

THE INFLUENCE OF GRAMMATICAL TRANSFORM
IN A SYLLOGISTIC REASONING TASK

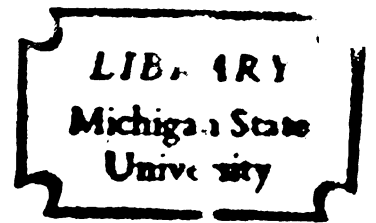
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ABSTRACT

THE INFLUENCE OF GRAMMATICAL TRANSFORM IN A SYLLOGISTIC REASONING TASK

by Marcia Z. Lippman

Recent research in verbal behavior has been based on the assumption that there may be a correspondence between syntactic relations as described by modern linguists and the psychological operations performed by the language user. The differential influence of syntactic structures (active, passive, negative, question, etc.) has been reflected in behavioral measures such as reaction time, motor response generalization, and recall, with sentential material. The active-affirmative structural form has been regarded as psychologically primary as well as syntactically primary. Some evidence suggests that Ss reword syntactically complex sentences into the active-affirmative at some stage in processing.

The present experiment investigated the influence of syntax on the operations of the language user by varying the structure of the major premise of syllogistic reasoning problems. Four behavioral measures were used: solution latency, rated difficulty, number of correct solutions and structure of verbal

solution. Of particular interest was the Passive-Active comparison; of secondary interest the Negative-Affirmative comparison.

It was hypothesized that (a) problems written in the Passive should take longer to solve and be rated more difficult than those written in the Active; (b) problems written in the Negative should take longer to solve and be rated more difficult than those written in the Affirmative; (c) verbal solutions should be given predominantly in the Active form; (d) verbal solutions to Passive problems may be given in the Passive to difficult problems as an atmosphere response.

A set of 32 syllogisms, each having a different semantic content, was employed. A valid conclusion could be reached for half of the syllogisms (determinant items); no valid conclusion could be reached for the other half of the syllogisms (indeterminant items). Eight of the determinant syllogisms contained a Negative term in the major premise; eight of the indeterminant syllogisms contained a Negative term in the minor premise. Voice (Active, Passive) and Position (1, 2) of the major premise of each syllogism was varied. Four forms were prepared such that each of the 32 syllogisms appeared on each of the four forms but represented a different combination of variables (Voice and Position) on each. In this way semantic content was counterbalanced. The two premises for each problem were manually presented on 4 x 5 white index cards. S was handed each of the 32 cards in succession by E. S was instructed to read the premises,

reach a solution, and tell it to E. Solution latency and the verbal solution were recorded. S rated each problem on an 11-point difficulty scale printed on a card in front of him after giving the solution.

Ss were 64 introductory psychology students.

The hypotheses were confirmed. More solution time was required when problems were written in the Passive or Negative than in the Active or Affirmative. The Passive and Negative problems were also rated as more difficult. Verbal solutions were given predominantly in the Active (85% to determinant items and 61% to indeterminant items) rather than Passive. (evidence for rewording of Passive) With respect to prediction D a dichotomy of Ss was found. One grouping of Ss took less time to give a Passive than Active response to Passive problems and rated those problems to which they gave a Passive response as easier. The second grouping of Ss took more time to give Passive than Active responses to Passive problems and rated those problems to which they gave a Passive response as harder. This latter group gave significantly more Passive responses than did the former. It was suggested that perhaps the dichotomy of Ss represents those Ss who gave Passive responses to easy problems because the solution was so obvious for them that no rewording into the Active was necessary, and those Ss who gave the Passive response to difficult problems as an atmosphere response out of uncertainty or cautiousness. Two steps may have been involved in the latter Ss'

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formulation of a solution accounting in part for the additional solution time required--rewording into Active, then back into Passive.

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INTRODUCTION

With the recent interest in the acquisition and recall of sentential material, given impetus by Miller's 1962 EPA Address, the role of syntactic as well as semantic components in these operations has been recognized and explored in some detail. The role of meaning in the learning of verbal material has been repeatedly demonstrated in the psychological literature. The semantic component (meaning), however, is only one aspect of a sentence. The first investigations of the syntax component of a sentence were primarily concerned with demonstrating that structure or syntax was important in learning and perception.

A modification of the procedure used by Miller and Selfridge (1950) of varying the order of approximation to English was adopted for these demonstrations. Miller and Selfridge had shown that recall of strings of words improved as their order of approximation to the statistical pattern of English increased. Their procedure, however, did not distinguish between syntactic and semantic factors. Verbal context was defined as the extent to which the choice of a particular word depended upon the word preceding it, or statistically, as dependent probabilities.

Salzinger, Portnoy, and Feldman (1962) demonstrated the contribution of both semantic and syntactic factors to the dependence of a word upon the preceding one. Ss were required to guess words that had been deleted from passages varying in order of approximation to the statistical structure of English sentences. The proportion of words given in the correct grammatical category increased with order of approximation. This demonstration of response specification with increasing orders of approximation could be explained in part by the influence of syntactical structure and in part by the contextual constraints on meaning.

Materials in which semantic and syntactic rules could be independently violated were constructed by Miller and Isard (1963) and by Marks and Miller (1964). The materials were based on a linguistic rather than statistical analysis of English sentences. The procedure made it possible to separate the role of semantic and syntactic components in the speech perception and recall tasks employed. Miller and Isard hypothesized that speech perception should be most difficult when linguistic rules have been violated and easiest when speech follows linguistic rules, allowing for processing in habitual fashion. The hypothesis was confirmed. Grammatical sentences (semantic and syntactic components maintained) were most accurately repeated by Ss; ungrammatical sentences (semantic and syntactic components destroyed) were least accurately

repeated; while, anomalous sentences (syntax only maintained) fell in between. Perceptual processing, thus, was facilitated when sentences followed grammatical rules, whether semantic or syntactic.

Marks and Miller also reported a facilitative effect of free recall when sentences followed grammatical rules. Normal sentences (semantic and syntactic components maintained) were most accurately recalled; strings of words following no grammatical rules were least accurately recalled; anagram (semantic components maintained) and anomalous (syntactic components maintained) strings fell in between. Both semantic and syntactic components had facilitative effects on recall.

That Ss do in fact, recognize the degree of grammaticalness of material has been shown by Coleman (1964). Ss ranked materials, which had been generated so that there were four levels of grammaticalness, in the predicted order. Learning was found to be a function of the grammatical level.

Once the influence of syntax on verbal learning has been demonstrated, psychologists' research interest turned toward investigating the "psychological reality" of the generative grammar rules proposed by modern linguists: phrase-structure rules and transformation rules. That is, psychologists have used these rules as a starting point for investigating the influence of structure on the operations performed by the user of a language. The assumption

was that behavioral measures would reflect a correspondence between psychological operations and phrase-structure and/or transformational relationships furnished by the grammars (Miller, 1962).

Phrase-Structure Rules

Phrase-structure rules apply to the constituent units (phrases) of a sentence such that a composite symbol representative of a functional unit, e.g., "the boy" (noun phrase, NP) or "caught the fish" (verb phrase, VP) is rewritten in a systematic fashion as follows:

Sentence (S) is rewritten as ($\rightarrow$) NP + VP

NP $\rightarrow$ T + N

VP $\rightarrow$ V + NP

NP $\rightarrow$ T + N

T $\rightarrow$ the, a, . . .

N $\rightarrow$ boy, fish, . . .

V $\rightarrow$ caught, . . .

The rules governing the expansion of a composite symbol into a set of symbols are to be applied whenever the composite symbol occurs. Thus, simple sentences such as "The boy caught the fish" may be described by formal statements and may be generated by the application of the phrase-structure rules. Generation would proceed in reverse order to the descriptive rewriting outlined above.

