XVII. MECHANICAL TRANSLATION*

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A. ON THE PROBLEM OF SENTENCE SYNONYMY

In Quarterly Progress Report No. 64 (pages 208-211) I pointed out that the problem of paraphrasing among semantically equisignificant sentences is a problem of translation, the difference between what is usually regarded as translation and paraphrasing being that in translation, sentences of one language system are mapped onto sentences of another language system and that in paraphrasing, sentences of a language system are mapped onto sentences in the same language system. A theory of semantics, in order to be complete, must be able to explain the nature of each type of paraphrase and be able to state explicitly the transformation rules of sentence synonymy, i.e., those rules that map sentences from one language system onto sentences within the same language system. The semantical theories thus far proposed can easily account for the synonymy of sentences like 'My thirty-year old uncle is a bachelor' and 'My thirty-year old uncle is an unmarried man'. However, it is relatively simple to explain how these two sentences are related as paraphrases, since 'bachelor' is defined as 'marriageable unmarried man'. The problem of paraphrase becomes more complicated, and correspondingly more interesting, when one has to explain the synonymy of sentences in which the only words that differ from one another are not lexically related as synonyms at all but retain their basic meanings. For example, it cannot be said that the morpheme 'all' is ever synonymous with the word 'only'. One has only to compare the two sentences 'All men are mortal' with 'Only men are mortal' to appreciate this fact. Yet the sentences

(1) All work and no play makes Jack a dull boy

and

(2) Only work and no play makes Jack a dull boy

are synonymous. Since the only change that occurs in these two sentences is the change from 'all' to 'only', superficially it appears that, in this instance, 'all' and 'only' have the same meaning. And yet, to say that they are synonyms runs counter to our intuitive understanding of the meaning of these words. It appears to be quite clear that 'all' in sentence (1) retains its meaning of totality and 'only' in sentence (2) has its meaning of excluding all else. Both of these words belong to the category of structural-constant and cannot be defined lexically in the manner of denotative terms like 'bachelor', but

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must be defined contextually within the interlocking logical system of other structural-constants.[1]

The explanation of why sentences (1) and (2) are paraphrases of each other is that both sentences, as wholes, have the same core meaning, i.e., sentence (1) belongs to a sentence-type containing certain invariant structural features that characterize the core meaning of sentence (2). The meaning of sentence (1) expressed through its structural features is: if every member of a certain class of functions related to Jack in such a way as to be an activity that Jack does is identical with the specialized function, work, and not identical with the specialized function, play, then Jack will be a dull boy. The core meaning of sentence (2), expressed through its structural features, has the same logical formulation. This core meaning, given through a logical formulation, is a formula belonging to the calculus of higher predicates because the universal-quantifier binds function and not arguments. The grammatical form of sentence (1) corresponds more closely to the logical formulation than sentence (2) because it contains the word 'all', an analogue of the universal-quantifier. This example of sentence synonymy was particularly chosen to show that we must not be misled by the fact that the only change in grammatical form of the two sentences is the replacement of 'all' by 'only' into thinking that the two words themselves are synonymous. It just happens that the structural features are the same in these two sentence-types. In most cases of sentence synonymy the structural features of the sentence-types differ in more respects.

To clarify the explanation of the synonymy of sentences (1) and (2), let us start with an analysis of a simpler sentence-type, which can be formulated within the lower predicate-calculus, such as

(3) Only John entered the room.

One method, although not the only method, of symbolizing sentence (3) is to use the universal-quantifier, whose analogue in the English language system is 'all', and to identify every member of the class of those entering the room with the uniquely specified individual, John, by means of the verb 'to be', the linguistic analogue of the logical identity-sign. In symbols, sentence (3) is then expressed as

(4) $(x)\ [\text{entered}\ (x,\ \text{the room}) \supset x = \text{John}]$.

Sentence (3) does not have a sentence paraphrase in English that corresponds notationally to formula (4). (By 'correspond notationally' I mean that there exists a relatively close coordination between the structural-constants of the sentence in the natural language system and the logical-constants of the symbolic representation.) There is, of course, the clumsy rendering, 'For all x, if x entered the room then x is identical with John', which, although a grammatically correct sentence of English, hardly represents a natural grammatical English sentence. Sentence (3) can also be expressed by the semantically equivalent formulation,

(5) $\overline{(\mathrm{Ex})\ \text{entered}\ (\mathrm{x}, \text{the room}).\quad \mathrm{x} \neq \text{John}}$.

Sentence (3) does have a sentence paraphrase in English that notationally corresponds in important respects to formula (5), namely 'Nobody but John entered the room'. Both formulas (4) and (5) can be regarded as logically equivalent methods of expressing sentence (3). There is no symbolic representation that corresponds notationally to the grammatical form of 'Only John entered the room'. If a logician does not have the symbolic means of expressing notationally the precise grammatical structure of a given sentence, he is content with expressing its paraphrase, since he is interested in truth-value for the most part. He would regard it as superfluous to develop the additional symbolism to express notationally all of the possible paraphrases of a given sentence. The various grammatical forms of the paraphrases, however, are just the things that interest the linguist. He needs the transformational rules of paraphrase because he is concerned with the structure of each and every sentence, not just some paraphrase of a sentence.

