Review article[1]

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Edward L. Keenan and Leonard M. Faltz: *Boolean Semantics for Natural Language*. Synthese Language Library 23. Dordrecht: Reidel, 1985. xii + 387 pp. US$54.00.

This book is a rare item among the linguistics titles of recent years: the attempt to present a formal treatment of a range of semantic phenomena which is broader than the scope of any other comparable work. In addition, it offers an analysis which correlates semantic phenomena hitherto treated separately, yielding some welcome generalizations. This comprehensive study, though, is presented in a rather idiosyncratic manner. A basically Montagovian model-theoretic framework comes along in the guise of yet a new notation devised by the authors; the object language is something in between the pidgin variety characteristic for the traditional Montagovian studies and some version of predicate logic; but, above all, there is hardly any discussion of relevant literature — despite the broad range of phenomena touched upon both by Keenan and Faltz (henceforth K&F) AND other authors. The idiosyncrasy of the work is a real drawback. The formalism and its complexity demand a degree of self-discipline on the part of the reader which will keep the number of fans low, and the lack of discussion of alternative analyses isolates an approach which is related to others in manifold ways. The book represents a very heterogeneous state of the art. Some traits of the general approach are new and promising, but others, in part at the very basis of the framework, have become questionable in the last years and are — in my view — bound to be generally abandoned sooner or later. I will start with a sketch of the general approach, add a brief survey of the content, and follow this with a discussion of the major problematic points.

The overall approach is of the Montagovian type in two major regards: (1) as a kind of axiom, syntactic and semantic structure are taken to be analogous (the meaning assignment is a homomorphism), (2) the object

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language is given an extensionalistic model-theoretic possible-worlds semantics. As a consequence of the first assumption, syntactic categories are assigned a fixed logical type of denotations and, accordingly, a fixed semantic role. In particular, K&F assume an invariable function–argument structure for, for example, NP-VP combinations. This point is not maintainable; at least it is a point which can and must be decided empirically rather than being settled in an *a priori* manner. There is quite a bit of work going on concerned with this question. The second feature of their approach, extensionalistic model-theoretic semantics, is likewise questionable. Instead of a primitive reference semantics — in fact a primitive semantics combined with an even more primitive implicit conception of reference — branches of semantic theorizing currently labeled as 'cognitive' are developing alternative and much more powerful ways to describe meanings as conceptual entities (see for example Bierwisch and Lang 1989). Some exemplary shortcomings of the extensionalistic approach will be pointed out below.

Works in the tradition of Montague's PTQ use an intermediate language of formal logic as the main tool of semantic description, some variant of intensional logic which is understood to be interpreted with a standard model-theoretic semantics. K&F, instead, discuss the semantics of a language which is neither ordinary English nor ordinary logic, but rather something in between. Their object language of 'logical forms' (LFs) is meant to be close to English surface forms (SFs), but the relationship between SFs and LFs is not explicitly defined. The LFs are taken to somehow represent the function–argument structure of some English surface forms, in some cases by means of typical logical tools like lambda operators. Morphological case marking and other syntactic subtleties such as focusing are largely neglected. Thus, strictly speaking, K&F's semantics is not a semantics of natural language but of the formal LF language they invent. In leaving the relationship between SFs and their 'LFs' open to imagination they weaken the one and only essential constraint which all semanticists agree on (more or less, at least): Frege's principle of compositionality. As long as it is not clear how to derive a LF from a SF, no systematic procedure is given for deriving the meaning of a complex SF from the meaning of its parts. (It doesn't even make sense to talk of LFs then.) Although K&F give mainly technical reasons for their method, the following quotation nevertheless shows that their real objective is different from the compositional assignment of meanings to expressions:

Fully specifying that function [that is, the function which would formally associate LFs with the English forms they are intended to represent; S.L.], however, would require that we enter many details of agreement and word order phenomena which are irrelevant to our principal goal of representing English meanings (p. 20).