Two psychological studies have demonstrated that the constituent units (phrases) of sentences may influence Ss' perception and learning of sentential material. Johnson (1965) has suggested that phrases are not only grammatically functional units, but, correspondingly, psychologically functional units, and may be thought of as integrated response units. The conditional probability of an S's recalling a whole phrase correctly, given that one word of the phrase was correctly recalled, was found to be greater than if each word were treated as an independent event. A greater probability of error at phrase boundaries than within phrases occurred as predicted. Fodor and Beven (1965) provided additional support for considering the phrase as an integrated response unit. Ss reported the location of clicks heard during sentences as having occurred at the phrase boundaries. Such displacement of clicks toward phrase boundaries was interpreted as Ss' way of insuring the integrity of these units.

Transformation Rules

A second set of generative grammar rules are the transformation rules proposed by Chomsky (1957). The transformation rules differ from the phrase-structure rules in that an entire string of symbols (sentence) may be rewritten by application of a particular transformation. However, not all transformations can be applied to all strings.

The application of the passive transform, for example, to a symbolic statement, $NP_1 \text{ -- } V \text{ -- } NP_2$, allows for rewriting as $NP_2 \text{ -- be -- } V + \text{en -- by + } NP_1$. That is, "The boy ate the apple," may be rewritten as, "The apple was eaten by the boy."

In the grammar proposed by Chomsky, phrase-structure rules apply to the initial symbolic constituents (e.g., NP_1) and to the products of the rewriting of constituents. Transformation rules, then, apply to the products of phrase-structure rules and sometimes to the products of other transformation rules (e.g., the passive transform may be applied to a negative sentence).

Chomsky has suggested that all syntactic transforms have identical derivation (the kernel string) and thus all transforms of a sentence are related. "The boy caught the fish" is exemplary of a kernel. Three transformations may be applied to such a kernel, producing the passive (P), the negative (N), and the question (Q). The transformation rules may also be applied to the products of transforms, resulting in the passive-negative (PN), the passive-question (PQ), the negative-question (NQ), and the passive-negative-question (PNQ). Miller (1962) presented a cubal representation of the transformational relations (Figure 1). Each vertex represents a type of sentence structure; adjacent vertices differ in only one transform. Several psychological investigations are premised on the notion that transformationally related sentences are psychologically

related. Sentences differing in only one transform should be more closely related than sentences differing in two or more transforms.

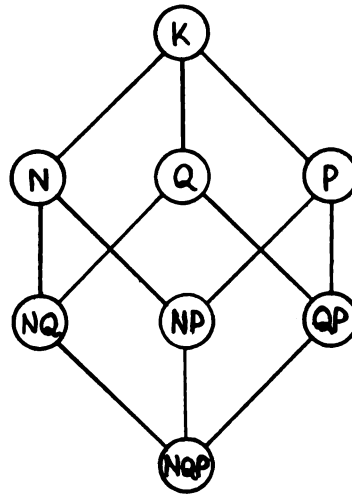


Figure 1. Syntactic relations of the eight sentences.

Behavioral measures of the relationship among these transforms have been reported by Miller (1962), Miller and McKean (1964), Clifton, Kurcz, and Jenkins (1965); and Clifton and Odom (1966). The evidence indicates that there is some correspondence between transformation relations and the behavioral measures. For example, using sentence identification time as a measure of relationship, Miller reported that the time taken to match up two sentences which differ only in transform was a function of the number of transformation rules applied.

Miller and McKean recorded the time required for actually transforming sentences. The results indicated that active-affirmative (K) sentences may be psychologically primary and easiest to process. Formation of the passive took more additional time than formation of the negative. When both transformations were required, the additional time needed for transformation was approximately the sum of the times for making two separate transforms.

Another behavioral measure of relationship has been employed by Clifton, Kurcz, and Jenkins. The degree to which a motor response generalizes between sentences as a function of transformational relatedness was explored. Ss saw a list of sentences for four trials. They were instructed to press a key immediately after reading each sentence. Then a longer list was presented and Ss were instructed to press the key only when they recognized a sentence from the first list. Sentences closely related transformationally were confused more than sentences having no grammatical relation, supporting the notion that sentences that are analyzed as being closely related grammatically are psychologically similar. Additional support was reported. Sentences differing by a combination of two transforms produced less generalization decrement than sentences differing by only one of the two transformations. The authors caution that generalization of semantic and physical similarity rather than syntactical similarity may account for the results.

Miller has offered an hypothesis concerning the manner in which transformed sentences are acquired. This hypothesis assumes that every sentence of a language could not possibly be memorized since memory capacity is limited, and that the psychological processing of sentences corresponds to the rules of generative grammar. It is hypothesized, in accord with the transformation rules, that sentences are remembered as kernel plus a "footnote" about the transformation.

Evidence for such a two stage process in the memorization of sentences has been reported by Mehler and Miller (1963). Using a retroactive interference paradigm, it was demonstrated that sentence content was first learned (and was first subject to interference), then syntactic details. Semantic aspects appeared to be coded separately from syntactic details. Similarly, Mehler (1963), using a method of prompted recall for sentences written in the active, passive, affirmative, negative, declarative, or interrogative, reported that most errors were due to syntactical confusions. An explanation similar to Miller's was offered:

" . . . Ss analyze the sentences into a semantic component plus syntactic corrections when they learn them, and . . . this separation of semantic content from syntactic form is one reason that the general meaning of a message is generally so much easier than its exact wording."

As a test of Miller's hypothesis, Savin and Perchinock (1965) measured the amount of memory capacity remaining after memorization of a sentence in each of 11 structural forms. The results supported the hypothesis: (a) the kernel sentence was found to require the least memory space; (b) transformed sentences somewhat more; and (c) multiple transformations always required more space than singular transformations. The underlying notion was that more memory space should be required if the transform phrase markers were encoded separately from the kernel string.

Gough (1965) used a procedure in which Ss were required to decide whether a sentence was true or false with respect to a picture. Active sentences were verified more quickly than passive, affirmative more quickly than negative ones. The results were interpreted as indicating that Ss must transform a sentence into its kernel before it is understood.

The Mehler and Miller, Mehler, Savin and Perchinock, and Gough studies lend indirect support to Miller's hypothesis about the way in which transformed sentences are learned or processed, i.e., a two stage process, kernel plus "footnote."

The results of one study investigating the nature of the words used by Ss as actor, verb, and object in passive and active sentence frames was interpreted as negative evidence for the two

stage hypothesis (Clark, 1965). The pattern of uncertainty in the actor, verb, and object, as well as the use of animate or inanimate nouns as actors and objects differed in the two syntactic forms. The author suggests that the results point to a sequential left-to-right generation of passive sentences rather than the application of the passive transform to active sentences. Because of the incomparability of what was required of the Ss in this experiment with the memory experiments, it is difficult to evaluate Clark's evidence with respect to the hypothesis.

The Present Experiment

The differential influence of syntactic structures (active, passive, negative, question, etc.) on psychological functioning has been reflected in behavioral measures such as reaction time, motor response generalization, recall, affirmation time. The experimental tasks employed to obtain these measures have required that S memorize or give a simple reaction, with the exception of the Miller and McKean study in which Ss were asked to make a particular transformation. It was the purpose of the present experiment to further investigate the influence of syntax on psychological functioning (operations of a language user) through the use of a syllogistic reasoning task. This task required Ss to formulate a sentence in solution to some of the problems rather than to memorize sentences.

The task allowed for four behavioral measures of the influence of transforms on syllogistic problem solving: latency, perceived difficulty, number of correct solutions, and the transforms of the verbal responses given as solutions. Of particular interest was the effect of the application of the Passive transform to simple Active-Affirmative statements comprising the major premises of the syllogisms. Interest was centered on the Passive transform since there are fewer contextual variables such as truth and falseness or exceptionality (Wason, 1965), which might interact with the structural manipulation. The Negative transform was of secondary interest only, for that reason. The nature of the syllogism did not permit the construction of the question and emphatic transforms.

It is to be emphasized that it was not the purpose of this study to investigate the influence of syntax on how people think, but to investigate the influence of syntax on the operations of the language user. Miller (1949) has stated emphatically that the laws of logic are simply not the laws of thought. The syllogism has proven a useful tool for the demonstration of the operation of verbal habits in problem solving and was employed as such in the present experiment. Deviations from the typical formal syllogistic reasoning task were necessary: (a) problems were written in content rather than symbolic form; (b) a transitive verb was employed in the major

premise to allow for the Passive transform; and (c) Ss had to formulate a response rather than choose from alternatives.

