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THE SEMANTICS OF NON-BOOLEAN "AND"[1]

JACK HOEKSEMA

ABSTRACT

The meaning of "and" in noun phrase conjunctions differs from its ordinary Boolean interpretation in other cases of conjunction, such as sentential and predicate conjunction. More precisely, this is the case when the noun phrases conjoined are referrring terms. A regular Boolean interpretation is still possible whenever two or more quantificational NPs are conjoined. Disjunction is always a Boolean operation. A semantics based on the notion of set formation is provided to deal with conjunctions of referring terms and compared to other proposals in this area, such as Link's lattice-theoretical approach. The present proposal has certain advantages, including the fact that it does not require conjunction to be an associative operation.

1.

In this paper I present an approach to noun phrase conjunction which I view as a natural development of the account given in an earlier paper of mine, called "Plurality and Conjunction" (Hoeksema 1983). Some aspects of that earlier paper were unsatisfactory, and are revised here; furthermore, some general conclusions are drawn concerning the ontology of natural language. Although this paper, like its predecessor, concentrates on the semantics of conjoined noun phrases, it has clear implications for the general theory of plurality which has been emerging in the works of Godehard Link, Remko Scha, David Dowty, Jan Lønning, Fred Landman, Craige Roberts, and a good many others. I will point out some of these implications at appropriate points. The analysis proposed here is indebted to earlier work by Partee and Rooth and van Benthem on type raising.

2.

One of the interesting features of noun phrase conjunction is that it does not always behave in a Boolean manner. The algebraic approach to the semantics of the coordinative connectives of English originated by George Boole in his 1854 book *An Investigation of the Laws of Thought* and carried out more recently in great depth in Keenan and Faltz' (1985) opus *Boolean*

Semantics for Natural Language has been surprisingly fruitful. The logic of the sentential connectives *and, or, not* has been generalized by Keenan and Faltz, Gazdar (1980), and others to nonsentential categories in the obvious way, by associating these categories semantically with boolean algebras. For example, verb phrases can be interpreted as members of some boolean algebra (let us say, of "properties") since all the laws which hold for sentential connectives appear to be valid here as well. Among other things, we have commutativity: *walk and talk* is equivalent with *talk and walk*, associativity: (*eat and drink*) *and be merry* is equivalent with *eat and* (*drink and be merry*) and idempotency: *sleep and sleep* is equivalent to *sleep*, if we ignore the more emphatic nature of the former expression. The laws of Boolean algebra can also be seen at work in the case of coordination and negation of adjectival, adverbial and other modifiers, relative clauses, sentential complements, and so on.

Nevertheless, some descriptive problems remain for the Boolean account of coordination. In particular, it is well known that conjunctions of proper names, definite descriptions, and existential quantifiers do not behave according to general Boolean principles. For example, (1) does not entail (2):

(1) Henry and Lynne drank all my liquor.
(2) Henry drank all my liquor.

Yet normally we can replace a conjunction by one of the conjuncts without changing the truth-value, as in (3):

(3) Henry ate and drank.

Henry drank.

This observation is commonly related to the fact that the conjunction of two singular terms usually counts as a plural term in English, cf. (4):

(4) A man and a woman {were/*was} arrested.

Again, this is a non-Boolean property, since in general the Boolean operations do not change the category of their arguments. However, as was noted in Hoeksema (1983), certain singular quantifiers are exceptions to this pattern. Sentences such as:

(5) a. Every day and every night was spent in bed.
b. Every man but no woman was upset.
c. No peasant and no pauper was ever President.
d. Many a day and many a night has passed by.

are perfectly acceptable, even though their verbs are singular.[2] Perhaps not entirely surprisingly, in these cases the conjunction obeys the Boolean "laws of thought".[3] So, for instance, (7) entails (8):

(7) Every man and every woman solved the crossword puzzle.
(8) Every man solved the crossword puzzle.

When we replace *every man* by a proper name, say *Tim*, and *every woman* by *Grace*, say, no such implication is valid. Given these facts, the question arises which noun phrases behave like the proper names[4] and which behave like *every man* or *no woman*, and why they show this behavior. I believe there is a systematic account for these facts, based on the semantic properties of the noun phrases involved. Most if not all other accounts of conjunction that I am aware of either fail to note these facts or would have to treat them as cases of arbitrary variation.

3.

In Hoeksema (1983), I made use of the theory of generalized quantifiers to provide a formal characterization of the class of expressions which behave essentially like proper names with regard to conjunction. A generalized quantifier can be construed, among other things, as a second-order predicate, denoting a collection of sets. For instance, the denotation of *no angel* is taken to be the collection of all sets of individuals which do not contain any angels, and likewise the denotation of *every Mormon* is the collection of all sets of individuals to which every Mormon belongs, etc. Many linguistically important classes of noun phrases can be characterized in terms of the formal properties of these collections of sets, such as closure properties, minimal members, and the like. The noun phrases which pattern with proper names in conjunction always denote collections of sets whose minimal members are singleton sets. I have called such noun phrases *atomic*. Consider now the following definitions in the manner of Barwise and Cooper (1981):

(9)
$$\|\text{John}\| = \{X < E: j \in X\}$$
$$\|\text{the Pope}\| = \{X < E: \|\text{pope}\| \subseteq X \;\&\; \text{Card}(\|\text{pope}\|) = 1\}$$
$$\|\text{a doctor}\| = \{X < E: \|\text{doctor}\| \cap X \neq \emptyset\}$$
$$\|\text{no doctor}\| = \{X < E: \|\text{doctor}\| \cap X = \emptyset\}$$
$$\|\text{every angel}\| = \{X < E: \|\text{angel}\| \subseteq X\}$$

Proper names are atomic, since their denotation has a single minimal element in every model, namely the singleton set of the individual we are talking about. For singular definite descriptions, we have the same result, albeit that here we may have different singletons in different situations. In the case of ‖a doctor‖, there can be more than one minimal element, but every minimal element must be the singleton of a doctor. In the jargon of Boolean algebra, the first two cases illustrate ultrafilters, and the third one a union of ultrafilters. An atomic quantifier, then, denotes a union of ultrafilters at every model. In the case of ‖no doctor‖, there is a single minimal element, the empty set. Since the empty set is not a singleton set, *no doctor* is not atomic. Finally, ‖every angel‖ has as its minimal the set of angels. This could be a singleton set, in which case ‖every angel‖ = ‖the angel‖. However, the minimal member is not a singleton in every model, and so *every angel* does not qualify as an atomic quantifier. Having made these semantic observations, one can proceed to give an interpretation for *and* which distinguishes the two classes of quantifiers. This is what I did in my (1983).