— 'meanings AS SUCH' one might add. So, what K&F really do is not give a semantics of a fragment of natural language but explore certain regions of the semantic/conceptual space SOMEHOW associated with natural language.

What is new about K&F's approach is the systematic exploitation of the fact that for most syntactic categories of natural language the set of possible denotations/meanings forms a Boolean algebra: meanings can be combined by conjunction ('and') or disjunction ('or') or can be reversed to the contrary. This fact is syntactically reflected by the possibility of conjunction and negation of expressions from almost all syntactic categories as well as by meaning relations between lexical items which can be described in Boolean terms. Thus, for example, the meaning of the common noun *stallion* is the Boolean conjunction of the meanings of *horse* and *male*; the meaning of *impossible* is the Boolean reverse of *possible*; in terms of set-theoretic extensions, conjunction and reverse are intersection and complement, which are just other instances of Boolean operations. Obviously, the Boolean operations are a pervasive conceptual tool which should be given a central role in the semantic description similar to that of entailment. The latter, too, can be considerably generalized in Boolean terms. In every Boolean algebra there is a natural way to introduce a partial ordering relation which coincides with the classical logical concept of entailment in the standard cases and in general represents the relationship of relative informativeness: A is more informative than B if A is less than B with respect to that partial ordering.

The exploitation of the Boolean structure of meaning classes allows for the characterization of semantic subcategories in simple algebraic terms, and it turns out, indeed, that many basic semantic characteristics correspond to basic algebraic properties. The investigation of semantic phenomena in algebraic terms is a relatively new development in linguistic semantics, also pursued in the theory of generalized quantifiers, which apparently developed independently from the K&F approach but overlaps considerably in the essential points and results (see Gärdenfors 1987 for representative work on generalized quantifiers). Further work by Keenan and others in the K&F framework concentrates on this area (see for example Keenan and Moss 1985; Keenan and Stavi 1986; Keenan 1987a, 1987b, 1987c; but also Keenan and Timberlake 1985; Keenan 1987d for work on other subjects). The study of the basic algebraic structures of semantic fields is a promising new line of investigation: if there are any mathematical conceptions relevant to the description of natural-language meanings, then certainly the conceptions of Boolean algebra and lattice structure (a weaker structure which is part of any Boolean structure) are among them. It is, however, by no means necessary to pursue this kind of question within the corset of a Montegovian framework.

The book consists of two major parts, the first and main part being 'The extensional logic' (pp. 31–271), followed by a second part, 'The intensional logic' (pp. 272–376). A 30-page overview introduces the reader to the general conception and constitutes a very useful chapter which conveys an idea of the overall endeavor in an informal way before the reader is expected to enter the *macchia* of 350 pages filled with thorny formalism. The main body of the book is a successive definition of the LF language and its semantics, starting from a core language introduced in the first half (A) of the first part (pp. 31–117), which covers the core categories N, NP (called $\overline{\text{N}}$ in K&F), Det, S, VP, and transitive verb phrases. I will not discuss the syntax of the LF language, which is by and large an orthodox Montague syntax, but concentrate on the semantic issues. The interpretation of the core language is characterized by the unusual decision to do predicate logic without a universe of individuals, a step which the authors apparently consider a major improvement but which actually is more than problematic, as I will argue below. The semantics in the first part is extensional. Sentences are assigned one of the two truth values 0 and 1, which together form the most simple Boolean algebra possible. Apart from this algebra there is another elementary algebra T_N of possible noun denotations. The elements of this algebra are called 'properties'. Nothing is said about the character of these objects. In standard predicate-logic semantics, one-place predicate constants, which normally correspond to natural-language common nouns, are interpreted either as sets of individuals or as functions from a universe of individuals into the set of truth values. In either case, the resulting algebra of properties is related to the algebra of sentence meanings, the former being parameterized versions of the latter. Under the K&F approach, however, there is no connection between the first-order objects called properties and truth values. Strictly speaking, there is no reason to call these entities properties except that they serve as common-noun denotations; from a logical point of view, they might as well be anything else. (Apart from that, it doesn't even fit common sense to take N EXtensions to be properties; in the Montague tradition it is rather the INtensions of Ns that are considered properties.) As a whole, in part for technical reasons, the algebra of properties has to fulfill certain conditions: K&F require it to be a complete atomic algebra. An algebra is atomic if

