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Integrative Semantics

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INTEGRATIVE SEMANTICS

My purpose here is to sketch a theory of integrative semantics developed by J.-P. Paillet and myself over the past few years, and to show how it works. Then I shall summarize its characteristics and propose some conditions on an adequate semantic theory. Lastly, I want to make explicit some differences between this theory and a class of other theories.

A complete theory of language provides that the description of a language will include a general mapping which connects each arrangement of formatives which is possible in the language to specified aspects of the reality(s) or real situation(s) to which it may be applied truly, falsely, appropriately, or not at all. For a number of reasons, there must be an intermediate level, a semantic representation, which is related to both the formative string and the universe of interpretation, or "reality(s)" above. This representation is presumably free of the syntactic and morphological irregularities present in a formative string (it is *content* and not *expression* in Hjelmslev's terms), nor does it contain particular objects or "facts" of the universe of interpretation (again with Hjelmslev, it is *form* of content and not *substance* of content). Of the information transmitted by a signal (expression), it represents all and only the information underlying variation which does not obligatorily express information about the source and/or destination (see my "Convergent Routes to Meaning", for 1972 meeting of C.L.A.).

Due to our interest in natural language, we are not very interested in the mapping between the semantic or content representation (CR) and the universe of interpretation : our interest in this interpretation is confined to whether or not the elements of the CR and the relations in the CR itself can indeed be interpreted in terms of a universe of interpretation.

On the other hand, the mapping between the formative string and the CR is mediated in part by linguistic transformations as defined in Chomsky or as in Harris. Because we find evidence that a CR is not generally expressible as trees, there will have to be parts of this mapping which cannot be stated in linguistic transformations. We would like to know, however, how much of that mapping can be stated in those terms, and how much should be. To attack that question, we must first discover as much as possible about the nature of an adequate CR.

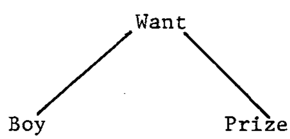
If we assume that the grammar (the mapping between the formative string and the CR) is consistent and not exceedingly complex, and that the interpretation (the mapping between the CR and the universe of interpretation) is likewise consistent and simple, we can show that some theories about the nature of the CR are not adequate.

We call "integrative" a theory of semantic representation which provides for the integration of the meanings of several sentences into a single unitary meaning. On a most fundamental level, the necessity for integrativity results from an assumption about semantic representation; if the meaning of a discourse of sentences S_1 followed by S_2 is the same as the meaning of an other discourse S_3, then the CR of S_1 followed by S_2 must be formally identical to the CR of S_3. This condition disallows the CR of successive sentences from being a simple conjunction of the CR's of the individual sentences; rearrangement of the sentences in a paragraph may alter its meaning, or more likely, may destroy it completely. Because $CR(S_1 + S_2) \neq CR(S_2 + S_1)$, then $CR(S_1 + S_2) \neq CR(S_1)$ & $CR(S_2)$. It is also clear that if $CR(S_3)$ is a single unitary graph (or tree), then $CR(S_1 + S_2)$ must also be. But $S_1 + S_2$ generally includes some redundancy if it paraphrases S_3, which means that $CR(S_1)$ overlaps $CR(S_2)$

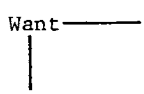
if together they are identical to $CR(S_3)$. This shows informally why CR's cannot simply be combined by a logical connective. Obvious arguments using paraphrastic discourse show further that the CR cannot indicate anything about the lexical items, the parts of speech, or even the sentence boundaries, of the expression.

But my purpose here is to exemplify, rather than provide rationale for, an integrative semantic theory. Arguments and rationale may be found in the various papers by Paillet and myself. For an example to demonstrate integration, let us take a sentence more familiarly known as Bach's paradox.

