

THE RECOGNITION OF AMBIGUITY

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ABSTRACT

The syntactic distinction between deep and surface structure ambiguity (MacKay & Bever 1967) is challenged on theoretical and empirical grounds. It is argued that both types of ambiguity can be resolved at the level of surface syntactic structure, contrary to the MacKay & Bever hypothesis that the types are syntactically distinct and have distinct behavioural consequences. A psycholinguistic experiment is reported which investigated naive native speakers' recognition of ambiguity. No significant difference in error scores was found between the two types of structural ambiguity, although both differed significantly from lexical ambiguity. The MacKay & Bever results are re-examined and it is concluded that their results can be accounted for in terms of surface clause complexity of the stimuli rather than in terms of two types of structural ambiguity.

INTRODUCTION

Two basic types of ambiguity have been discussed by linguists: lexical ambiguity and structural ambiguity. Lexical ambiguity refers simply to homophony, a phonological form with more than one meaning. For example, the English /ber/ can mean **bare** (either a verb or an adjective), **bear** (a noun), or **bear** (a verb with two meanings). Often when such a form is found in a sentence, one or more of its potential meanings is automatically excluded for syntactic or semantic reasons. In the sentence "Fred couldn't bear the thought of another piece of pie", the nominal and adjectival meanings of /ber/ are excluded. However, in other sentences lexical ambiguity remains, at least potentially. For example, in the sentence "After her operation, she couldn't bear children", /ber/ must necessarily function syntactically as a verb, but from the sentence alone it is not clear which of the meanings of **bear** was intended by the speaker. As has often been pointed out, the context in which a sentence is uttered often serves to remove potential ambiguity, and in normal language use, lexical ambiguity is quite rare, with the chief exceptions being comedians searching for a cheap laugh or linguists citing isolated examples.

The second type of ambiguity, structural ambiguity, refers to two (or more) meanings of a clause rather than to different meanings of a particular lexical item within a sentence. For example, the sentence "The stout doctor's wife stayed at home" is structurally ambiguous in the sense that **stout** can modify either doctor or wife. Structural ambiguity occurs in those sentences in which strings of words can be grouped in different ways or in which words can have different grammatical functions depending on the inferred relations among them.

Structural ambiguity has played an important role in linguistic theory. In transformational theory (e.g., Chomsky 1957, 1965), with its emphasis on a contextless grammar with an autonomous syntax, the correct specification of structural ambiguity has been taken as an adequacy condition on grammar construction. Two types of structural ambiguity have been distinguished in the

transformational literature; surface structure (or "superficial") ambiguity and deep structure (or "underlying") ambiguity. In transformational terms, surface structure ambiguity refers to those sentences in which the surface string can be bracketed in two distinct ways, one for each of the meanings. An example of surface structure ambiguity is the sentence cited above, "The stout doctor's wife stayed at home." Deep structure ambiguity, on the other hand, refers to those sentences for which the different meanings reside in distinct grammatical roles or functions being played by particular constituents. A widely-cited example of deep structure ambiguity is the sentence "The mayor ordered the police to stop drinking," which can mean either "The Mayor ordered the police to cease drinking" or "The mayor ordered the police to prevent drinking". Under the meaning associated with the first paraphrase, it is presumed that the police themselves have been drinking and that they should stop. The deep structure analysis of this reading contains the noun phrase (NP) **the police** as the grammatical subject of both **stop** and **drink**. Under the meaning associated with the second paraphrase, it is presumed that others have been drinking and the task of the police is to prevent further drinking. The deep structure analysis of this second reading contains the NP **the police** as the grammatical subject of **stop** but the subject of **drink** is an unspecified NP such as **someone** or **others** (cf., MacKay & Bever 1967; Fodor, Bever & Garrett 1974). Here again, in a particular context, one or the other of the meanings would probably be obvious and natural, but in the absence of context, the sentence is at least potentially ambiguous.

The two types of structural ambiguity are quite different in terms of the kinds of information being conveyed. Deep structure ambiguity depends on different interpretations of grammatical relations such as subject and direct object in a given sentence, while surface structure ambiguity is generally associated with the scope or groupings of various words. Within transformational theory, with its emphasis on syntactic representations, the difference between the two types of structural ambiguity has been dealt with in purely syntactic terms. It has been argued by numerous linguists and psycholinguists (e.g., Chomsky 1965; Fodor, Bever & Garrett 1974; MacKay 1966; MacKay & Bever 1967) that sentences with deep syntactic ambiguity cannot be assigned two distinct surface bracketings. Rather, they argue, the meaning distinctions can be represented **only** at the level of deep syntactic structure since in transformational theory it is at the level of deep structure that grammatical relations such as subject-of and direct object-of are syntactically specified. Within such a theory, structural ambiguity is seen as a case in which distinct deep structures, one for each of the meanings of the sentence, are mapped into a single surface string. For surface structure ambiguity the surface string still has as many distinct surface bracketings as the sentence has meanings, but for deep structure ambiguity there is only one surface structure bracketing. In fact, the existence of structural ambiguity has been used in transformational theory as one of the central arguments in support of a level of abstract deep structure as distinct from surface structure.