(1) there is a set of atoms included in the algebra, where atoms are elements of maximal informativity, different from the zero element (in this case the impossible property), which have nothing in common with each other, and if (2) for any nonatomic element in the algebra there are atoms which are less than, that is, entail, that element. If one thinks of N denotations as sets of individuals, then the atoms are exactly the sets with one element; one property (that is, set) is more informative than another iff it is included in that set; thus the singleton sets are the maximally informative sets, as they do not possess any nonzero proper subsets. Needless to say, any arbitrary nonzero set includes one or more singleton sets. An algebra is complete iff the conjunction and disjunction of any arbitrary (possibly infinite) number of members of the algebra belongs to that algebra, that is, if the algebra is closed under infinite conjunction and disjunction. The set of all subsets of the universe, including the empty set and the universe itself, forms a complete algebra, but completeness is not a necessary or trivial property of Boolean algebras. In fact, it can be shown that an algebra is complete and atomic iff it is isomorphic to a power-set algebra (see K&F: p. 65 f). Thus, though 'eliminating the universe', K&F impose the very same algebraic structure on the set of N denotations as they would if they were to define it in the usual way.

In the usual Montagovian manner Dets combine with Ns to form NPs; semantically they operate on properties to yield sets of properties, that is, second-order predicates/properties (or quantifiers). Among the resulting NP denotations a certain subclass of 'individuals' can be characterized algebraically. Intuitively the individuals are the sets of all properties which 'apply' to an individual member of the eliminated universe: if N denotations are sets of individuals, then K&F's individuals are those sets of sets which consist of all supersets of a singleton set. (This is the way proper nouns and pronouns are usually treated in extensional Montague semantics.) Formally, the K&F individuals, henceforth *Individuals*, are those sets of properties which consist of all properties 'entailed' by a certain atom. There is a 1–1 correspondence between those Individuals and the atomic properties, but they are not identical. The atoms are first-order predicates, the Individuals second-order. N denotations, though called 'properties', are never *applied* to anything. The only thing they do is appear as members of NP denotations (that is, of sets of 'properties).

VPs are usually assigned the same logical type as common nouns. K&F, however, have decided to treat them as third-order predicates, taking NP denotations, that is, quantifiers, as arguments. As this interpretation reverses (in most cases) the roles of functor and argument — normally, in NP–VP combinations the noun is the functor that takes the VP as its argument, at least if NPs are in general analyzed as quantifiers

— K&F have to postulate that VP denotations are homomorphisms. As a result, the combination of NP and VP behaves semantically as though the VP were the argument of the NP. K&F not only have to postulate a special status (homomorphism) for VP denotations but they also explicitly require that the VP denotations are essentially defined on the Individuals, that is, in exactly the usual way, except for the artificially complex conception of individuals. They even prove that the algebra of VP denotations is isomorphic to the algebra of properties: the two algebras could easily be identified as is customary in model-theoretic semantics. Yet K&F insist on the formal difference. This decision is as counterintuitive as it is semantically unfounded, and K&F fail to produce any really convincing arguments for such a peculiar step. A possible argument for such a step could only be provided by the existence of verbs which express genuine quantifier properties which cannot be applied to individuals. Such verbs do not exist. (The problems of collective predicates which K&F mention later can be solved by introducing a lattice structure in the universe of discourse or, equivalently, by giving up the atomicity of the property algebra.) While the elimination of the universe appears to be at least subjectively motivated by the desire to render all denotation sets Boolean algebras, I can't see any reason for the choice of such queer objects as third-order predicates as denotations of the most elementary words of natural languages. Apart from this, there are serious technical problems with the step which will be pointed out below.