To aid in the understanding of the experimental task the following description of syllogisms, adopted from Chapman and Chapman (1959), is presented.

A syllogism consists of three statements, the first two of which are premises, the third a conclusion:

1. The major premise states the relationship between the middle term (common to both premises) and the predicate of the conclusion.
2. The minor premise states the relation between the middle term and the subject of the conclusion.
3. The conclusion is an inferred, or deduced relation between the minor term (subject) and the major term (predicate).

There are four categorical propositions used in expressing the three statements of a syllogism:

<u>Name</u>	<u>Expression</u>	<u>Symbol</u>
Universal affirmative	All Ss are Ps	A
Universal negative	No Ss are Ps	E
Particular affirmative	Some Ss are Ps	I
Particular negative	Some Ss are not Ps	O

Each of the three statements of a syllogism could be written as A, E, I, O. The combination in a given problem determines its mood. There are 16 possible combinations of major and minor premises, most of which yield no valid conclusion. An example of

a valid syllogism of the All mood in symbolic logic and content form is as follows:

All Ms are Ps	If all carnivores eat meat,
Some Ss are Ms	And some animals are carnivores;
Therefore:	Then,
Some Ss are Ps	Some animals eat meat.

An example of an invalid syllogism of the III mood is as follows:

Some Ms are Ps	If some typists transcribe shorthand,
Some Ss are Ms	And some secretaries are typists;
Therefore:	Then,
Some Ss are Ps	Some secretaries transcribe shorthand.

The use of the syllogistic reasoning task was chosen since it allowed (a) for disguising the nature of the inquiry from Ss; (b) for manipulation of the syntax of the material to be read by Ss; (c) for a verbal response from Ss, but still constraining responses enough to be analyzable; and (d) because of the constraint, allowed for analysis of tendencies to respond to the atmosphere created by the syntactic mood of the problem.

If the Active-Affirmative is the psychologically primary structural form of semantic content, it may be hypothesized that when information which must be related to other information is stated in the Passive (or Negative), it will require more time to relate the material (reach a solution). This alteration would also be likely to be considered more difficult by Ss. If it is true that

Ss transform a sentence into their own words or the kernel form, it would be predicted that Ss will phrase their responses predominantly in the Active irrespective of the transform of the premises and that perhaps the extra time Ss take in responding to transformed sentences is because of the operation of "putting into own words." (Mehler, 1963; Gough, 1965.)

Another consideration may determine the structural form of the response given by an S. It was mentioned earlier that Ss' solutions to syllogisms tend to be revealing of verbal habits used as a substitute for thinking (through error analysis).

Many of the errors that Ss make in formal syllogistic reasoning have been interpreted as the result of atmosphere effect (Woodworth & Sells, 1935; Sells, 1936; Chapman & Chapman, 1959; Simpson & Johnson, 1966). The operation of atmosphere effect in formal syllogistic reasoning has been recently stated as an hypothesis and support for it found: "When both premises of a syllogism contain the same qualifier, 'are' or 'are not' or the same quantifier, 'all' or 'some,' many Ss will accept a conclusion which also contains the common term." (Simpson & Johnson) Atmosphere effect has also been described more generally as a temporary set of an individual arising from a given situation or problem in which there are a limited number of response alternatives. This set leads the individual to respond in keeping with the general mood or tone of the situation or problem (Sells).

It was suggested that Ss would probably formulate a solution in the Active form in the present experiment, irrespective of the transform of the premises in keeping with the findings of the current literature. However, it might be possible to expand upon the definition of atmosphere effect and propose that Ss will formulate a solution in keeping with the structural form--active or passive--of the major premise as well as in keeping with the qualifiers and quantifiers.

Both predictions may be plausible. The structural form that an S actually employs may depend in part on the difficulty of a given Passive problem for him. Ss may find it "necessary" to adopt a set consistent with the syntactic mood on the difficult problems in formulating a response, i.e., change strategy and respond in the Passive after rote substitution of the terms. With less difficult problems Ss may find it possible to actively attempt to relate the information given in the major premise to that given in the minor premise in reaching a solution. For the easier problems it might be predicted that solution would be most often in the Active form in accord with the first hypothesis.

Thus, the major questions of concern were:

1. Does it take Ss longer to solve problems when they are written in the Passive (or Negative) transform than when they are written in the Active (or Affirmative) .
2. Do Ss consider problems more difficult when they are written in the Passive (or Negative) transform than when they are written in the Active (or Affirmative) .

3. What is the predominant verbal response form--active or passive. Do Ss have a tendency under any conditions to respond in keeping with the transform of the premises.
4. What might account for the additional solution time for problems written in the Passive transform, if that occurs.

METHOD

Subjects

The Ss were 64 students enrolled in an introductory psychology course at Michigan State University. Course credit was given for participation.

Materials

Eight combinations of universal and particular, affirmative and negative premises were used in preparing the syllogisms: AA, AI, EA, EI, II, IA, AE, IE. In symbolic form, A = All X is Y; E = All X is not Y; I = Some X is Y. Four instances of each of the eight combinations of premises were included, making a total of 32 syllogisms. A valid conclusion could be reached for each of the first four combinations of premises listed above (determinant syllogisms); no valid conclusion was possible for any of the other four combinations (indeterminant syllogisms).

The four determinant combinations of premises were balanced in terms of the use of universal (all) and particular (some) quantifiers, and negative terms (not). The four indeterminant combinations were balanced similarly except for the substitution of II

(two particular premises) for AA (two universal premises). The indeterminant combinations were included primarily as buffer items to reduce Ss' response set tendencies. The major premise of each syllogism was written with a transitive verb, the minor premise always with "are." Half (8) of the determinant syllogisms contained a negative term in the major premise and no negative term in the other half. Half of the indeterminant syllogisms contained a negative term in the minor premise and no negative term in other other half. The semantic content was different for each of the 32 syllogisms.

Voice (Active, Passive) and Position (1, 2) of the major premise of each syllogism was varied. Rather than designating a particular syllogism to represent a particular combination of Voice and Position, four forms (A, B, C, D) were constructed in order to counterbalance semantic content. The major premise of each syllogism was written four ways: Active, first Position; Active, second Position; Passive, first Position; Passive, second Position. Each of the four variations of a syllogism was systematically assigned to a different form. Thus, each of the 32 syllogisms appeared on each of the four forms but represented a different combination of variables (Voice and Position). Each form contained four examples of each of the four combinations of variables for

determinant items and four examples of each combination for indeterminate items.

The two premises for each syllogism were typed on a 4 x 5 plain white card. An 11-point difficulty rating scale was printed on a 5 x 8 white card. The left side was labeled EASY, the right side HARD.

Procedure

S was seated at a table at right angles to E. The instructions were read and explanatory diagrams drawn for three practice problems in symbolic logic form. Ss were informed that their solution time would be recorded but that the task was not a speed test. The instructions cautioned against reliance on knowledge of the semantic relationship among the terms of a problem. Ss were asked to pay attention to the logical relationship established by "all," "some," and "no," as illustrated in the practice problems where A, B, and C, having no meaning were used. They were then informed that E would give them the two premises for each problem on a card. After reading the premises and reaching a conclusion, they were to tell it to E. If they thought that there was no conclusion that followed, they were instructed to say "no conclusion."

The stimulus cards were placed face down on the table in front of E. The cards were handed to S one by one. E saw only the code number of the card handed to S to minimize possible E bias.

E started the stopwatch as soon as S took the card. Ss promptly concentrated on each card. The stopwatch was stopped at the first word of S's response. The verbal response and solution latency were recorded for each syllogism. S rated each problem on the 11-point scale for difficulty after each solution.

Four sequences of syllogistic content were used for each form with four Ss assigned to each sequence. The sequences were: (a) problems 1-32; (b) 32-1; (c) 16-1, 32-17; and (d) 17-32, 1-16.