4.

A more interesting account would also give some independent reason *why* natural language conjunction is sensitive to the distinction between atomic and nonatomic quantifiers. Within the Montagovian tradition, in which NPs are always viewed as second-order predicates, such an independent reason is not forthcoming, since the domain of interpretation for NPs has a uniform Boolean structure and it seems mysterious why that structure is not used for all cases of conjunction. Another problem with my previous account is that it seems odd that conjunction should be sensitive to an essentially intensional property like atomicity. The Boolean connectives have always appeared to be among the most clearcut cases of purely extensional operators. Now we must abandon that view, it appears. Yet intuitively, *and* is not at all similar to modal operators such as *necessarily* or *possibly*.

A deeper explanation is arrived at when we return to an older view, according to which the singular terms we have called atomic quantifiers denote not quantifiers, but individuals (that is, elements of type e, in Montague's terminology), rather than second-order properties (which have type ⟨⟨e,t⟩,t⟩). As pointed out in Partee and Rooth (1983), there is no reason to assume that the domain of individuals is a full-fledged Boolean algebra, and so there is no reason to expect that the Boolean connectives have their regular Boolean interpretation in this domain. It is intuitively natural to assume that individuals do not have complements and that there are no disjunctive individuals. This does not mean, of course, that the domain of individuals has no structure whatsoever. (On the contrary, we shall assume, with Link, Landman, and others, that the domain of individuals is endowed with a part-of relation, but more about that later.) Interpreting proper names and definite descriptions as individuals should not seem problematic or perverse. The case of singular indefinites like *a nurse* or *some doctor*, however, is not quite as clear-cut, since the Fregean tradition treats them as existential quantifiers. While it might appear that it would fly in the face of a whole logical tradition to treat singular indefinites as referring expressions, the situation is actually not that hopeless, give the recent emergence of a new approach to indefinites in work by Hans Kamp and Irene Heim (cf. e.g. Kamp (1981), Heim (1982)). This approach, referred to by Kamp as *Discourse Representation Theory* and by Heim as *File-Change Semantics*, makes crucial use of the assumption that indefinites are not quantifiers, but variables. The main advantage of this new theory is that it offers a more explanatory account of donkey-sentences and discourse anaphora. According to this point of view, indefinites do not refer to a specified member of the universe, but rather to a so-called "discourse referent" or place-holder. Since such place-holders may correspond to more than one real object, we get the quantificational flavor of indefinites back, but in an indirect way. For my purposes, it is not necessary to dwell on the details or the motivation of this theory. Its most important aspect, from the point of view of this paper, is that it treats the noun phrases *Ronald Reagan*, *the President*, and *some White House cowboy* on a par as referring expressions. The manner in which they refer, to be sure, is different in each case, but none of them has quantificational force at the level of discourse representation. In this respect, they differ crucially from such noun phrases as *every monkey* or *many a bookworm*.[5]

5.

Now that we have established that there is a basic distinction between referring terms on the one hand and quantified noun phrases on the other hand with regard to their semantic behaviour in conjunctions, let us consider exactly how this difference works out in a formal system. The basic model I assume is a structure ⟨E, { },‖.‖⟩, where E is a set of entities closed under the operation of group formation (indicated here by { }) and ‖.‖ is the interpretation function. Groups are defined as sets with two or more members. We can think of E as being constructed from a set of basic individuals I by letting E be the closure of I under group formation. It is clear that even if I is finite, E will be infinite, since we can iterate group for mation, using the same basic elements: if a,b in I, then {a,b} in E, and {{a,b},a} in E and {{{a,b},a},a} in E, etc. In Hoeksema (1983) I proposed to allow only groups which can be derived from I by a finite number of applications of group formation, since presumably we don't need anything more.

Before I say more about groups, let me briefly dismiss what I consider to be a red herring. Link (1983) has argued against using sets as denotations for plural objects because sets are abstract objects, yet the denotation of a plural NP like *my parents* is not abstract at all, but very concrete. Instead, he proposes to use sums, which are supposed to be as concrete as their parts. With Landman (1987) and Cresswell (1985), I fail to see why sets are more abstract than individuals or sums. If I kick or kiss my parents, have I, in doing so, touched a set or a sum? It seems rather arbitrary to make any exclusive choice here. While certain sets undoubtedly have to be viewed as purely abstract objects (i.e. many mathematically interesting sets such as the set of all real numbers or the power set of the irrational numbers), there is no compelling reason, it seems to me, to restrict the notion "set" to abstract objects and to use a different term for collections of concrete objects. Note also that Link's sums have the same problem as sets, in that they are sometimes concrete ("Ronald and Nancy") and sometimes abstract ("the square root of 2 and the cardinality of Q").

Returning to the main topic, it is straightforward to interpret a conjunction of referring terms as denoting group formation of the entities referred to. If "Adam" refers to individual a and "Eve" to individual b, then "Adam and Eve" refers to the group $\{a,b\}$. This kind of conjunction is non-Boolean, since group formation is not a Boolean operation. Depending on its proper parsing, a noun phrase such as *Tom and Dick and Harry* could correspond to any of the three groups in (10):

(10) a. $\{t,d,h\}$
b. $\{\{t,d\},h\}$
c. $\{t, \{d,h\}\}$

If NP-conjunction were a Boolean operation, these three interpretations would be equivalent. In the present framework, all three groups are distinct. For more discussion of this, cf. Section 7 below. I note also that conjunctions of plural referring terms are interpreted in exactly the same way as conjunctions of singular terms. For instance, the NP *the Democrats and the Republicans* denotes a group of two groups, just as *the President and the Secretary-of-State* denotes a group consisting of two individuals. It is important to distinguish such cases of reference to a group from cases of quantification over the members of that group, as in *every Democrat and every Republican*.

