities were. If it is indeed the case that English speakers share a limited inventory of available values for the relation variable, then it is fair to say that the context (or background knowledge) does provide the salient values (namely at most all of the possible values), and the role of inference is one of selection or disambiguation, just as in the case of pronouns discussed above.[12]

7.3.3.2 *Compounds* Compounds like *milk truck*, *fire engine*, *pony cart* seem notoriously non-compositional. But if we assume that compounding is a lexical process, and follow Dowty (1979) in regarding lexical rules as rules for extending the language by adding new basic expressions, then a natural approach is to assume that the compounding rule involves a free variable, as indicated in (17), where "BCN" stands for "basic common noun".

(17)a. $[\mathrm{BCN}_1\ \mathrm{BCN}_2]_{\mathrm{BCN}}$
b. $\lambda x[\mathrm{BCN}_2'(x) \wedge {}^{\vee}\Re(^{\wedge}\mathrm{BCN}_1')(x)]$

On this approach the interpretation of a novel compound would contain a free variable, whose possible values would depend on context and plausibility. As in the case of other lexical rules, frequent use could lead to a particular compound's entering the lexicon with a fixed relation in place of the variable $\Re$, and subsequent semantic shift could lead to a compound's coming to have a meaning in conflict with the predictions of the rule (e.g. a *bookworm* is normally not a worm but a person; an *ashtray* is not a tray).

Moortgat (1983) investigates the semantics of "synthetic compounds" like *price increase*, *mountain climber*, *tax evasion* in Dutch and German; he offers an interesting lexical-rule analysis in which the first noun is interpreted as a generalized quantifier (by introducing a free variable over an appropriate subclass of determiner meanings) which is quantified into a free argument position contained in the interpretation of the head noun. This suggests a dualism in the interpretation of compounds similar to the dualism in Stump's analysis of adjuncts: if the head of the construction is interpreted as a relation (or contains a free "argument-variable"), the non-head constituent is interpreted

as its argument; otherwise, a free context-dependent higher-order relation variable is added as part of the interpretation of the construction. There are differences between Stump's and Moortgat's proposals which are glossed over in this formulation of the parallels between them, but the similarity is striking, and extends also to the interpretation of genitives discussed briefly in the following section.

7.3.3.3 *Genitives* The analysis of genitives in English poses a challenge to MCP when we consider a range of cases as in (18)–(20).

(18)a. John's team
b. That team is John's

(19)a. John's brother
b. (*)That brother is John's

(20)a. John's favorite movie
b. (*)That favorite movie is John's

Without going into details,[13] we can formulate the basic problem as follows. One can provide a compositional analysis of these examples by making a syntactic and semantic distinction between one-place common noun phrases (CNs) and relational, or "transitive" common noun phrases (TCNs). When a genitive determiner combines with a TCN, as in (19a) and (20a), the genitive is interpreted as an argument of the TCN function; when it combines with a simple CN, as in (18a), the interpretation rule introduces a free relation variable, to be evaluated as a contextually salient relevant relation. The "free relation" interpretation is the only one available for predicative genitives, which accounts for the contrast between (18b) and (19b), (20b). The disadvantage of such an analysis is that it increases lexical and syntactic ambiguity considerably; ordinary CN/CN adjectives must all be given TCN/TCN homonyms, most relational nouns are only optionally so (*portrait*, *teacher*, etc.), and the genitive construction itself would have to be split into two separate constructions accidentally looking alike in a great many languages.[14] As far as I can see, the only possible syntactic argument for multiplying categories and constructions in this way is the deviance of examples like (19b) and (20b), deviance which could, I believe, just as easily be regarded as purely semantic. It would seem that there is a tradeoff relation here between compositionality and syntactic ambiguity; the genitive construction could be treated as syntactically uniform and the TCN category eliminated if the semantic interpretation rule were allowed to be stated in such a way that its outcome would be ambiguous if the genitive was in construction with a common noun phrase that was optionally relational.[15]

