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Formal Semantics and the Grammar of Predication

In this article I will discuss the semantics of predication in English and some of its implications for syntax. Consider (1):

(1)   John is crazy.

(1) says that John has (or instantiates) a certain property (or state), the property of being crazy. This, of course, is informative only to the extent that we know what properties are and what operations we can perform on them (for example, under what conditions we can conjoin two properties or attribute a property to an individual). Suppose it is possible to determine the set of operations we can perform on properties and to use the resulting structure in spelling out the semantics of predicative constructions. Presumably, there will be just a finite set of such allowable operations. Since there must exist some systematic relation between syntax and semantics, it follows that this will make predictions about the behavior of predicative expressions. For example, it may set up a limited range of patterns that we should expect to find. Thus, a (semantic) theory of properties might be a significant step toward defining what a possible grammar for natural languages can be.

I will argue that this is indeed so, by developing a semantic theory of properties and predication that tries to be highly restrictive, "perhaps erring in that direction," to borrow Williams's words. The approach I will develop is cast in the tradition of logical semantics. I will sketch an axiomatic theory of properties and its model-theoretic interpretation. I will then show how this theory, embedded in an independently motivated theory of syntax, explains significant aspects of the way nominal and verbal predicative structures behave in English.

A few terminological preliminaries are in order. By *property* (or *propositional function*) I will refer to whatever Verb Phrases (as they occur in sentences like (1)) are semantically associated with. The main characteristic of properties can be taken to be that they can be meaningfully attributed to (or saturated by) a subject (or, more neutrally, an argument).[1] In this regard properties differ crucially from other popular semantic

[1] The same holds, more generally, for *n*-place relations. Within the tradition of logic, properties are usually regarded as 1-place relations and propositions as 0-place relations.

creatures. Take individuals—for instance, the semantic values of simple Noun Phrases like *Pavarotti*. The bearer of this name, besides being a well-known tenor, is a saturated particular; he cannot take an argument. We cannot attribute individuals to other individuals like we can attribute properties to individuals. Consider next the semantic value of overtly clausal constructions (such as (1)), namely propositions. Propositions result when a property is saturated by (applied to/predicated of) an individual in an act of predication. They share with individuals the fact that they are saturated structures (which, of course, does not imply that propositions are individuals). Various semantic theories of propositions exist. For instance, it has been proposed that such entities should be construed as sets of possible worlds, or as sets of situations, or as events, etc. Some approaches take the notion of proposition as primitive and provide an axiomatic (or algebraic) characterization of their structure. In what follows, I will focus on the nature of properties, while remaining neutral about the nature of propositions. Readers should feel free to fill in their favorite views concerning the semantic value of Ss.

1. The Problem

It can be argued that as speakers of natural languages we do not use properties just to predicate something of an individual (as in (1)). We also *refer* to them and attribute other properties *to* them. We may even attribute properties to themselves. Consider, for example, the following sentences.

(2) a.   Wisdom is hard to find.
    b.   The property of being wise is hard to find.
    c. $\begin{Bmatrix} \text{Being wise} \\ \text{To be wise} \end{Bmatrix}$ is crazy.
    d.   Wearing black ties is a passing fad.
    e.   Being crazy is crazy.

(2a) contains a morphological nominalization and (2b) a gerund headed by the noun *property*. Such examples clearly suggest that the domain of individuals we refer to must contain a way of representing property-like creatures. However, the nature of nominalizations such as those in (2a–b) is still largely unknown, which relegates our considerations to the realm of intuitions. I believe that a more compelling point concerning the fact that properties can also be arguments of other properties (and, possibly, arguments of themselves) can be made in connection with (2c–e). To a certain degree, such a point will be theory dependent, for theories differ significantly with regard to analyzing infinitives and gerunds. Four major current hypotheses can be distinguished and summarized schematically as follows:

(3) | Hypothesis | Syntax | Semantics | Framework |
| :---: | --- | --- | --- |
| I | nonclausal (VPs) | nonpropositional (properties) | Classical Montague Grammar (MG) |
| II | clausal (S's) | nonpropositional (properties) | Williams's predication theory |
| III | nonclausal | propositional | Lexical Functional Grammar (LFG) |
| IV | clausal | propositional | Government-Binding Theory (GB) |

If hypothesis III or IV is correct, it is not clear that properties can be arguments of other properties; but if I or II is correct, they obviously can. Thus, I and II seem to call for a semantic framework that allows for properties to saturate argument positions of other properties (including, possibly, their own argument positions, as in (2e)). Our task will be to develop such a framework. Though various proposals have been made toward developing approaches with the characteristics just sketched (especially within the tradition of philosophical logic; see section 1.2), the systematic study of the consequences that different property theories have for natural language semantics has barely begun.

In what follows I will adopt hypothesis I. In section 2.1 I will propose a theory of properties and predication that accomplishes what hypothesis I seems to call for. I will then show how to implement such an approach within a theory of grammar that can perhaps best be described as base-generated syntax plus compositional semantics. Finally, in sections 3 and 4 I will discuss some empirical consequences of this semantics and compare it with other approaches (especially the Government-Binding framework).

1.1. The Control Issue

Within the limits of this article there is no way to do justice to the criticisms that have been leveled against hypothesis I (see, for example, Koster and May (1982)). However, I would like to discuss briefly the problem of control. If infinitives have no "subjects" either in the syntax or in the semantics, why are they usually understood as if they had one? Hypothesis I offers no obvious answer to this question, and potentially this constitutes an obstacle to bearing with what follows. Without any pretense of exhaustiveness, then, I would like to recall some of the strategies that have been developed to handle control phenomena within hypothesis I.

One possibility is to build into the interpretive procedure a device that inserts the missing subjects in the semantics. For example, although infinitives like *to leave* denote properties (i.e. unsaturated, subjectless structures), something like *John wishes to leave*

would end up having something like *wish' (leave'(j))(j)* as its meaning. Infinitives would get their subjects by a semantic rule. This view is defended in detail in (for example) Klein and Sag (1982).

A second possibility is to regard control as a matter of semantic entailments. According to this view, something like *wish* is semantically a relation between properties and individuals. Thus, for example, *John wishes to leave* says that the wish-relation holds between John and leaving, and its meaning (its truth-conditional import) can be represented as *wish'(leave')(j)*. However, when such a relation holds, it must also be the case that in all the situations where what John wishes is the case (i.e. in the worlds of John's desires) John, in fact, leaves. Our intuition that there is an understood subject in control structures is simply based on the circumstance that by knowing the lexical meaning of an item, we also know the entailments associated with it. If we know the meaning of ' + ' (i.e. addition), we must know that for every a and every b, $a + b = b + a$. If we know what *wish* means, we must know that for every a and every property P, if a wishes P, then a wishes to bring $P(a)$ about. Entailments of this sort can be captured in various ways, for example, by meaning postulates schemata. This second view has been defended in (for example) Thomason (1976), Dowty (1982b), Chierchia (1983; 1984).[2]

Deciding among competing theories of control is an empirical issue, and our semantics of predication will certainly be affected by (and perhaps, indirectly, affect) the outcome of the debate on control-related phenomena. For present purposes, however, it is only necessary to keep in mind that various theories of control based on hypothesis I have been developed in detail and have been motivated on grounds largely or completely independent of the facts we will consider below.

1.2. Semantic Perspectives on Properties and Predication

Hypothesis I seems to call for a theory where properties can be arguments of other properties, including, possibly, themselves. Since Russell's paradox, we know that to construct domains with these characteristics is not a straightforward matter. Within the tradition of philosophical logic, three families of approaches to this problem have been developed, which I will illustrate on the basis of (4a–b) (= (1), (2c)).

(4) a.   John is crazy.
    b.   Being wise is crazy.