There is one advantage which the authors claim for their analysis: the possibility of characterizing syntactic categories in general as 'argument categories', 'predicate categories', and 'modifier categories'. Predicate categories, they say, correspond to algebras of homomorphisms. But, as we have seen, this correspondence is artificial. Argument categories are characterized as corresponding to algebras which have the structure of the power set of a power set, or, the set of second-order properties. If anything, such algebras are not the denotation sets of ARGUMENT categories but of QUANTIFIER categories. Again, this treatment of the 'argument category' NP is not the only analysis possible. Thus the category characterization proposed by K&F does not say so much about what these categories are like but rather how K&F choose to treat them.

The second half of the first part (pp. 118–271) is devoted to the analysis of a comprehensive range of additional syntactic categories: adjectives and verb modifiers, predicatives (that is, all sorts of NP-taking operators, such as adjectives and nouns with additional arguments, prepositions, ditransitive verbs); the semantics of passives is discussed, the category Det is extended, and some logical devices such as reflexivity and lambda operators are introduced. Different subcategories of adjectives can easily be distinguished in algebraic terms as being restrictive, intersective, etc. A new contribution is the analysis of scalarity, including proposals for the description of *very* and the comparative. Some adjectives, those which are nontransparent, cannot be treated extensionally and are therefore left to the intensional part. Adjectives are given the type of functions from properties to properties, representing the first occurrence of a modifier category. This type assignment is traditional in Montague grammar. More recent analyses, however, in particular Bierwisch and Lang (1989), simply propose assigning a property type to adjectives.

Predicate modifiers, adverbs and adverbials, are discussed at some length (pp. 150–177), although with little benefit except for the feeling that there is something wrong with the extensional approach to these phenomena. The section about 'predicatives' (pp. 177–202) adds several categories of expressions to the object language, such as NP-taking nouns, three-place verbs, and prepositions. The extension is mainly technical in nature. One remark by K&F about functional nouns like *sex (of)*, *temperature (of)* reveals a rather strange idea about the role of 'ontologies' in the semantic description:

> ... *edge of the plate*, *sex of the President*, *temperature of the patient* ... such expressions seem not to denote properties of individuals. Moreover if they did, we would be forced to say that e.g. the sex of the President, the temperature of the room, etc. could denote individuals, and thus perhaps even be things like John, or you, or me etc. This seems ontologically dubious at best (p. 190).

Apparently, K&F feel obliged to adhere to some intuitive 'ontological' conception of individuals, which typically seem to be persons (why not also tables, and, if tables, edges of tables etc. — where is the borderline to be drawn?). This is not the way to do natural-language semantics; any *a priori* ontology is nothing but an arbitrary external constraint on the range of possible interpretations. The relevant 'ontology' is inherent in the object language, and it is an exciting task of cognitive linguistics to reveal the ontological presuppositions underlying the way language is used. To give just one example: whether something 'is an individual' is not a matter of being like you and me or Keenan and Faltz but rather of being an argument of a first-order predicate. Individualhood is not a sortal property but a well-defined LOGICAL ROLE.

The chapter about passive (pp. 202–227) contains some interesting aspects. While the analysis of standard passives is rather conventional (saturation of the dropped argument place by existential quantification), K&F offer generalizations of the corresponding semantic concept to other cases such as prepositions and two-place nouns and adjectives. Determiners are the subject of the following section (pp. 227–249). New determiners — most of them complex expressions — are added and subcategories are defined under the perspective of the theory of generalized quantifiers. This section, which is linked to a lot of other work by Keenan and others (see references), offers the most profound results in the book, and at the same time it is the part where the above-mentioned objective of the whole enterprise becomes most apparent: what K&F are interested in is the structure of the semantic spaces associated with the categories of natural language, rather than the analysis of word meanings and the mechanisms of meaning composition. Under the latter perspective, one would not treat complex expressions such as *between six and ten*, *more than half the*, or *more ... than ...* as if they were basic determiners, but would rather try to explain their meaning compositionally.