I have only scratched the surface of the complexities of the genitive construction here, and have not touched at all on the similar problems that arise

with the main verb *have*[16] (as in *John has a sister* vs. *John has a car*). I intend to explore these issues further in a subsequent paper. One conclusion seems firm: the interpretation of genitive constructions at least sometimes introduces a free higher-order variable as "semantic glue" between its parts, just as in one of Stump's two subcases of free adjunct constructions and in one of Moortgat's rules for lexical compounds. And in all three cases, the meaning of the whole is not determinate without a value for the variable, nor need there be a most salient value for the variable "already" in the context. These analyses satisfy MCP, but this use of free variables may be pinpointing places at which compositionality as it is commonly understood is indeed best viewed as not fully deterministic. The further open problem that remains for all three of these construction types (adjuncts, compounds, and genitives) is either to unify what have been treated as pairs of constructions with and without a free higher-order variable, or to explain why and predict when such constructions should occur in homonymous pairs.

7.4 Implicit Arguments and Invisible Variables

7.4.1 Issues

Predicates of various categories are sometimes understood as having implicitly on some level more arguments than appear on the surface. The analysis of such cases raises both descriptive and theoretical problems that bear on the compositionality thesis.

7.4.2 At what level(s) are implicit arguments present?

The principle of compositionality would be most easily satisfied if implicit arguments were present at both a syntactic and semantic level or at neither. The first option requires syntactic deletion rules (as in early transformational treatments of subjectless imperatives and agentless passives), which have been steadily losing favor on grounds of both descriptive and theoretical arguments. The second option, not representing the "understood" arguments in either the syntax or the semantics in any overt way, is exemplified by Montague's treatment of infinitives as (subjectless) VPs on both the syntactic and semantic level, contrasting with treatments like those of Bresnan (1982) and Gazdar (1982), which treat infinitives as VPs syntactically but provide an explicit subject argument for them in the semantics. The latter typifies a third option, representing understood arguments in the semantics but not in the syntax; this alternative, while it may be carried out compositionally, suggests a mismatch between syntax and semantics which one would not want to impute to a natural language without good reason. The reasons for doing so often turn on the apparent interaction of the "missing" argument with other elements in the

sentence, as with the involvement of the understood subject of controlled infinitives with the distribution of reflexive and non-reflexive pronouns.[17]

We then have three possible answers to the question of where to represent understood arguments: (a) in both the syntax and the semantics; (b) in the semantics but not in the syntax; and (c) in neither. As option (a) recedes in attractiveness, it becomes important to articulate principles concerning (b) and (c) and the choice between them. If (b) is to continue as an available option, the natural questions to raise concern constraints on the introduction of semantic constituents that do not correspond directly to syntactic ones. Do they enter only via the lexicon, only via the interpretation of syntactic rules, or in both ways? One example of a general principle of this sort was proposed by Gazdar (1982): a parenthesized constituent in a phrase structure rule, if not chosen, is always to be interpreted as an existentially quantified variable of the appropriate type.[18]

As for option (c), representing understood arguments in neither the syntax nor the semantics, this would seem the most attractive for combining a tightly constrained syntax with a compositional semantics limited to a constrained inventory of kinds of interpretation rules.[19] What is needed on this approach are (i) an account of the basis for intuitions that there *is* an understood argument – presumably to be derivable from a substantive theory of lexical meaning –, and (ii) a means for explaining the apparent interaction of implicit arguments with explicit parts of the interpretation, e.g. if the implicit argument acts like a bindable variable (see cases in section 7.4.3 below).

Among the kinds of interpretations that have been proposed in the literature for implicit arguments, the three that I want to focus on are (i) existentially quantified variables (7.4.3), (ii) deictics or indexicals[20] (7.4.4), and (iii) bindable variables (7.4.5).

7.4.3 Existential quantifier vs. indexical or free variable

How should we represent the "understood agent" in (21)?

(21) John was killed

Intuitively it has generally been agreed to be an existentially quantified variable; arguments have emerged which reinforce this view and show that furthermore the existential quantifier has maximally narrow scope relative to any other scope-bearing elements in the sentence (Partee 1975a; Dowty 1979; Fodor and Fodor 1980; Dowty 1982b). Crucial test cases include sentences with quantifiers or negation like (22) and (23):

(22) Three of John's books have been reviewed

(23) John wasn't killed

Only a narrow-scope existential gives the right truth conditions for such sentences; even if the identity of the agent may be clear from the context of an utterance of (21), (22) and (23) show that a uniform interpretation of the passive agent cannot be deictic, nor can it be a free variable left to be bound existentially by general convention at the highest sentence or discourse level.[21]

Similar arguments show a difference in the implicit arguments of relational common nouns like *father* and *enemy* when they are used as simple one-place predicates. Compare (24a–c) with (25a–c).

