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On the explanatory adequacy of Montague grammar

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1. Despite the efforts of a handful of linguists and logicians (Emmon Bach, Robin Cooper, David Dowty, Barbara Partee, Richmond Thomason, among others), Montague Grammar (MG) has not gained wide acceptance within the linguistic community. One reason for this is no doubt the complexity of the notation used, especially in the semantic component. But more importantly, many linguists seem to feel that the theory is too unconstrained to be of any interest and therefore to justify the expenditure of effort required for its understanding.

In this paper, I argue that the range of possible analyses for English existential sentences is much more severely constrained in principle within MG than in transformational grammar (TG), and that, consequently, at least for this restricted area of English grammar, MG comes much closer to achieving explanatory adequacy than TG [1].

Two preliminary observations are in order. First, it should be kept in mind that Chomsky's ideal of a theory with explanatory adequacy remains unrealized, and in fact very far from realization. It is not the case that we have a theory which for the most part can choose descriptively adequate grammars over descriptively inadequate ones and just happens to fail occasionally. Things are much worse. In fact, it would be hard to identify one single noncontroversial case where the theory of TG selects an analysis in a principled way. Given this state of affairs, a demonstration like the one presented here should have considerable intrinsic interest for linguists of all persuasions.

[1] In Chomsky's (1964:63) words, 'a linguistic theory that aims for explanatory adequacy... aims to provide a principled basis, independently of any particular language, for the selection of the descriptively adequate grammar of each language'.

Second, it is not my intention to suggest that MG as formulated by Montague (1974) is optimally constrained. Far from it. I agree with Partee (1979) that in order for this theory to approach the goal of characterizing human language, additional constraints are needed. Her suggestions in this direction are highly promising.

The plan of this essay is as follows. First, I will present a basic introduction to MG, followed by a section on the general implications for the analysis of English existential sentences. Next, three types of analysis of English existential sentences within TG will be discussed, and it will be shown how they would be ruled out in principle within MG. The next section will present a MG analysis of English existential sentences, followed by independent evidence for the analysis proposed. The concluding section summarizes the argument.

2. MG is an explicit theory applicable to formal and natural languages which specifies the well-formed expressions of the language and assigns them semantic interpretations [2]. The specification of well-formed expressions is done by a set of recursive syntactic rules operating on a set of basic expressions assigned to various categories. All syntactic rules are of the following form:

(1) If $a \in X$, and b Y, then $F_i(a, b) \in W$.

(Read: If a is a member of category X, and b is a member of category Y, then a specified function F_i of a and b is a member of category W.)

For example, let a be *read*, and b *books;* let X be TV (transitive verb), and Y NP (noun phrase). If we specify F_i (a, b), as concatenation of a and b in that order, and let W stand for IV (intransitive verb phrase), rule (2) specifies that *read books* is a member of category IV.

(2) If $a \in$ TV, and $b \in$ NP, then $F_i(a, b) \in$ IV.

Syntactic functions F_i are not restricted to concatenation. If they were, MG syntax would be a notational variant of Phrase Structure grammar. Just what constitutes a possible syntactic operation is clearly in need of specification. Partee (1979) has made some suggestions in this respect. One plausible candidate to be added to concatenation

[2] Useful introductions to MG include Cooper 1979, Dowty 1978, Partee 1975 and Thomason's introduction to Montague 1974.

is an operation called *right wrap* (RWRAP), which Bach (1979) defines as follows:

(3) If *a* has the form $[_{XP}$ X W], then RWRAP *(a, b)* is $X\widehat{\ }b\widehat{\ }W$. (Read: If *a* has the form XW, where X is the head of a phrase of type XP, then RWRAP of *a* and *b* is the function that places *b* to the immediate right of the head X of *a).*

For example, if *a* is the phrase *persuade to leave,* and *b* is *Bill,* then RWRAP (a, b) yields *persuade Bill to leave.*