Experimental Design

The experimental design for determinant items was a 2 x 2 x 2 factorial with repeated measures. The design for indeterminant items was also a 2 x 2 x 2 factorial with repeated measures. The independent variables were: Voice (Active, Passive); Qualification (Affirmative, Negative); and Position of the major premise (1, 2).

Four dependent measures were obtained: solution latency; difficulty ratings; transforms of Ss verbal solutions; and number of correct solutions.

RESULTS

Solution latency and difficulty rating data were treated similarly and will be considered together wherever possible to display consistencies in the trends. The tau coefficient of agreement in rank order was computed for the eight latency and rating means (representing each combination of variables). Latency and rating scores were found to be in high agreement (tau = .93).

Table 1 presents the mean latencies and ratings for the various transforms in order of increasing magnitude (collapsed across Position). Ss required less time to reach a solution when the major premise was written in the Active rather than Passive, and when written in the Affirmative rather than Negative. Correspondingly, the Active problems were rated easier than Passive ones, and Affirmative problems easier than Negative ones.

Separate statistical analyses were performed on determinant and indeterminant latencies and ratings for three reasons: (1) confounding due to the difference in location of the Negative term (major premise for determinant items; minor premise for indeterminant items); (2) the imbalance in the use of particular (some) premises in constructing the materials (this imbalance

would be expected to reduce differences in an Affirmative-Negative comparison across all items, and to enhance the difficulty of the indeterminate items); (3) the difference in the type of correct solution ("no conclusion" versus a valid statement of relationship).

It would have been possible to balance the use of particulars, universals and negatives--but only at the expense of increasing the likelihood of a response set tendency which would have been incompatible with the purposes of the experiment. The determinant-indeterminate comparison was not critical to the major purposes. Consistencies in the results with determinant and indeterminate items may be considered as indicative of the generality of the results.

Solution Latency

Significant Voice, Affirmative-Negative, and Position main effects were found for both determinant and indeterminate item solution latencies. Latency was augmented when (a) the major premise was written in the Passive transform, (b) the major or minor premise was Negative, or (c) the major premise was in the second Position on the stimulus card.

The Voice x Position and the Voice x Position x Affirmative-Negative interactions reached significance for determinant item latencies. Inspection of the means indicated that the significant Voice x Position interaction may be the result of disproportionately long

latencies when a Passive premise appeared in the second Position.

The three-way interaction is presented graphically in Figure 2.

A Newman-Keuls multiple comparison revealed that placing the major premise in Position 2 significantly ($p < .01$) increased Passive-Negative latencies only. Position did not significantly influence other variations. ($p > .05$)

The multiple comparison also revealed that Active-Negative and Passive-Affirmative mean latencies were not significantly different ($p > .05$) in either Position. Mean latencies for all variations were significantly different from Active-Affirmative latencies with the exception of the Passive-Affirmative in Position 1, and Active-Negative in Position 1 (from Active-Affirmative in Position 1 only).

Difficulty Ratings

The results of the analyses of variance of difficulty ratings are summarized in Table 4 and Table 5. Voice, Affirmative-Negative, and Position main effects for determinant item ratings were significant and in the same direction as for latencies. Items were rated more difficult when (a) the major premise was written in the Passive transform, (b) the major premise was Negative, or (c) the major premise was in the second Position.

Voice and Affirmative-Negative main effects for indeterminate items reached significance. The Position main effect failed to reach a statistically significant level. Indeterminant items were rated more difficult when (a) the major premise was written in the Passive, or (b) the minor premise was Negative.

The significant Voice x Position x Affirmative-Negative interaction for determinant item ratings is illustrated in Figure 3. A Newman-Keuls multiple comparison revealed that Position 2 had a significant ($p > .01$) influence on Passive-Negative ratings only. Position did not significantly influence other variations. ($p > .05$)

The multiple comparison also revealed that Active-Negative and Passive-Affirmative items were not rated significantly different ($p > .05$) in either Position. Mean ratings for all variations were significantly different from Active-Affirmative ratings with the exception of the Passive-Affirmative in Position 1 and 2 (from Active-Affirmative in Position 2 only).

Summary of Analyses of Variance

A summary of the results of the four analyses of variance is presented in Table 6. The significant main effects were all in the same direction: Active < Passive; Affirmative < Negative; and Position 1 < Position 2.

Correct Solutions

The number of correct solutions was tabulated for Active, Passive, Affirmative, and Negative items. Determinant items were scored as correct only if a valid conclusion was given. Indeterminant items were scored as correct only if "no conclusion" was given as a response. Table 7 presents the mean number correct (out of possible 4). The reversal in order of magnitude of the means for determinant and indeterminant items should be noted. This reversal may be due to the difference in the form of the response necessary to be considered correct: a valid conclusion in sentence form as opposed to "no conclusion."

Transform of Verbal Solution

The number of responses given in the Active, Passive, Affirmative, and Negative transforms or as "no conclusion" were tabulated for each combination of variables represented within premises. Percentages were found and are presented in Table 8. The percentages in identical premise transform-response transform cells are underscored. For both determinant and indeterminant items, a considerably greater percentage of responses was given in the Active (85.5% and 61.2%) than in the Passive (11.1% and 15.9%). Position had little influence on the structure of the response given. The increased percentage of "no conclusion" responses to Negative premises for both determinant and indeterminant items should be noted.

Even though responses were given predominantly in the Active, a two-category chi-square analysis revealed that significantly more than half of the Ss did give at least one Passive response ($\chi^2 = 5.06$, $df 1$, $p < .05$).

A median test was performed to determine if there was any relationship between the number of Passive responses Ss gave to Passive items and speed of solution. Ss were categorized as falling above or below the median solution latency score (70 seconds) for Passive determinant items and above or below the median number of Passive responses given (1). A nonsignificant $\chi^2 = 0.399$, $df 3$, was obtained.

To determine if a differential amount of time might be required to respond in the Active or Passive, a finer measure was employed. The mean solution time was found for determinant Passive problems to which a Passive response was given; likewise, for those to which an Active response was given. A t-test for related measures was performed and a nonsignificant $t = 0.09$ ($df 39$) was found. A nonsignificant tendency ($t = 1.91$, $df 39$, $p < .10$) was found for Ss who gave at least one Passive response to determinant Passive items, to rate those problems to which they gave a Passive response as more difficult than those to which they gave an Active response.

Two opposing hypotheses were made concerning the form of the response Ss might give and the influence of latency. The nonsignificant results above may be indicative of the operation of atmosphere, on the one hand, increasing latency of responses given in the Passive, and on the other, of Ss avoiding the time consuming operation of putting the premise in their own words and responding directly in the Passive.

When Ss were divided into two groups according to whether they had a plus score (took more time to respond with a Passive than Active verbal response) on the amount of time required to respond to Passive determinant items with a Passive, and those who had a minus score (took less time to respond with a Passive than Active), it was found that Ss with plus scores gave significantly more Passive responses than did those Ss with minus scores ($t = 2.90$, $df\ 39$, $P < .01$). The Ss with plus scores also rated Passive problems to which they gave a Passive response an average of 1.08 more difficult than those to which they gave an Active response, while Ss with minus scores rated Passive problems to which they gave a Passive response an average of .272 less difficult than those to which they gave an Active response.

This dichotomy may represent those Ss who did not give the Passive as an atmosphere response, Ss who did not give the Passive as an atmosphere response taking less time to give Passives than Actives to Passive problems.

To determine if Ss, in general, responded to the atmosphere of problems, a t -test for related measures was performed. Ss gave significantly more Passive responses to indeterminant items than to determinant items ($t = 3.46$, $df\ 63$, $p < .01$). It might be noted that those Ss who were in the plus group above gave an average of 1.14 more Passives to indeterminant items than did minus Ss.

Table 1. Mean solution latency and difficulty ratings for active-affirmative, active-negative, passive-affirmative, and passive-negative items.