(24)a. John is a father
b. John isn't a father
c. Every man in this room is a father

(25)a. John is an enemy
b. John isn't an enemy
c. Every man in this room is an enemy

In (25), we understood *enemy* as enemy of some particular contextually determined person or group, often "me" or "us" (but other values could be made more salient by context), even in the presence of negation or quantifiers. Sentence (25b), for instance, does not require that there be no one John is an enemy of. In (24), however, the facts support a narrow-scope existential, as with the agentless passives. Similar contrasts with verbs have been noted, as with the contrast between *eat* (existential) and *notice* (deictic) in (26) and (27).

(26) John hasn't eaten

(27) John hasn't noticed

Interaction with other scope-bearing elements appears then to provide a fairly clear test for choosing between an existential interpretation and an indexical or variable interpretation. We turn now to the problem of distinguishing between the latter two.

7.4.4 Free variable vs. indexical

The notions "indexical" and "variable" are both highly theory-dependent notions, so it is not surprising that their application to natural language phenomena is often a matter of dispute. The paradigm indexicals are the "pure indexicals" like *I*, *here*, and *now*, whose interpretation seems best described as a function from context of utterance to a particular semantic value (see Kaplan 1977; but see also Klein 1978 for an indication of how complex the relevant parameters of context may be). Are they more like variables or more like

constants? Or do we need to rethink the foundations on which that dichotomy is based?[22] The paradigm cases where variables are invoked to explicate natural language phenomena are cases describable in terms of variable binding, cases which involve something like "coreference" between terms which are not in fact "referential" in any straightforward sense, typified by cases of pronouns with quantificational antecedents like (28a,b).

(28)a. Every man believed that he would win
b. No man believed that he would lose

In these sentences, the pronoun *he* seems to act like a bound variable and the antecedent quantifier like a variable-binder. The paradigm indexicals *I*, *here*, and *now* do not act like variables in that sense; *I* has no bound-variable uses (in English[23]), and neither does *here*, even in contexts where it could mean "place where I am", as in (29) and (30).

(29) (#) In every city I am in, I try to interview someone who has lived here all his life

(30) (#) Wherever I am, John is here too

In this respect the paradigm indexicals seem clearly more like constants than like variables; *I*, *here*, and *now* always get a *particular* value from the context of the whole utterance,[24] and are unaffected by sentence-internal quantifiers or operators.

Janssen (1981) explicitly advocates treating indexicals as constants and limiting the introduction of free variables to the translation of explicitly variable syntactic elements (like Montague's he_0, etc.); he offers both descriptive and formal arguments against viewing a variable-assignment index as part of a context of utterance.

However, there are other expressions in English that seem to share properties of indexicals and variables; the "demonstrative" *there* contrasts with the "indexical" *here* precisely in the fact that it can both receive a particular value from the utterance context, as in (31), and be used as a bound variable, as in (32).[25]

(31) You should be sitting there

(32) In every city I am in, I try to interview someone who has lived there all his life.

Similar contrasts can be seen between *I* and *he*, between *now* and *then*, and even between *I* and *we*: a bound-variable use of *we* is illustrated in (33).

(33) Everyone I play duets with seems relieved when we stop

There seem to be at least as many elements that show this dual nature as there are "pure indexicals", and probably more. This is one reason for the attraction of Montague's suggestion that contexts might be taken to include a variable assignment, so that such elements could be uniformly interpreted as variables; they may then end up either as bound variables or remain free within the sentence and receive a value from the particular variable-assignment associated with the context.

When we consider the interpretation of implicit arguments in this light, we find that those which act like variables or indexicals rather than like existentially quantified terms generally follow the pattern of *he*, *there*, and *then* rather than that of *I*, *here*, and *now*. Thus alongside the "indexical" interpretation of the implicit arguments of *enemy* and *notice* in (25) and (27) (section 7.4.3), we find corresponding bound variable interpretations in (34) and (35) below.