The semantic interpretation in MG is done by means of model-theoretic semantics, which assigns truth values to the sentences of the language relative to a model (where model means roughly possible world). In most versions of MG, model-theoretic semantics applies not to the expressions of the language itself but to their translations into intensional logic. These translations have no theoretical status and are used only for convenience, since semantic rules for intensional logic are well known to logicians. Translation rules are of the following form:

(4) If *a* translates as *a'*, and *b* translates as *b'*, then F_i *(a, b)* translates as G_k *(a', b').*

The function G_k specifies the particular way in which the interpretations of the parts determine the interpretation of the whole. Obviously, the set of possible semantic operations G_n must be specified in the theory. Some suggestions along these lines are found in Partee (1979).

MG also includes two constraints, stated below. The first is explicitly stated in Montague's writings; the second is implicit, but has been formulated explicitly by Partee (1979).

(5) The compositionality constraint (CC).

(a) There is a semantic interpretation rule corresponding to each syntactic rule, so that the interpretation of each expression is determined by the interpretation of its syntactic subparts and the rule by which they are combined.

(b) All expressions of a given syntactic category must be translated into expressions of a single type, or semantic category.

(6) The well-formedness constraint (WFC), (from Partee 1979). Each syntactic rule operates on well-formed expressions of specified categories to produce a well-formed expression of a specified category.

The CC establishes a close tie between syntactic and semantic rules, so that only syntactic rules which may have coherent semantic counterparts are allowed.

The WFC prohibits the use of ill-formed strings at any stage in the derivation. Thus, ungrammatical structures which must undergo obligatory transformations are disallowed, as are ill-formed outputs which must be filtered out, as in Chomsky and Lasnik (1977).

I will demonstrate in this paper that CC and WFC have interesting consequences for the analysis of English existential sentences. In fact, they restrict the range of possible analyses to just those which can be independently shown to be descriptively adequate.

Let us first clarify the notion existential sentence (henceforth ES).

3. Milsark (1974) distinguishes the following types of ES:

(7) a. ONTOLOGICAL ES
[*there* - Aux - *be* - NP]
There are no ghosts.
There is only one even prime.
There is little sense to his remarks[3].

b. LOCATIONAL ES
[*there* - AUX - *be* - NP - LOC]
There is a fly in the mustard.
There is a robin over there.

c. PERIPHRASTIC ES

$$\left[\textit{there}\quad \text{AUX - } \textit{be} \text{ - NP} \left[\begin{array}{ll} \text{VP} & \left\{\begin{array}{c} \text{V-en-X} \\ \text{V-ing-X} \\ [\ \text{PRED}^{\text{AP}}\ ] \end{array}\right\} \end{array}\right] \text{ - } \right]$$

There are peasants murdered every day.
There are people dancing in that room.
There were many people sick.

d. VERBAL ES
i. *Inside Verbal ES*
[*there* - AUX - NP - X], where V $\neq$ *be*.
There arose many trivial objections during the meeting.
There ensued a riot immediately upon the reading of the riot act.

ii. *Outside Verbal ES*
[*there* – AUX – V – X – NP], where V $\neq$ *be*.
There walked into the room a fierce-looking tomcat.
There stood on the table the most gorgeous lamp I'd ever seen.

[3] This last example seems to be different from the other two, but I have nothing of interest to say with respect to that difference.

It has been convincingly argued, for instance by Aissen (1975) and by Rochemont (1978), that (7dii) constitutes a separate class. These sentences, unlike the rest, are stylistically marked, allow definite NPs freely, they do not allow wh-extraction (**What did there stand on that spot*?), raising to subject (** There happened to sit a stranger next to Mary*), or subject-auxiliary inversion. (** Does there stand a house at the edge of the lake*?). We will ignore them in our discussion, without this implying, of course, that their analysis could not somehow be related to that of the remaining ESs.