6.

Interesting mixed cases of reference to groups and quantification over their parts are partitive constructions like *every one of the Republicans*. The partitive construction directly exploits the part-of relation between groups and their members. In fact, they use more than we have considered so far, because they can also be used with mass-determiners, in which case they also make use of the part-of relation between individuals and their proper parts, which I have not mentioned so far. It seems to me that the object of partitive *of* must be a referring term, and cannot be a quantified noun phrase. So we have partitives such as *most of the cake* and *some of the boys*, but not **three of no boys* or **seven of every student*, where partitive *of* is followed by a quantificational noun phrase.[6] Count determiners only cooccur with group-level entities, whereas mass determiners can also cooccur with individual-level entities. So we have *several of the cakes* and *three of the women* but not **several of the cake* or **three of the woman*, for obvious reasons. There is an interesting distinction here between mass determiners and count determiners with respect to quantifiers. As I said, partitive *of* appears to select referring terms, not quantifiers. However, when the determiner is a mass-determiner, this claim appears to be falsified, since we find acceptable cases like *try to eat some of every dish* or *of no dish did she eat very much.* Such cases, I maintain, involve wide scope of the quantifier. The *of* really operates on a variable, and so we expect to find the mass-determiners, but not the count determiners, in these cases. This is because variables refer to individuals, not groups, and only mass determiners apply to expressions which concern parts of individuals. This account of partitives is somewhat different from that of Barwise and Cooper (1981) and Ladusaw (1982). I believe that the general framework of this paper offers some minor conceptual advantages over these earlier accounts. According to Barwise and Cooper as well as Ladusaw, partitive *of* can only apply to definite noun phrases. We have already seen that there are counterexamples to this claim. Ladusaw himself notes cases like *one of three students*.[7] Moreover, and more importantly, it seems odd that the partitive construction should make reference to the notion definiteness, since definiteness, just like atomicity, is not an extensional property. According to Barwise and Cooper's definition, a generalized quantifier Q is definite just in case it denotes a proper principal filter in every model on which it is defined. To see whether a noun phrase is definite, it is not enough to check its denotation in a particular model. This makes the partitive construction an essentially intensional construction, which is just as odd as the supposition of my (1983) paper that NP-conjunction is intensional. My present account, which claims that definite NPs correspond to individuals and groups, avoids this problem.

7.

The model presented here compares favorably, I believe, with other models proposed in the literature on plurals, such as Link's (1983) lattice model and Landman's (1987) domain of graded types, as well as Lønning's (1986) Boolean model. For instance, Link's system features an associative summation operation. This is an undesirable property. For the purposes of NP-conjunction it does not seem appropriate to postulate associativity. This is most obvious in the case of highly connotative conjunctions such as [*Bob Dylan and* [*Simon and Garfunkel*]]. While it seems true that Bob Dylan and Simon and Garfunkel wrote many hits in the 1960s, it does not follow that Dylan and Simon or Garfunkel wrote many hits. Likewise, there seems to be a true ambiguity in sentences like *Karttunen and Peters and Ritchie never published in the same journal*. Either this sentence claims that the journals in which Karttunen and Peters published are not the same as those in which Ritchie published, or else it claims that Karttunen did not publish in journals where Peters and Ritchie published.[8] This can be captured naturally by postulating a structural ambiguity between [*Karttunen and* [*Peters and Ritchie*]] and [[*Karttunen and Peters*] *and Ritchie*]. Associativity of conjunction has the unpleasant consequence of making this structural ambiguity irrelevant to semantic interpretation. (For some further criticisms of Link's theory, see Landman (1987).

Landman's model is an ordered pair $\langle A_\omega, \| \, \| \rangle$, where A is based on a set A of basic individuals through the following inductive definition:

$$A_0 = A$$
$$A_{n+1} = \text{pow}(A_n) - \{\emptyset\}$$
$$A_\omega = \text{pow}(\cup_{m<\omega} A_m) - \{\emptyset\}$$

This definition gives us all the sets that can be constructed out of A, except for those that contain the empty set. Note that A contains no individuals – the smallest elements are singletons of individuals. This means that we can use set union instead of group formation as the basic operation in the interpretation of conjunction. Again, there is a drawback to this: set union is associative. Union (or rather: the Boolean join-operation) is also employed by Lønning (1986). Apart from the empirical problem of nonassociativity, the choice of this operation to model conjunction is also rather startling given that we would expect *or*, and not *and*, to express union. Another unattractive feature of the way in which Landman has set up his domain is the fact that it distinguishes all of the following sets:

{a}
{{a}}
{{{a}}}
{{{{a}}}}
etc.

This is a spurious structure that does not seem to be needed anywhere in the semantics of plurals and indeed I suspect that it has no basis in cognition either. While we seem to be perfectly capable of conceiving of collections, collections of collections and so on in everyday life, we do not seem to distinguish, except in our more mathematical moments, elements from their singleton sets and the singletons of their singletons. By requiring that groups have at least two members we avoid this problem. (As an historical aside, I note here that some versions of set theory, such as the one in Quine's *New Foundations*, have equated elements with their unit sets, and hence do not distinguish between the singletons listed above either.)