(34) Every man faced an enemy

(35) Every man who shaves off his beard expects at least his wife to notice.

In fact, I don't know of any cases of implicit arguments which can be interpreted *only* as bound variables or *only* as indexicals, which seems to me a further argument against frameworks which force a sharp dichotomy between the two.[26]

7.4.5 The indexical/variable problem and the "lexical source" option

In section 7.4.2 we raised the question at what level, if any, implicit arguments are to be represented explicitly, and if they are represented explicitly in the semantics, how they get there. In this section I want to point out some theoretical difficulties that appear to stand in the way of what seems to me an intuitively plausible approach to the range of phenomena considered above.

First of all let us suppose that some "missing arguments" and "invisible variables" enter the semantic interpretation explicitly via the interpretation of syntactic rules. We expect these to be regular and productive, and to share properties with the interpretation of syntactically realized constituents within and across languages. (I don't expect to find simple necessary and sufficient conditions for separating syntactic from lexical cases; cf. the continuing debate about the treatment of agentless passives, and the general discussions in Dowty 1982a, 1982b.)

Many other cases seem lexically governed, and for these we still have two options that both seem worth pursuing. One is to represent them explicitly in the semantics – e.g. translate the intransitive *notice* into (say) intensional logic

as if it were *notice* it_i (a family of translations, probably having to include "Cooper pronouns" if we stay within Montague's framework; cf. note 23). On this option one would be claiming that *notice* is always semantically transitive even when syntactically intransitive (and there may be reasons for doing so; I don't want to try to settle this issue here, but just try to clarify the options). The other option for the lexically governed cases is not to represent the missing arguments explicitly at all – e.g. translate intransitive *notice* as a single non-logical constant $notice'_2$ (distinct from $notice'_1$, the translation of transitive *notice*), and give a lexical account that makes the implicit argument *part of* the meaning of that predicate (e.g. via explicit definition or meaning postulates).

Now here is the problem. In Montague's framework and related ones, even those enriched to handle context-dependency by making meanings functions from contexts as well as indices (cf. Lewis 1980), predicate constants are interpreted very differently from variables, so that it is impossible to interpret a predicate constant as having a variable as *part of* its meaning. (In PTQ, for instance, predicate constants are interpreted by the function F which is part of the interpretation $\mathcal{A}$, variables by the entirely separate variable-assignment *g*; all formal semantic systems descended from the Tarskian tradition have a similar dichotomy, as far as I am aware.) If this is so, then the second option of the previous paragraph is not even a real option, and the first option makes the intermediate level of translation indispensable – in neither case can we give a direct model-theoretic interpretation of an intransitive *notice* that lets its "missing argument" be a bindable variable (or a context-dependent one, for that matter, if indexicals are either assimilated to variables or treated as a third class of items distinct from both variables and ordinary constants).

This is too big a problem to try to resolve here. In current frameworks, it seems that variables have to be introduced explicitly in order to be bound and that this cannot be done lexically in systems which do not recognize a separate level of logical form. But I am not happy with that assumption, and would rather see a modification of the framework that allows the interpretation of lexical items to be sensitive to context *and* variable-assignments, with "pure constants", "pure indexicals", and "pure variables" as distinguished pure-breds, but also with room for hybrids (which I expect we will find plenty of once we begin to look for them).[27]

Let me try to summarize the main point of this section with respect to the compositionality principle. It seems that many "implicitly understood" arguments share the versatility of third-person pronouns and words like *there* and *then* in being able to function as demonstratives, "donkey-pronouns", and bound variables; in at least the latter two roles they can interact with variable-binders overt in the sentence, and given the formal properties of frameworks like Montague's, this requires that they be represented explicitly in the semantic interpretation. But this requires either a mismatch between syntax and semantics (albeit one which does not violate strict compositionality in the

cases where they can be argued to be introduced via the interpretation of syntactic rules) or, in the case of introduction via particular lexical predicates, the non-dispensability of an intermediate level of translation, which does violate MCP. Since many of these cases clearly seem to be lexical, it appears that MCP is not compatible with the traditional sharp dichotomy between constants and variables. And my guess is that we'd be better off descriptively as well without the sharp dichotomy, but I do not have a revised framework to offer here.