Transform	Latency		Rating	
	Determinant	Indeterminant	Determinant	Indeterminant
Active-Affirmative	6.30	9.89	2.41	3.50
Passive-Affirmative	8.10	11.86	2.82	3.99
Active-Negative	8.30	14.61	3.03	4.57
Passive-Negative	11.03	15.69	3.63	4.81

Table 2. Summary of the analysis of variance of determinant-item solution latencies.

Source	df	Mean Square	F	P
Active-Passive (V)	1	2,619.07	39.28	.01
Affirmative-Negative (N)	1	3,120.50	46.80	.01
Position (P)	1	661.13	9.91	.01
V x P	1	343.86	5.14	.05
N x P	1	149.50	2.24	--
V x N	1	108.78	1.63	--
V x P x N	1	712.56	10.69	.01
Subjects	63	385.30		
Error	441	66.68		
Total	511			

Table 3. Summary of the analysis of variance of indeterminant-item solution latencies.

Source	df	Mean Square	F	P
Active-Passive (V)	1	1,194.38	8.27	.01
Affirmative-Negative (N)	1	9,358.83	64.77	.01
Position (P)	1	686.81	4.75	.05
V x P	1	157.83	1.09	--
N x P	1	13.46	--	--
V x N	1	101.53	--	--
V x P x N	1	272.63	--	--
Subjects	63	1,745.03		
Error	441	144.50		
Total	511			

Table 4. Summary of the analysis of variance of determinant-item difficulty ratings.

Source	df	Mean Square	F	P
Active-Passive (V)	1	131.02	41.46	.01
Affirmative-Negative (N)	1	257.36	81.44	.01
Position (P)	1	19.93	6.31	.05
V x P	1	1.06	--	--
N x P	1	5.08	1.61	--
V x N	1	4.69	1.84	--
V x P x N	1	30.72	9.72	.01
Subjects	63	33.87		
Error	441	3.16		
Total	511			

Table 5. Summary of the analysis of variance of indeterminant-item difficulty ratings.

Source	df	Mean Square	F	P
Active-Passive (V)	1	68.84	9.30	.01
Affirmative-Negative(N)	1	451.87	61.06	.01
Position (P)	1	21.53	2.91	--
V x P	1	8.99	1.21	--
N x P	1	7.27	--	--
V x N	1	6.26	--	--
V x P x N	1	25.55	3.45	--
Subjects	63	49.99		
Error	411	7.40		
Total	511			

Table 6. Summary of results of latency and rating analyses of variance.

Source	Latency		Rating	
	Determinant	Indeterminant	Determinant	Indeterminant
Voice	**	**	**	**
Affirmative-Negative	**	**	**	**
Position	**	*	*	-
V x P	*	-	-	-
N x P	-	-	-	-
V x N	-	-	-	-
V x P x N	**	-	*	-

* $p < .05$
 ** $p < .01$

Table 7. Mean number of correct solutions.

Premise	Determinant Items	Indeterminant Items
Active-Affirmative	3.23	0.39
Passive-Affirmative	2.89	0.48
Active-Negative	1.89	1.56
Passive-Negative	1.58	1.25

Table 8. Percentage of responses given in Active, Passive, Affirmative, Negative, No Conclusion for each combination of variables.

		Responses				No Conclusion
		ACTIVE		PASSIVE		
		affirmative	negative	affirmative	negative	
Determinant- Item Premise						
ACTIVE	-aff 1	<u>99.2%</u>	0 %	0 %	0 %	0.8 %
	aff 2	<u>96.9</u>	0.8	0.8	0	1.5
	neg 1	3.1	<u>92.2</u>	0	0	4.7
	neg 2	5.5	<u>87.5</u>	0	0	7.0
PASSIVE-	aff 1	82.8	0	<u>17.2</u>	0	0
	aff 2	81.2	0	<u>17.2</u>	0	1.6
	neg 1	3.1	68.8	0.8	<u>25.0</u>	2.3
	neg 2	3.1	60.2	2.3	<u>25.0</u>	9.4
% of Total		46.8	38.7	4.9	6.2	3.4
Indeterminant- Item Premise						
ACTIVE	-aff 1	<u>90.6</u>	0.8	0	0	8.6
	aff 2	<u>86.0</u>	3.1	0	0	10.9
	neg 1	10.2	<u>51.5</u>	0	0	38.3
	neg 2	4.7	<u>53.1</u>	1.6	0.8	39.8
PASSIVE	-aff 1	55.4	0.8	<u>30.5</u>	0.8	12.5
	aff 2	53.9	0.8	<u>33.6</u>	0.8	10.9
	neg 1	4.7	36.0	3.9	<u>23.4</u>	32.0
	neg 2	4.7	32.8	3.9	<u>28.1</u>	30.5
% of Total		38.8	22.4	9.2	6.7	22.9

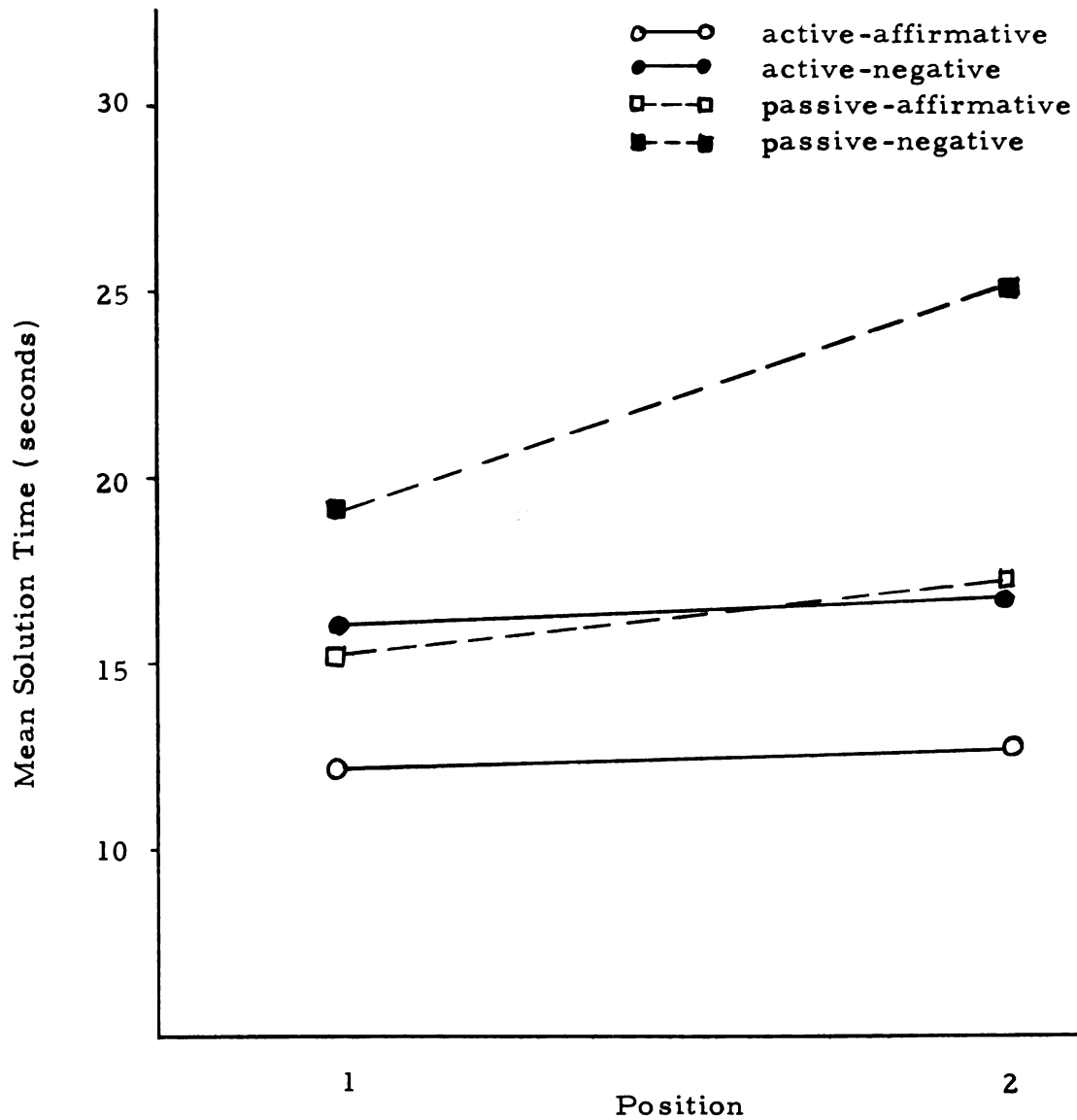


Figure 2. Mean determinant-item latency as a function of Voice, Negation, and Position.

