Cahier de linguistique

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 arrang-
ement 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 represent-
ation, which is related to both the formative string and the universe
of interpretation, or "reality(s)" above. This representation is pre-
sumably 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 univ-
erse 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 interest-
ed 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;
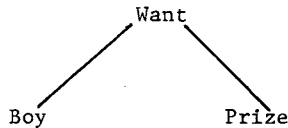
which may be stated in linear form : *Want (Boy, Prize)*. We will use this same graphic (and easily linearized) notation, rotated so that domination is down and to the right.
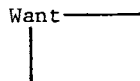
The direction downward represents the first actant, rightward the last actant, with other actants (if any) in order between. For a content representation, it is necessary to make a fundamental modification to dependency representation, based on the question : *What is it that wants ?*, in the above sentence. 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 :

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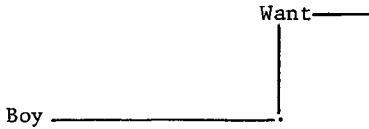
or linearly : *Want (x, y) & Boy(x)*.   The same applies in-toto for *prize*,
as in the graph below. We must also treat the past tense marker *-ed*,
the semantic component of which we will call *Past*. What is past is the
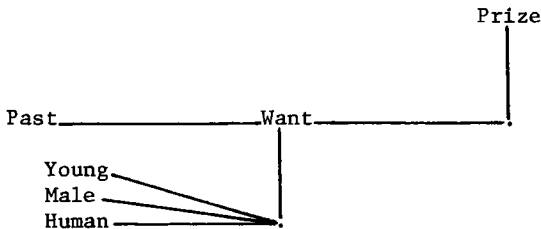relationship named *Want (x, y)*, hence *Past* will dominate that relationship;

```
                                          Prize
                                           │
                                           │
          Past————————————Want ——————————•
                           │
                           │
          Boy——————————————•
```
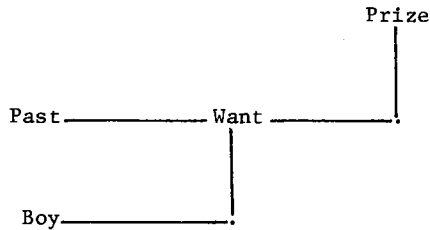
or : *Boy (x) & Prize(y) & Past (Want(x, y))*.

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 postu-
lates 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);

```
                                          Prize
                                           │
                                           │
          Past————————————————Want————————•
              Young╲                │
              Male ╲                │
              Human ———————————————•
```

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,

```
                                            Prize
                                              |
                                              |
                                              |
        Past _____ Deserve _____•*
                                    |
                                    |
                                    |
        Male _____ •*
```
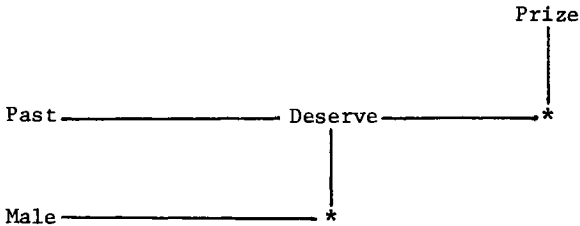
where the asterisk (*) represents the definiteness of the nominal in the second sentence. Such asterisks indicate that the sentence from which they originate cannot stand alone, and they must be removed by integration into a C-net. This pre-integration graph, the only type which can contain asterisks, 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]);

Deserve   Prize

Want

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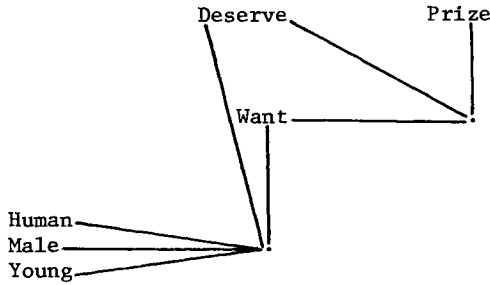
By the simple and consistent. grammar, the sequence of these two sentences,
resulting in this C-net, should have as paraphrases *a boy wanted the prize*
*he deserved* and *the boy who deserved it wanted a prize* etc.

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 ;

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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.

Get   Prize

Deserve

Want

Young

Male

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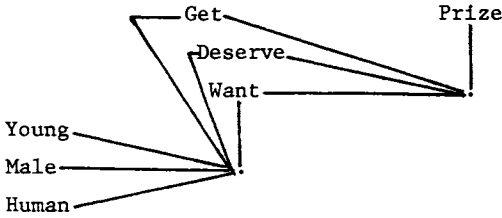
This C-net also stands for the content of *the boy who wanted it got the prize he deserved.*

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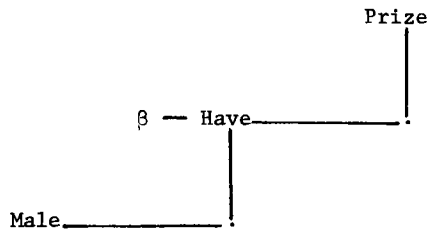
  Referential indices are a patch for a theory of deep structure, and they necessitate another patch to make non-distinct those deep structures which differ only in the arrangement of the indices, e.g. *he$_1$ saw him$_2$* vs. *he$_2$ saw him$_1$* .