For the rest of the ESs, assuming that there is rule which combines *there* with a string of category X, where X could be a Sentence or a Verb Phrase, there are two possible ways in which such a rule could operate: either *there* is a basic expression of a given category, say NP, or is introduced syncategorematically, that is, it is not assigned to any category. The first alternative is ruled out by part (b) of CC, which requires that all expressions of a given syntactic category be translated into expressions of a single semantic type. It should be clear that whatever semantic type *John* is assigned to (the type of 'individuals' or something more abstract like 'a set of properties'), *there* cannot be assigned to the same type. Suppose we interpret *John is a lawyer* as 'the individual *John* belongs to the class of people who are lawyers'. There is no similar interpretation for *There is a lawyer*. We are in no better position if we interpret *John is a lawyer* as 'the set of properties designated by *John* includes that of being a lawyer'. It follows, then, that a theory constrained by CC prevents in principle assigning *there* to the same syntactic category as *John*.

Let us consider the second alternative, namely that of introducing *there* syncategorematically. This alternative is compatible with two possible interpretation rules: either *there* is assigned an interpretation which will combine with the interpretation of X to produce the interpretation of *there* X, or *there* is assigned no interpretation at all, and the semantic rule responsible for assigning an interpretation to *there* X is the identity mapping, that is, it simply retains whatever meaning had been assigned to X. Suppose we adopt the first alternative. The most likely candidate for 'interpretation of *there*' is the existential operator, since many ESs seem to assert the existence of something. This analysis would yield the right results for ontological and locational ESs (see (7) above), but not for periphrastic and verbal ESs: *There are peasants murdered every day* does not mean 'There exist peasants such that they are murdered every day', and

There arose many trivial objections during the meeting does not mean 'There exist many trivial objections such that they arose during the meeting'. If ESs constitute a coherent class, we must then reject this alternative. We are thus left only with the analysis which treats *there* as semantically empty. In other words, the rule of *there*-insertion must be meaning-preserving.

I will now examine three types of analysis of ESs within TG, and show how they fail the requirements just discussed [4].

4. THE 'STANDARD' TRANSFORMATIONAL ANALYSIS

The rule given as (8) is fairly representative of what we might call the standard transformational analysis [5].

(8) *There* insertion (optional)

NP [-def]	- Tense	- (Modal)	(have en)	- be
1	2	3	4	5 =>
there	2	3	4	5 + 1

This rule derives the b strings in (9-11) from the corresponding a strings.

(9) a. * No ghosts are.
b. There are no ghosts.

(10) a. A fly is in the mustard.
b. There is a fly in the mustard.

(11) a. Peasants are murdered every day.
b. There are peasants murdered every day.

It should be clear that the counterpart of a rule like (8 would be inadmissible within MG, since it violates both WFC ((9a) is an ill-formed string) and CC (the ambiguity of (11a) is not preserved in (11b)). It is true that (8) would also be an ill-formed rule under stricter versions of TG than that of Chomsky (1965), for example, a

[4] TG is, of course, based on different premises than MG, so it is not appropriate to apply to it the constraints which are part of MG. The following demonstration must, then, be understood in terms of this question: If this analysis were translated into the MG framework, would it violate the constraints in question?

[5] This is the version presented in AKMAJIAN and HENY 1975.

version that constrains transformations by Chomsky's minimal factorization principle (see Chomsky 1977). But the point is that under no version of MG could (8) be well formed.

Transformationalists have, of course, been aware of various deficiencies of (8), but since there is no general principle in TG which rules it out, efforts to patch it up one way or another have abounded, all to no avail.

Here is a list of the problems which I am aware of with respect to this rule:

1. Although the rule must be marked as optional, there are certain unclear cases where it must apply obligatorily, e.g., if the input is (9a).

2. It does not account for verbal ESs.

3. It requires an adhoc treatment for the semimodals *be going to* and *be to* so as to make the following predictions correctly:

(i) There is going to be a demonstration.
(ii) *There is a demonstration going to be.
(iii) There is a petition being drafted.
(iv) *There is being a petition drafted.