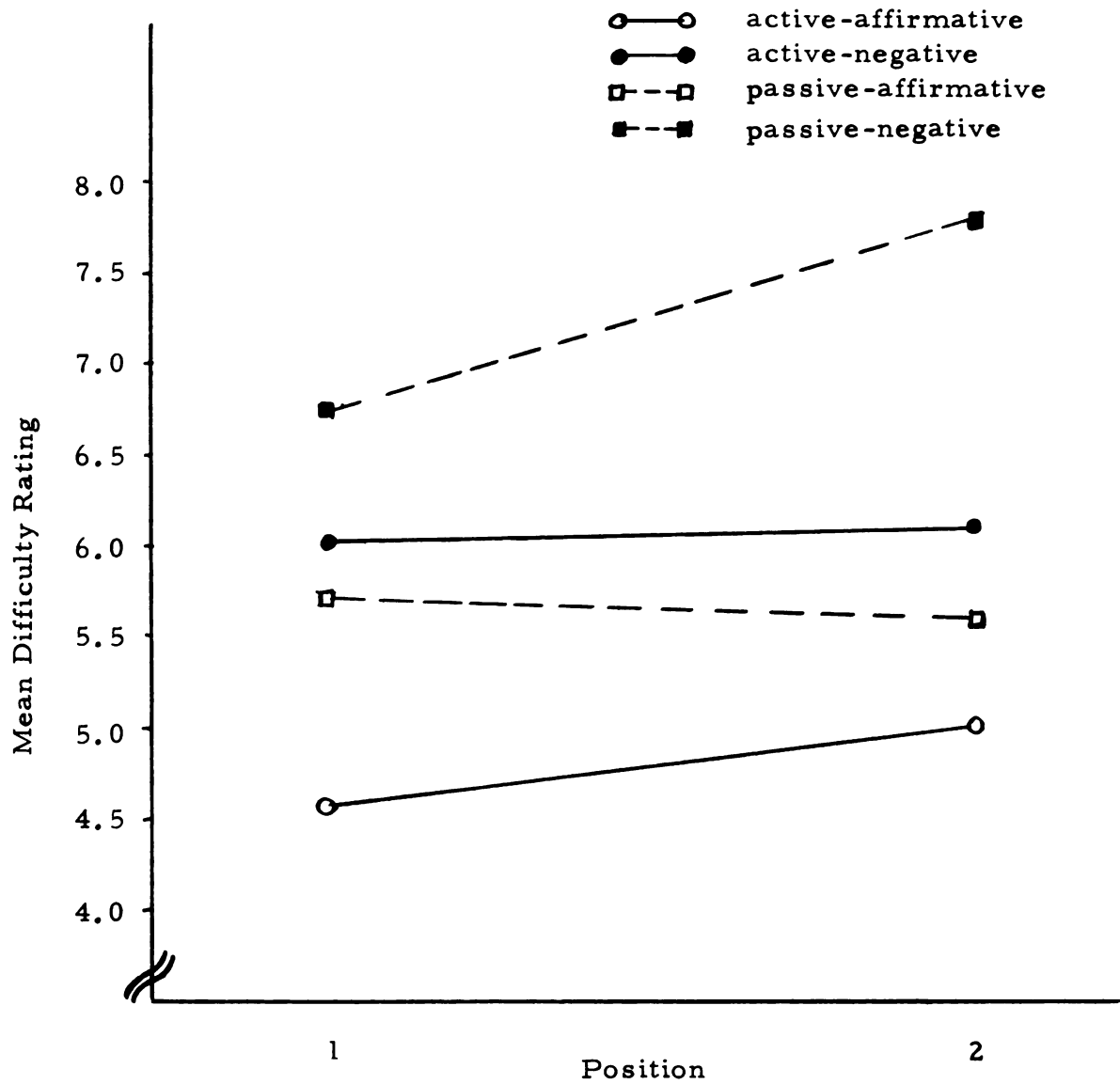


Figure 3. Mean determinant-item difficulty ratings as a function of Voice, Negation, and Position.

DISCUSSION

In general the results suggest that the Active-Affirmative is the habitual structural form of semantic information for the language user. Ss required less time to solve problems when the information was in the Active-Affirmative structural form, found them less difficult, and made fewer errors. Solutions were most often given in the Active irrespective of the transform of the premises.

Solution Latency

The determinant-item results indicate that (a) when the major premise of a syllogism is expressed in the Passive transform, more solution time is required; (b) when the major premise of a syllogism is expressed in the Negative transform, more solution time is required; (3) Passive-Affirmative and Active-Negative premises lengthen solution time almost equally. Furthermore, the significant interaction between Voice, Position, and Affirmative-Negative indicates that disproportionately more solution time is required when the major premise is written in the Passive-Negative and is in Position 2 on the stimulus card.

These results are generally in keeping with those reported by Miller and McKean (1964) and by Gough (1965), also using

latency measure but quite different tasks. Miller and McKean required Ss to transform one type of sentence into another and measured the amount of S controlled presentation time. More time was required when transforming a passive sentence than when transforming an active (about 1 second); about 0.4 seconds more was required when transforming a negative sentence than an affirmative. The difference between active-passive times was greater than between affirmative-negative. When the sentence to be transformed was both passive and negative, the additional time required was approximately the sum of the time needed for the two separate transforms. Time differences were a function of the structural form of the sentence being transformed, not the transformation being applied. Thus transformation time was found to vary with the kind and number of transformations.

Gough reported results indicating that speed of understanding sentences also varies with the number and kind of transformations that have been applied to the kernel. Active sentences were understood faster than passive, affirmative faster than negative ones. Passive sentences were understood faster than negative ones. The results were interpreted as evidence for the notion that Ss must transform complex sentences into the kernel before understanding. Gough pointed out that transformational complexity was confounded with frequency and length. This confounding is common to almost all experiments on syntax.

These two experiments were concerned in part with the differential influence of the number and kind of transformations on latency as well as the influence on the passive compared with the active, negative compared with the affirmative. This concern is based on the notion that transformationally related sentences are perhaps psychologically related. It might be noted that in the Miller and McKean experiment the negative required less time than the passive; in the Gough experiment the negative required more time than the passive. This seems to indicate that the psychological relationship of transforms varies with tasks, the sentential material (context), etc.

Little can be concluded with respect to the relation of the Negative, Passive, and Passive-Negative transforms from the present experiment either. The Passive-Affirmative and Active-Negative premises lengthened solution time almost equally in determinant problems, which might be considered as evidence for the notion that all transforms equally influence behavioral measures. It is difficult to determine whether the additional time required for solution of a problem written in the Passive-Negative was the sum or greater than the sum of the additional time required for the Passive and Negative alone because of the significant Position effect. However, a roughly additive relation was found.

The reason for the disproportionately long latencies when a Passive-Negative problem was in the second Position is

not immediately evident especially since Position had no effect on other variations. Position of the major premise was varied in the experiment simply to insure that if Ss read the premises in sequence the last premise read would not always be a simple "are" sentence which might influence the structural form of the response given. Position was found to have little influence on the form given. The nature of the influence of Position on Passive-Negative latency may be inferred by comparing the effect of Position on Ss' task. If it can be assumed that Ss do put the Passive-Negative structured information into their own words in Active form, and that this operation requires a little time, it may be hypothesized that when the Passive-Negative premise is first, the "putting into own words" operation may occur simultaneous with the reading of the second premise. When the Passive-Negative premise is second, however, extra time may be needed to perform this operation before an attempt to relate the two premises is made. The presence of two sets of phrase markers (be-en-by; not) serve to make the sentence structurally complex and to delay the other operations.