In the last major section of the extensional part (pp. 250–267) the object language is completed by formal devices which allow quantifying-in, relative clauses, and certain reflexive constructions. Part 1 concludes with a few remarks about apparent nonhomomorphic predicates, essentially collectives, which cannot be treated along the lines developed.

The idiosyncrasy of K&F's presentation finally culminates in the second part about intensional semantics. Instead of intensionalizing the whole language, K&F try to confine intensionality to those categories and subcategories where nontransparent semantics are necessary. The resulting system, however, is very complex and heterogeneous, and as van Benthem points out in his review of K&F (to appear in *Language*), it is not even clear how the basic concepts of extensionality and intensionality could be defined with respect to that system. Intensions, where they are defined, are functions from some index set to the former denotation sets. The sets of intensions for certain categories do not form Boolean algebras but are rather divided into several distinct algebras with distinct structure; thus, for example, both extensional and intensional verb intensions form an algebra of their own. Such consequences of the analysis are hardly to be preferred to a Montague-type description, which has all verbs in principle intensional, the extensional verbs representing some well-defined kind of exceptions. The range of phenomena treated includes adjectives, prepositions, and sentence-taking predicates. K&F distinguish two sentential categories, S and $\bar{S}$, the latter being an argument category like NP, that is, a category associated with a complete atomic algebra of meanings. (By the way, it is rather painful to read — *horribile dictu* — fifty times or so *de dictu* instead of *de dicto*. Somebody among the many persons handling the book should have noticed that.)

Thus far the contents of the book. I must confess that I disagree with most of the analyses offered. But I will confine my criticism to two major points of more general interest: the (non)arbitrariness of semantic representation and what I would like to call extensionalism.

The book is an elaborate version of Keenan and Faltz (1978), which already contained the basic conception, including the treatment of VPs as functors on NPs. This treatment was vigorously attacked by Ballmer (1980), who showed that it is impossible to keep to a fixed assignment of the functor and argument roles for the VP and NP, respectively. Faltz (1982) replied to the criticism but didn't manage to prove the contrary, as Ballmer (1982) was able to demonstrate. Yet K&F stuck to their analysis, without even mentioning the debate with Ballmer in their 1985 version.

When Montague introduced the uniform quantifier treatment of NPs (thereby giving the VPs argument status) and K&F decided to treat the VP as a third-order predicate (giving it functor status), they apparently felt free to choose any type assignment whatsoever as long as it yielded a functor–argument combination of sentential type and the correct logical entailments. The problems with this procedure is that there ARE criteria for deciding the functor or argument status in such cases, that is, the type assignment and, more generally, the semantic description is NOT only constrained by the criterion of logical correctness. Let P be a first-order predicate, that is, a functor that yields a sentence when combined with an individual expression or *term*. Let T be such a term. On the other hand let Q be a (generalized) quantifier, that is, a second-order predicate that takes a first-order predicate as argument, likewise yielding a sentence. In the sentence *P(T)*, P is a functor; in the sentence *Q(P)*, P is an argument. Now, if we consider a NP–VP sentence and assume that the VP represents a first-order predicate like P above, how can we decide whether the VP is functor or argument, or, equivalently, whether the NP is a term or a quantifier? (The point is that it makes sense to ask what the NP status really IS — the type assignment is not merely a technical problem!) The answer is simple, and there is no framework which is more appropriate for that purpose than K&F's. Predicates — to be precise: predicate denotations — form a Boolean algebra with respect to the operations of pointwise negation and conjunction. The negation of a predicate P, *not-P*, yields the opposite truth value for every argument, and the conjunction of two predicates P and P′, say *P-and-P′*, is true of an argument T iff P is true and P′ is true; *not-P(T)* is defined as *not P(T)* and *P-and-P′(T)* as *P(T) and P′(T)*. Quantifiers, as second-order predicates, define another Boolean algebra, again with respect to pointwise negation and conjunction; this time, however, the arguments are not individuals but first-order predicates. The negation of a quantifier Q assigns the opposite truth value for every predicate argument, and the conjunction of two quantifiers applied to a predicate yields a true sentence iff both quantifiers separately do so. However, if a quantifier is applied to the conjunction of two predicates, the result is not the same as the conjunction of the application of the quantifier to each predicate separately: *Q(P-and-P′)* is different from *Q(P) and Q(P′)*. Likewise, for the well-known distinction between inner and outer negation, *(not-Q)(P)* or equivalently *not Q(P)* is normally not the same as *Q(not-P)*. The criterion, thus, is simple. If an expression X yields a sentence when combined with a predicate P, then X is the argument of the predicate if and only if the combination *X+ (not-P)* is logically equivalent to *not(X+ P)* and the combination *X+ (P-and-P′)* to *(X+ P) and (X+ P′)*. If one of the conditions is violated, then X is a functor (in fact a quantifier) which takes the predicate as an argument.