4. It assigns an incorrect constituent structure to ALL its outputs. Thus, when term 5 of its structural description is the auxiliary *be*, it places the underlying subject inside the auxiliary, as shown by the following example:

(i) There $[_{AUX}$ is *a petition* being] $[_{VP}$ drafted].

On the other hand, when term 5 is the main verb *be*, it yields a derived structure where *be* plus the underlying subject constitute a verb, as shown in (ii):

(ii) There $\left[_{VP}\ [_{V}$be a fly] [in the mustard]$\right]$ [6].

5. It has no way of dealing with the so called 'predicate restriction'. That is, while it correctly derives *There are some people sick* from *Some people are sick*, it also derives **There are some people smart* from *Some people are smart* [7].

[6] For a not very successful attempt to deal with this problem, see AKMAJIAN and WASOW 1975. This analysis is abandoned in AKMAJIAN, STEELE and WASOW 1979.

[7] For an attempt to deal with this problem in a principled way, see EMONDS 1976.

5. Milsark's semantic analysis

In the spirit of Chomsky's (1977) restrictive theory of transformations, which does not allow mention of 'irrelevant contexts' in structural descriptions, Milsark (1974) has proposed to derive ESs by means of two syntactic rules: NP movement and *there*-insertion. The combined effect of these two rules is shown in (12).

(12)

X	NP	Y	*be*		Z	
1	2	3	4		5	=>
1	*there*	3	4	2	5	

Since these syntactic rules generate many ungrammatical strings, a rule of interpretation is necessary. Only strings which receive an interpretation by this rule are considered grammatical, the rest are discarded. The interpretive rule is as follows:

(13) *E* rule (cyclical)
there AUX (have en) be Q NP X is interpreted:
the class C denoted by NP has at least one member c such that P(c) is true, where P is a predicate and P is the reading of X, and the set of such members c is of cardinality Q.

For example, the string *there were two people in the room* is interpreted: "The class *people* has at least one member *p* such that *p* was in the room, an the cardinality of the set of such members *p* is two.

We may now ask whether the counterpart of an analysis like this would be allowed in principle in MG. The answer is clearly no. Just like the standard analysis, Milsark's solution violates both WFC and CC, the former because it overgenerates madly, and the latter because there is no systematic relation between the interpretation of the input strings and that of their corresponding outputs. And again it turns out that the principled exclusion of this analysis is supported by independent evidence. In fact, Milsark's solution not only shares deficiencies 2, 3, 4, and 5 with the standard analysis, but it adds two new ones. First, it incorrectly marks as deviant sentences like *There is likely to be trouble* for the following reason: Since rule (13) i cyclical it must apply twice in the derivation of this sentence, assuming that its underlying structure is as in (14).

(14) $\left[\underset{s}{e} \text{ is likely } \underset{s}{[\text{trouble be}]} \right]$

Disregarding for the time being the problem of whether the reading assigned is correct or not, it is clear that rule (13) will assign a reading to the string *there be trouble* in the first cycle. But after raising takes place in the second cycle, the string *There is likely to be trouble* fails to meet the structural description of (13), so it receives no interpretation. The convention, we must remember, is that such strings are marked as deviant.

The second problem is that rule (13) assigns the wrong reading to sentences like *There are three chairs in every room*, namely "The class *chairs* has at least one member p such that p is in every room and the cardinality of the set of such members p is three".

6. The Phrase Structure analysis

An analysis which avoids many of the problems discussed is that of Jenkins (1975), which derives ESs from deep structure configurations where *there* is inserted directly in subject position. According to this analysis, both *John is a plumber* and *There is a Santa Claus* have the following deep structure:

(15) NP - AUX - *be* - $[_{\text{PRED}}\text{NP}]$

Since the category Predicate includes both Noun Phrases and Adjective Phrases, Jenkins must add a *deep structure condition* as follows:

(16) DS condition: *there* may occur only in the context — AUX *be* NP.

This condition has the effect of blocking ill-formed strings like **There is smart* and of restricting *there* to subject position.