Much work in psycholinguistics has been devoted to the question of the "psychological reality" of abstract deep structures as defined within transformational theory. Several psycholinguists have argued that the formal distinction between deep and surface structure ambiguity is reflected in subject performance, thus giving some measure of support to the psychological reality of deep structure. (See Fodor, Bever & Garrett 1974, pp. 261ff, 362ff for a review of these experiments.) The logic of such a claim is as follows: If the two types of structural ambiguity are different in kind, with deep structure ambiguity representable **only** at the level of deep structure, then differential subject responses

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to the two types of ambiguity support the psychological reality of such deep structures.

However, an alternative linguistic theory is conceivable, namely a theory which allows only one level of syntactic representation for a sentence--the surface structure. Of course, every sentence must obviously have some sort of cognitive representation quite different from surface structure, but there is no reason to believe that such a representation must be a syntactic object or even that it be usefully represented as a syntactic object. In such a theory, the cognitive representation of a sentence would be the locus of the organization of the information content of the sentence and as such it would include various types of grammatical information such as the specification of grammatical roles and relations being played by various constituents.

Such a representation need not, however, be a syntactic object at all. In the sentence, "The mayor ordered the police to stop drinking", the ambiguity resides in the clause "the police (to) stop drinking." The transformational theory suggests that there is one and only one surface structure bracketing for this clause with **stop** and **drink** both analyzed as verbs. However, in the alternative theory, one can assign two distinct surface bracketings to the clause. In one case, **stop+drinking** would be treated as a compound intransitive verb, paralleling the meaning "the police ceased drinking," while in the other case **stop** would be treated as a transitive verb with **drinking** taken as the direct object NP, paralleling the meaning "the police prevented drinking". In fact, there exists a well-known linguistic theory, that of Z. Harris (1957), in which only one level of syntactic representation is allowed. It has been shown that using Harris' methods one can, in fact, assign **distinct** surface structures for cases of so-called deep structure ambiguity using well-defined paraphrase tests (Prideaux 1972). Under such a linguistic theory, the difference between the two types of structural ambiguity is not a matter of surface versus deep structure at all, since both types are representable at the level of surface bracketing. Since, under such a theory, surface bracketing is an available device for representing both types of structural ambiguity, deep structure syntactic arguments are unnecessary to account for the differences. From the point of view of structural ambiguity, deep structure is not necessary.

While such a formal analysis can dispense with deep syntactic structure as necessary for handling structural ambiguity, it is more important to ask about the empirical evidence relating to such a level. In psycholinguistics, the two types of structural ambiguity have served as an empirical testing ground for assessing the psychological reality of hypothesized abstract deep structure. In their study, MacKay & Bever attempted to test for differential response times of the subjects to different types of ambiguity. Under the assumption that deep and surface structure ambiguities are **syntactically** different in kind, they hypothesized that the fastest recognition of ambiguity would come with lexical ambiguity, the next faster with surface ambiguity, and the slowest with deep ambiguity. Subjects were presented with sentences typed on cards and after the subject read the sentence he was to say "yes" as soon as he detected the ambiguity. Response latency was measured. The results were in conformity with the expectation of a three-way differentiation in response times in the order of lexical, surface, and deep ambiguity. However, if the alternative theory proposed above, which suggests that deep and surface ambiguities need not be distinguished at other than the surface level of representation, is correct, then the results reported by MacKay & Bever must be re-examined. That is, the two linguistic theories provide different hypotheses about subject processing of structural ambiguity. The MacKay & Bever approach, assuming a transformational

theory, suggests that the differential response times to different types of ambiguity support the psychological reality of deep syntactic structure as something distinct from and in addition to surface structure. The alternative theory, which allows only a single (surface) syntactic level, suggests that any differences between the two types of ambiguity are representable at the level of surface structure and do not support a level of deep structure at all. In order to test the MacKay & Bever hypothesis against the hypothesis that subjects should not have more difficulty recognizing deep structure ambiguity than surface structure ambiguity, the MacKay & Bever study was extended.

METHOD

SUBJECTS AND STIMULI

Subjects were 30 university students, with an equal number of males and females. All were native speakers of English who had received no formal linguistic training. Each was paid for participating in the experiment.