If we are not going to make a distinction between singletons and their members, as I propose, then certain other features of Landman's account must be rejected as well, such as his operators ↑ and ↓, which send entities to their unit sets and vice versa. Landman uses these operators to distinguish group-level readings from distributive readings. Link and Landman make use of a formal metalanguage LP in which predicates are marked by a star for distributivity. More precisely, if $\|P\|$ is some set of individuals, then $\|{*P}\|$ is the closure of that set under summation. This means that whenever $*P(x+y)$ is the case, we have $*P(x)$ and $*P(y)$. In other words, starred predicates distribute over the parts of the sums they apply to. Now there are various degrees to which a predicate can be said to be distributive. Consider for example the difference between the following two sentences:

(11) a. The cards below 7 and the cards from 7 up are red.
b. The cards below 7 and the cards from 7 up are shuffled.

In both cases, the predicate can be distributed over the conjuncts, so that we can infer (12a) and (12b) from (11a) and (11b) respectively.

(12) a. The cards below 7 are red and the cards from 7 up are red.
b. The cards below 7 are shuffled and the cards from 7 up are shuffled.

However, in the case of (11a), we can infer a lot more, namely that every card is red. In the case of (11b), of course, no inferences about individual cards can be made; indeed, it makes little sense to say of an individual card that it is shuffled. This difference is represented in LP by assigning the following translations to (11a) and (11b):

(11′) a. $*\text{Red}\ ((\sigma x{:}\ x < 7) + (\sigma x{:}\ x \geq 7))$
b. $*\text{SH}\ (\uparrow(\sigma x{:}\ x < 7) + \uparrow((\sigma x{:}\ x \geq 7))$

(In these formulas, the symbol σ stands for 'sum'.) From (11'b) we can derive

(11'') b. $*SH (\uparrow(\sigma x: x < 7))$ and $*SH (\uparrow(\sigma x: x \geq 7)$

because the predicate *SH applies to a sum. However, since expressions of the form $\uparrow X$ denote singleton sets, which cannot be taken to be sums of other sets (given that the empty set is excluded from the domain), the predicate cannot be distributed over its parts. This result is the main motivation for having the $\uparrow$ operator in LP.

This way of characterizing the complex patterns of collective and distibutive readings is rather counterintuitive in my opinion. A simple conjunction of noun phrases like *the boys and the girls* becomes at least 8-way ambiguous (or more if we add spurious repetitions of the $\uparrow$ operator) on this account since we can have each of the following representations in LP:

$(\sigma x: boy(x)) + (\sigma y: girl(y))$
$(\sigma x; boy(x)) + \uparrow(\sigma y: girl(y))$
$\uparrow(\sigma x: boy(x)) + (\sigma y: girl(y))$
$\uparrow(\sigma x: boy(x)) + \uparrow(\sigma y: girl(y))$
$\uparrow(\sigma x: boy(x)) + (\sigma y: girl(y))$
$\uparrow(\uparrow(\sigma x: boy(x)) + (\sigma y: girl(y))$
$\uparrow((\sigma x: boy(x)) + \uparrow(\sigma y: girl(y))$
$\uparrow(\uparrow(\sigma x: boy(x)) + \uparrow(\sigma y: girl(y))$

Instead, I treat such conjunctions as having a single logical form. The several readings that arise in various contexts are not produced by the translations of the conjoined noun phrases, but arise from lexical entailments or pragmatic implicatures associated with the predicates. If you will, these can be spelled out in the form of meaning postulates, as in Scha (1981), Hoeksema (1983), or Dowty (1986). This approach may not be fully satisfactory, for reasons pointed out in Roberts (1987), but it has some rather attractive features.[9] For instance, distinctions between predicates that distribute all the way down to the individuals, such as *be red* in (11a) and predicates which distribute down to the immediate-constituents of the groups they apply to, like *be shuffled* in (11b), are not hard to handle. We just state: if a group $\{X,Y, \ldots, Z\} \varepsilon \|$be shuffled$\|$, where $X,Y, \ldots, Z$ are groups, then so are $X,Y, \ldots, Z$. I note that this automatically accounts for Landman's observation that the statement that the cards below 7 and the ones from 7 up are shuffled does not entail that the cards below 10 and the ones from 10 up are shuffled, even though both collections make up the same deck of cards. The observation is accounted for because a group $\{X, Y\}$ need not have W and Z as proper parts, even though $X \cup Y = W \cup Z$. In the case of (11a), X and Y are the groups of cards below 7 and from 7 up, which consist of individual cards. The predicate $\|$be shuffled$\|$ does not apply to individuals, and so the predicate will not distribute all the way down. In the case of $\|$be red$\|$, we drop the requirement that X and Y be groups, and so this predicate will apply all the way down to the individual cards, as required. An attractive aspect of this point of view, which is not present in the Link/Landman theories, was pointed out in Dowty (1986), namely, that it needs no special machinery to handle mixed conjunctions of distributive and collective predicates, as in *We met in a bar and had a good time*. It is not a knock-down argument, since Landman shows how to treat such cases by using type-shifting rules, but it is rather appealing to have a theory which does not need any extra provisions for such cases. I further note here that collective/distributive ambiguities can even be found when the subject does not refer to a group but to an individual. For example, from the fact that Marie weighs less than 110 lbs, we may safely conclude that her arms or her legs weigh less than 110 lbs, but from the fact that Dick weighs more than 150 lbs, we can conclude nothing about the weights of his body parts. So 'weighs less than X' is a distributive predicate, whereas 'weighs more than X' is not.

However, for some purposes, an explicit marking of distributivity such as an operator makes available may be useful, as in the case of discourse pronomina in a Kamp-style account. This point was made in Roberts (1987) and is well-taken. If a singular indefinite is used as part of a distributive predicate, it becomes unavailable as an antecedent for a pronoun in the following sentence (unless a wide-scope reading is represented). To see this, consider the following discourse:

Bill, Pete, Hank and Dan lifted a piano. It was very heavy.

Roberts notes that on the relevant reading, where each of the four men lifts a (possibly different) piano, the noun phrase *a piano* is not a good antecedent for the pronoun in the second sentence. In a theory such as Kamp's *Discourse Representation Theory*, this calls for some kind of overt marking of distributivity, so as to block such anaphoric links.