How does this analysis fare with respect to WFC and CC? As for WFC, there is no violation, since, for example, *There are no ghosts* is generated directly, and not from an ill-formed **No ghosts are*. However, blocking strings like **There is smart*, as we have just seen, requires adding to the grammar an adhoc device, deep structure conditions. So compliance with WFC is not totally free of cost.

On the other hand, this analysis clearly violates CC, since the NP *there* cannot be assigned to the same semantic type as other NPs.

In addition, there are independent reasons for rejecting Jenkins' analysis. Like the other two analyses, it is incapable of dealing with verbal ESs and with the predicate restriction. Furthermore, by requiring that the constituent following *be* in ESs be analyzed as an

NP, it either fails to generate or assigns the wrong structure to sentences like the following, where the whole constituent after *be* is clearly not an NP:

(17) a. There's been a man shot.
(Cf. *A man shot just walked in.)
b. While you watch, there will be a live pig roasted.
(Cf. *A live pig roasted was served for dinner.)

I have demonstrated that a theory including the compositionality constraint and the well-formedness constraint rules out in principle three types of analysis of English existential sentences. To my knowledge, these three types exhaust the range of analyses that have been proposed within the transformational framework.

In the following section, I will outline an analysis of English existential sentences in Montague grammar.

7. I will assume that existential sentences are formed on the basis of a special type of verb phrases which I will call existential verb phrases (EVP). The translation rule corresponding to the syntactic rule forming existential sentences will be the identity mapping.

The rules which form EVPs assume the syntactic categories NP, LOC (locative expressions), and EV (existential verb, e.g. *be, ensue, begin,* etc.), and the following subfunctions (See Bach 1979):

(18) RCO (Right Concatenation):
If a is the function and b the argument, then RCON(a, b) is $a^\frown b$
Ex.: RCON(*be, a fool*) = *be*$^\frown$*a fool.*

(19) RWRAP (Right Wrap):
(i) If a is simple, then RWRAP(a, b) = RCON(a, b).
(ii) If a has the form $[_{XP}$ X W], then RWRAP(a, b) = X$^\frown b^\frown$W.
Ex.: RWRAP (*be murdered, peasants*)
= *be*$^\frown$*peasants*$^\frown$*murdered.*

The first two rules to consider are (20) and (21).

(20) If a is a (member of the category) EV, and b is an NP, then RCON (a, b) is an EVP.
Ex.: RCON(*be, no ghosts*) = *be*$^\frown$*no ghosts.*

(21) If a is an EVP and b is a LOC, then RCON(a, b) is an EVP.
Ex.: RCON *(be no ghosts, in the kitchen).*
be no ghosts$^\frown$*in the kitchen.*

Rule (20) generates verb phrases which can form ontological and (inside) verbal ESs, like *There are no ghosts* and *There ensued a riot.*

Rule (21) generates verb phrases which can form locational ESs, like *There are no ghosts in the kitchen.*

The derivation of periphrastic ESs is slightly more complex. First, we need a set of rules that would combine *be* with past participles, present participles, and a subclass of adjectives (including *sick* but excluding *smart,* for example) to yield a special type of 'transitive' verb phrase of the form *be murdered, be dancing,* and *be sick.* I abbreviate these rules as (22).

(22) If a is *be* and b is either (i) a PVP
(ii) a PrVP
(iii) an AP_x
then RCON(a, b) is a TV_{cop}
Exs.: (i) RCON*(be, murdered)* = *be*⌢*murdered*
(ii) RCON*(be, dancing)* = *be*⌢*dancing*
(iii) RCON*(be, sick)* = *be*⌢*sick*

The structures generated by rule (22) are subject to rule (23), which inserts an 'object' after *be,* the result being an EVP.

(23) If a is a TV_{cop} and b is an NP, then RWRAP *(a, b)* is an EVP.
Exs.: RWRAP*(be murdered, peasants)* = *be*⌢*peasants*⌢*murdered*
RWRAP*(be dancing, people)* = *be*⌢*people*⌢*dancing*
RWRAP*(be sick, people)* = *be*⌢*people*⌢*sick*

Finally, rule (24) applies to the EVPs generated by (20), (21) and (23) and forms existential sentences by concatenating them with *there.*

(24) If a is an EVP, then RCON*(there, a)* is an S.