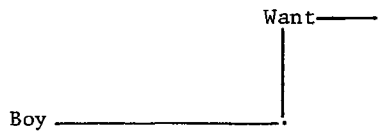
In dependency grammar, the sentence *a boy wanted a prize* is represented as;



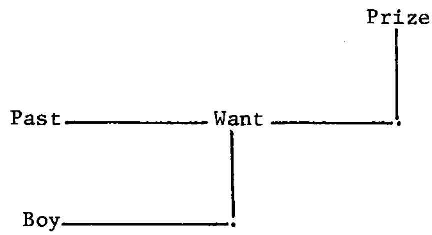
which may be stated in linear form : *Want(Boy, Prize)*. We will use this same graphic (and easily linearized) notation, rotated so that domination is down and to the right.



The direction downward represents the first actant, rightward the last actant, with other actants (if any) in order between. For a content representation, it is necessary to make a fundamental modification to dependency representation, based on the question : *What is it that wants ?*, in the above sentence. Obviously, it is not *boy*, but something which is a boy. Our example sentence is paraphrased by *something which is a boy wants a prize*, hence must have the same CR. The relations between *boy* and *something*, and between *wants a prize* and *something* are both predications about this thing : their representations must be alike. Thus we will graph as follows :

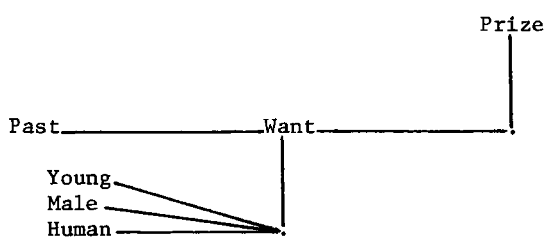


or linearly : *Want(x, y) & Boy(x)*. The same applies in-toto for *prize*, as in the graph below. We must also treat the past tense marker *-ed*, the semantic component of which we will call *Past*. What is past is the relationship named *Want (x, y)*, hence *Past* will dominate that relationship;



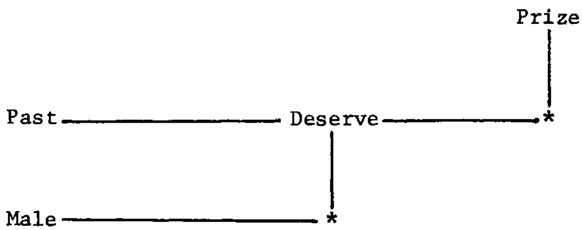
or : *Boy(x) & Prize(y) & Past (Want(x, y))*.

This representation, which we call a C-net, contains unanalysed words. As mentioned above, an adequate CR does not contain words, thus we are not finished. For this example, it will suffice for the moment to analyse *boy*. Both componential analysis and Carnap's meaning postulates yield three elements in the meaning of *boy*--to call something a boy is to purport that he is human, male and young--*Boy(x)* ===> *Human(x) & Male(x) & Young(x)*. Thus, we arrive at a temporary analysis of the sentence (I shall omit the linearized forms from now on as they are too cumbersome);



or, *in the past, a thing which was young, male and human wanted something which was a prize.* This is the complete C-net for the sentence as there are no sentences for it to be integrated into.

If a second sentence is encountered, *he deserved the prize*, it will be mapped by the simple and consistent grammar we assumed, into the following,



where the asterisk (*) represents the definiteness of the nominal in the second sentence. Such asterisks indicate that the sentence from which they originate cannot stand alone, and they must be removed by integration into a C-net. This pre-integration graph, the only type which can contain asterisks, is called a D-net; it is roughly analogous to the deep structure of a sentence in a transformational grammar, except that it resembles more closely a dependency structure.

The process of integration creates a new C-net from the C-net resulting from the previous sentence(s) by adding the portions of the C-net which are not already there. This can involve some choice as to which of two maximal integrations is intended, which accounts for much of the misunderstanding in ordinary discourse[1]. In this case, there is no choice.