K&F are aware of this criterion; they even prove formally that there are no genuine quantifiers besides those corresponding directly to individuals, if the algebra of first-order predicates is complete and atomic (p. 76). However, they do not recognize the relevance of the criterion for their ontological outset because they do not draw their ontology from an analysis of language but from pretheoretic intuitions. If one applies the argument criterion, it turns out that the category of NPs does not represent a uniform logical type: definites are arguments of the VP, while genuine quantifier NPs such as *every student* take the VP as their argument (see Löbner 1987 for details). We therefore NEED a universe of individuals for the denotations of definite NPs but also an algebra of quantifier denotations. The only way to deal with both types (and in fact with a third yet different type for indefinites, which represent first-order predicates) is to treat VPs as first-order predicates. It is easy enough to cope with the type differences for different subcategories of NPs: the way the VP combines with the subject to yield the sentence meaning is governed by natural type-combination principles. The natural way to combine a first-order predicate with an individual expression is to take the latter as the argument of the former, whereas a predicate combines naturally with a quantifier iff the predicate is taken as the quantifier's argument. Given this perspective, the role of syntax is not to fix the function–argument structure of the sentence but only to mark SOME relationship between semantically interacting constituents.

The argument criterion can also be used to show that the third-order treatment of VPs is inadequate. The logical behavior of quantifier–verb combinations clearly proves that the predicate contained in the verb is the argument of the quantifier and not the other way around. K&F know that, but instead of accepting the consequence and accordingly assigning VPs the type of first-order predicates, they postulate a constraint that VP denotations be homomorphisms — which has exactly the effect that they are functors that behave like arguments of their arguments. (And K&F even dare to use the homomorphism property as a characteristic criterion for 'predicate categories'.) Apart from all this, the analysis does not even work and, in fact, cannot work. It only works with NPs for which the quantifier meaning can be defined in Boolean terms, that is, NPs which are essentially terms or quantificational NPs expressing the standard logical quantifiers such as *for-all.* For these NP meanings the homomorphism postulate yields the correct results, but the mechanism does not work at all for nonlogical quantifier NPs such as *many N* or *most N* since the semantic operations corresponding to *many* and *most* are non-Boolean and simply not covered by the homomorphism constraint (*every*, in contrast, is covered, as it represents generalized Boolean conjunction). As it turns out, the VP treatment is not only methodologically but also logically inadequate.

When compared with theoretical syntax, Montague semantics has always suffered from a certain image of arbitrariness. The formal apparatus is so powerful that an analysis within that framework doesn't say much about what natural-language semantics is really like as long as semantic theorizing is not committed to stronger constraints than just logical adequacy. One powerful constraint could be provided by the demand that the logical structure of complex natural-language expressions be preserved by the semantic description, regardless of any pretheoretical decisions to treat all NPs in the same way or to eliminate universes.