A stimulus set of 32 sentences was constructed, with each sentence 12 words long. Each sentence had a main clause and a subordinate clause. Eight of the sentences contained an instance of lexical ambiguity, eight were examples of surface structure ambiguity, and eight were examples of deep structure ambiguity. All the ambiguous sentences were variations of those reported in MacKay & Bever (1967), and their taxonomy of lexical, surface, and deep ambiguities was adhered to in the construction of the stimuli. The remaining eight sentences were non-ambiguous and served as distractors. Each non-ambiguous sentence was 12 words long with two clauses, paralleling the structure of the ambiguous sentences. Within each set of eight ambiguous sentences, four contained the ambiguity in the first clause and in the other four the ambiguity was in the second clause.

PROCEDURE

Subjects were individually tested. Each was seated before a CRT screen and the instructions and stimuli were presented on the screen under control of a PDP-12 computer. In the instruction period subjects were told that the experiment dealt with the detection of ambiguity. They were presented with examples of each type of ambiguity and the ambiguity was demonstrated by the use of paraphrases. They were also presented with examples of non-ambiguous sentences. Upon seeing a sentence on the screen, the subject was to decide whether or not it was ambiguous and to enter his decision on a scoring sheet by circling "yes" beside the sentence number if he detected an ambiguity or "no" if he did not. After a short practice run, the experiment began. Each of the 32 sentences was presented for seven seconds on the CRT screen. After each presentation, the screen went blank, then presented a row of asterisks to indicate a new stimulus was coming. The next sentence then appeared. The sentences were presented in random order and each subject was tested on all 32 sentences. The total task, including the instruction period, took about 20 minutes.

When the task was completed, subjects were given a written list of all the stimulus sentences. They were instructed to look at those sentences which they had marked as ambiguous and to write, for each, two meanings of the sentence. This was done to verify their detection of ambiguity. This second task proved to be quite difficult for the subjects, chiefly because they did not seem capable of paraphrasing ambiguous sentences in such a way as to distinguish clearly between the two meanings. Nevertheless, the response to the task was sufficiently complete to determine that

subjects were conscientiously performing the primary task. The observed difficulty of the second task as presented here is in distinct contrast to the apparent ease of such a task as reported by MacKay & Bever, leading one to wonder whether their subjects were possibly "contaminated" by previous formal linguistic training.

RESULTS

The results were scored in terms of the errors made by subjects on each ambiguous sentence. If a subject did not recognize an ambiguous sentence as ambiguous, a score of "1" was entered. The error data, as a function of ambiguity type and position for all sentences, is presented in Table 1. The maximum number of errors for a given subject in a particular ambiguity type and clause position is four, in which case the subject failed to detect the ambiguity in all the four sentences having that particular condition.

TABLE 1. Number of Errors Reported as a Function of Ambiguity Type and Position

Subject	Lexical		Surface		Deep	
	Front	Back	Front	Back	Front	Back
1	2	3	2	3	2	3
2	1	2	1	2	1	1
3	0	1	1	1	2	3
4	1	1	1	2	1	1
5	3	2	2	2	3	2
6	1	1	3	2	2	1
7	0	1	3	2	2	1
8	0	1	2	1	1	1
9	0	1	3	3	2	2
10	3	4	1	1	2	2
11	3	0	2	2	1	2
12	2	1	1	1	1	0
13	0	0	0	1	3	3
14	1	2	2	3	3	1
15	3	3	4	2	2	3
16	1	0	0	2	1	2
17	3	1	0	2	4	2
18	2	1	2	2	3	2
19	3	3	2	3	2	4
20	1	1	2	2	1	3
21	1	2	3	2	3	2
22	1	2	4	2	3	1
23	2	2	0	2	2	1
24	1	1	2	2	2	2
25	0	1	2	2	3	3
26	1	0	2	0	1	0
27	0	1	1	0	1	1
28	1	1	2	1	3	1
29	2	2	2	1	2	2
30	2	3	4	2	4	2

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An analysis of variance (ANOVA) was carried out on the error data with type of ambiguity (Type) and position of ambiguity (Position) as the two main factors. The Type factor had three levels: Lexical, Surface, and Deep, while the Position factor had two levels: Front and Back. The results of the ANOVA are presented in Table 2.

TABLE 2. ANOVA of Error Scores

Source	df	SSq	MSq	F
Type	2	9.2444	4.6222	6.31**
Position	1	0.4500	0.4500	0.61
Type x Position	2	1.2000	0.6000	0.82
Replicates	29	62.4944		
Error	145	106.2723	0.7329	
Total	179	179.6611		

**p < .01

Ambiguity Type was significant [$F(2,145)=6.31, p < .01$], but Position was not, nor was there a significant Type x Position interaction. In order to determine just which of the three types of ambiguity was contributing to the Type significance, *t* tests for correlated means were run on the pairs Lexical vs. Surface, Lexical vs. Deep, and Surface vs. Deep. Since ANOVA revealed no significant Position effect, the Position errors in each Type were combined for each subject for the *t* tests. (In no case was sex a significant factor.) The Lexical vs. Deep difference was significant, $t(29)=2.20, p < .05$, as was the Lexical vs. Surface difference, $t(29)=3.06, p < .01$. However, the Surface vs. Deep test was not significant.