The first approach is based on Russell's theory of types and is still the one most generally adopted within standard Montague Grammar. According to this view, properties are ranked on the basis of the arguments they can take. In (4a), then, *is crazy* is a property of individuals, but in (4b) it would have to be associated with a different property of a higher type that can take properties (of the first level) as arguments; and

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[2] Chierchia (1984) represents an attempt to integrate a semantic approach to control based on meaning postulates with a theory of (syntactic) predication based on that of Williams (1980).

so on. There are several problems with this view. Syntactically, the two VPs in (4a–b) appear to be identical. Yet type theory postulates a semantic distinction—one that is not signaled in any way in either the syntax or the morphology. This does not seem to be an accident of English. To the best of my knowledge, no systematic correlation of type-theoretic hierarchies with overt syntactic markings has been found in any language. If type-theoretic hierarchies are real, isn't it strange that they should go unmarked in language after language? Furthermore, although type theory allows properties to apply to other properties, this makes it hard, if not impossible, to model what looks like self-attribution of properties. Indeed, I believe that a fairly strong case can be made against attempts to base a semantics for predication on the classical theory of types (such as the one adopted by Montague). However, I will not pursue this here.[3]

A second approach is to construct a first-order theory of properties (see for example Bealer (1982)). In such a theory, properties are primitives, and a predication (or instantiation) relation, say '$\triangle$', connects properties to (genuine) individuals. Thus, *John runs* is represented as 'j$\triangle$ run' (John instantiates the property of running). Paradoxes are eliminated by regimenting the "logic" of '$\triangle$' via a set of axioms. Typically, these axioms will look like those of set theory, minus, of course, extensionality. That is, unlike sets, two properties can have the same instances without being identical.

A third approach goes back to Frege's view that properties can be said to have two modes of being. When they occur in predicate position (like *is crazy* in (4a)), they are intrinsically functional, "gapped," or unsaturated structures (perhaps cognitive capacities of some sort). However, these structures are systematically correlated with individuals. For example, *is wise* is semantically associated with an unsaturated structure that can be taken to have a certain state, the state of being wise, as its individual correlate. When we say something *about* properties, we really purport to refer to their individual correlates. Thus, the basic feature of this view is that propositional functions (i.e. properties in their predicative role) strictly speaking never apply to themselves but only to their individual images. Until quite recently there was a serious problem with this view, namely that as originally formulated by Frege it was inconsistent (because subject to Russell's paradox). However, ways have been found of making it work. In the following section I will briefly describe one solution (drawing from work by N. B. Cocchiarella). This third approach is the one I will defend, by arguing that it explains the behavior of English predicative expressions in a way other approaches cannot.

2. The Framework

In this section I will sketch the assumptions within which an arguably optimal solution to the problem discussed above can be achieved. First, I will outline a semantic theory of properties and predication inspired by Frege's view (familiarity with the basic notions

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[3] Parsons (1979) and Cresswell (1973) represent the most extensive developments of Montague's type-theoretic approach. Detailed discussion and criticism of those views can be found in Chierchia (1982; 1984) and Turner (1983).

of Montague semantics will be assumed). Then I will construe the theory as an *empirical theory of meaning*, by relating it in a principled way to syntax.

2.1. Semantics

In order to make a Fregean theory of predication precise, it is necessary to identify a mechanism with known formal properties that can accommodate the intuitive content of such a theory. To this end, consider standard second-order logic. Besides individual and predicative constants, such a logic includes individual variables (x_1, x_2, . . .), (*n*-place) predicative variables (P_1^n, P_2^n, . . .), and the standard connectives and quantifiers, the latter being allowed to bind predicative variables as well as individual ones. The formation rule for atomic formulae is the following:

(5)   If β is an *n*-place predicative expression and α_1, . . . , α_n are singular terms, then $\beta(\alpha_1)$ . . . (α_n) is an atomic well-formed formula. (Here and throughout I use a Montague-style notation for relations.)

Now, the singular terms of standard second-order logic are just individual variables or individual constants. To the usual formation rules, we will add a new one that allows us to derive complex singular terms *from* predicative expressions, along the following lines:

(6)   If β is an *n*-place predicative expression, $^\cap\beta$ is a singular term.

For self-evident reasons, predicative expressions preceded by '$^\cap$' will be called *nominalized predicative expressions*. Under the standard assumption that well-formed formulas (i.e. sentences) really are 0-place predicative expressions, rule (6) will allow us to nominalize them as well. (7) contains examples of well-formed formulas of the formal system so obtained:

(7) a. $\exists P[P(^\cap P)]$
    b. $R(^\cap Q)(x)$
    c. $\text{believe}'(^\cap[Q(x)])(j)$

As shown in Cocchiarella (1978; 1979), a variety of systems obtained by adding (6) (or something equivalent) to second-order logic are consistent relative to (Zermelo-Fraenkel) set theory. In fact, modifying the comprehension principle of standard second-order logic in various ways results in different logics for nominalized predicates that can be said to reflect different philosophical positions on the nature of universals.[4] Furthermore, these systems can be augmented by standard tense and modal operators and by the λ-abstractor.

    The trademark of the logics just described is that properties are projected in two distinct logical roles: as predicates and as singular terms. These roles can be taken to

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[4] For discussion, see for example Cocchiarella (1979). The system adopted in Chierchia (1984) is Cocchiarella's HST*.

represent the forms or modes of being that characterize properties from a Fregean point of view. This can perhaps be seen more clearly by considering the model-theoretic frames with respect to which standard metatheoretical results (such as consistency and completeness) are obtainable. Such frames can be informally described as follows:

(8)   Propositional Fregean frames: $\langle U, X_n, W, J_\leqslant, f \rangle_{n \in \omega}$

In intuitive terms: U is the domain of individuals. X_0 is an algebra of proposition. For $n > 0$, X_n is the domain of n-place relations (propositional functions). An n-place propositional function is represented as in the work of Schonfinkel and Montague as a function from U into an $n - 1$ relation. In particular, a 1-place propositional function (a property) will be a function from individuals into propositions (whatever the latter are taken to be). $J_\leqslant$ is the set of times. W is the set of worlds, possibly viewed as (time-indexed) sets of propositions (functions in $\{0,1\}^{X_0 \times J}$). f is a map from $\bigcup\limits_{n \in \omega} X_n$ into U. Intuitively, f is what provides an individual image for each propositional function and is used to give the semantics of the nominalization operator '⌒'. For example: Let Q be a 1-place predicative constant and let $[\![\quad]\!]$ be the interpretation function. $[\![Q]\!]$ will be a member of P^U and for any $u \in U$, $[\![Q]\!](u)$ will be a proposition (i.e. a member of P). $[\![Q]\!](u)$ is true at a world w and a time j iff $w([\![Q]\!](u), j) = 1$. Furthermore, $[\![{}^\frown Q]\!] = f([\![Q]\!])$; that is, syntactic nominalizations correspond to a semantic operation that takes a propositional function to its individual correlate.

This example should help clarify the sense in which the model-theoretic frame in (8), besides being a technical tool for testing fundamental metatheoretical properties of our theory, also provides a precise heuristic into what its "intended" interpretation might be taken to be. The theory just sketched (via its axioms and models) answers the following questions, among others. Given two properties P, Q, is there the property of being both P and Q? (Yes.) Given a 2-place relation R, is there the property of standing in the relation R to someone? (Yes.) Is there a property that something has just in case it cannot apply to itself? (No.) Thus, such a theory characterizes what we can do with properties in the same way, for example, a theory of numbers (e.g. Peano's) specifies what we can do with numbers.

