

THE EFFECTS OF PREMISE CONTENT ON ACCURACY  
AND SOLUTION TIME IN SYLLOGISTIC REASONING

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## ABSTRACT

### THE EFFECTS OF PREMISE CONTENT ON ACCURACY AND SOLUTION TIME IN SYLLOGISTIC REASONING

By George L. Parrott

This investigation was concerned with the effects of true premise content, false premise content, and mixed premise content on logical reasoning scores for both accuracy and solution time. Three test forms were developed with items of differing truth-falsity content, but matched for logical structure. In contrast to the development of earlier scales, the truth-falsity of each premise was scaled by a sample of subjects, rather than only by the experimenter.

Experiment I compared the three test forms for number correct with a sample of 99 undergraduate students randomly assigned to test forms. In support of the hypotheses, the false items were found to be easiest, then the true items, and then the mixed premises items.

Experiment II compared the three types of item content for total solution time with 10-item scales matched for word length. A total of 24 subjects were individually tested in this experiment with the items presented with the Johnson Serial Exposure Box. In

terms of total solution time, false items take the longest, then true items, and then mixed premise items.

A sub-comparison made in Experiment II concerned the relative transfer effects of the true-then-false presentation order as compared to the false-then-true order. For number correct, the transfer for both orders was identical, but the false-then-true order significantly reduced the solution time for the true items, while the true items did not significantly reduce the solution time of the subsequent false items.

The discussion of the results emphasized the suggestions of Henle (1962) in terms of errors in logical reasoning; and Berlyne's model of conceptual conflict best fit the data for both solution time and number correct. Even the Berlyne model was not completely satisfactory, and an attempt was made at intergrating an information processing model with the Henle (1962) and Berlyne (1957) conceptions to derive a theoretical system that handled all three types of item content for both number correct and solution time. Of some methodological and theoretical interest, it was suggested that solution time and number correct are not the interchangeable dependent variables that they have often been assumed to be, but rather for some problems, at least, they are positively correlated measurements.

Suggestions for further research investigating differential effects of training procedures and instructions on reasoning with varied item content, and

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for investigating the test-retest reliability of solution  
time scores were made.

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TIME IN SYLLOGISTIC REASONING

By

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To My Wonderful Wife

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## INTRODUCTION

While the logician has asserted "there are logical principles of psychology (as of every science), but there are no psychological principles of logic" (Windelband, 1961, p. 9), the psychologist must approach the application of logical thinking as an area relevant to his study.

Syllogistic reasoning is one special form of logical deduction which has been studied by the psychologist in his research on human cognitive processes. This paper will concentrate on the effects of premise content on syllogistic reasoning.

One of the earliest and most comprehensive investigations into variables affecting syllogistic reasoning was the Wilkins (1928) study. This author developed four different twenty-item tests (with alternate forms of each test); these four tests were approximately equated for logical structure. Logical structure refers to the four types of premises commonly called universal affirmative, particular affirmative, universal negative and particular negative. The basic differences between the four tests Wilkins studied were as follows: Test 1 premises dealt with familiar material; Test 2 premises dealt with symbolic material, e.g. all A is B; Test 3 premises dealt with unfamiliar and made up terms, e.g. all zygatropes are metathanes; and Test 4 premises dealt with what Wilkins called "suggestive" material, e.g. all metal is wet. Form 1 and Form 4 are of most interest to us, as these compare what might be called "true" or factual premises (input) with what might be called "false"

or unreasonable premises. In the suggestive items of the Wilkins study, subjects were required to perform reasoning operations with unreasonable premises. A sample problem from the suggestive items is as follows:

All Anglosaxons are English; all British are Anglosaxons; therefore

- A. All British are English
- B. All English are British
- C. Some British are not English

Subjects were instructed to mark the correct conclusions with a (+) and the incorrect conclusions with a (-). Wilkins compared percent correct scores on these suggestive items with similar scores on the familiar items and concluded that familiar items were easier. Two critical difficulties in this study are apparent to the careful reader: 1. Wilkins judged suggestive premises herself, and what might be "suggestive" to an advanced graduate student need not be equally so to her undergraduate subjects; and 2. her Form 1 and Form 4 scales were not exactly matched for logical structure, thus the effects of item content are confounded by unbalanced scales (Thistlewaite, 1950, has shown that "psychological" structure is an important variable in reasoning distortions). In addition to these design problems, little statistical analysis of the differences obtained between treatment groups was done in this early study.