A companion explanation may be that it is more difficult to identify the middle term, subject of the conclusion, and predicate when the premise carrying the predicate is the second piece of information given and when changes have been made in phrase structure displacing the habitual subject-object positions and add another term

(not) to the predicate. The perceptual difficulty in identifying the terms may be augmented by the nature of the information given in the two premises. The major premise sets the bounds of the final response (Cochroaches are not caged by all zoos). The minor premise is more global (Some menageries are zoos). Knowing the bounds first may aid in solution when the terms are not immediately discriminable.

The results with indeterminant items indicate that (a) when the major premise of a syllogism is expressed in the Passive transform, solution time increases; (b) when the minor premise of a syllogism is expressed in the Negative transform solution time increases; (c) the Negative premise increases solution time (almost 2 1/2 times) more than the Passive.

It would be expected that the indeterminant items would require more evaluation time in general than determinant items since the tentative responses might not "sound just right". However, it is noteworthy that the influence of transform (Passive and Negative) on solution time was increasing as with determinant items. The somewhat greater magnitude of additional time required for the solution when the minor premise was expressed in the Negative may reflect the operation of having to add the Negative term to the predicate of the major premise in forming a tentative solution. The Negative always occurred in the major premise of

determinant items so this operation was not necessary, as reflected in the relatively shorter additional time needed. It is also possible that the extra time required for problems when the minor premise was Negative was a function of context. There is some evidence that context influences speed of response to negatives (Gough, 1965; Wason, 1965). The major premise was a simple statement of fact--All vegetarians do not eat meat--whereas the minor premise was a statement of relationship of a smaller category to a larger category--Some animals are not vegetarians. That this latter context may be much more difficult is supported by the difficulty ratings and by comparing the relative differences in latency and ratings between Passive and Negative determinant and indeterminant items. Passive and Negative determinant problems took almost equally long to solve while Negative indeterminant problems took almost three seconds longer to solve than did Passive problems.

Difficulty Ratings

The difficulty ratings of determinant items indicate that (a) when the major premise of a syllogism is written in the Passive transform the problem is considered more difficult than when in the Active; (b) when the major premise of a syllogism is written in the Negative the problem is considered more difficult than when in

the Affirmative. These results support Miller's contention that the Active-Affirmative sentence is the habitual syntactic form for Ss. Semantic content expressed in the habitual syntactic form is easier to understand (Gough) and thus solving a problem should also be easier. The rating results substantiate findings with various behavioral measures which purportedly reflect the influence of syntax on psychological operations. That is, Ss' perception of judgment of the difficulty of an item was in high agreement with the influence of transform on the latency of solution of an item, suggesting the influence of syntax is "real".

The significant Voice x Position x Affirmative-Negative interaction revealed that the occurrence of a Passive-Negative premise in Position 2 was disproportionately more difficult than other premises in either Position. This mirrors the influence found on latency.

The ratings of indeterminant items indicate that (a) when the major premise of a syllogism is expressed in the Passive the problem is considered more difficult than when in the Active; (b) when the minor premise is expressed in the Negative the problem is considered more difficult than when in Affirmative.

These results also support the contention that Active-Affirmative sentences are the habitual structural form for Ss and thus easiest for them.

Correct Solutions

The tabulated results indicate that (a) more correct solutions are given when premises are expressed in the Active than in the Passive; (b) more correct solutions are given to problems expressed in the Affirmative than Negative. (For determinant items)

It was expected that errors would increase along with latency and rated difficulty. The expectation was supported, but since most errors were omissions of the quantifiers (some and all), error analysis was not very revealing of the nature of the influence of syntax on Ss' perception of content. Errors other than omissions of quantifiers were few but were almost all actor-object confusions in response to Passive premises. The object rather than the actor would be quantified.

The indeterminant item results indicate that (a) more correct solutions are given to Negative than Affirmative items; (b) the number of correct solutions given to Passive items differs only slightly from the number given to Active items.

This reversal in pattern with Indeterminant items is simply due to the nature of the response necessary to be considered correct--"no conclusion". Ss had a tendency to say "no conclusion" to those problems which they rated as most difficult (Negative and Passive). Either it was more obvious that there was no conclusion to Negative problems or Ss used the response as an 'out'.

It would have perhaps been better had this option been omitted in the instructions. The analysis of the structural form of responses was considerably weakened because of the high proportion of "no conclusion" responses given to indeterminant items as an "out".

Structural Form of the Response

The percentages indicate that (a) the Active sentence is the predominant structural form used by Ss in speech irrespective of the structural form of the stimulus material before them; (b) Position of the major premise has little influence on the structural form of the response given to syllogisms. The findings again support Miller's notion that the Active form is the primary syntactic form for the language user. The predominant use of the Active structure in responding, in conjunction with the consistently shorter solution time and Ss' difficulty ratings (easier), is convincing evidence of Miller's notion.

There is some evidence (Mehler & Miller, 1963; Mehler, 1963; Gough, 1965) that Ss reword a transformed sentence into their own words--an active-affirmative sentence--in the process of memorizing or responding to a sentence. It has been suggested that the extra time taken in understanding and responding to transformed sentences may be in part a function of the time required for this operation.

That Ss responded predominantly in the Active to Passive premises as well as to Active premises in the present experiment and required more time suggests that Ss did reword the information at some point in the solution process and that this process may account for longer latency in solution.

Analysis was made of the structural form of the responses given as solutions to Passive problems (since more than half of the Ss did give at least one Passive response) in order to gain more insight into the relation between syntax of response, latency, and difficulty of Passive problems.

The number of Passive responses given was found to have no relation to the time required for solution. Amount of time to solve problems by giving an Active versus Passive response was not found to vary. These findings suggested that even if it could be hypothesized that two operations--putting into own words, and then back into Passive--were involved in responding with the Passive, it was not reflected in latency.

It was found, however, that a dichotomy of Ss existed which was producing no differences in the results above: Ss who required less time to solve problems when they gave their response in the Passive than in the Active; and Ss who required more time to solve Passive problems when they gave their solution in the Passive than in the Active. That is, Ss who responded directly to the Passive

without "putting it into their own words" first and those who performed two operations in formulating a Passive response, formed the dichotomy.

Both groups of Ss provide evidence that latency is influenced by the operation of "putting into own words". The grouping of Ss who required less time to solve Passive problems when they gave their response in the Passive than Active, gave significantly fewer Passive responses and rated the problems as easier to which they gave a Passive response than those to which they gave an Active. This suggests that the solution of some of the problems was simply so obvious that no rewording was necessary for these Ss.

It was hypothesized that Ss might tend to formulate a solution in keeping with the structural form or atmosphere--active or passive--of the major premise, particularly on difficult problems. That this was not the case in general was indicated by the overall high percentage of responses given in the Active. On the problems where atmosphere responding would be most expected--indeterminant items--however, somewhat more Passive responses were given (significantly more than to determinant items). The half of the Ss who required more time to solve Passive problems with a Passive solution than an Active tended to give more atmosphere responses. They gave more Passives to indeterminant items than did the "less time" Ss, and gave significantly more Passive responses to determinant Passive items. They also rated the Passive problems to

which they gave a Passive response harder than those to which they gave an Active response. This is consistent with the prediction.

These results suggest that it was necessary for the "more time" Ss to change their strategy and formulate a solution in keeping with the syntax of the premises on difficult problems, perhaps out of cautiousness or uncertainty. It is suggested that formulating a Passive response to a problem with which Ss were having difficulty was not a one-step process but involved "putting into own words" in an attempt to understand the relation expressed. Then, not feeling certain about the solution, Ss reformulated the solution by adding the Passive phrase markers.

Negative items could not be profitably analyzed with respect to these considerations since the tendency to respond with Negative when there is a Negative premise is very high in syllogistic reasoning. The Negative problems did require more time, were more difficult, produced more errors on determinant items, and considerably more "no conclusion" responses to indeterminant items, than did the Affirmative problems. This suggests that the Negative term influenced the Ss' perception, understanding, and/or required them to put the premise in the Affirmative form, then put the Negative term back in.