Before implementing this system in a grammar, we must address another issue. The logic thus far described is conceived as a second-order (modal) theory of properties and should provide a framework within which to do semantics. However, certain considerations suggest that such a framework might still be inadequate for that purpose. In the logic sketched above, everything is either a property or an individual. But presumably we would not want to claim that every expression in a natural language should be analyzed either as an individual or as a property of some sort. In particular, I do not think we want to analyze adverbs or prepositions as properties (although in principle we could; see Chierchia (1982)). To see this, imagine that *any* predicative expression of our logic can be nominalized. But adverbs, prepositions, determiners, etc., obviously cannot be nominalized in the sense in which predicates can. This would follow, if we assume that they are not properties and thus do not fall within the domain of the Fregean correlation

function. It is easy enough to accomplish this, by modeling adverbs, etc., as third-order functional constants (i.e. functions defined over properties) of our logic. Adding the latter to the formal system described above is completely straightforward. For example, adverbs like *slowly* would be represented as functions from 1-place propositional functions into 1-place propositional functions. Prepositions in their adverbial uses (*John runs in the park*) would be functions from NP-type meanings into adverb-type meanings, and so on. The way of modeling these entities is the one familiar from standard Montague Grammar. The functions that accomplish this (being of a higher order than properties) cannot be nominalized. It is important to note in this connection that to model nonpredicative categories (like adverbs or prepositions) we seem to need nothing higher than third-order functions. In Montague's system, properties do not have individual images. This was presumably one of the reasons for wanting to build the entire type-theoretic hierarchy into semantics, for each reference to a property P of type n seemed to require resorting to a property of Q of a higher type (and so on, up the ladder of types). The imaging of properties in the domain of individuals allows us to do away with this infinite type-theoretic progression, while preserving the type-theoretic distinctions we (arguably) need.

The logic just described can be implemented as a type theory of the following sort. Let e and p be our basic types. Individual expressions will be of type e and take their values in U. Well-formed formulas will be of type p and take their values in P. We then say that if b is a type and $a = e$ or $a = \langle e_n, p \rangle$ (where $\langle e_n, p \rangle = \underbrace{\langle e, \ldots \langle e, p \rangle \ldots \rangle}_{n\text{-times}}$),

then $\langle a, b \rangle$ is also a type. This recursive schema will generate types like $\langle \langle e, p \rangle, \langle e, p \rangle \rangle$ (i.e. functions from 1-place propositional functions into 1-place propositional functions), but not types like $\langle \langle p, p \rangle, e \rangle$ or $\langle \langle \langle e, p \rangle, p \rangle, p \rangle$ (where the latter would correspond to a function that maps second-order functions into propositions). We assume that our logic contains denumerably many constants and variables of type e and $\langle e_n, p \rangle$ and denumerably many constants of other types.

The resulting system, which I call IL_*, has various features in common with Montague's Intensional Logic (IL), but differs from it in type-theoretic structure. The type-theoretic structure of IL_* is much more constrained and simple. Instead of the infinite layers of types of IL, IL_* has only three layers of types (or semantic categories): individuals (e), propositional functions ($\langle e_n, p \rangle$), and third-order functors (e.g. $\langle \langle e, p \rangle, \langle e, p \rangle \rangle$). In addition, it has the Fregean nominalization device. Note, moreover, that quantificational reference to third-order entities (e.g. functions of type $\langle \langle e, p \rangle, p \rangle$) is disallowed in IL_*. If our goal is to model adverbs and the like, the minimal addition needed to our basic theory of properties is simply a number of constants. Thus, the resulting system is still to be regarded as a (nonstandard) second-order logic with modalities and λ-abstraction. This similarity in structure to Montague's IL will enable us to inherit in a straightforward way the results achieved within that framework, as will become apparent.

2.2 Syntax

I will assume here, following Montague (1974), that syntax and semantics are related by a homomorphism; that is, that semantics takes the form of a compositional interpretation procedure on surface syntactic structures. Though controversial, this claim represents the most restrictive hypothesis on the relation between syntax and (model-theoretic) semantics that I know of.[5]

Mostly for the sake of execution, our discussion will be couched in categorial rather than phrase-structural terms. Therefore, we will assume that there exists a small pool of primitive ("nonfunctional") syntactic categories, out of which all other categories are recursively defined. Derived ("functional") categories are taken to have the form A/B or A//B. An item of category A/B (or A//B) is something that combines with a B to give an A. The mode of combination need not be simple concatenation (although this can be taken to be the unmarked choice in configurational languages like English). The following is a sample categorial base for English:

(9) a.   Basic categories: NP, S[6]
    b.   VP = S/NP
    c.   TVP (transitive verb phrases) = VP/NP
    d.   *try*-type verbs: VP/VP
    e.   ADV (adverb phrases) = VP//VP etc.

A categorial base of just this sort has been defended on various grounds by a number of authors (e.g. Bach (1980), Keenan and Faltz (1978)) and forms the base of what has come to be known as the *categorial theory of grammatical relations* (Dowty (1982a,b)).

Compositionality is built into the framework in two steps. First, it is assumed that each syntactic category is associated with exactly one semantic type. Second, for each syntactic rule there will be exactly one semantic rule (which is what Bach calls the *Rule-by-Rule Hypothesis*). The actual implementation of compositionality is governed by (some version of) Partee's (1979) Well-formedness Constraint—that is, an evaluation metric that ranks as marked "abstract" syntactic structures (or rules).

Clearly this proposal would still leave too much freedom to language-particular grammars, for each language would be free to stipulate its own assignment of semantic types to syntactic categories or its own pairing of syntactic rules with semantic ones. Montague's original proposal, however, can be tightened significantly in fairly simple and reasonable ways, and much work in the Montague tradition has been devoted to such a goal. As one example, let us consider in more detail the particular form of compositionality I would like to assume, drawing from several recent proposals.

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[5] The current state of the debate on compositionality is discussed in Partee (1983). See also the references there.

[6] NP corresponds to Montague's T, S to Montague's *t*, and VP to Montague's IV. For simplicity I will not differentiate between lexical and nonlexical categories.

Let us focus first on the category-type correspondence. Our goal is to narrow down the number of logically conceivable ways in which a language can pair its own categorial base with semantic types. A fairly simple principle that Montague (1974) adopted (even though he did not state it explicitly) is the following:

(10) *Functional Correspondence*

A lexical item α is syntactically a function (belongs to a syntactic category of the form A/B) iff it is semantically a function (that is, its meaning is of type ⟨a,b⟩).

It is evident that (10) significantly constrains the number of possible category-type mappings. For instance, Bennett's type assignment (Dowty, Wall, and Peters (1981, 188ff.)) is ruled out by (10). Essentially, by virtue of (10), all nonfunctional (primitive) categories will have to be mapped into types that are not of the form ⟨a,b⟩, and there are only two such types in our theory: e and p. Furthermore, it seems natural to stipulate that S is the only universally primitive category that must be mapped into p. We are then left with e as the only type into which all other primitive categories will have to be mapped. Thus, the nonfunctional categories will have to be "nominal" in the sense that their meanings will have to be logically classified as individuals of some sort (i.e. nonfunctions).[7]

What about functional (derived) categories? Clearly in these cases we want some way of recursively specifying the type of a functional category by mirroring the way the category itself is built up. Now functional categories are of the form A/B or A//B. This notation is Montague's, but I shall use it in a different way, where the difference is really dictated by the semantics I am proposing. This semantics distinguishes propositional functions (which are nominalizable) from higher-order functors (modifiers, which are not nominalizable). In general, we would expect universal semantic distinctions to be encoded in the syntax with some systematicity. Thus, in particular, we expect to find (at least) two classes of functions in the syntax: those that correspond to propositional functions (which we will denote as A/B's) and those that correspond to functors (which we will denote as A//B's). This hypothesis can be made explicit in a type-assignment schema that uses a simple recursion like this:

(11) $\tau(A)$ = the type corresponding to A
     a. $\tau(A/B) = \langle e, \tau(A)\rangle$
     b. $\tau(A//B) = \langle \tau(B), \tau(A)\rangle$

(11b) simply says that an element of category A//B will be associated with a function from things of the type corresponding to B's to things of the type corresponding to A's. This will not do, in general, for elements of a category A/B, for we have stipulated that such categories correspond to propositional functions. Propositional functions are, by defi-

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[7] Of course, they might be "abstract" individuals of various sorts. For a more detailed consideration of the issues involved, see Chierchia (1984, chap. II).

nition, functions from individuals into propositions. Hence, the semantic type of the argument in a category of the form A/B can only be e, viz., the type of individuals. In other words, the single vs. double slash notation can be viewed as a semantically motivated syntactic feature. It says that syntactic categories form two natural classes according to the kind of semantic functions they are associated with. A/B's and A//B's are expected to behave differently with respect to a number of grammatical processes, such as nominalization. Some such processes will be discussed in sections 3–5.