However, the facts here are not straightforward. For me, many cases of distributive readings are not at all incompatible with subsequent anaphora. For instance, the following pieces of discourse strike me as being rather natural:

The men were told to keep a diary. It would help them remember their present plight.
They all have a car. Unfortunately, they don't let anyone else drive it.

Both *keep a diary* and *have a car* have obvious distributive readings, yet in each case the pronoun can be used to pick up the indefinite. Hence the status of this argument is not clear.

I have nothing against the use of a distributivity operator as a device to mark the readings of a predicate. What I do want to dispute, however, is that distributive/collective ambiguities of conjoined noun phrases should be ascribed to different translations or logical forms of these conjunctions. Whenever there is such an ambiguity, the source can be found in the predication involved.

8.

Returning to conjunction, I want to point out an interesting consequence of the present proposal: Coreferential NPs cannot be conjoined. The reason is that the group consisting of some individual a, a and a is not defined (unlike for instance the join of a set with itself). To me, this seems a reasonable result, given that most such conjunctions are in fact unacceptable. For instance, while we can express John's similarity to Mary by saying either (13a) or (13b), only (14a) is a possible way of expressing John's similarity to himself:

(13). a. John is similar to Mary.
b. John and Mary are similar.

(14) a. John is similar to himself.
b. *John and John are similar.

The situation is more complex than that, however, because other kinds of conjunctions of coreferential elements are actually fine, as the following examples illustrate:

(15) The Morning Star and the Evening Star are the same planet.
(16) Cicero and Tully are one and the same person.

Cases like these do not count as counterexamples to the present theory. Rather, they indicate that the notion of 'individual' involved is more sophisticated than one might have supposed. Indeed, in order to make sense of such examples, it seems necessary to appeal to the intentional objects invoked by philosophers like Husserl and semanticists like Landman (see his 1986, 1987). It seems most attractive to introduce two distinct intentional objects, the Morning Star and the Evening Star, or Cicero and Tully, which may correspond to only one real-world entity. Because there are two intentional objects, we get the plural agreement on the predicate. At this point, no doubt some would like to invoke Occam's Razor, which forbids us to multiply entities beyond necessity. Why this need for intentional objects on top of the real-world objects which any truth-conditional theory of semantics must postulate? One might point out that it is quite natural to invoke intentional objects in the case of fiction. Consider for instance the strange story of Dr. Jekyll and Mr. Hyde. First we are introduced to two individuals, one outstanding and respectable, the other dangerous and despicable. After a while, we learn that Dr. Jekyll is in fact Mr. Hyde, and so the two entities collapse into one. In the meantime, we are aware this is fiction, and we know that Dr. Jekyll and Mr. Hyde have no counterpart or counterparts in the real world. So we have two individuals who are really one who are really none. An austere referential semantics would not do justice to this and similar cases. It is not my purpose here to formulate a theory of intentional objects. All I want to suggest here is that we need such a theory to understand what is going on in examples such as (15) and (16). One possibility that one might pursue here is that intentional objects are discourse referents in the sense of the Kamp/Heim theory of discourse anaphora. Landman (1986) argues against this construal, but the matter is not settled in my opinion. The conjunction facts which ought to be accounted for are actually quite complex. For instance, it has been noted in the literature that a conjunction of two singular terms can combine with a plural and a singular predicate, depending on whether the terms are taken to be coreferential or not. Some examples taken from van Eijck (1983:99) illustrate this phenomenon:

(17) a. His aged servant and the subsequent editor of his collected papers was with him at his deathbed.
b. His aged servant and the subsequent editor of his collected papers were with him at his deathbed.

As a matter of fact, as things stand right now, the first type of conjunction, called *appositional conjunction* by Quirk et al. (1972), cannot be handled by our semantic approach at all. I will come back to these examples later on. Van Eijck deals with these cases by introducing a individual-level discourse marker for the first example, of which the properties named by the two NPs and the VP are predicated, while the second case gets a group-level marker, the members of which are the marker for the aged servant and the one for the editor of the papers. This brings me to an issue not yet addressed here. The group structure imposed here on the domain of individuals must be extended to the domain of discourse referents: just as we have individuals and groups, we need individual and group discourse referents. The latter have been introduced into the literature on discourse representations in van Eijck (1983) in an attempt to deal with plural pronouns. A more recent application can be found in Hoeksema (1986), where plural referents are employed in the analysis of relative clauses with split antecedents, such as Perlmutter and Ross' (1970) example

(18) A man entered the room and a woman went out who were quite similar.

Such sentences have always posed a formidable problem for compositional semantics, but can be handled quite straightforwardly in Kamp's discourse representation theory. The two singular indefinite NPs each introduce a new discourse referent to the representation. The representation can then be optionally extended by adding group-level referents consisting of elements that are already present. For instance, suppose we have the referents u and w in the representation, then we can add [u,w] to this representation. (The optionality is added only to avoid overloading the representations with too many discourse referents.) This new group marker can then function as the referent of a plural pronoun or, in the case of split relatives, be available to predicate something of, such as the property of being similar in the case of (18). For the case of conjunctions of indefinites, I propose a similar scheme. The conjoined elements themselves give rise to discourse referents and the conjunction adds a group-level referent. This time, however, the addition is obligatory, because it is this plural object that the verb phrase is predicated of. For a little piece of discourse such as

(19) A man and a woman entered. They embraced. He was short, she was tall.

we get the following representation:

(20) u,v, [u,v]
man(u)
woman(v)
enter([u,v])
embrace([u,v])
short(u)
tall(v)

The embedding function f, which assigns values in the actual model to the discourse referents must have some obvious properties: if f(u) = a and f(v) = b, then f([a,b]) = {a,b}. More generally, f([x,y,...,z]) = {f(x), f(y),...,f(z)}.

8.