The second major point which I consider problematic is extensionalism. Although they claim to eliminate the universe, K&F use the eliminated individuals as their main model basis. VP denotations as well as N denotations are essentially sets of individuals; VP modifiers are functions from sets of individuals to sets of individuals. This is good old Montague tradition, but it is as wrong as it is old. Consider for example a VP modifier such as *skillfully* (discussed at some length in K&F). Taking it as a modifier of a first-order predicate to be described in terms of extensions, that is, sets of individuals, K&F first observe that it is restrictive: the resulting set of individuals is a subset of the set of individuals corresponding to the bare VP. The question arises, then, what the function which yields the smaller set from the bigger one is like. It turns out that the function must be nontransparent. There is no simple way to reconstruct the restriction. One way, for example, could be to find a corresponding property (set) such that the resulting set is the intersection of the VP denotation and that property. Taken extensionally, there is such a set, in fact there are many such sets in every particular case. But there is no way to assign any such property coherently to the modifier *skillfully.*

This is a strange consequence in light of the fact that the adjective *skillful*, on the other hand, is treated by K&F as a transparent adjective. How can the same word have a transparent and a nontransparent meaning depending on its syntactic position? The reason that the adverb analysis does not work is simply that the verb analysis is wrong. The extensional approach takes the set of agents involved in a situation of the kind specified by the VP as the extension of the VP. But the agent is only one parameter of the situation, a further, more central one being the event (or situation) itself. As an adverb of manner, *skillful(ly)* expresses a property of the event itself and not of the agent, and it is transparent in the very same way as in its adjectival use. Examples like this show that it is inadequate to try to capture the meanings of verbs or VPs in general just by looking for the sets of agents. In another case treated by K&F the extensional approach appears even more absurd: their treatment of locatives. Locatives like *in the park* taken as VP modifiers (a very arguable position, by the way — in many cases discussed by K&F the locative PPs appear rather to be something like free-floating predicates) yield a Boolean algebra which is ultimately isomorphic to the set of N denotations. This algebra thus has to be complete and atomic, the atoms corresponding to individuals. But locative meanings are simply not atomic. If anything is at a certain location, then any proper parts of that thing are also at the same location. If, for example, Ed Keenan is at the atomic location corresponding to himself, his head is there, too. Thus, the location is NOT atomic because there is apparently another object, different from Ed Keenan, which is also where he is. (There is absolutely no reason to exclude Ed Keenan's head from the universe, even if the authors intend to eliminate the universe altogether.) The impossibility of treating locatives in this way is due to the fact that locatives as predicates are not count predicates but homogeneous in the same way that mass nouns are. Accordingly, the corresponding property algebra is nonatomic.

The two points made so far could probably be remedied somehow by introducing appropriate types for verbs and PPs. There is, however, a more serious objection against extensionalism. K&F first define extensional models for those parts of the language which appear to allow it and then intensionalize their semantics by introducing a world parameter, reconstructing meanings as functions from some index set to the former extensions. Apart from the fact that it is impossible to define the index set properly, there is abolutely no constraint on the functions which serve as intensions. Noun intensions, for example, in the K&F models have intensions which assign a 'property' (presumably a subset of the eliminated universe) to every index. But there is nothing to prevent a N meaning from assigning the property 'cap' to one index, the property 'car' to the next, and the property 'cat' to a third index. And what is worse, it is not even possible to formulate any such constraint on intensions, since in the set-theoretical setting used in K&F and elsewhere any old set of pairs of indices and possible denotations is a legitimate intension. This is the extensionalism one buys with set theory. Mathematics has chosen to ban anything 'intensional' or 'conceptual' from the range of objects to be treated, a decision which is relatively recent — Frege still distinguished between concepts and their extensions, but Cantor won. Extensionalism, however fruitful it may be for the mathematical enterprise, appears to be the wrong kind of abstinence for semanticists. There is no way to infer from extensions to intensions, no way to imagine that any human being carries around sets of ordered pairs of worlds and denotations in his head as the meanings of the words he knows, no way to explain how it is possible to know what a sentence means without knowing if it is true. To start from the extensions is to put the cart before the horse. Rather than extensions, it is INtensions which are primary, and extensions are inferred from the knowledge of intensions and the knowledge of relevant facts about the world. Intensions could be modeled as mental procedures which, provided with the relevant input information, yield results of a certain kind. Common-noun meanings, for example, would be procedures which yield a binary result when fed with the relevant information about an individual. THIS would be a plausible sense in which common-noun meanings concern properties.