The most controversial categories in this sketchy analysis are probably PVP, PrVP and TV_{cop}. I will now justify them.

With respect to PVP, Bach (1980) has presented two pieces of evidence which clearly establishes its existence. First, the occurrence of passive sentences without active counterparts, illustrated in (25), indicates that the grammar must generate passive verb phrases independently of active verb phrases.

(25) a. John was said to be in Rome.
(Cf. *They said John to be in Rome).
b. Mary is reported to be a genius.
(*They report Mary to be a genius).

Second, the existence of phrases like the ones underlined in the following set of sentences indicates that passive verb phrases include a constituent identical to our PVP:

(26) a. I met a man *arrested by the police.*
b. *Sent off on Tuesday,* the package didn't arrive until Saturday.
c. His children *finally sent off to college,* Alfred returned to his work.
d. I had my car *washed* yesterday afternoon.
e. I got these packages *sent off* yesterday.

As for the category PrPV, it can also be shown that it occurs independently of *be,* as in the following examples:

(27) a. *Not wanting to hurt his feelings,* Mary didn't say anything to John.
b. People *having finished the exam* may leave.

The category TV_{cop} figures crucially in rule (23), which treats *peasants, people,* etc. as 'objects' of complex 'transitive' verb phrases like *be murdered, be dancing, etc.* [8] I will argue for the category TV_{cop} indirectly by showing that rule (23) makes some interesting predictions with respect to quantifier scope.

Consider the following two sentences:

(28) a. There were many targets hit by every arrow.
b. There are many fans at every Sonics game.

In (28 a), *many* has wider scope than *every.* It can be glossed "There were many targets such that every arrow hit them", not "For every arrow, it was the case that it hit many targets". In (28 b), the situation is reversed, that is, *every* has wider scope than *many.* "Every Sonics game is well attended" would be an appropriate gloss, but not "There are many fans who attend every single Sonics game".

[8] For arguments in favor of a similar analysis for phrases like *persuade John to go,* see BACH 1979.

Quite clearly, any explanation in terms of surface order is bound to fail, since in both sentences *many* precedes *every*[9]. On the other hand, the analysis proposed here makes exactly the right predictions, as can be seen from the analysis trees corresponding to the sentences in question, where the quantifier with wider scope is in a higher position than the one with narrow scope.

(29) a. There were many targets hit by every arrow, S (24)
be many targets hit b every arrow, EVP (23)
be hit by every arrow, TV_{cop} (22 many targets, NP
be hit by every arrow, PVP

b. There are many fans at every Sonics game, S (24)
be many fans at every Sonics game, EVP (21)
be many fans, EVP (20) at every Sonics game, LOC
be, EV many fans, NP

These correct predictions constitute strong support for the analysis presented.

8. In conclusion, I have demonstrated that the range of possible analyses of ESs allowed within MG is quite narrow, due to the compositionality constraint and the well-formedness constraint. In addition, I have shown that a MG analysis makes interesting predictions with respect to quantifier scope. By contrast, transformational grammar allows a wide range of analyses, and no analysis to date is descriptively adequate. Since it is widely believed that MG is woefully unconstrained, this demonstration may be of some interest.

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[9] The principle suggested by IOUP (1975) also fails. Her suggestion is that quantifier scope obeys the following hierarchy: deep and surface subject > deep subject / surface subject > indirect object > preposition object > direct object. According to this principle, *every* should have wider scope than *many* since it occurs in the deep structure subject, while the NP *many targets* is neither the deep nor the surface structure subject. This is, of course, the wrong prediction. Similarly, for (28 b) this principle suggests that *many* should have wider scope than *every*, since a deep structure subject ranks higher than a preposition object. This is also the wrong prediction.

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