From these considerations we can conclude, then, that Universal Grammar embodies a principle, Functional Correspondence, that allows a simple, compositional implementation of our semantics in a categorial grammar. Among other things, such an implementation allows possible category-type assignments to be restricted to the following: all primitive categories (except S) must be mapped into e; the type of derived categories is determined by the type of the input categories via the schema in (11). For the English sample, we thus have:

(12) a. $\tau(S) = p, \tau(NP) = e$
   b. $\tau(VP) = \tau(S/NP) = \langle e, \tau(S) \rangle = \langle e, p \rangle$
   c. $\tau(TVP) = \tau(VP/NP) = \langle e, \tau(VP) \rangle = \langle e, \langle e, p \rangle \rangle (= \langle e_2, p \rangle)$
   d. $\tau(VP/VP) = \langle e, \tau(VP) \rangle = \langle e, \langle e, p \rangle \rangle (= \langle e_2, p \rangle)$
   e. $\tau(VP//VP) = \langle \tau(VP), \tau(VP) \rangle = \langle \langle e, p \rangle, \langle e, p \rangle \rangle$

Thus, the unmarked semantic make-up of items of various categories can be said to be fully determined by fairly general principles of Universal Grammar, such as Functional Correspondence.

Similar considerations apply to the way syntactic rules are associated with their semantic counterparts. In particular, I will assume that there are only two unmarked syntactic-semantic rule pairs. The syntax will include rules of binding and rules of categorial cancellation. Binding rules are essentially taken to be Cooper-storage devices (Cooper (1983)). In what follows, I will not discuss binding rules at all, and I will proceed as though all NPs were simple referential NPs. I do so purely for expository purposes, and nothing that I will say hinges upon it. The format of categorial cancellation rules is given in (13a), and an example in (13b):

(13) a. If $\beta \in P_{A/B}$ and $\alpha \in P_A$, $Affix_n(\alpha,\beta) \in P_A$
   b. If $\beta \in P_{VP}$, and $\alpha \in P_{NP}$, RCONCATENATE $(\alpha,\beta) \in P_S$

$Affix_n(\alpha,\beta)$ is taken to be the only syntactic operation of core grammar (to be read "Affix α after the nth constituent of β"). The parameter n and the level of constituenthood that $Affix_n(\alpha,\beta)$ has access to are severely restricted by an independent set of principles determining how such parameters may covary with a particular categorial base, the configurational characteristics of the language, etc.[8] Right concatenation and Bach's "Rightwrap" ("Affix α after the head of β") are the only instances of the core operation that have been argued to be active in the grammar of English.

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[8] See Ades and Steedman (1982), Bach (1980; 1983), and references therein for discussion.

The semantic rules that correspond to (syntactic) binding and categorial cancellation are λ-Abstraction and Functional Application, respectively. As usual, we assume that semantics takes the form of a set of rules of translation into a logical language (here, IL_*). Since the model-theoretic interpretation of such a language is a well-defined and well-known entity, such translations can be said to specify the truth conditions associated with sentences of English. The general format of Functional Application is this:

(14)   If $\beta \in P_{A/B}$ translates as β' and $\alpha \in P_A$ translates as α', then $\text{Affix}_n(\alpha,\beta)$ translates as $\beta'(\alpha')$.

Thus, the picture emerges of a set of interrelated syntactic and semantic categories and rules that generate and interpret in tandem the well-formed expressions of a language.

   In the same spirit as many current lexicalist approaches, this framework encodes a substantial amount of information in the lexicon rather than, say, in tree-theoretic notions. The strong form of compositionality adopted here limits in a principled fashion the range of choices available to language-particular grammars. Modulo the selection of a particular categorial base (and some honest housekeeping), the syntax *and* semantics of an item can be basically read off its syntactic category. Thus, to exemplify further, a language-learning device confronted with a set of data must choose a particular categorial base from a narrowly circumscribed inventory. Then a number of crucial properties of the grammar (how items of different categories differ in meaning, what syntactic and semantic rules the grammar includes, etc.) will follow automatically, thanks to a very strict compositional characterization of the syntax-semantics interface. Borrowing a different theoretical vocabulary, one could say that compositionality, as characterized above, enables us to deduce a number of important features of language-particular grammars from the subcategorization properties of lexical items. In this sense, compositionality would subsume significant effects of what in the GB framework is handled in terms of (various forms of) the Projection Principle.

3. Some Consequences

In this section I will consider some empirical consequences of the semantic theory of properties developed earlier. The general line I will take is based on a simple observation. If the semantic distinctions (individuals vs. propositional functions vs. functors) made above are real, they ought to play a crucial role in explaining the behavior of a wide range of constructions. More precisely, we should be able to find empirical patterns whose characteristics can be deduced from the characteristics of the semantics we have been developing. As we will see, some of the empirical consequences of this semantics for predication do not depend on the particular view of the syntax-semantics relation presented in section 2.2. These weakly theory-bound consequences are also more speculative. Other, more solid empirical consequences of the semantics seem to depend on a compositional view of the syntax-semantics mapping, such as the one sketched in the preceding section (indeed, they appear to support it). In either case, odd and seemingly

unrelated properties of English predicative constructions can be derived from the proposed theory of properties construed as the semantic component of a grammar.

First, let us consider what I believe can be regarded as weakly theory-bound evidence for the proposed theory. Recall the following properties of IL_*:

(15) a. IL_* has expressions of three logical types.
     b. IL_* does not have variable-binding mechanisms for (third-order) functors.

Now, if we adopt IL_* as our semantics, (15a–b) become claims concerning possible grammatical processes. In particular, (15a) entails that every expression of every natural language must belong to one of three semantic categories and that if something is classified as a predicate, it ought to be nominalizable, whereas if it is classified as a functor, it ought not to be nominalizable (the *Three-Layers Hypothesis*).[9] Furthermore, there is general agreement on the fact that to deal with anaphoric dependencies, variable-binding mechanisms of some sort are required. Thus, (15b) entails that there can be no anaphoric phenomenon that involves functors (the *Functor Anaphora Constraint*). Of course, these constraints are not absolute. For example, one could extend IL_* to accommodate, say, fourth-order functors. However, these extensions will involve stipulations beyond those made so far, which in an obvious sense gives them a marked status. As usual, then, any constraint built into IL_* is to be viewed not as a once-and-for-all prohibition but as a contribution to a theory of markedness.

Let us now consider evidence bearing on these two constraints.

3.1. *The Three-Layers Hypothesis*

The fact that adverbs, prepositions, determiners, and complementizers do not undergo nominalization processes in any way comparable to those that verbs (or adjectives) undergo was part of the original motivation for building a three-leveled semantic system. Is there any independent evidence that might support it? The following considerations suggest that there is.