Whereas the logical symbolism of formula (4) does not correspond notationally to a natural sentence of English, the grammatical form of a sentence like

(6) All John got was a scolding

exhibits a notational similarity to the logical formulation,

(7) $(\mathrm{x})\ [\text{got}\ (\text{John}, \mathrm{x}) \supset \mathrm{x} = \text{a scolding}]$.

Comparison of sentence (6) and formula (7) shows that the sentence contains the analogue of the universal-quantifier, 'all', and the singular form of the verb 'to be', 'was', which functions to equate every member of the class 'what John got' with a specified single thing, 'a scolding'.

Again, the synonymous sentences 'The only thing John got was a scolding' and 'John got only a scolding' have to be expressed by means of formula (7) or by

(8) $\overline{(\mathrm{Ex})\ \text{got}\ (\text{John}, \mathrm{x}).\quad \mathrm{x} \neq \text{a scolding}}$

since no representative symbolic notation has been introduced into the logical calculus. Notationally, formula (8) corresponds relatively closely to 'There is nothing John got but a scolding' and less closely to the grammatical form of 'John got nothing but a scolding'.

Let us now return to the discussion of the synonymy of the first pair of paraphrases, sentences (1) and (2). The logical analysis of this pair follows a pattern similar to that of the simpler cases. Because, however, the universal-quantifier binds functions, such as the verbs, 'work' and 'play', the grammatical form of sentence (1) differs from that of sentence (6), just as the logical structure of formula (9) differs from that of formula (7), although the universal-quantifier, as an operator, retains its fundamental meaning of totality. The logical formulation of sentence (1) is

(9) $(\mathrm{f})\ [(\mathrm{f} \in \alpha)\ .\ \mathrm{f}\ (\text{Jack}) \supset \mathrm{f} = \text{work}\ \ .\ \ \mathrm{f} \neq \text{play}] \supset \text{dull boy}\ (\text{Jack})$.

Careful inspection of formula (9) reveals its basic similarity to both formulas (4) and

(7) because, even though formula (9) differs in that the universal-quantifier ranges over all functions and that the major implication is itself a conditional, there is the same identification of every member of a given set with a specialized individual. In formula (9), the expression '$(f \in \alpha)$' serves to restrict the functions to a special class of verbs that are "doing" verbs; the expression 'f (Jack)' further restricts the functions to those related to Jack. The 'f' in 'f (Jack)' is a bound function variable whose analogue in English could be rendered, perhaps, by the verbal phrase 'do something', which expresses some kind of generality. As in the previous examples, there is no specific logical formulation corresponding notationally to the grammatical form of 'Only work and no play . . .'. Formula (9), thus, represents a method of expressing sentence (2) symbolically. Formula (9) can also be transformed by the derivation rules of the higher predicate-calculus into the semantically equivalent formulation with a denied existential-quantifier plus the appropriate changes of the logical constants. This formulation corresponds notationally to

(10) Nothing but work and no play makes Jack a dull boy

which is a paraphrase of both sentences (1) and (2).

The grammatical form of the following paraphrase of sentence (1), although not a natural English sentence, notationally corresponds more faithfully to the logical structure of formula (9) than does sentence (1):

(11) If all Jack does is work and not play, then this makes Jack a dull boy .

In sentence (11) the reader can see quite clearly the grammatical analogues of the important logical constants in formula (9): the 'if-then' corresponding to the major implication, the 'all' corresponding to the universal-quantifier, the verb 'does' corresponding to the function variable 'f', the copula 'is' corresponding to the identity-sign '=', the connective 'and' corresponding to the operation of conjunction, ' . ', the negation 'not' corresponding to the denial of the identity-sign '$\neq$', and the referent 'this' referring to the minor conditional as a whole.

The fact that speakers of English recognize that sentence (11) is a paraphrase, albeit a clumsy one, of sentence (1) gives empirical evidence that the logical analysis of the meaning of sentence (1) is correct. Sentence (11) bears a closer relationship of synonymity to sentence (1) than to sentence (2). The author is currently working on a precise formulation of this relationship. On the basis of this preliminary formulation, it is expected that a necessary condition for word-synonymy can be established.

There still remains a great deal of work to be done to formulate explicitly the transformation rules for sentence synonomy. The purpose of this presentation, however, is to outline the nature of the type of rules required for an adequate explanation of sentence paraphrase. It should be clear from the comparison of sentences (1), (2), and (10) that no simple substitution method suffices to explain their synonymity. One must first understand the underlying structural features of sets of semantically equivalent sentences in order to be able to formulate the correct transformation rules of synonymy so that there can be a mechanical procedure for transforming any sentence-type into all of its possible paraphrases.

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References

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