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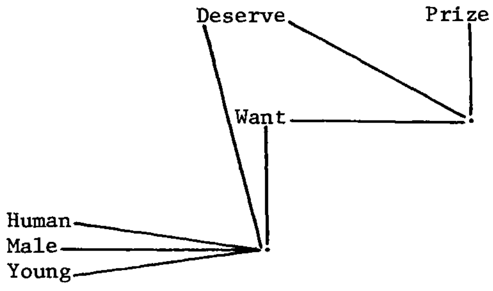
1. There are two interesting aspects that have not been explored here. First, the parts of the D-net which are not matched are the "new information" provided by that sentence (with certain exclusions, like performative markers, if they are present in D-nets). This promises to yield a formalization of what and maybe how much cognitive information is provided by a sentence in a given context. We may expect also that these unmatched parts of D will be the 'focus' of the sentence when

Integration proceeds by adding the unmatched elements of the D-net to the C-net. The resulting C-net is, (I shall ignore the Past markers here forward[2]);



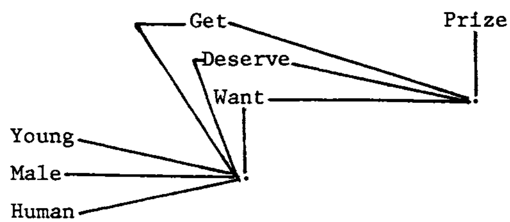
By the simple and consistent grammar, the sequence of these two sentences, resulting in this C-net, should have as paraphrases *a boy wanted the prize he deserved* and *the boy who deserved it wanted a prize* etc.

A third sentence, *the boy got the prize,* will have a D-net similar to that of the second sentence. If integrated into the previous C-net, the result will be ;

focus is marked. If so, a marked focus will reduce the possibilities of integration. It may also allow an algorithm to extract the focus in a language which doesn't mark focus (e.g. written English) for translation to a language which does mark focus (e.g. French).

Second, the predicates which dominate an asterisk, and are not under the action of a performative, are conditions on integration. If integration is to be successful, they must be found in the old C-net. These comprise a major class of presuppositions; this leads to the suspicion that all true presuppositions are of the following nature : conditions on a C-net which must be satisfied if a sentence is to be integrated into it.

2. It seems probably that tense markers are elements of a different orders — as are all the "shifters" of R. Jakobson. These and other deictic elements may not belong to C-nets at all.



This C-net also stands for the content of *the boy who wanted it got the prize he deserved.*

This sentence was known as Bach's paradox, for the following observation : if pronominalization is the replacement of the whole noun phrase by a pronoun (as was supposed), then this sentence would have an infinite deep structure. It motivated the device of referential indices, which allow the problem — what is an adequate CR — to be sidestepped, but which don't really solve it[3].

This example also shows that if a syntax (rules of arrangement) identifies clause boundaries, it is fairly easy to construct a grammar which maps one clause at a time into an integratable D-net. It thus appears that there is no need in a general linguistic theory for a "deep structure", or its integrative analogue a D-net, for a whole sentence. Moreover, to have such a level of representation necessitates otherwise unnecessary complexity and attributes to natural language a possibility it doesn't have. That is, the D-nets of clauses can be integrated directly, without passing through a D-net for the whole sentence. The other case is possible : a D-net for the sentence could be created (by integrating the D-nets for its clauses), which would then be integrated into the C-net

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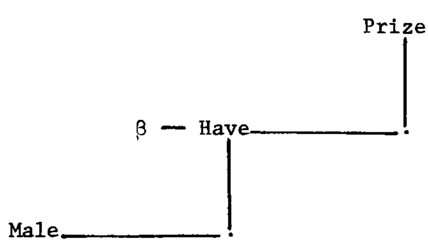
3. Indices are identical if and only if reference is made to the same object. Indexing of objects is not intended, and can have no justification. Indices are a formal, but much too powerful device to tie the branches (or twigs) of a deep structure tree together. Thus tied, the deep structure is no longer a tree, but a graph.