At this point, it is appropriate to reflect on what has been proposed so far. To account for the fact that conjunctions of NPs do not generally behave like intersections of sets, it was suggested that the older theory, which holds that some NPs refer to individuals, and others behave more like higher order objects, like quantifiers, might well be correct. However, it is not enough to just fall back on this older theory; after all, when Montague first proposed his unified account of NP interpretation, this was seen as a major step forward, because it offered (1), a single semantic type for what syntactically appears to behave as a single category, (2) a solution to the problem that referring terms can be coordinated with quantificational terms, as in *the President and some senators, 1965 and every preceding year, Hannah or any of her sisters*, and so on, which seems to indicate that the semantic type of quantifiers and referring terms is really the same. It is rather interesting to see that conjunction can be used to argue for as well as against the distinction between referring and quantificational terms. In order to take care of these problems, it seems best to follow a growing number of semanticists who enjoy the benefits of higher-order interpretations without entirely giving up on the simpler interpretations which first-order theories provide, by making use of type-raising. Type-raising is a common device in much current work in categorial grammar, such as Dowty's (to appear) study of non-constituent coordination and Steedman's (1985, to appear) work on extraction and coordination. For our purposes, it will not be necessary to consider a general theory of type-raising. All we need is a rule which relates elements of type ⟨e⟩ to second-order predicates of type ⟨⟨e,t⟩,t⟩. The basic motivation behind such a rule is an observation made by various logicians, including Ramsey and Geach, long before Montague, namely that a subject-predicate combination such as *Socrates is mortal* can be viewed in two different, but equivalent ways: either the predicate is taken to give a property of the subject, in this case by ascribing mortality to Socrates, or else the subject is taken to provide a property of the predicate, in this case by ascribing to mortality the property that is applied to Socrates. In the latter case the subject is interpreted as a property of a predicate, which makes it a second-order predicate. The use of referring terms as second-order predicates is modelled simply by the following rule which maps individuals into the ultrafilters they generate:

TYPE LIFTING
$f: \langle e\rangle \longrightarrow \langle\langle e,t\rangle,t\rangle: f(a) = \lambda P[P(a)]$

Type-lifting makes it possible to conjoin referring terms with quantifiers and to interpret disjunctions of referring terms. For example, it is now possible to interpret the conjunction *the Pope and every other Catholic* as follows:

the Pope $\rightarrow$ g(i)x:Pope(x) (first-order analysis)
$\rightarrow$ λP[P(g(i)x:Pope(x))] (second-order analysis)

every other Catholic $\rightarrow$ λP[∀x:Catholic(x) & −Pope(x) $\rightarrow$ Px]

the Pope and every other Catholic $\rightarrow$ λP[P(g(i)x:Pope(x)) & ∀x: Catholic(x) & Pope(x) $\rightarrow$ Px] = λP[∀x:Catholic(x) $\rightarrow$ Px]

As pointed out by a reviewer, one might also type-raise the non-Boolean conjunction operator itself, if a more general perspective on type-lifting, such as that of the Lambek-calculus (Lambek 1958, van Benthem 1986), is adopted. In that case one may get non-Boolean conjunctions of higher-order expressions, e.g. noun phrases of type $\langle\langle e,t\rangle,t\rangle$, as well as mixed conjunctions of elements of type $\langle e\rangle$ with elements of type $\langle\langle e,t\rangle,t\rangle$. In van Benthem's version of the Lambek calculus, the rules of type change are:

(i) $a \Rightarrow a$
(ii) $a\ \langle a,b\rangle \Rightarrow b$
(iii) $a\ A \Rightarrow b$, then $A \Rightarrow \langle a,b\rangle$
(iv) $A \Rightarrow b$, then $B\ A\ C \Rightarrow B\ b\ C$
(v) $A \Rightarrow B$, and $B \Rightarrow C$, then $A \Rightarrow C$

where a,b are any types, and A,B,C any sequences of types, and the order of functors and their arguments is irrelevant

The earlier type-lifting $\langle e\rangle \Rightarrow \langle\langle e,t\rangle,t\rangle$ now turns out to be a special case which can be shown to follow from the Lambek calculus

(I) $e\ \langle e,t\rangle \Rightarrow t$ (case of ii)
(II) $e \Rightarrow \langle\langle e,t\rangle,t\rangle$ (by I and iii)

Non-boolean conjunction is an operator of type $\langle e, \langle e,e\rangle\rangle$: it takes an argument of type e, and then another argument of type e, to yield a value of type e. It can be raised to type $\langle T, \langle T,T\rangle\rangle$, where $T = \langle\langle e,t\rangle,t\rangle$ in the Lambek calculus, cf.:

(a) $\langle e\rangle\ \langle e,\langle e,e\rangle\rangle \Rightarrow \langle e,e\rangle$ by (ii)
(b) $\langle e,e\rangle\ \langle e\rangle \Rightarrow \langle e\rangle$ (permutation-variant of ii)
(c) $\langle e\rangle\ \langle e,\langle e,e\rangle\rangle\ \langle e\rangle \Rightarrow \langle e\rangle$ (by iv and v from (a) and (b))
(d) $\langle e\rangle\ \langle e,\langle e,e\rangle\rangle\ \langle e\rangle\ \langle e,t\rangle \Rightarrow \langle t\rangle$ (by iv, v from (c) and (II))
(e) $\langle e,\langle e,e\rangle\rangle\ \langle e\rangle\ \langle e,t\rangle \Rightarrow \langle e,t\rangle$ (by iii from (d))

(f) $\langle e,t\rangle\ \langle T\rangle \Rightarrow t$ (by ii)
(g) $\langle e,\langle e,e\rangle\rangle\ \langle e\rangle\ \langle e,t\rangle\ \langle T\rangle \Rightarrow$ (by iv and v from (e) and (f))
(h) $\langle e,\langle e,e\rangle\rangle\ \langle e,t\rangle\ \langle T\rangle \Rightarrow \langle e,t\rangle$ (by iii from (g))
(i) $\langle e,\langle e,e\rangle\rangle\ \langle e,t\rangle\ \langle T\rangle\ \langle T\rangle \Rightarrow t$ (by iv, v from (h) and (f))
(j) $\langle e,\langle e,e\rangle\rangle\ \langle T\rangle\ \langle T\rangle \Rightarrow \langle\langle e,t\rangle,t\rangle = T$ (by iii from (i)
(k) $\langle e,\langle e,e\rangle\rangle \Rightarrow \langle T,\langle T,T\rangle\rangle$ (by two applications of ii from (j))