Thurstone (1938) in his factor analysis of primary mental abilities used three types of syllogistic reasoning tests; his false premises test was composed of items similar to the following example:

All haystacks are catfish. All catfish are typewriters. Therefore all haystacks are catfish. (+)



scales, one of "emotional" item content, and one of "nonemotional" content and compared validity judgments (among other things) for these two types of item content. He concluded that neutrally toned items were solved more correctly than emotionally toned items and that solving emotionally toned items first had a negative effect on later solution of neutral items. When neutral items proceeded emotional items, some subjects seemed to exhibit positive transfer on the later emotional items, but here Lefford is not too clear as this conclusion is based on score distributions and not on group means or other more accepted measures of central tendency. No statistical test and no group means are reported for these experiments, and thus these results must be open to review.

Morgan and Morton (1943, 1944) have reported several investigations of distortions in logical reasoning as a function of personal convictions. Similar to the work of Janis and Frick (1943), these authors find that the amount and direction of distortion in logical reasoning can often be related to personal attitudes. Thistlewaite (1950) has used this general "distortion" design with items of neutral and ethnocentric content, and in a well designed study confirmed that personal convictions clearly influence sensitivity to distortions in logical thinking.

Henle and Michael (1956) have summarized much of this previous "personal conviction influence" literature in their discussion and research on the influence of attitudes on syllogistic reasoning. Using a multiple-choice test format, Henle and Michael replicated the Morgan and Morton (1943, 1944) findings, but they then measured the subjects'

attitudes rather than inferring that attitude was the critical factor. Their results agreed with the Morgan and Morton findings, but their attitude measures indicated that attitude was not the critical factor in reasoning distortions. In fact, attitude loaded items were solved correctly slightly more often than symbolic items, thus Henle and Michael concluded that many subjects did not understand the task correctly. In a second experiment, subjects were given quite complete instructions in doing syllogistic reasoning, and significant gains in accuracy of reasoning for both types of material were found. Henle and Michael suggest that research needs to be designed to consider not whether attitudes influence reasoning, but how they influence the reasoning process.

Asch (1952) has discussed the interaction of attitude with fact and suggests that "what is needed is observation of reactions to facts that are compatible with one's established view and to facts that contradict it."

Henle (1962) has concluded that there are four basic sources of errors in syllogistic reasoning: 1. failure to accept the logical task; 2. restatement of the premises; 3. omission of a premise; and 4. addition of a premise. Thus Henle sees errors not as a function of logical faults, but rather due to the lack of acceptance of the task as designed. If this interpretation of errors is correct, it implies that more errors would be made with material that could be easily misread or misunderstood by the subjects. This hypothesis could be tested with appropriately designed premise material; for example, items with one true or familiar premise and one false or unfamiliar premise should be more susceptible to misreading or premise restatement than either both true premises or both false premises material.

Wilson (1965) has investigated the effects of "competition" instructions, defined in terms of public reporting of individual subjects scores, on syllogistic reasoning, and some of his findings are of direct interest here. Wilson used items from the Ruch, Warren, and Gray (1963) workbook, and his results indicated that "biased" items took longer to solve and were solved less accurately than familiar items. These results must be held somewhat questionable due to the incomparability of many of the items for logical structure. It should also be noted that subjects simply indicated correct or incorrect for each item, and thus the actual reasoning task was very directly related to the single conclusion presented. Another, if not more reasonable, procedure would have been to have subjects select the correct conclusion from a number of alternatives.