The argument structure of a predicate can be manipulated in a number of ways. For example, arguments can be deleted (*I ate the cake ~ I ate*) or added (*I walked ~ I walked the dog*). Semantically, these argument-manipulating operations can be naturally construed as (third-order) predicate modifiers that map predicates into predicates. So, for instance, there might be a functor *CAUSE* that maps 1-place propositional functions into 2-place ones, defined roughly as follows:

(16) a. $CAUSE =_{df} \lambda P \, \lambda x \, \lambda y [y$ brings about $P(x)]$[10]
     b. $CAUSE(walk')(x)(y) = y$ brings about that x walks

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[9] Jespersen (1924, chap. VII) claims that syntactic categories can be grouped in three natural classes: primary (NP-like things), secondary (predicate-like things), and tertiary (everything else). I think that this is, in essence, the Three-Layers Hypothesis.

[10] A rigorous definition of *CAUSE* can be found in Dowty (1976).

Adverbs are treated as 1-place functors that map properties into properties. Thus, not only can a function like *CAUSE* not apply to adverbs—there actually can be no functor *CAUSE** that "causativizes" adverbs. Such a functor would have to take adverbs as arguments, which would make it a fourth-order functor. But that is beyond IL$_*$'s limits. Hence, IL$_*$ predicts that there can be no analogue of causativization (or argument drop, passive, etc.) for adverbs (or determiners, prepositions, etc.). Note that within either a system like Montague's IL or a first-order theory of properties, to define something like *CAUSE** presents no problem. In a fully typed system, there will obviously be fourth- (or higher) order functions. This holds also for a first-order system, since such a system essentially pushes the whole type-theoretic hierarchy back down in the domain of individuals.

There are items that appear to modify functors. Modifiers of functors (e.g. modifiers of adverbs) would have to be construed as fourth- (or higher) order functors (since they take third-level entities as arguments) and hence might present a problem. *Only* is a good example (as in *John only eats slowly,* where *slowly* is focused). What does IL$_*$ say about those? To answer this, let us consider other operators that do not fit the three-layered mold of our logic—for example, *and*. Clearly, *and* has special properties: it is cross-categorial, and it has a "universal" semantic content. These characteristics independently require that *and* be treated as a logical operator, that is, mapped into a generalized meet operator of some sort.[11] Because of the universal semantic content of *and*, this move is without cost, for we can assume that such an operator is provided by Universal Grammar (i.e. by a possibly innate capacity for concept formation). Thus, it seems reasonable to expect that if a function does not fit neatly in any of our three semantic categories, either it should have characteristics similar to those of *and*, or it is marked. Clearly, items like *only* do have the expected characteristics (that is, cross-categoricity and universal semantic content) and are therefore well-behaved in this regard.[12]

Thus, the Three-Layers Hypothesis makes at least two very general predictions that are independent of any nominalization phenomena: namely, that there can be no operations like passivization or causativization for functors (e.g. adverbs) and that modifiers of functors should have certain characteristics. Preliminary consideration of the available evidence suggests that these predictions are borne out.

3.2. The Functor Anaphora Constraint

The existence of anaphoric phenomena that involve predicates as such (i.e. in their predicative role) is well attested. *One* anaphora and VP deletion are good examples in English. Consider:

(17)   Ezio likes every *book about Pavarotti,* while Nando only likes this *one.*

(18)   Ezio *hates Pavarotti* and Nando *does* too.

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[11] For discussion, see Rooth and Partee (1983) (and references therein).
[12] A detailed discussion of the syntax and semantics of *only* and related items can be found in Rooth (1984).

Phenomena like VP deletion (within semantically oriented approaches) have been analyzed as processes that amount to binding a predicate variable to an antecedent.[13] I know of no process analogous to VP deletion for adverbs, prepositions, and the like. For example, as far as I know, no language displays anaphoric dependencies like the following:

(19)   John runs *in* the park and Mary runs *pro* the gym.

This is just what we would expect on the basis of IL$_*$. These processes are expected to be highly marked since their semantics clearly involves a variable-binding mechanism for functors.

Of course, adverbs are good candidates as an easy counterexample to this claim, for they clearly enter anaphoric relations of various sorts. For example, in English they can be *wh*-moved. *Wh* Movement must be cast as a binding rule whose semantics would seem to involve quantification (λ-abstraction) over functors, in our terminology. Therefore, perhaps the Functor Anaphora Constraint will have to be weakened. However, since trying to maintain the most restrictive available hypothesis has proven to be a useful research strategy, let us ask first how we might keep it as it is. Essentially, we would have to claim that all anaphoric dependencies involving adverbs are really instances of predicate anaphora in disguise. To see what this could mean (and whether it is viable), let us consider an example.

English *how*-questions are a clear instance of *Wh* Movement of adverbs. To make the point, we need a clear hypothesis on the semantics of questions. For the sake of exposition, I will adopt Karttunen's (1977), although I believe that the same point could be made with respect to other approaches. In simplified terms, Karttunen claims that the meaning of a question can be represented by the set of its (true) answers. (20a–b) are two simple examples, using Montague's IL.

(20) a.   Who ate the cake? $\Rightarrow \lambda p[\check{}p \land \exists x[p = {}^{\wedge}\text{ate}'(\text{the cake}')(x)]]$
     b.   How does John play chess? $\Rightarrow$
          $\lambda p[\check{}p \land \exists \mathfrak{Q}[p = {}^{\wedge}\mathfrak{Q}(\text{play chess}')(j)]](\mathfrak{Q}$ is a variable over adverb meanings)

As is evident from (20b), the semantics of *how*-questions does appear to involve quantification over adverbs, which is ruled out in IL$_*$. However, the overwhelming majority of adverbs have predicative counterparts—that is, they are morphosyntactically derived from predicates. Therefore, both our syntax and our semantics must include some way of mapping predicates into adverbs. For manner adverbials, we must therefore assume, in our semantics, the existence of a function (call it *ly'*) that maps predicates into predicate modifiers, roughly as follows:

(21) $ly'(P)(Q)(x) = x\ Q$s in a P manner
       (for example: $ly'(\text{slow}')(\text{run}')(j) = j$ runs in a slow manner)

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[13] See Williams (1977) and Sag (1976). A discussion of those approaches within a Montague-like framework can be found in Rooth (1982), where the interpretation of VP deletion is explicitly handled as λ-abstraction over properties.

Given this independently needed adverb-forming functor ly', we can formulate the meaning of (20b) in IL_* in a way that does not require quantifying over adverb type meanings, namely:

(22) $\lambda p[\check{}p \wedge \exists P[p = {}^\wedge ly'(P)(\text{play chess}')(j)]]$
       (where P ranges, as usual, over properties)

The same line can be pursued for any *wh*-phenomenon involving adverbs.[14] On the face of it this move might seem quite strange. In a theory like Montague's (or in a first-order property theory) it would not be needed, since anything can be quantified over in such a theory. Yet the proposal just sketched makes the following clear-cut prediction, which a Montague-like theory does not make. There are adverbs (like *too, again, also, even, almost*) that do not have predicative counterparts. Hence, we cannot adopt the solution sketched above for manner adverbials, even though both kinds of adverbs may be construed as functions of the same semantic type. It follows that adverbs that lack a predicative counterpart cannot be *wh*-moved or, for that matter, enter any anaphoric relationship. This appears to be correct.

       Thus, the Functor Anaphora Constraint (as built into IL_*) predicts the inability of prepositions, determiners, and the like to enter anaphoric relationships (analogous to *Wh* Movement or VP Deletion) and furthermore predicts *which* adverbs can enter such relationships. In a theory where every conceivable logical type (or, in fact, *no* conceivable logical type) exists as such, it is possible to quantify over everything and thus, as far as semantics goes, such a theory cannot make these predictions.

       The preceding considerations are at present largely speculative. However, the preliminary evidence that we have discussed does seem to support them. And even if subsequent research shows the need to qualify or weaken them in various ways, it should still be evident that the line taken here is worth pursuing.

       The claims considered in this section depend solely on adopting IL_* as a semantic framework for natural languages. They follow from the intrinsic limitations and characteristics of IL_*, and no particular view of the syntax-semantics mapping is necessary to obtain them.