As the reader pointed out, the semantics for type-change in van Benthem (1986) will associate with the type-lifted non-Boolean conjunction the following interpretation: $\|\text{and}\| = \lambda P\lambda\Phi\lambda\Pi.\Phi(\lambda x.\Pi(\lambda y.P(\{x,y\})))$, where Φ and Π range over denotations of type T and *P* is a variable over type $\langle e,t\rangle$. To see this, note that every application of rule (ii) corresponds to application of a variable and every application of rule (iii) to the abstraction over a variable. So steps (a) and (b) correspond to applying basic (not type-lifted) non-Boolean "and" to x and y, resulting in the doubleton {x,y}. Steps (e), (h) and (j) correspond to the three abstractions in the translation of "and". What is crucial here is that the denotation of "and" after type-lifting is not stipulated ad hoc, but follows from van Benthem's semantics for type-shifting. For a conjunction of two quantificational noun phrases, such as *every soldier and every officer*, type-lifted non-Boolean conjunction will produce the set of all properties of all pairs of a soldier and an officer. This gives the right interpretation for sentences such as *every soldier and every officer met, no soldier and no officer have danced together* etc. (cf. also Footnote 1). For cases of mixed conjunctions (i.e. where a quantificational noun phrase is conjoined with a referring term), we now have the option to lift the type of the referring term to that of a generalized quantifier and then apply Boolean conjunction, or else to lift the type of the conjunction operator for one of its arguments. In the latter case we get the set of properties of all pairs consisting of the Pope and a Catholic as the denotation of the conjunction *the Pope and every other Catholic.*

A major unsolved problem with the type-lifting approach is that we must block the use of type lifting in situations where it is not needed, in particular in the cases of non-Boolean conjunction discussed in the beginning of this paper. Partee and Rooth (1983) suggest a processing strategy, according to which one uses the lowest types possible. However, the facts they had in mind (scopal readings of disjunctions) are of a different status than the ones I am concerned with here. In particular, it seems simply wrong to say that *Bill and Harry was watching TV* is a possible English sentence, and that its oddness stems from the fact that the sentence *Bill and Harry were watching TV* is the preferred variant because of some processing strategy. In fact, there are cases were a Boolean interpretation is enforced, such as in the 'X as well as Y' construction, cf. *John as well as Harry works on this problem.* Here there seems to be no processing problem at all. So we must invoke a rule to use minimal types only, but this rule appears to be not a processing strategy but rather a principle of grammar.

9.

It might be supposed that type-lifting will also give us a handle on appositional conjunction. Conjunction of the noun phrases *his aged servant* and *the subsequent editor of his collected papers* is blocked at the first-order level, since group formation of a and b is not defined in case a = b. Lifting the type and applying regular Boolean conjunction gives us appositional conjunction for free. However, things are not this simple. It should be noted that appositional conjunction is restricted to definites and indefinites; proper names do not seem to be conjoinable in this way. So we have the following pattern:

(21)
a. My great opponent and the hero of my youth has passed away.
b. A great man and a good father has passed away.
c. A great man and the best magician in New Jersey has passed away.
d. *Dr. Jekyll and Mr. Hyde has passed away.
e. *Charles Dodgson and Lewis Carroll has passed away.

Even though two names can refer to the same entity, appositional conjunction is disallowed. The only way to account for this that comes to my mind, is by stipulating that different proper names always correspond to different discourse markers in the discourse representation structure, whereas descriptions may be represented by a single marker. Hence there will always be the possibility of first-order conjunction for proper names, even in cases of coreference, and the availability of such a conjunction will block the higher-order analysis needed for appositional conjunction. As we have seen, some such blocking principle is needed anyway to rule out Boolean conjunctions of non-coreferential singular terms. However, making this distinction seems an ad hoc proposal at the moment, and moreover, it still fails to cover the facts entirely, since it would predict that appositive conjunction of a proper name with a definite description would be possible. As far as I am aware, this is not the case.

(22)
a. *John and my best friend is sick.
b. *My hero and Houdini has passed away.
c. *Amy and a long-time lover lies buried here.

10.

To conclude, let me sum up the main claims of this paper. It was found that quantified noun phrases and referring terms behave differently in conjunctions. This finding makes sense if we take quantified noun phrases to denote generalized quantifiers, while holding on to the view that referring expressions denote individuals. The domain of individuals was sketched with its group structure and compared with alternative proposals. For indefinites, the Kamp/Heim theory of discourse representations was adopted, which has the desirable property of treating indefinites as referring terms instead of existential quantifiers. Since this theory was originally motivated for an entirely different set of phenomena, this paper provides some additional support for it. Finally, it was shown how type raising can be used to relate referring terms to generalized quantifiers so that it is possible to interpret disjunctions of referring terms and mixed conjunctions of referring and quantified expressions. This approach seems preferable over the more unified Montagovian approach, which treats all NPs as having the same logical type. This brings me to a matter discussed by Ed Keenan (1982) in a paper called "Eliminating the Universe (A Study in Ontological Perfection)". According to Keenan, a semantics for L is *ontologically perfect* just in case the elements of its ontology are possible denotations for expressions in L. He argues that it is desirable to have an ontologically perfect semantics, for "[o]therwise the denotations of some expressions would be defined in terms of semantic things which we cannot refer to in the language and so in some sense cannot know". While I think we don't have to be able to refer to an object in order to know it (in fact, it is not necessary to speak any language at all to know some objects, as prelinguistic babies seem to show), ontological perfection seems to be a desirable feature. It is closely related to Occam's Razor and similar requirements of parsimony in scientific methodology. The semantics for a fragment of English in Montague's PTQ (Montague 1974) is not ontologically perfect, since it introduces objects without having any expressions denote them. Instead, the objects are needed to build up sets of objects, as denotations for the predicates, and sets of sets of objects, for the NPs and so on. Keenan proposes to eliminate objects and use properties instead as the primitive elements of his Boolean semantics. This paper suggests yet another road to ontological bliss, not by eliminating the universe, but by re-introducing referring terms.