   Referential indices are a patch for a theory of deep structure, and they necessitate another patch to make non-distinct those deep structures which differ only in the arrangement of the indices, e.g. *he*$_1$ *saw him*$_2$ vs. *he*$_2$ *saw him*$_1$.

of previous sentences. A language which utilized the possibilities of reference allowed in that case is in principle possible, but is different from natural language; the identifications made in the process of integration (identifications of referents and of concepts) would be made so far as possible within the sentence. This seems not to be the case for natural language; in the following discourse *he* does not refer to Bill unambiguously : *John came to visit. The fact that he was disliked by the nurse didn't bother Bill in the slightest.*

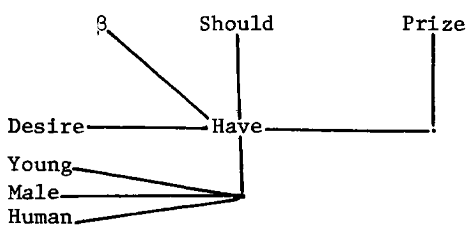
We have given an example of the integration of sentential meaning into discourse meaning. It should be noted that the replacement of the predicate *Boy* by the three atomic predicates *Human*, *Young* and *Male* can be considered simply as the lexical item *boy* "covering" these three predicates. This is formalized as conversion rules (analogous to meaning postulates) in my "Interpretation and integration...[4]". This paper gives other examples, and proposes a formal model that deals with problems of integration.

Let us return to this example, as there is more to be milked from it. Based on various sorts of evidence (McCawley (1970) and Bierwisch (1970)), it is clear that *get* with a nominal object can be analysed as an inchoative element β and a predicate *Have* (the predicate underlying *have NP*); it can be paraphrased as *come to have*. It is easily seen that *he gets a prize* has a C-net;

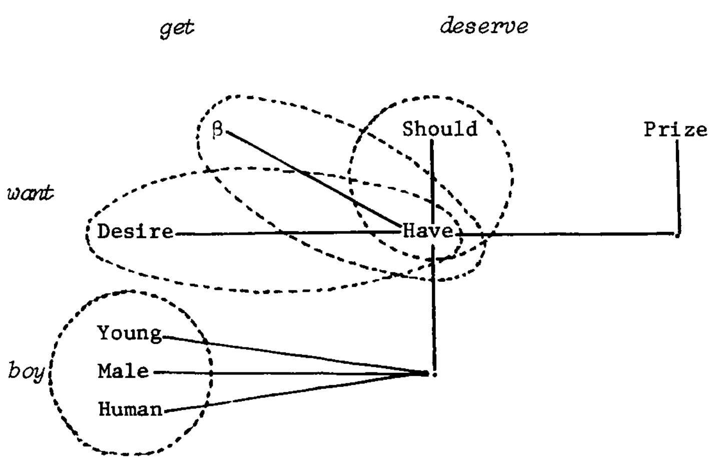


4. T. R. Hofmann, 1972, "Interpretation and Integration of Sentences into a C-ret", dans R. Kittredge (éd.), *Etudes en linguistique appliquée à la traduction automatique*, TAUM, Montréal, Université de Montréal.

In much the same way, *want* is analysable as *desire to have*, and *deserve* as *should have*. If the pseudo-predicates *Get*, *Want* and *Deserve* are replaced by these analyses, we might expect that then three distinct occurrences of the relationship *Have* would appear in the C-net. What is asserted by the sentence is however, that of the relationship of a boy having a prize, it was desired, it should have been, and it came to be. The integration of the maximal amount of elements insures this result : the predicate *Have* in the D-nets of successive sentences (or clauses) matches the *Have* in the C-net already present, hence integratior does not allow its repetition. The resultant C-net is really :



The portions of the C-net covered by the lexical items *get*, *want* and *deserve* overlap.



This redundancy is not unusual but cannot be adequately represented without a graph representation. Such overlapping also accounts for selectional restriction, as I shall show later. It also accounts for at least part of the restrictions between governing and subordinate verbs.