       Specifically, let us see how some of the results achieved above can be obtained by conjoining aspects of the semantics adopted here with assumptions developed within theories of syntax different from the one described in section 2.2. For instance, effects of the Functor Anaphora Constraint could be derived in the Government-Binding framework along the following lines.[15] Suppose we adopt the view defended here that there

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[14] This also includes clausal adverbials, such as for instance *why*-questions. The latter could be analyzed as follows,
   (i)   Why does John smoke?
         $\lambda p[\check{}p \wedge \exists q[p = {}^\wedge \text{because}'(q)(\text{smoke}')(j)]]$
where p and q are propositional variables and *because'* is of type $\langle p, \langle\langle e,p\rangle, \langle e,p\rangle\rangle\rangle$.
   [15] My thanks to R. Larson for pointing this out.

is some fundamental semantic difference between predicates (propositional functions) and adverbs (functions from predicates into predicates). Suppose, furthermore, that we adopt the view that proper government is lexical government, along the lines developed in (for example) Stowell (1981). In the present terms, we would say that a trace is properly governed iff it is the argument of some propositional function. Then it follows that there cannot be any functor anaphora. For adverbials are not lexically governed and hence (under, say, *Wh* Movement) could not be properly governed. Cases of apparent violations of this restriction could be blamed on the (exceptional) governing character of certain morphemes, such as *-ly*.

4. On the Distribution of Predicative Expressions

The proposed theory, coupled with a compositional interpretive procedure, has further consequences. Generally speaking, on this view properties have two forms or modes of being: propositional functions and individual correlates of propositional functions. The former are what their name suggests: functions. The latter are nonfunctions. Hence, we ought to expect on the one hand syntactic patterns where predicative expressions display a behavior typical of functions and on the other hand syntactic patterns where predicative expressions display a behavior typical of arguments. If properties had only *one* form or mode of being, as other theories claim, there would be no reason to expect precisely this systematic duality.

Let us now look at the facts. First we will consider cases involving predicate nominals, then cases involving verbs.

4.1. NPs vs. Predicate Nominals: The Case of Mass Nouns

In a language like English a conspicuous cluster of distributional properties differentiates phrases like those in (23a) from phrases like those in (23b).

> (23) a. Pavarotti, she, this, every student, a lousy tenor
>   b. student, lousy tenor, cabin with a red roof

Distributional clusterings such as those in (23) are precisely what syntactic categories are designed to capture. In the particular case at hand, the pattern in (23) is presumably best handled by saying that the phrases in (23a) and those in (23b) belong to related but distinct syntactic categories. Within a categorial setting, the phrases in (23a) could be analyzed as NPs (Montague's term-phrases) and those in (23b) as CNPs (common noun phrases).[16] CNPs combine with determiners to yield NPs. Now in a framework where syntax and semantics go hand in hand, differences in syntactic categories are usually expected to correlate with differences in semantic type. This expectation seems to be

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[16] Within an X̄-theory the relevant distinction would be represented as a distinction in "bar" level.

warranted in the present case. Consider the following examples:

(24) a. Every man jogs.
  b. $\forall x[\text{man}'(x) \to \text{jog}'(x)]$[17]
  c. John and Bill are students.
  d. student (j) $\wedge$ student (b)
  e. I want Fritz president.
  f. want$'$(president$'$(f))(I)

(24b,d,f) provide a plausible representation of the truth-conditional import of (24a,c,e), respectively. Note that although there might be some doubt about the exact syntactic category of what occurs in postcopular position in (24c) and in the complement structure of *want* in (24e), the syntactic category of what follows the determiner in (24a) is un-controversial. Be that as it may, the point is that in (24b,d,f) the CNs show up system-atically in predicate position. That is, the contribution that the CNs seem to make to the truth conditions of these sentences is most straightforwardly accommodated by as-suming that CNs are semantically propositional functions of some sort. If CNs are propo-sitional functions, their semantic type must in our terms be $\langle e, p \rangle$. And if the type of CNPs is $\langle e, p \rangle$, then, by Functional Correspondence, the category CNP must be analyzed as a functional category of some sort, say S/NP (while VP would be defined as S/NP).
                                         $_{[-\text{V}]}$ $_{[+\text{V}]}$

Considerations of this sort lead us to establish the existence of two related nominal categories: NP (associated with semantic type e and hence nonfunctional) and CNP (associated with semantic type $\langle e, p \rangle$ and hence functional).[18] Indeed, we are merely recasting in our terms the analysis most generally adopted within Montague-oriented approaches.

Now, where do mass nouns fall with respect to the CNP-NP contrast? The answer seems to be: in both categories. Consider the following examples:

(25) a. John found some gold yesterday.
  b. This stuff is gold.
  c. This ring is gold.
  d. White gold is gold.
(26) a. John loves gold.
  b. Gold is rare.
  c. Fake gold is common.

The mass expression *gold* behaves like a CNP in (25), and like an NP in (26). It is reasonable in cases like this to enter the relevant items in one of the two categories, and then have a category-switching rule that maps them into the other. Since NP-forming rules that take CNP inputs are needed in any event, we might assume that basic mass expressions belong to the lexical category of common nouns and later are turned by rule into NPs. Now, as independently established, the types of CNPs and NPs are propo-

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[17] Adopting restricted quantification would not affect the point being made.
[18] A different line is adopted in Chierchia (1984), but the relevant point is the same on both approaches.

sitional functions and individuals, respectively (recall that we are disregarding quantified NPs from consideration). Thus, the relevant category-switching rule *must* be interpreted in terms of a semantic rule that maps propositional functions into individuals. It is an immediate consequence of the syntax-semantics homomorphism that if the output of a certain syntactic rule belongs to a category A, its meaning must be of the type that corresponds to A. Thus, although mass CNPs semantically are propositional functions, for each such propositional function there must be a corresponding individual that acts as the semantic value of the corresponding mass NP.

This is a necessary consequence of our semantics that turns out to make good sense of the pattern in (25) and (26). (25) shows that as propositional functions, mass expressions can be true of various sorts of subjects: stuff (25b), ordinary things (25c), and kinds of things (25d). The individual correlates of such propositional functions (i.e. the individuals that mass NPs purport to refer to) can be thought of as kinds or substances, with the warning that they may, but need not, be natural kinds (cf. (26c)). For instance, (26a) says that the love-relation holds between John and a certain kind; (26b) says of the gold-kind that it is rare; and so on. This seems to be simple and intuitive, and it can be made very precise (cf. Pelletier and Schubert (1984)).

Now, according to the analysis just sketched, mass predicates must have an individual correlate (to be regarded as a kind, I suggest). But this is exactly how our theory claims that properties in general behave. If a systematic correlation between propositional functions and individuals were not already built into our semantics, we would have to construct it ad hoc, for the case under consideration. This is in fact precisely what the most articulated recent proposal on this topic does (Pelletier and Schubert (1984)). I submit that the mechanism that Pelletier and Schubert develop to deal with mass expressions is a particular case of (and can be derived in terms of) a general semantics for predication.

Moreover, I believe that the pattern mass nouns display is typical of the nominal system in its entirety (including, that is, count nouns). The work on bare plural NPs by Carlson (1977) and others calls for just the same kind of Fregean analysis of properties (see Chierchia (1982; 1984) for discussion).

Thus, in the case of mass nominals, the two modes of being that a Fregean theory posits for properties are actually syntacticized as two different categories (i.e. as two distinct clusters of distributional characteristics). Categorial structure is no less "real" than, say, overt morphemes. Languages use both to convey information. And if properties did not have two modes of being, why should natural languages realize them so often as two distinct syntactic categories?