7.5 Concluding Remarks

In this chapter I have touched on a wide range of issues surrounding the principle of compositionality. This has by no means been an exhaustive survey, since compositionality is almost as broad a topic as the question of how semantics relates to syntax. I have reviewed a number of cases where apparent challenges to compositionality have been successfully met by compositional analyses that are elegant and insightful; I've also discussed cases where what seems to me the best available account violates at least MCP. And I've raised cases for which I don't think there is any completely satisfactory solution so far, and for which I suspect that either the compositionality principle or some other basic aspects of Montague-like frameworks may need to be revised.

As for possible weakenings of MCP, there are at least two directions that seem to have serious support and plausibility, and which have recurred several times in the discussion above. One has to do with intermediate levels of representation and the other with determinacy and the role of context. Many alternatives to Montague grammar and some variants of it include one or more levels of intermediate semantic representation, sometimes disambiguated, sometimes not. It is consistent with many of the advantages that have been claimed for Montague grammar to have intermediate levels which are not dispensable, although such theories do not conform to the formally elegant constraints of Montague's "Universal Grammar". Certainly the demands for explicitness, rigor, and accountability for truth-conditions and entailment relations are not automatically violated by making the mapping from syntax to model-theoretic interpretation[28] less direct; but of course such proposals will be judged in part on their inclusion of equally general principles and constraints governing the nature of such intermediate levels and the mappings between them. The large number of plausible analyses that do conform to MCP provide at the least a yardstick for evaluating alternatives.

The other direction of weakening MCP involves very global questions about how much should be accounted for by grammar. The many cases of tradeoffs between context-dependency and ambiguity resolution discussed above seem to show pretty clearly that from the perspective of a "user" of

a grammar, there may not be much difference between grammars which leave some aspects of interpretation locally underdetermined (requiring some "construction" of appropriate meaning that fits the context) and grammars that are formally strictly compositional but posit greater syntactic ambiguity and/or introduce more free variables or invisible indexicals (requiring "selection" of appropriate readings and/or values of variables that fit the context). The advantage of maintaining compositionality in such cases may be only in a greater explicitness in marking what needs to be filled in and what choices are to be selected among; on either approach one needs a supplementary theory to explain how context is used by the hearer to construct or select appropriate choices (and analogously exploited by the speaker), and a theory encompassing both grammar and its use in context might also include general principles governing the distribution of "invisible" context-dependent elements that could render their explicit inclusion within the statement of the grammar superfluous.

None of these uncertainties about the long-run tenability of a strict compositionality principle reflect on its value as a working hypothesis. I take the fruitfulness of trying to work within highly constrained theories as well established, and the compositionality constraint as one of the driving forces in recent progress in semantics. But as I have tried to emphasize, there are in principle many versions of it, and the tighter a constraint one makes it, the more chances there are that it will come into conflict with other constraints. My main goal in these pages has been to try to bring together and put into perspective a wide range of arguments and problems where it would seem that either MCP is too strong or something else has to be modified – in some cases (like those discussed in section 7.3.1) all that may be needed is a better analysis of some puzzling construction; in some (as suggested for some of the cases in 7.3.2 and 7.3.3) we may be led to a different way of looking at such issues as the relation between ambiguity and sentence-internal context-dependence; while in other cases, it seems that attention to the principle can help us to uncover important problems that may require substantial modification of currently available theoretical frameworks.

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Notes

1 Janssen (1983) contains an excellent discussion of the homomorphism requirement and the constraints it places on the use of intermediate levels of translation such as Montague's IL. The central constraint is that for any translation rule "$F_i(\alpha, \beta)$ translates as $G_K(\alpha', \beta')$", the operation G_K on expressions must be such that for semantically equivalent input expressions it yields semantically equivalent results. Hence the only properties of expressions in the intermediate level that can play a role in compositional translation rules are those which are also properties of the corresponding meanings.