One type of overlapping is worthy of special mention, as it has occasionally been the source of much argument among linguists. Irregular expressions of tense, comparatives and so on have a natural representation in C-nets. Simple arguments assure us that *got* is the expression for *Past (Get (x, y))*. If *Get (x, y)* is analysed as β*(Have (x, y))*, then *Got (x, y)* is replaced by *Past* (β*(Have (x, y)))*, parallel to the replacement of *Boy (x)* by *Human (x) & Young (x) & Male (x)*.

get : β —— Have ——
got : Past —— β —— Have ——

Got is simply a word like any other — an association between an acoustic image and a concept (incomplete C-net). It is a hyponym of *get* just as *boy* is a hyponym of *person*. It is different from most hyponymic terms in that the additional atom that distinguishes its concept from that of *get*, a predicate *Past*, is obligatorily expressed in English, unlike the additional atom for *boy*, *Young*. The use of *got* instead of *get* is accordingly obligatory if *Past* is appropriate.

With these examples to bring substance to the following discussion, let us note some characteristics of the C-net theory of integrative semantic representation.

1) The basic assumption is that identical representations must be afforded to paraphrastic expressions. This means that the same representation must be assigned to the same meaning regardless of the syntactic structures (or lexical items) used.

2) Deriving from this, a C-net (or any adequate semantic representation) cannot contain syntactic or lexical information. No markers of the form of expression, syntactic or lexical, may appear.

3) Based on an assumption of simplicity, and indeed, to model our comprehension of a discourse, there are no repeated mentions of objects of the universe of interpretation. The points, which stand in a one to one correspondance with objects in the universe of interpretation, are not repeated as are the variables in the linear notation of the predicate calculus or the referential indices of transformational grammar.

4) Multiple domination of a point (or a predicate, for that matter) corresponds to the logician's conjunction (there are several other types of conjunction in natural language). The logician needs two devices to linearize the C-net; a conjunction operator and variables (names for points).

5) It is observable that natural language never has names for individual points, only descriptors which may be more or less specific. Names which designate unique individuals are a philosopher's fiction which falls apart if pressed very hard.

6) Meaning of words are observed to be connected sub-networks which are in general incomplete. Except for predicates designating conditions (e.g. *Rain*), words have one or more unfilled actants[5]. Word meaning, altough it is contained in discourse meaning, is of a fundamentally different nature, as discourse meaning (a C-net) contains no unfilled actants.

5. One might ask the question whether all lexical words can be defined in terms of atomic predicates. The answer is now fairly clear as yes, but significant portions of the meanings of many (especially infrequent) words are only hinted at by their analyses. It seems that every word has two types of meaning; a conceptual meaning which we have discussed here, & an experiencial meaning which is some sort of generalization over the contexts it has been found in (by the individual who has that meaning). The conceptual meaning includes the term's position in a folk taxonomy (e.g. *pinto*; type of pony), hence there is always at least one predicate present in the conceptual meaning. The conceptual meaning controls the generalization across contexts of experiencial meaning, and is the only aspect of meaning a speaker is held socially accountable for.

A complete description of a language includes a mapping from formative strings (sequences of words) to assertions and questions about a universe of discourse. For such a description to be adequate, we claim that it must include a level of representation which has the above properties. It is possible to investigate this level of representation directly, as I have shown above. And it is necessary to investigate this level if one wants to compare various syntactic theories (e.g. transformational syntax in either its interpretative or generative semantic varieties, tagmemic or other) for adequacy as a theory of grammar.

In addition, an adequate representation must handle selectional restrictions, but not as constraints of combinability. I will return to this shortly to show how this variety of integrative semantics handles them. We expect it furthermore to make explicit what the presuppositions of a discourse are, and to express the meaning in terms of entailed propositions (see note 1).