DISCUSSION

If the MacKay & Beaver hypothesis is correct, subjects should fail to detect errors in deep structure ambiguity more often than in surface structure ambiguity. Such a prediction follows from the transformational view that in detecting surface structure ambiguity, one need only access the surface structure representations, but for deep structure ambiguity one must advert, in addition, to the level of deep syntactic representation to get at the source of the ambiguity. Of course, such a position depends implicitly on the view that subjects are processing language material in syntactic terms, with the meaning of sentences being inferred from the deep structure. If, on the other hand, both types of ambiguity are capable of distinct surface syntactic representations, then there should be no difference in the error scores for the two types of ambiguity if the detection of ambiguity is a purely syntactic matter. Under this alternative view of linguistic structure, there is no need for a second level of (deep) syntactic representation. Rather, various surface structures are directly paired with cognitive representations. Under both hypotheses, lexical ambiguity should be easier to detect than structural ambiguity of either type since lexical ambiguity resides in a word or phrase and not in relations between words or phrases.

The results of the present experiment support the alternative hypothesis and fail to support the MacKay & Bever hypothesis. That is, the results do not support the psychological status of deep syntactic structure. One can always, of course, deny the relevance of experiments such as the present one to the issue of deep structure.

However, the position is usually taken in the linguistic literature that notions like deep structure, transformations, and rule ordering are somehow "characterizations" of mental reality, (Chomsky, 1965). If deep structure has no behavioral consequences, then it is at best only a theoretical concept with no empirical content. The problem, of course, is if one wishes to claim mental status for a theoretical concept then he is obliged to submit such a concept to some sort of empirical testability. And this is exactly the position taken by MacKay & Bever when they attempt to give empirical content to the notion of deep structure.

However, the results originally reported by MacKay & Bever seem to be inconsistent with those of the present study. MacKay & Bever reported differential responses to the different types of ambiguity, whereas in the present study lexical ambiguity was detected with significantly less error than either type of structural ambiguity, but there was no significant difference in the error score for the two types of structural ambiguity. It is therefore important to re-examine the MacKay & Bever results.

MacKay & Bever did not control for the position of ambiguity within their stimuli, but from the results of the present study it can be concluded that position was not significant. The MacKay & Bever stimuli were fairly well controlled for length since each sentence was from seven to nine words long. However, their stimuli were quite heterogeneous in terms of surface syntactic complexity. Most of their lexically ambiguous sentences (12 out of 14) consisted of only **one** clause, as did all but one of their surface structure ambiguous sentences. However, their deep structure ambiguous sentences consisted chiefly of **two** clauses (eight out of 10). That is, their deep structure ambiguous sentences were by and large **more** complex at the level of surface structure than were their surface structure ambiguous sentences. Furthermore, their subjects were told in advance that all the sentences in the experiment would be ambiguous and that their task was to search for the ambiguity. Their task was both less natural and easier than that of the subjects in the present experiment.

In the present experiment, all the stimuli were of the same general syntactic form, namely a main clause and a subordinate clause. All stimuli were exactly 12 words long. Thus, both sentence length and clause structure were controlled. The number of clauses per sentence was not considered by MacKay & Bever in the interpretation of their results. However, if processing difficulty and time are a function of surface syntactic complexity, then more complex sentences should be relatively harder to process. If, in addition, the sentences are ambiguous, processing time should be even greater. Consequently, the differential response times reported by MacKay & Bever can be attributed simply to the number of surface clauses in the stimuli, quite independent of the type of ambiguity involved. In the present study, clause complexity was controlled and differential results for deep versus surface ambiguity did not occur. It can therefore be concluded that the MacKay & Bever results are not incompatible with the results of the present study: a surface structure syntactic analysis can account for both sets of results.

More importantly, in neither study is there any evidence to support the psychological status of deep syntactic structure since both sets of results can be accounted for in purely surface structure terms. If there is no psycholinguistic evidence to support a level of deep structure, then any linguistic theory which requires such a level and which purports to have psychological status is highly suspect. The alternative theory discussed above, which contains only one level of (surface) syntactic representation, is thus to be preferred over the transformational theory which must of necessity invoke a second level of (deep) syntactic structure.

Such an alternative theory must, as discussed above, also contain a level of cognitive representation, but the empirical evidence suggests that the cognitive representation need not be a syntactic object.

Clearly the last word on structural ambiguity has not been said. However, the MacKay & Bever results do not, contrary to their claim, provide support for a level of deep structure, despite the fact that the study has been quoted time and again in the psycholinguistic literature as empirical evidence in support of deep structure. It has been demonstrated here that a surface structure analysis alone can account for the MacKay & Bever results as well as the results of the present study.

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