It is proposed that the influence of transformed sentences on latency, difficulty and the necessity to reword, is a function of a frequency of occurrence and use variable. Transformed sentences have simply not been as frequently encountered by Ss. Because of the consistent combination of structural and semantic aspects (position of actors, objects, etc. and phrase markers) in the most frequently encountered Active-Affirmative sentence form, the sentence may function as an integrated response unit. On the other hand, because the structural and semantic aspects of transformed sentences are not as frequently encountered, the sentence may not function as an integrated response unit. The subject, verb, and object components and their relationship may not be perceptually distinctive in the less frequently encountered forms. Ss may have to go through the process of identifying these components, during the process, rewording them, before their syntactically mediated relationship becomes clear.

SUMMARY

Recent research in verbal behavior has been based on the assumption that there may be a correspondence between syntactic relations as described by modern linguists and the psychological operations performed by the language user. The differential influence of syntactic structures (active, passive, negative, question, etc.) has been reflected in behavioral measures such as reaction time, motor response generalization, and recall with sentential material. The active-affirmative structural form has been regarded as psychologically primary as well as syntactically primary. Some evidence suggests that Ss reword syntactically complex sentences into the active-affirmative at some stage in processing.

The present experiment investigated the influence of syntax on the operations of the language user by varying the structure of the major premise of syllogistic reasoning problems. Four behavioral measures were used: solution latency, rated difficulty, number of correct solutions, and structure of verbal solution. Of particular interest was the Passive-Active comparison; of secondary interest the Negative-Affirmative comparison.

It was hypothesized that (a) problems written in the Passive should take longer to solve and be rated more difficult than

those written in the Active; (b) problems written in the Negative should take longer to solve and be rated more difficult than those in the Affirmative; (c) verbal solutions should be given predominantly in the Active form; (d) verbal solutions to Passive problems may be given in the Passive to difficult problems as an atmosphere response.

A set of 32 syllogisms, each having a different semantic content, was employed. A valid conclusion could be reached for half of the syllogisms (determinant items); no valid conclusion could be reached for the other half of the syllogisms (indeterminant items). Eight of the determinant syllogisms contained a Negative term in the major premise; eight of the indeterminant syllogisms contained a Negative term in the minor premise. Voice (Active, Passive) and Position (1, 2) of the major premise of each syllogism was varied. Four forms were prepared such that each of the 32 syllogisms appeared on each of the four forms but represented a different combination of variables (Voice and Position) on each. In this way semantic content was counterbalanced. The two premises for each problem were manually presented on 4 x 5 white index cards. S was handed each of the 32 cards in succession by E. S was instructed to read the premises, reach a solution, and tell it to E. Solution latency and the verbal solution were recorded. S rated each problem on an 11-point difficulty scale printed on a card in front of him after giving the solution.

Ss were 64 introductory psychology students.

The hypotheses were confirmed. More solution time was required when problems were written in the Passive or Negative than in the Active or Affirmative. The Passive and Negative problems were also rated as more difficult. Verbal solutions were given predominantly in the Active (85% to determinant items and 61% to indeterminate items) rather than Passive (evidence for rewording of Passive). With respect to prediction D a dichotomy of Ss was found. One grouping of Ss took less time to give a Passive than Active response to Passive problems and rated those problems to which they gave a Passive response as easier. The second grouping of Ss took more time to give Passive than Active responses to Passive problems and rated those problems to which they gave a Passive response as harder. This latter group gave significantly more Passive responses than did the former. It was suggested that perhaps the dichotomy of Ss represents those Ss who gave Passive responses to easy problems because the solution was so obvious for them that no rewording into the Active was necessary, and those Ss who gave the Passive response to difficult problems as an atmosphere response out of uncertainty or cautiousness. Two steps may have been involved in the latter Ss' formulation of a solution accounting in part for the additional solution time required--rewording into Active, then back into Passive.

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APPENDIX A

Instructions

This is a task in logical reasoning. The problems you will have are called syllogisms. A syllogism consists of three statements; the first two are premises which state relationships, and the third is a conclusion which "hopefully" follows from the premises.

The problems might be in this form (draw Euler diagrams and explain each premise as draw in terms of relationships.)

If all As are Bs
And some Cs are As
Then, some Cs are Bs

If no As are Bs
And some Cs are As
Then, some Cs are not Bs

If some As are Bs
And some Cs are As
Then, this time there is not a conclusion. We do not have enough information about the relationship between the Cs and Bs this time.

The problems you will have will be similar to these except that in place of the As, Bs, and Cs will be words so that you will have sentences which make more or less sense. In a way these will be easier, in a way more difficult. You remember, the relationship was established by the alls, somes, and nos, not

whether, A, B, or C meant anything. So--you will have to be careful not to rely on your knowledge of the semantic relationship between the words--the meanings--but to pay attention to the logical relationship established by the alls, somes, and nos.

I will give you the two premises on a card. Read them. When you have decided what the conclusion is, tell it to me. If you think there is no conclusion that follows, say "no conclusion."

After each problem I want you to tell me how difficult you thought it was (show scale). Pick a number down here (point toward end marked easy) if you thought it was pretty easy and one up here (point toward end marked easy) if you thought it was pretty easy and one up here (point toward end marked easy) if you thought it was pretty easy and one up here (point toward end marked hard) if you thought it was hard.

I will be timing you but this is not a speed test. Work at a rate comfortable for yourself.

OK--let's try the first one.

APPENDIX B

Difficulty Rating Scale

EASY 1 2 3 4 5 6 7 8 9 10 11 HARD

APPENDIX C

Syllogisms

Determinant items

If all plants need water,
And all flowers are plants;
Then,

If all teenagers enjoy movies,
And all 15-year-olds are teenagers;
Then,

If all spiders spin webs,
And all tarantulas are spiders;
Then,

If all students must take exams,
And all freshmen are students;
Then,

If all clubs elect officers,
And some groups are clubs;
Then,

If all carnivores eat meat,
And some animals are carnivores;
Then,

If all sweets cause cavities,
And some desserts are sweets;
Then,

If all surgeons perform operations,
And some doctors are surgeons;
Then,

If all glass does not conduct electricity,
And all windows are glass;
Then,

If all dogs do not tell storeis,
And all poodles are dogs;
Then,

If all farmers do not raise elephants,
And all husbandrymen are farmers;
Then,

If all grocery stores do not sell furniture,
And all supermarkets are grocery stores;
Then,

If all renters do not pay school taxes,
And some residents are renters;
Then,

If all zoos do not cage cockroaches,
And some menageries are zoos;
Then,

If all newspapers do not report secrets,
And some journals are newspapers;
Then,

If all schools do not require basketweaving,
And some institutions are schools;
Then,

Indeterminant Items

If some women outweigh the average man,
And some women are spinsters;
Then,

If some gestures express emotion,
And some movements are gestures;
Then,

If some gamblers lose money,
And some speculators are gamblers;
Then,

If some typists transcribe shorthand,
 And some typists are secretaries;
 Then,

*If some hunters shoot pheasants,
 And all hunters are sportsmen;
 Then,

*If some dressmakers use thimbles,
 And all dressmakers are seamstresses;
 Then,

If some drivers obey laws,
 And all chauffeurs are drivers;
 Then,

If some bears raid dumps,
 And all grizzlies are bears;
 Then,

If all children recite nursery rhymes,
 And all children are not poets;
 Then,

If all lawyers document cases,
 And all bailiffs are not lawyers;
 Then,

If all cobblers mend shoes,
 And all cobblers are not factory workers;
 Then,

If all lamps provide illumination,
 And all chairs are not lamps;
 Then,

If some rules guide behavior,
 And all rules are not promises;
 Then,

If some sentences represent ideas,
 And all fragments are not sentences;
 Then,

* Error in classification was found; a valid conclusion is possible.

If some researchers conduct polls,
And all researchers are not philosophers;
Then,

If some rodents carry disease,
And all invertebrates are not rodents;
Then,

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