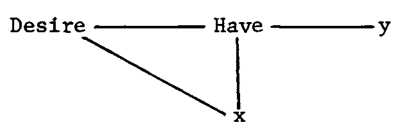
Over and above these requirements, we assume several further conditions in order to study content representations without assuming specific theories of grammar and interpretation — in order to study semantics autonomously. First, we must assume that there *is* a grammar and an interpretation, and that they are both consistent and not complex. We suppose, and have not yet been contradicted, that for any meaning there is one unique representation corresponding to it — there are not two CR's for the same meaning. This assumption is really of the nature of a condition on what we would (like to) accept as a representation of meaning. The reason that I keep *like to* is that it is conceivable that this condition cannot be preserved; it may even be provably unpreservable. So far, our variety of integrative semantics has been able to preserve it, while both linear types of representation (e.g. the predicate calculus and generative semantics) fail miserably.

A condition of analysability, that analyses involving a predicate are independent of the analysis of the predicate itself, is rather important for autonymous investigation into semantics, for without it, all analyses may be destroyed at a later date by investigation into their bases. If it holds, one need not worry about later investigation, as it will not affect present analyses. Fortunately it can be relaxed to some degree without ill effect, and a better formulation of this condition would be useful.

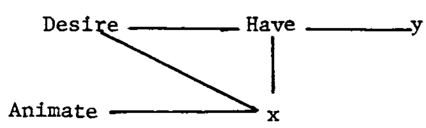
An other rule of thumb, that the meaning of a word is a locally-connected subgraph of the C-net to which it contributes, holds true so far as we know for lexical items, but shows signs of cracking for the case of quantifiers. This condition of local connectivity is apparently entailed by the condition of analysability and they may both fail for quantifiers.

Returning to our example we may illustrate how selectional restrictions can be handled. An adequate theory of language cannot treat them as restrictions or conditions on using a given collocation because they are too easily broken, as for example in a children's story (a universe of interpretation which is fictitious) *the old rocking chair was tired and wanted a rest* or in metaphor we propose that a selectional restriction is nothing more than a part of the meaning (concept) of the word.

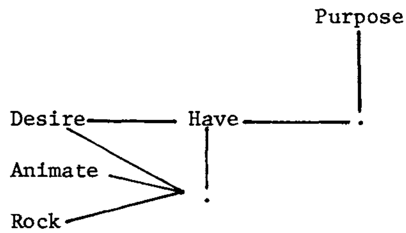
Assuming that *want*, with its usual meaning, requires of its subject that it refer to an animal object, we may revise the analysis assigned to it. Instead of the following,



we propose that its subject (x) be animate :



In the above analyses, the addition of *Animate* will cause no contradiction, but a sentence *this rock wants a purpose* will have a C-net



This contains a contradiction on the lower point; there is something which is both a rock and is animate. This particular contradiction can be solved in two ways. The general way is to treat it metaphorically, as personifying or animating the rock, and the specific way is to find an unusual meaning for *want* (or *rock*), here *lack* or *not have* as in *this rock lacks a purpose*.

To account for this latter possibility, we propose that the absence of contradictions is another condition for integration. With the other conditions on integration, the possible interpretations given to a sentence (its possible integrations) in context is usually quite small. One of the biggest problems for computer comprehension (or translation) of human language is the multitudes of ambiguities met in ordinary language. The theory of language must account for the fact that although these ambiguities exist for the sentence in isolation, they do not hinder interpretation. Integrative semantics is a first attempt to account for these blatant problems.

I would like to note that these problems are far from exhausting semantics. First, besides the conceptual meaning of a word which we have discussed, there is an experiencial meaning derived from one's experiences with the word. This part is not social, hence not investigatable by linguistic modes of inquiry. I presume that affect is included here. There are also performative aspects of sentences, and "universe-creating" verbs (e.g. *say*), which Paillet in particular has suggested relating to the "shifters" of Jakobson (see note 2). Our present view is that these connect whole C-nets rather than points or predicates.

An other thing which we have not touched is the process of making reference. One may also study the dictionary as a system of concepts. I would recommend Lamb (1970) for the philosophy of how this interacts with human life and some idea of its scope,and Bierwich (1970) for a well-developed account of some of what this entails. Related to this, McCawley has approached questions of "what is a possible lexical item [conceptual meaning] ?"