2 The phrase "logical form" raises such a host of questions that it would require a separate paper to even begin to sort out the different things that are meant by it in different discussions. On some of its uses, its closest analog in Montague's framework is the level of disambiguated language (derivation trees in PTQ), in others it seems more parallel to the translation into intensional logic. But in the latter case difficulties begin as soon as one talks of "*the* translation" or "*the* logical form" of a sentence, given the multitude of logically equivalent expressions; see, for instance, the criticism of Keenan and Faltz (1978) by Landman and Moerdijk (1983), who point out the problematic nature of trying to impose constraints directly on the relation between the syntactic form of a sentence and "the" translation of that sentence into a logical representation. It is even more difficult to make comparisons between model-theoretic semantics and approaches in which a "logical form" or "semantic representation" is the final output of semantic interpretation, as David Lewis (1970) emphasized in his discussion of "markerese".

3 One thing that most notions of "logical form" have in common is that logical forms are unambiguous; but there are beginning to appear proposals which allow for ambiguous logical forms, for instance with respect to quantifier scope and/or the place of prepositional phrase attachment for sentence-final prepositional phrases. (See, for example, Schubert and Pelletier 1982.) In such cases it may be that compositionality is maintained in the translation procedure but not in the model-theoretic interpretation of the logic, rather than (as more commonly) the other way around.

4 Explicit arguments against direct model-theoretic interpretation and for the inclusion of an intermediate level that is *not* simply a translation into a logical language can be found in the work of Kamp (1981) and Heim (1982), which is discussed in the following section.

5 Of course the semantic interpretation may show the expression to be a tautology, a contradiction, or in some other way ill-suited to any useful communicative purpose, and in such ways an intuition of anomalousness may be explained at a semantic or pragmatic rather than syntactic level. Similarly meaning postulates may indirectly effect a sort of semantic filtering; and a theory of presuppositions, especially if it involves a three-valued logic, will declare some sentences syntactically well-formed but semantically (or at least pragmatically) anomalous. So the issue of filtering is not completely clearcut; but there is nothing available in a compositional theory comparable to Chomsky's very general syntactic rule "move α" with its radical overgeneration plus filters at the level of "logical form" ruling out whole classes of resulting (non-)sentences. See Landman and Moerdijk (1983) for related comparisons.

6 See Heim (1982) for a critical review of previous proposals for the treatment of *donkey*-sentence pronouns.

7 Whether the ambiguity (between kind-level and individual-level) is to be pinned on the determiner *the*, or on the common noun, or introduced constructionally is controversial; all that is crucial here is the recognition that the noun phrase as a whole is indeed ambiguous.

8 Partee (1975) argues against Chomsky's proposal on the grounds of the ambiguity of sentences with multiple plurals like "The boys gave the girls nickels", for which a sentence-level "plurality" feature is clearly not sufficient to determine the range of possible interpretations.

9 Although there are many cases were nearly everyone who invokes function-argument structure at all agrees on which constituent in a given construction is the function and which the argument, there have been few *general* criteria offered besides Keenan's for determining which is which. See Ballmer (1980, 1982) for some grounds for skepticism toward the idea that the answer is in general determinate.

10 Note that if nothing is known about the propositional relation except that it is factive, the minimal choice would seem to be *and*, since conjunction is implied by all "two-sided factive" propositional relations. The main difference between an overt conjunction and an adjunct construction appears to be the differential degree of "assertedness" of the two parts, as with non-restrictive adverbials.

11 Note that if one could defend the view of Quirk et al. (1972) that the literal interpretation of the relation is just *and*, this argument would not apply; nor would it apply if the relation, however determined, were not part of the truth-conditional content.

12 I have focused here on one particular and potentially controversial aspect of Stump's work because of its bearing on the issue of compositionality; these remarks have oversimplified some parts and completely neglected many other parts of this rich and tightly argued analysis, which is for the most part perfectly compositional.

13 The first draft of this paper had a longer section on genitives, but since the paper was too long and I was not really satisfied with the analysis presented there, it seemed better to defer fuller discussion of genitives to a separate paper (in progress). [Author's note 2003: The deleted section on genitives was eventually published as an appendix to Janssen (1997) and appears here as chapter 8. The author's more recent work on genitives, joint with Vladimir Borschev, is represented here by chapter 15.]

14 The positing of a near-universal ambiguity would certainly need strong argument, but it is not necessarily indefensible. An example of a serious attempt to provide an explanation for a possible universal ambiguity of a single negative morpheme can be found in Seuren (1985).