Frase (1966), in the most recent published investigation in the area of syllogistic reasoning and belief variables, found that error and solution time scores were systematically influenced by varying conclusion statements at three levels of semantic differential incongruity.

This summary of the available research in the area of syllogistic reasoning with varied material points out some clear gaps in the experimental literature. While we have some evidence that familiar material is easier than "suggestive" material (Wilkins, 1928; Wilson, 1965) and nonemotional is easier than emotional (Lefford, 1946), neither of these conclusions is based on tests which have been carefully balanced for logical structure, or in case of the Wilson (1965) material, for item length. The work

of Henle (1962) and Henle and Michael (1956) has shown that attitudes may influence reasoning, as some of these earlier experimenters concluded, but the unanswered question is how the reasoning process is affected by varying item content.

McGuire (1960) has shown that subjects' reasoning processes correspond to a logical model based on the structure of the syllogism. In his research, he had subjects rate statements on a truth-falsity scale from 0 (completely false) to 100 (completely true); these statements were both premises and conclusions to syllogistic arguments, and when subjects received information designed to change the truth-falsity rating of a conclusion, the appropriate changes in the rating of the premises leading to that conclusion also took place. Johnson (in press) has covered much of this previous research in his paper on reasoning and logic, and he concludes that while a logical model of human reasoning is not perfect, no other model works so well.

In attempting to analyze the effects of bias on logical reasoning, we should re-examine the work of Wilkins (1928) and Lefford (1946). As Wilkins admitted (p. 15), some of her suggestive items were not interpreted by her subjects as she had designed them to be interpreted; and Lefford (1946) also developed his emotional items based on his a priori judgment of their emotionality. On close inspection, it might appear that his emotional items could also be considered untrue or half-truths. In reviewing these items, this experimenter had subjects scale the truth-falsity of each premise from the Lefford tests on a scale from one to seven. The nonemotional items

had a mean premise value of 2.31 (SD=1.77) and the emotional items had a mean premise value of 3.97 (SD=2.01); this difference in scaled truth-falsity of the Lefford premises was statistically significant ( $t=3.37$ ,  $p.<01$ ); and it suggests that the emotionality factor which Lefford attempted to study was confounded by varying truth-falsity of his emotional and non-emotional items.

#### REASONING WITH TRUE AND FALSE PREMISES

Reasoning with premises of varying truth-falsity, it has been asserted, occurred in the Lefford (1946) study, the Wilkins (1928) study, and the similar Wilson (1965) research. Reasoning with this type of premise material could be looked at from at least two theoretical positions: 1. the belief-disbelief theory of Rokeach (1960); and 2. the later information processing approach, typified by the work of Suedfeld and Hagen (1966) and Schroeder, Driver and Streufert (1967). Both of these theoretical positions lend themselves to treatment of the question of reasoning with material of different types.

Rokeach (1960) presents a model of cognitive structure called the belief-disbelief system, and he asserts that the belief system is a relatively well interconnected and organized structure as compared with the disbelief system. Rokeach (1960, p. 33) defines the belief system as representing "all the beliefs, sets, expectancies, or hypotheses...that a person...accepts as true...." The disbelief system "is composed of a series of subsystems rather than merely a single one, and contains all the disbeliefs...a person at a given time rejects as false." While Rokeach's major concern is with

individual differences in these belief-disbelief systems, for the cognitive theorist they present a model which might be tested in some general way. False premise syllogisms could be considered disbelief system statements and true premise syllogisms belief system statements; from the general Rokeach model, the disbelief statements would be harder to reason with (take more time) than the belief system statements, but no clear prediction as to errors in reasoning can be made from this theoretical model.