It is particularly interesting that the semantic makeup of the relevant categories can be established independently of the behavior of mass nouns. Consequently, our general view of the syntax-semantics mapping leaves no choice but to posit a correlation between propositional functions and individuals. Therefore, such a correlation turns out to be both necessary and sufficient to explain why mass expressions have the characteristics that they have.

4.2. The Distribution of Inflection in VPs and the Notion of "Finiteness"

Certain English verbs, like *believe* and *know*, take as their complement (subcategorize for) an S' whose main verb is inflected (a finite S'). Other verbs, like *want* and *prefer*, subcategorize for an S' whose main verb lacks inflection (*for-to* clauses, usually analyzed as nonfinite clausal structures). But verbs that take VP as complement subcategorize only for uninflected VPs. In other words, there are no constructions like (27a–b):

(27) a. *John tries leaves.
    b. *John forces Mary leaves.

These well-known observations can be summarized as follows:

(28)   S'   S'   *VP   VP
       [+infl] [−infl] [+infl] [−infl]

Interestingly, this paradigm is by no means restricted to English. Something analogous shows up in many languages (although nonfiniteness in VPs need not always be marked by [−infl]).

    To my knowledge, no fully satisfactory account of the gap in (28) is currently available. Base-generated approaches stipulate its existence by means of some feature co-occurrence restriction (see for example Gazdar, Pullum, and Sag (1981), Bresnan (1982)). Within the GB framework it is usually stipulated that although [+infl] (regarded as an abstract node, daughter of S) governs and assigns case to the subject position, [−infl] does not. Furthermore, PRO (the null subject of infinitives) is stipulated to be able to occur only in caseless positions (Chomsky (1981, 190ff.)). Though these stipulations might arguably account for more than the distribution of PRO (but see Bresnan (1982) for strong arguments to the contrary), still we might wonder whether they could be altogether eliminated, or reduced to something more general. I submit that the theory of predication developed thus far can do precisely that.

    Suppose we stipulate that finite (i.e. [+finite]) VPs are propositional functions, and that nonfinite (i.e. [−finite]) VPs are their individual correlates. Suppose in other words that the feature [−finite] (which in English happens to be realized as the lack of inflection) is the syntacticization of the Fregean embedding of our semantics, as far as the verbal system is concerned. Then paradigm (28) falls into place. *Try, wish*, etc., are propositional functions, that is, by definition, functions from individuals into propositions. As such, they cannot apply to other propositional functions but only to their individual correlates. The feature [−finite] maps propositional functions (such as the semantic values of *kisses Mary*) into their correlates (i.e. *to kiss Mary*), which can be thought of as actions or states.[19] Hence, VP-taking verbs can only take nonfinite complements. Finite VPs, being

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[19] For this account to work properly, something will have to guarantee that although [−finite] is morphologically realized on the verb, its semantic scope must be the whole VP. We want to nominalize the complex property *kiss'(m)* (i.e. *to kiss Mary*), not just the relation *kiss'*. The problems that these asymmetries pose in morphology are fairly well known (think of tense, for example), and various proposals have been made about how to handle them. For a discussion of the problems involved in a categorial framework, see for example Bach (1983) or Chierchia (1984, chap. II).

propositional functions, are of the wrong logical type to be arguments of other propositional functions. Conversely, the unacceptability of, say, *John to leave* would be accounted for by the fact that *to leave* is not a function and hence cannot be saturated by an argument. These considerations can be summed up as follows:

(29) a.   John leaves.
     b.   leave'(j)
     c.   *John to leave.
     d.   [⌒leave'](j)
     e.   John tries to leave.
     f.   try'(⌒leave')(j)
     g.   *John tries leaves.
     h.   try'(leave')(j)

(29b,d,f,h) would be the semantics associated with (29a,c,e,g), respectively. (29d) is semantically incoherent because ⌒*leave'* is a name of an individual (say, something like an action) and individuals do not take arguments. (29f) is all right since *try* is semantically a relation (2-place propositional function) between individuals and actions. (29g) is ruled out, because *leave'*, being a propositional function and not an individual, is simply not in the domain of *try'*.

This account has many appealing features. The semantics proposed here includes a universal distinction between propositional functions and their individual correlates, and we expect it to be realized in the syntax. By assuming that it is realized in the verbal system as the [±finite] contrast, we account simply for the pervasive paradigm (28). Case theory can then be simplified essentially to the statement "Propositional functions assign case."[20] There is no need to stipulate that [+infl] assigns case and [−infl] does not. That [−infl] is a non-case-assigner can be attributed to its meaning, that is, to the fact that [−infl] is semantically a mapping from functions into individuals (and only functions can assign case). This enables us to reduce a stipulation on the case-assigning properties of [±infl] to a stipulation about its meaning. This is a step forward, since the new stipulation clearly covers more territory. For one thing, it allows us to account for paradigm (28) in terms of a mechanism that automatically takes care of the truth-conditional import of the constructions in question. Furthermore, such a mechanism (our theory of predication) handles a number of seemingly unrelated patterns, such as the behavior of predicate nominals, the Three-Layers Hypothesis, and the Functor Anaphora Constraint.

I am assuming here that there are (at least) two sorts of propositional functions. Propositional functions that are the semantic values of common nouns have *kinds* as their individual correlates. Propositional functions that are the semantic values of VPs are instead correlated with something like *states* or *actions*. The copula *be* would then be interpreted semantically as a function that maps propositional functions of the first sort (e.g. *gold*, *men*) into propositional functions of the second sort (e.g. *be gold*, *be men*). This hinges upon the issue of the semantic difference between common nouns and VPs, an issue that is still open and cannot be properly addressed here.

[20] For relevant discussion, see for example Keenan and Faltz (1978), Bach (1983), Chierchia (1984, chap. II).

Thus, at the very least the stipulation on the meaning of [±infl] (or, more generally, [±finite]) relates pattern (28) in an interesting way to a range of data broader than what other conceivable stipulations can cover.

However, I believe that the syntactic framework developed in section 2.2 enables us to dispense with the stipulation on the meaning of [±infl] altogether. That is, it can be derived from other properties of the system. Consider the categorial analysis of simple subject-predicate sentences according to the system developed in section 2.2:

(30) a.   John runs, S

                     John, NP   runs, S/NP
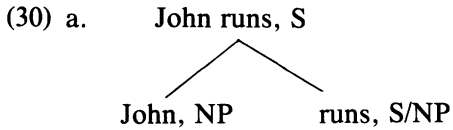
      b.   run'(j)

If anything is a VP, *runs* is. By the independently motivated categorial base for English presented in section 2.2, VP = S/NP. Hence, by our general syntax-semantics mapping, *runs* must be semantically associated with a propositional function. This eliminates the need for stipulating that finite VPs are semantically propositional functions. Now, we adopt the view that infinitives are syntactically VPs. Again, such a view has been motivated on the basis of facts completely independent of paradigm (28). In fact, that paradigm has often been presented as a problem for the VP analysis of infinitives (see for example Koster and May (1982)). In the categorial setting, from the VP analysis of infinitives, it follows that infinitival-taking verbs must be analyzed as VP/VP (rather than VP//VP), since they share all the distributional and morphological properties of verbs rather than those of modifiers. On the basis of the category-type mapping, an item of category VP/VP must be of the semantic type of 2-place propositional functions. Hence, an item of category VP/VP cannot take an inflected VP as argument, for the latter are propositional functions. If something of category VP/VP were to combine with an inflected VP, the relevant rule (i.e. Categorial Cancellation/Functional Application) could not be used, and some other marked mechanism would have to be invoked. Thus, the VPs that VP-taking verbs combine with must be logically individuals, and we would expect there to be something (a morpheme, a particle, a categorial marking) that maps propositional functions into their individual correlates. For suppose there were a language where no morphological marking distinguished VPs occurring in matrix sentences from VPs occurring in argument position. That is, suppose there were a language just like English that did systematically display paradigms like the following:

(31) a.   John leaves.
     b.   John tries leaves.
     c.   John forces Mary leaves.