One advantage of the Keenan and Faltz's approach which makes it promising is the fact that its Booleanism can be adopted for almost any kind of semantic framework, including alternative intensionalistic systems. In fact, in my view, what makes their approach interesting after all — despite the ballast they carry along — is their contribution to the CONCEPTUAL analysis of natural language rather than the fact that they have managed to widen the scope of model-theoretic Montague-style semantic description.

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References

Ballmer, Thomas T. (1980). Is Keen an' Faltz Keen or False? *Theoretical Linguistics* 7, 155–169.

—(1982). The answer is: as Faltz as Keen(an). *Theoretical Linguistics* 9, 247–274.

Bierwisch, Manfred, and Lang, Ewald (eds.) (1989) *Dimensional Adjectives: Grammatical Structure and Semantic Interpretation*. Language and Communication Series 26. Berlin, New York, Heidelberg: Springer.

Faltz, Leonard M. (1982). On the non-Bal(l)m(i)er character of Keenan-Faltz grammar. *Theoretical Linguistics* 9, 221–246.

Gärdenfors, Peter (ed.) (1987). *Generalized Quantifiers: Linguistic and Logical Approaches*. Linguistics and Philosophy Series 32. Dordrecht: Reidel.

Keenan, Edward L. (1987a). Unreducible n-ary quantifiers in natural language. In *Generalized Quantifiers*, P. Gärdenfors (ed.), 109–150. Dordrecht: Reidel.

—(1987b). Lexical freedom and large categories. In *Studies in Discourse Representation Theory and the Theory of Generalized Quantifiers*, Jeroen Groenendijk, Dick de Jongh, and Martin Stokhof (eds.), 27–52. Groningen-Amsterdam Studies in Semantics 7. Dordrecht: Foris.

—(1987c). A semantic definition of 'indefinite' NP's. In *The Representation of (In)definiteness*, Eric Reuland and Alice ter Meulen (eds.), 286–317. Cambridge, MA: MIT Press.

—(1987d). Semantic case theory. In *Proceedings of the Sixth Amsterdam Colloquium April 13–16, 1987*, Jeroen Groenendijk, Martin Stokhof, and Frank Veltman (eds.), 109–132. Amsterdam: Institute for Language, Logic and Information, University of Amsterdam.

—, and Faltz, Leonard M. (1978). *Logical Types of Natural Language*. UCLA Occasional Papers in Linguistics 3. Los Angeles: UCLA.

—, and Moss, Larry (1985). Generalized quantifiers and the expressive power of natural language. In *Generalized Quantifiers in Natural Language*, Johan van Benthem and Alice ter Meulen (eds.), 73–124. Groningen-Amsterdam Studies in Semantics 4. Dordrecht: Foris.

—, and Stavi, Jonathan (1986). A semantic characterization of natural language determiners. *Linguistics and Philosophy* 9, 253–326.

—, and Timberlake, Alan (1985). Valency affecting rules in extended categorial grammar. *Language Research* 21, 415–434.

Löbner, Sebastian (1987). Natural language and generalized quantifier theory. In *Generalized Quantifiers*, P. Gärdenfors (ed.), 181–201. Dordrecht: Reidel.