The more recent information processing theorists consider information complexity to be the critical environmental variable (Suedfeld and Hagen, 1966); this complexity is determined by: 1. information load; 2. information diversity; and 3. rate of change of information. Many of the workers in the area of information processing approaches to cognition have discussed categories or codes used by the subject in integrating new information or perception (Bruner, 1957a; 1957b; Wallach, 1958). If the true premise material can be considered analogous to available, well used categories, while the false premise material represents poorly used or unavailable categories, it is not too difficult to consider false premises as a relatively high information input load, and a relatively diverse input load as compared to reasoning with true (familiar) statements. Longer total solution time should be required for reasoning with false premises as compared to true premises; again, this model offers no insight for reasoning accuracy.

Berlyne (1957) suggests that "conceptual conflict" may be produced as a function of the conceptual incongruity of the false material (that is, a conflict between learned

symbolic response), and that this conflict produces a drive reduction process leading to behavior (search for knowledge). The behavior or search for knowledge would take the form of the active relating of the unfamiliar (false) premises into a coherent argument. Consequently, we might expect more time to be involved in solving false items than true items, but here the implication exists that the extra time should lead to more correct solutions to the false items.

In an exploratory study by this experimenter using syllogisms with true and false premises, some evidence was obtained that false premises were encoded (or read) more slowly than true premises, and some indication was found that false items were gotten correct at least as often as true items. This current study will follow up these findings and attempt to further compare reasoning with true and false premises in a larger sample of subjects and to further obtain data for subjects reasoning with syllogistic arguments composed of one true and one false premise. Thus three test forms will be developed, identical in logical form and word length, but differing in specific item content: 1. all true premises (True or T); 2. all false premises (False or F); and 3. one true and one false premise in each item (Mixed or M).

From the exploratory study, and the previous work in this area, the following hypotheses can be generated and tested:

For Number Correct

- H<sub>1</sub>. Mixed items will lead to more errors (Henle, 1962).
- H<sub>2</sub>. False items will have fewer errors than true items (from exploratory study).

## For Solution Time

- H<sub>3</sub>. False items will take longest; this prediction is based on both theory (Rokeach, 1960; Suedfeld and Hagen, 1966; Berlyne, 1957) and earlier data (Wilson, 1965; and the exploratory study).

(Note: No difference can be predicted in solution time between the true and the mixed items).

## For Transfer Effects

- H<sub>4</sub>. An interaction between order of testing and true and false item content is predicted for solution times. Based on the Lefford (1946) study of errors, solution times should show a positive transfer from the false-then-true order, while the true-then-false order should show no significant transfer benefits. This hypothesis is based both on the exploratory study and an einstellung notion (Schulz, 1960).

(Note: No effects of presentation order on number correct can be predicted, for no evidence indicated differential transfer on the exploratory study, and Lefford's interpretation does not appear to be soundly based--never replicated).

A preliminary scaling of the premises used in the three test forms was done to insure that the subject population actually interpreted the material as it was designed. Thus a check on the experimenter's a priori judgment of the item premises was made.

## METHOD

Subjects: Subjects were undergraduate psychology students at Michigan State University during the Winter and Spring 1967 terms; a total of 89 subjects participated in the scaling of the premises for truth-falsity, another 99 subjects participated in Experiment I (randomly assigned to conditions), and 24 subjects participated in Experiment II (randomly assigned to conditions).

Material: The materials used in the premise scaling for truth-falsity consisted of two separate scaling batteries (Form 3 has 117 items and Form 4 has 109 items). Subjects used IBM 10-choice answer sheets to record scale values for each statement, and the Michigan State University Test Scoring Office provided a complete frequency count for each statement directly from the IBM answer sheets. These materials may be found in Appendix A.

In Experiment I, three forms of a 27-item syllogism test were developed. Similar to the technique of Wilkins (1928) and Lefford (1946) these test forms were designed to vary in the truth-falsity of their premises--but the truth-falsity of these statements was also judged by a sample of subjects. Form I of the test was composed of all true premises; Form IV all false premises; and Form IM items had one true premise and one false premise. No attempt was made to match all the items in these tests for item length, logical structure, or logical conclusions, though 15 of the 27 items are matched for structure and length and represent matched test forms differing in truth-falsity. These tests and their IBM answer sheets

may be found in Appendix B.