15 McConnell-Ginet (1982) offers an interestingly innovative solution to the problem of variable polyadicity in verbs in connection with the analysis of adverbs; since all of the arguments of "relational" nouns are expressed by PPs, the problem of the proper treatment of relational nouns is similar to that of distinguishing "oblique" arguments of verbs from modifiers, to which McConnell-Ginet's proposals are directly relevant.

16 See Wierzbicka (1982) for a detailed discussion of the kinds of relations *have* typically expresses and the factors that govern the choice among more specific interpretations.

17 This is what led Bach and Partee (1980) to add subject variables in the interpretation of infinitives; Landman and Moerdijk (1983) treat the same phenomena without semantic subjects but with quantifying-in rules in the syntax.

18 I am not sure whether the principle is correct; Dowty (1982b) argues that deictic interpretation of understood arguments is even more productive than existential interpretation, and treats both kinds lexically rather than syntactically. But it is principles of this sort which need to be found.

19 Chierchia (1984) is developing an approach of this sort, which includes an account of control phenomena and their interaction with passives, etc., without representing "missing subjects" overtly in either the syntax or the semantics.

20 I am using the terms *deictic* and *indexical* interchangeably for expressions whose interpretation is supposed to be supplied by the context.

21 Ivan Sag in a talk once proposed the last-mentioned treatment as a general alternative to Gazdar's uniform treatment of optionally missing arguments as existentials; the argument against that possibility given here does not apply to the variable-like treatments of existentials of Kamp (1981) and Heim (1982). A number of the issues raised below might be viewed very differently in their systems, but I cannot try to discuss their frameworks in detail here.

22 Terry Parsons in lectures in 1972 suggested that virtually every content word of a natural language may be context-dependent to some degree; the idea that some words have constant intensions and others are indexical may be just a simplifying fiction.

23 This is not universal; Emmon Bach (personal communication) has pointed out that the first-person pronoun can be used in Amharic in embedded sentences in ways suggestive of Castañeda's "he*"; verb agreement distinguishes the anaphoric from the indexical "I".

24 But *here* and *now* can "shift" in *style indirect libre* as discussed in Banfield (1973), while *I* cannot. And *here* at least can sometimes be anaphoric, but none of these can ever be a bound variable (see von Stechow 1982; Klein 1978).

25 The desire to find a basis for a unified treatment of elements which can function as demonstratives, definite anaphors, and bound variables is one of the central concerns of Cooper (1979), Kamp (1981), and von Stechow (1982). (There is a great deal of variability in the use of the terms "indexical", "deictic", and "demonstrative", not to mention "anaphor", reflecting both different historical traditions and different points of view about what sorts of classifications yield the best generalizations. My use of scare quotes in the text signals an attempt to refer to fairly common classifications without presupposing their appropriateness.)

26 Matters are still more complicated; neither the *we* in (33) nor the implicit argument of *notice* in (35) is a *simple* bound variable, in that neither is understood as "co-indexed" with an antecedent that appears directly as a constituent in the sentence. They rather seem to manifest properties of "donkey-sentence-pronouns" as discussed in Cooper (1979), Heim (1982), and Dowty (1982b). Compare also the indirect relation between the implicit bound "country" arguments in (i) below and the "unselective" quantifier *always*:

(i) The capital is not always the largest city

(I think I got this kind of example from discussions with Greg Carlson and/or Irene Heim.)

27 I think this issue is directly relevant to (i) the treatment of nouns like *price*, *temperature*, and *president*, for which Montague's technique of invoking individual concepts is probably not satisfactory; (ii) the various phenomena for which Skolem functions have been invoked by a number of recent writers (iii) the interpretation of the adjective *local*, discussed by Jonathan Mitchell in unpublished work (University of Massachusetts); (iv) the parallels drawn by Barwise and Perry between "discourse situations", "resource situations", and "subject-matter situations", making it easier to impose similar structure on context and content domains. See Schiebe (1982) for what appears to be a step in the suggested direction.

28 And even the inclusion of model-theoretic interpretation as an indispensable part of semantic interpretation is not sacrosanct, if proposed alternatives can be shown to move us forward and not backward.

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