Department of Linguistics
University of Pennsylvania
619 Williams Hall
Philadelphia, PA 19104-6305
USA

NOTES

1. Earlier versions of this paper have been presented at the University of Washington and Stanford University. I am indebted to the audiences at these presentations as well as D. Dowty, C. Roberts and J. Lønning and an anonymous reviewer for comments and criticisms.
2. In many of these cases, both plural and singular agreements are possible. Exactly what causes this variation is not clear to me, but it would seem that the singular agreement is caused by the Boolean nature of the conjunction in these cases (hence semantically motivated) and the plural agreement is due to the formal analogy of these conjunctions with the much more common non-Boolean variety (hence syntactically-driven). In the area of agreement, such variation is not uncommon, and usually hard to account for in a rigorous manner. To be sure, the existence of this variation is often taken to be evidence for a syntactic account of number agreement, since there appear to be no semantic differences. However, the position that number agreement is a purely syntactic phenomenon, a position commonly taken in GPSG-studies of agreement and conjunction, such as Sag, Gazdar, Wasow, and Weisler (1985), seems unnecessarily weak. My position is that most facts about number agreement can only be explained (as opposed to described) semantically, but that there remains some arbitrariness which must be ascribed to syntactic encoding. This general position is also taken in Sadock (1983).
3. David Dowty has drawn my attention to the existence of cases where the conjunction of two quantifiers does not behave in a Boolean manner, but rather in the manner of branching quantifiers:

(i) No farmer and no student were ever alike.

Unlike the rather similar examples discussed in Barwise (1979), these cannot be explained away quite as easily by invoking the logical properties of reciprocal predicates, as in the appendix of Hoeksema (1983). For an analysis of these cases in terms of type-lifting of the non-Boolean conjunction operator, see Section 8.
4. In the case of proper names, it should be noted that there is a rather common use of conjoined proper names as singular expressions, namely when the conjunction as a whole is used as a single proper name. Examples of this special use of conjunctions are brandnames (e.g. *Strawbridge and Clothier is having a sale; Bolt, Beranek and Newman has hired a linguist; Johnson and Johnson sells baby products*), reference to publications by the names of the authors (as in *Dowty, Wall and Peters is out of print*), etc. Semantically, the internal of these names is irrelevant. Each name refers to a single individual-level entity, and not to a group. Of course, this entity may have a certain historical relationship to a group, such as the relationship between a firm and its founders, or that between a paper and its authors, but that relationship does not take part in the interpretation of the complex names under consideration. In this respect, such names are on a par with other complex names, such as booktitles, quotes, or placenames like *Bird-in-Hand, Pa* and *White Plains, N.Y.* .
5. Lønning (1986) and Roberts (1987) have also appealed to the distinction between quantificational and referring terms to explain certain differences in distributivity of conjoined expressions.
6. An unsolved problem for almost all accounts of partitives is the non-occurrence of conjoined NPs after partitive *of*, as illustrated by the ungrammaticality of examples like *one of you and me, two of Tom, Dick and Harry, none of Janice and me*, etc. Only the account given in Keenan and Stavi (1986) has no difficulty with such cases, because these authors analyze the partitive construction as involving a complex determiner of the form "*det* of *det*" combined with a common-noun phrase. While *two of the boys* or *several of my friends* allows such a parsing, the cases involving conjunctions do not. However, that account seems flawed for other reasons (cf. Hoeksema 1984 for some discussion).

7. Even more problematic cases like *one of every three students* actually seem to involve an idiomatic interpretation. Clearly, such expressions do not quantify over all triples of students, but rather over all triples in a given partition of the domain. Note that we could have used *one in every three students* as well. Otherwise, it is not possible to replace partitive *of* by *in*.
8. Of course there is a third reading, according to which none of the three men ever published in the same journal, which does not concern us here.
9. A problem which arises is that either meaning postulates must be allowed to be optional, which is inconsistent, or else rather pervasive lexical ambiguity must be assumed, given the large amount of verbs which give rise to both distributive and collective readings.

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RESTRICTIONS ON DATIVE CLITICIZATION IN FRENCH CAUSATIVES*

JOHAN ROORYCK

ABSTRACT

Causative constructions in French display restrictions as to the cliticization of lexical datives onto the causative. In altogether different frameworks, Fauconnier (1983), Burzio (1986) and Goodall (1987) have related this restriction to the ergative-inergative distinction. However, the inability to formally define ergative verbs in French, as well as further restrictions on the cliticization of datives in causative constructions show that this hypothesis fails to account for the data observed. A thematic condition on dative cliticization in causatives adequately describes the restrictions noted.

1. INTRODUCTION

Recent work on causative 'restructuring'[1] constructions in French (Fauconnier 1983; Tasmowski 1984; Burzio 1986) draws the attention to the fact that syntactically similar verbs differ with respect to the cliticization of their animate indirect object or dative complement when inserted into the causative construction. This difference appears most strikingly when verbs corresponding to the *NP1 VP à NP2* ↔ *NP1 lui2 VP* format are constructed with a causative.

(1) a. J'ai fait parvenir/arriver cette lettre à son amie.
'I made that letter arrive to her friend.'
b. Je lui ai fait parvenir/arriver cette lettre.
'I (to her) made arrive that letter.

(2) a. J'ai fait nuire/obéir/ressembler Oscar à ce général.
'I made Oscar harm/obey/resemble that general.'
b. *Je lui ai fait nuire/obéir/ressembler Oscar.
'I made him harm/obey/resemble that general.'

These restrictions also apply to certain verbs selecting both a direct and indirect object (*téléphoner, répondre*) or two indirect objects (*parler*) when only the dative is expressed.