In Experiment II, subjects were presented only 10 of the 15 matched items from Experiment I which were further selected to equate the three test forms for word length. Table 1 shows the comparison for word length for the three scales.

Table 1  
Mean Length and SD of True, False, and Mixed Reasoning Scales Used in Exp. II

	True	Mixed	False
$\bar{X}$ words/ item	41.1	41.1	40.9
SD	6.04	7.58	11.00

These three forms of syllogistic reasoning tests are identical for syllogistic structure, and each form has three indeterminate items (# 4,8,10) and seven determinate items (all seven remaining). For presentation to the subjects, items were typed separately on standard 5 x 8 cards for use in the Johnson Serial Exposure Box.

An example of an item from the "True" premises scale is as follows:

Varsity football is a very popular sport here at MSU. Popular sports have large crowds.

1. Varsity football has large crowds here at MSU.
2. Varsity football is popular at Notre Dame.
3. MSU is a first-rate academic institution.
4. John Hannah likes football.
5. None of the above.

The item from the "False" premise scale matched with the above item for logical structure was as follows:

Physics is the most popular course of study here at MSU. Popular courses of study are very easy.

1. Physics is very easy here.
2. Elementary Education is easier than Physics.
3. Physics is very difficult here.
4. Physics students are very intelligent.
5. None of the above.

The item from the "mixed" premise scale matched to the two preceding items for logical structure was the following:

Varsity football is a very popular sport here at MSU. All popular sports have very small crowds.

1. Varsity football here has large crowds.
2. Varsity football here has small crowds.
3. Varsity football here is not very popular.
4. Varsity football here provides much income for the university.
5. None of the above.

Appendix C lists the items from the original 27 item tests which were selected for use in both the 15-item Experiment I analysis and the 10-item Experiment II analysis.

Individual subject's records for solution time and choice, in Experiment II, were kept on a standard record sheet developed for this purpose, and this can be found in Appendix D.

Apparatus: In Experiment II, subjects were presented individual test items with the Johnson Serial Exposure Box. This apparatus allows measurement of premise encoding or reading time, conclusion selection time, and conclusion choice; and it has been described elsewhere in the literature (Beech, 1964 ; Johnson, 1962).

Procedure: For the premise scaling task, subjects

were given the scaling batteries in a group testing situation of from 4-20 subjects; these were administered either by the experimenter or by regular teaching assistants during class time. The following instructions were given for this task:

"You are to read the following statements and rate or score them by marking on the accompanying IBM answer sheet a number from one to seven on the scale which you will be instructed to use.

These statements may vary from one end of the scale to the other; your own judgment is the best answer. A statement neither one way or the other or indeterminate should receive a score of four.

Here is the scale you are to use--the number one end of the rating scale is the completely true or valid end; the number seven end is the completely false or invalid end. You are to rate each statement for its validity or truth-falsity.

Rate each statement on this scale, work as rapidly as possible, but make sure you do not lose your place on the answer sheet.

The IBM answer sheets were then scored for a frequency count for each item, and each item received a truth falsity value based on a semi-interquartile range of  $\pm 1$ . For example, the following distribution might have been obtained on an item:

Scale Value:	1	2	3	4	5	6	7
Frequency	2%	8%	14%	40%	11%	15%	5%

For this hypothetical item, a scale value of 4 would be assigned, for  $\pm 1$  from 4 includes at least fifty percent of the distribution of ratings. This survey scaling of the item premises was used to verify the a priori development of the true and false premise syllogism tests, and to insure that items in Experiment I and II did

differ significantly and consistently on the truth-falsity variable between the three test forms.

Experiment I was designed to compare tests with three types of item content in terms of number correct. All subjects were given the following instructions by the experimenter:

You will be given a series of arguments or statements from which conclusions may be drawn. You are to choose the correct logical conclusion for each argument or set of statements from the alternatives listed. If none of the conclusion statements is logically correct, you would select the "none of the above" alternative. Do not make any marks in the test booklet please.