An other very interesting area which needs exploration is how the presence of certain predicates about a point negates other predicates (presumably in integration). For instance, the predicates of *tall boy* are the simple sum of the predicates of *tall* and *boy*, but not so for *girl bachelor* where the *Male* of *bachelor* is somehow supressed. Furthermore, there are cases of atomic predicates which have two actants and a given interpretation. If only one of these actants is filled, the interpretation (in English at least) seems to be slightly different. One case of this is the predicate paraphrased as *is a child of*, which I will argue to be *is young* if the second actant is not filled.

C-networks can be expressed in a parenthesis notation resembling that of the predicate calculus. This notational equivalence is useful for rendering this semantic representation completely formal and familiar, but tends to suggest that C-networks are a notational variant of predicate calculus. They are actually two hypotheses which differ in a number of ways. I would like to make these differences explicit, as the predicate calculus has found considerable acceptance in linguistic works of recent years (see Fodor (1970) or Bellert (1972)). I hope to make it apparent that they are not equivalent in any sense and will indicate areas in which evidence may be sought to eliminate one or the other hypothesis.

It is perhaps appropriate first to sketch the algorithm for converting diagrammatic C-networks into the linear C-networks which resemble the predicate calculus notation :

1) First, a variable (x, y, z, etc.) is assigned to each point.

2) Then for each predicate (P_j) dominating a point (V_i), the line of domination is erased between P_j and V_i, and P_j is replaced by $P_j(V_i)$. Predicates P_j which dominate two or more points V_i, $V_{i+1,\ldots}$, in counter-clockwise direction beginning from downward, are replaced by $P_j(V_i, V_{i+1,\ldots})$ with all of the lines of domination erased.

3) Points from which all domination lines have been removed are erased.

4) Operations 2) and 3) are repeated until they can no longer apply, with the term *point* understood as "Predicate with its arguments under it" (i.e. one which no longer dominates anything graphically). Where there is multiple domination of a predicate, it is necessary to give it (and all it dominates) a name (p, q, r, etc.) — equivalent to returning to the first rather than the second step of the algorithm. When this procedure reaches the maximal elements of the network, the resulting formulae are not erased because no line dominating them was erased (as they didn't have any dominating elements).

5) The last step is to conjoin all these formulae.

This algorithm is readily reversible, thus the two notations are weakly equivalent. There are obvious differences for a metric of simplicity, but equivalent metrics can be defined, by virtue of the equivalence of notations. The graphic notation seems more natural, because, like natural language, it does not utilize, nor allow, the naming of individuals (points). The introduction of variables to name individuals and predication in the linear notation is needed only to express information concerning coreference, and serves as a device to express a non-linear network as a formal, linear notation[6]. A simplicity metric for the linear

6. This linear notation is essentially identical with that used on the Université de Montréal computer (in LISP).

expression of a C-network will accordingly be complex, as it must essentially reconstruct the graphic formulation and operate on it. The concern here with simplicity is not for the purpose of formalizing an explicit simplicity metric. We are presently concerned with simplicity only on the informal and intuitive level, where a science assumes the (intuitively) most simple explanation for a phenomenon, until proven wrong. It is simplicity as measured on the graphic representation that is assumed important to the discovery of an adequate semantic representation of natural language.

Turning now to the differences between the predicate calculus (PC) notation and the C-notation, it is first noticed that PC notation is not integrative. I have explained elsewhere why an adequate semantic theory of natural language must be integrative. PC could be used integratively, but as it is commonly understood, used and defined, it is not so. This means that there are generally equivalent forms which are formally distinct, and this entails the presence of rules of derivation, to convert each form into its equivalent forms. This characteristic is present also in the linear C-notation, but the equivalent C-forms differ only in predications (the p, q, r, etc., above). The use of predicate names can be removed[7] at the expense of some redundancy, and the only rule of derivation is the commutativity of the logical &.