(31b–c) would require associating some ''abstract'' nominalizer of the propositional

function with *leaves*. But this would be ranked very poorly by the evaluation metric (the Well-formedness Constraint) and hence a language with the properties in (31) should not be easily found, which seems to be correct. It should be emphasized that the [−finite] morpheme in English is not a null element in the same sense as the abstract morpheme that would have to be postulated for (31). The point is simply that the [+finite]/[−finite] contrast in English is signaled by an overt morphological alternation (the presence or absence of inflection). Thus, the stipulation that [−infl] is the syntacticization of the Fregean embedding can also be seen to follow from independent characteristics of the framework adopted here.

The present approach has other empirical consequences:

(i) We have already seen that an infinitival VP is a nominalized property and as such cannot be saturated by a subject; this predicts the inability of *NP to VP* sequences to form clausal structures. The rule for combining VPs with NPs must be Categorial Cancellation/Functional Application. But in *NP to VP* structures there is no function to be applied; hence, the standard rule would block. This also implies that whenever *NP to VP* sequences are found in the complement structure of some verb, they cannot form a constituent. In other words, structures of the following form are not expected to exist:

(32)

```
         VP
        /  \
       /    \
      V      X
            / \
           /   \
         NP     VP
              [−infl]
```
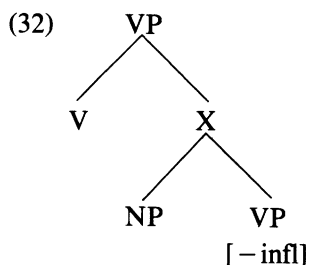
Compositionality requires that X in (32) be a well-formed semantic unit and that it be obtained by Functional Application. But since uninflected VPs are not functions, this requirement cannot be satisfied. To illustrate:

(33) a. John forces (persuades, etc.) Mary to leave.
     b. John expects (believes, etc.) Mary to leave.

In (33) *NP to VP* sequences occur in the argument structure of a higher verb. Given the meaning of [−infl], such sequences cannot semantically form a unit. Hence, they cannot be constituents. For one of the consequences of compositionality, as defined here, is that in general things that are not semantic units cannot be syntactic units. This prediction can be tested, and indeed, Passive, Clefting, and Right Node Raising all converge in showing that the relevant structures in (33) do not form a constituent (see Bresnan (1982) for detailed discussion). What is of interest here is that we are led to make detailed predictions about the constituent structure of certain constructions on the basis of a rather abstract semantics for predication, compositionally implemented.

(ii) Infinitival VPs must be semantically associated with individuals (activities and the like). Individuals cannot be directly saturated by arguments. However, infinitives denote a special sort of individual, namely properties that have lost their unsaturatedness, as it were. Hence, it is conceivable for entities of this special sort to be *indirectly* related to arguments via, say, some higher function. Such a function should somehow give back to infinitives the unsaturatedness that they have lost. In other words, structures like (34) should exist:

(34) $[_X \alpha \; NP \; \underset{[-\text{infl}]}{VP}]$

The infinitival VP cannot directly relate to the NP, being a *nominalized* propositional function. However, it has the potential for doing so, being a nominalized propositional *function*. Thus, there can be items, such as α in (34), that take the NP and the infinitival VP as arguments and "mesh" them. For that to be possible, α would simply have to have the meaning of a predication operator, something that says "Recover the propositional function associated with this individual and apply it to that individual."[21] Of course, given the Well-formedness Constraint, we would expect such a predication operator to be realized, in general, as some overt functor.

Again, at least for English, these expectations appear to be warranted. The relevant structures are *for-to* clauses. In *for NP to VP* structures, NP clearly acts as the subject of the VP. But, as just argued, this is possible only if there is some overt predicator that "denominalizes" the infinitival VP. Thus, the *for* in *for-to* clauses must play exactly the role of α in (34). That is, its semantics must be roughly as follows:

(35) $\text{for}'(NP')(VP') = VP'(NP')$

For is a functor that takes two arguments and yields a proposition. Given this semantics, it follows that *for-to* clauses must be syntactically constituents, since *for* and its arguments form a semantic unit. Thus, if an NP – $\underset{[-\text{infl}]}{VP}$ occurs within the argument structure of a verb that does not subcategorize *for*, it cannot form a constituent; if such a structure occurs within the argument structure of a verb that does subcategorize *for*, it must form a constituent. These predictions appear to be borne out.

To summarize: Nonfinite VPs can be related to a "subject" only indirectly, either via entailments associated with some higher verb or via a predication marker. This is bound to condition what the constituent structure of these constructions can be (subject to various language-particular parameters). In cases where the NP – $\underset{[-\text{infl}]}{VP}$ constructions appear to be directly connected without the mediation of an overt predication marker, we would be forced to postulate a null predication marker of some sort, a costly (i.e. marked) option.

Thus, the central generalizations concerning the distribution of [±infl] (the finite-

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[21] Formally: $\alpha' = \lambda x \lambda y [\cup x(y)]$, where '$\cup$' is the inverse function of '$\cap$'.

nonfinite contrast) in English can be deduced from an abstract and very general hypothesis about the semantics of predication and the assumption that [− infl] (nonfiniteness) is the syntactic manifestation of the Fregean embedding function within the verbal system. This assumption is quite simple, even if it were to be stipulated. Presumably, if one were to embed the present theory of properties within a different theory of syntax, such a stipulation would be necessary. It is not needed, however, in the framework adopted here, where the nonfiniteness–Fregean embedding correlation can be derived from general properties of the grammar (such as the category-type mapping, compositionality, and the inability of propositional functions to be arguments).

5. Conclusions

If semantics exists, it must say something about the meaning of predicative expressions (properties) and their nexus to subjects (predication). Various general considerations strongly suggest that properties can in some sense be predicated of themselves (pace type theory). A Fregean approach allows for this by distinguishing two systematically interconnected modes of being for properties: as propositional functions and as individual images of propositional functions. First-order theories of properties grant them only the latter status, namely as individuals (see for example Bealer (1982, 85ff.)). If the Fregean approach is correct, one would expect the fundamental semantic contrast between propositional functions and individual correlates to play an identifiable role in the behavior of predicative expressions, that is, to manifest itself in a number of syntactic patterns.

I have argued that this is indeed what happens. Within the English nominal system, the behavior of mass nouns shows that the Fregean contrast can be encoded as a categorial one (NP vs. CNP). Within the verbal system, it can be encoded in whatever instantiates the finite vs. nonfinite contrast ([± infl] in English). This sets up a pool of parameters for the realization of the relevant semantic distinction that might be nearly exhaustive. However, I shall not pursue this here.

Four points are worth emphasizing. First, the hypotheses on the encoding of the nominalizing function are not stipulations, but the point of convergence of several independent considerations. Second, such hypotheses allow us to deduce fairly complex and differentiated patterns of predicative constructions from a few formal properties of the grammar. Third, the proposed theory of predication also claims that a number of classificatory principles for semantic domains are built into Universal Grammar, principles that have been seen to make certain interesting predictions (the Three-Layers Hypothesis, the functor-property asymmetries). Fourth, this theory not only accommodates what can be observed, but also rules out various a priori conceivable grammatical processes. By limiting the possible semantic processes, it also severely limits the possible syntactic processes.

Various aspects of my proposals might of course be falsified by future research. It might be, for instance, that the compositional implementation of the proposed theory of properties will have to be substantially modified, although I have argued that the opposite

is the case. Be that as it may, the considerations I have presented would still constitute evidence that logical (model-theoretic) semantics is not simply a way of spelling out truth conditions, possibly convenient but low in explanatory potential. On the contrary, its principled implementation in Universal Grammar is a valuable contribution to the investigation of the notion "possible human language."

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