of previous sentences. A language which utilized the possibilities of
reference allowed in that case is in principle possible, but is differ-
ent 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 pre-
dicates. 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 pro-
blems 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;

```
                                      Prize
                                        |
                                        |
                                        |
          β — Have_____.
                    |
                    |
Male_____.
```

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 integration does not allow its repetition. The resultant C-net is really :
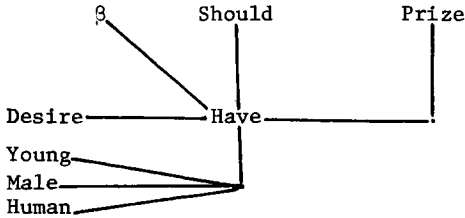
The portions of the C-net covered by the lexical items *get*, *want* and *deserve* overlap.
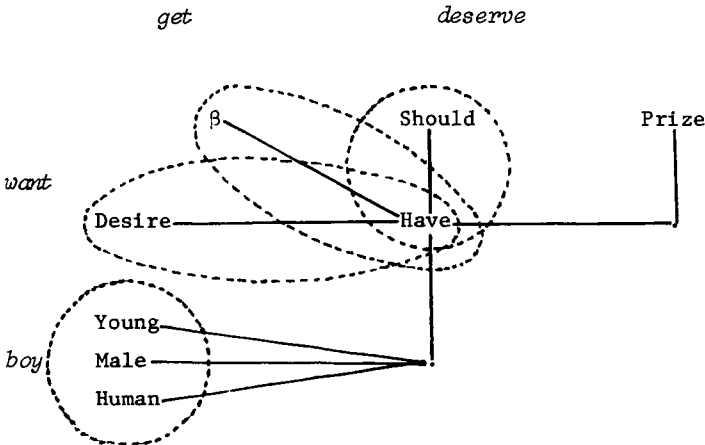
This redundancy is not unusual but cannot be adequately represented without a graph representation. Such overlapping also accounts for

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. Irreg-
ular expressions of tense, comparatives and so on have a natural repre-
sentation in C-nets. Simple arguments assure us that *got* is the expres-
sion 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 accor-
dingly 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 se-
mantic representation.

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

2) Deriving from this, a C-net (or any adequate semantic represen-
tation) 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.

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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 forma-
tive strings (sequences of words) to assertions and questions about a
universe of disoourse. For such a description to be adequate, we claim
that it must include a level of representation which has the above pro-
perties. It is possible to investigate this level of representation di-
rectly, as I have shown above. And it is necessary to investigate this
level if one wants to compare various syntactic theories (e.g. transfor-
mational syntax in either its interpretative or generative semantic va-
rieties, tagmemic or other) for adequacy as a theory of grammar.

In addition, an adequate representation must handle selectional res-
trictions, 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 propo-
sitions (see note 1).

Over and above these requirements, we assume several further condi-
tions 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 inter-
pretation, 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 im-

portant 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 <u>local connectivity</u> 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,
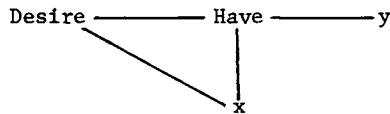
we propose that its subject (x) be animate :
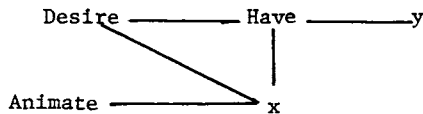
In the above analyses, the addition of *Animate* will cause no contradic-
tion, but a sentence *this rock wants a purpose* will have a C-net

Purpose

Desire——————— Have —————— !

Animate

Rock

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
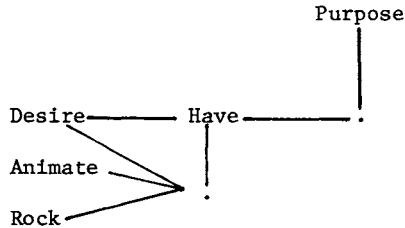rock lacks a purpose*.

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 sen-
tence (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 lan-
guage. 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 inves-
tigatable 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. Further-
more, 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 famil-
iar, 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 conver-
ting 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 simpli-
city, 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 indivi-
duals (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

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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 essen-
tially reconstruct the graphic formulation and operate on it. The con-
cern here with simplicity is not for the purpose of formalizing an expli-
cit simplicity metric. We are presently concerned with simplicity only
on the informal and intuitive level, where a science assumes the (intui-
tively) 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 na-
tural 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 dis-
tinct, 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 pre-
dications (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 deri-
vation 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 jth 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

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

   she asserts that I deny her assertion

   $$a = \text{Assert (she, b) \& b = Deny (I, a)}$$

   this sentence is false $a = \text{False (a)}$

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 follow-
ing : 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 En-
glish *or*, or the Latin *aut* or *vel*. Many occurrences of *and* are not repre-
sentable by the logical &. I am inclined to think that neither the logi-
cal & 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 distor-
tion 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 ith sentence S_i) :

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

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 accep-
ted to make an extended PC, it would be no more than weakly equivalent
to a C-network.

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