An illustration of the non-integrative nature of PC-notation is a conjoined formula over variables x, y, z, where the j^{th} formula is an equation 'x = y'. In an integrative PC, this formula would demand that all y's in previous formulae (F_1 to F_{j-1}) are replaced by x's, and it

7. This is not so for circular assertions, such as following. If such are possible, the use of referential indices for predicates is necessitated in linear and tree representations of content.

she asserts that I deny her assertion

a = Assert (she, b) & b = Deny (I, a)

this sentence is false a = False (a)

would stand on the side, to cause later formulae (F_j + n + 1) to undergo this same replacement. The existence of such equations in PC-formulae, with x's and y's in formulae on both sides, is a result of PC not being integrative. Incidentally, the naturalness of the graphic notation is readily apparent here. If a sentence decodes into such an equation, each conjoined formula in the linear C-notation will be subjected to the above replacement. In the graphic notation, the two points need only be brought together and superimposed; the equation causes a change in the structure of the C-network and then itself disappears.

Substantial differences between PC an C hypotheses include the following : 1) C-notation, like natural language, has no names for points. PC has both individual names and variable names; 2) PC has functors & and v. McCawley has shown that v, the inclusive *or* of PC, does not match the English *or*, or the Latin *aut* or *vel*. Many occurrences of *and* are not representable by the logical &. I am inclined to think that neither the logical & nor its dual v is needed for the representation of natural language; 3) PC does not represent the differences between the quantification in the following sentences. C-notation, if adequate, must;

(1) *elephants are found in Africa and Asia*
(2) *the elephant is found in Africa and Asia*
(3) **an elephant is found in Africa and Asia*
(4) *all elephants are found in Africa and Asia*
(5) ?*every elephant is found in Africa and Asia*
(6) *each elephant is found in Africa and Asia*
(7) *any elephant is found in Africa and Asia*

4) C-notation includes two-place predicates in which either place may be absent, where the meanings of the resulting one-place predicates are a function of the two-place predicates. PC-notation does not allow this directly and an equivalent well-formed PC-notation contains some distortion and additional rules of derivation; 5) PC has no limit on the number of variables a predicate may relate; C-predicates can be limited to two

places, not as a mathematical convention, but as a condition of naturalness and simplicity in the analysis of natural human languages.

Quantifiers were not mentioned above with regard to the linear C-notation. This is because 6) there seems to be only one such; it asserts existence in C. Of course, a C-network may contain an atomic quasi-predicate (following a suggestion of Paillet[8]) which expresses what a PC quantifier does; such would assert existence etc., in the universe of interpretation (not in C); 7) the iota and lambda operators of PC are similar to, but different from definite or anaphoric L. This operator asserts that the listener can identify a unique referent with the information accompanying it. This information need not include its essential properties; identification may be made based solely on accidental characteristics. L is intimately related to the concept of integration; the closest PC can come to expressing it would be a definition of the sort (for a definite nominal f in the i^{th} sentence S_i) :

$$L_i x\ (f(x)) :==\ x\ (f(x)\ \&\ [\exists\ j,\ 1 \leq j \leq i-1\ \&\ S_j \Rightarrow f(w)] \Rightarrow (w=x))$$

This definition of the L operator ignores the properties of L with regard to the universe of interpretation. In this aspect, the interpretation of L is dependant on the state of the universe at the time of usage : it is thus impossible to represent in a non-integrative PC. Further, L does not assert more than 'local uniqueness' in the interpretation universe, e.g. *hand me the (L) red pencil* does not presuppose that there is only one red pencil in the universe. Iota, on the other hand, asserts uniqueness for the entire universe of interpretation.

It is obvious that PC-notation can be extended — to include additional quantifiers, different functors, an L operator, and even systematically ambiguous predicates. The form of the notation is weakly equivalent, and it could be used in an integrative way. But with these

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8. See p. 1-18, J.-P. Paillet article.

extensions, or just half of them, it would seem to be seriously different from what one understands by predicate calculus. PC is therefore not a notational variant of C-network. And, if all these extensions were accepted to make an extended PC, it would be no more than weakly equivalent to a C-network.

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