Work rapidly, but do not rush carelessly through the material.

Answers were recorded on IBM answer sheets, and tests were scored by the Michigan State University Test Scoring Office.

In Experiment II, the principle interest was the collection of data on total solution time for the three types of item content. Subjects were tested in individual testing sessions and randomly assigned to conditions; each subject worked two ten-item syllogism tests in one of the following orders: TF, FT, MT, or MF.

This treatment design was used to provide two different comparisons: 1. analysis for differences between the three test forms for both number correct and solution time when items have been carefully selected for word length and logical structure, but differ in truth-falsity; and 2. analysis for relative transfer effects between the true-then-false and the false-then-true order of presentation. Eight subjects were used in each treatment order.

Originally it was decided to eliminate any subject with prior training in syllogistic reasoning, and one subject in the initial 24 was rejected when post-experimental questioning revealed that he had received training in syllogistic reasoning quite recently.

Each subject in Experiment II was given the following instructions by the experimenter:

Here is what we will do in this experiment; I will present items similar to the one on this sheet of paper (show subject sample item) with this apparatus (show subject where item will appear in window).

Sample item: All patriots are loyal.  
 Some Frenchmen are not loyal.

- a. Some Frenchmen are not patriots.
- b. De Gaulle is a French patriot.
- c. Most Frenchmen are loyal.
- d. Brigitte Bardot is a very loyal "Frenchman."
- e. None of the above.

You are to use the first two statements you are given as your background information; these will appear in the left hand window of the box when we begin. After you have read and understand the material on the left, flip the toggle switch (point to switch) to your right and carefully examine the statements you see there. If one of the given statements is a logical conclusion or deduction based on the background information you have been given, press the button on the box panel corresponding to that selection; if no alternative is correct, press button #5. If after examining the conclusion alternatives, you desire to reread the background information, you may do so by returning the toggle switch to your left. You are in complete command of how long you spend examining each part of the problems you will be working on. Do you have any questions?

The inter-item presentation interval was approximately 30 seconds, and the experimenter gave no signal that after the first 10 items had been completed a second test was being given. All tests were administered in a standard order of presentation of items within tests, and the experimenter recorded premise reading time, conclusion selection time, and the alternative selected on the individual subject's record sheet.

## RESULTS

The examination of the truth-falsity scaling of the premises used in the test forms to be compared in Experiment I and II indicated that the premises assumed by the experimenter to be false and those assumed to be true were so interpreted by the subjects. Using the mean scale value for the two premises in each item, every item in the true premise battery had a scale value from 1-3, while every item in the false premise battery had a scale value of from 5-7.

### Effect of Premise Content on Number Correct

From Experiment I, the results with 27-item scales which differ in truth-falsity, but are not equated for logical structure, may be found in Table 2.

Table 2

Mean Number Correct by Premise Content, Exp. I, 27-Items

	Mixed	True	False
$\bar{X}$	13.94	17.06	19.12
SD	5.63	2.15	3.08

Table 3 summarizes the analysis of variance for any overall differences in the effects of the three types of tests.

Table 3

ANOVA for Total Score on 27-Item Tests

Source	S.S.	df	M.S.	F	p
Tests	449.2	2	224.6	14.27	.001
Error	1511.2	96	15.7		
Total	1960.4	98			

The differences between the means for the groups (shown in Table 2) were analyzed with ordered  $t$  tests, and each mean is significantly different from the next in the series (between M and T,  $t=2.94$ ,  $p<.001$ ; between T and F,  $t=3.12$ ,  $p<.001$ ).<sup>1</sup>

The analysis of the effects of premise content on number correct is confounded in the 27-item scales by the effects of items unmatched for logical structure. A second analysis on the above data can be made on the 15 items in each of the scales which have been matched for logical structure. These 15 item subsets of the original scales may be compared for mean number correct with equated sets of items, and Table 4 summarizes this comparison.

Table 4

Mean Number Correct by Premise Content, Exp. I, 15-Items

	Mixed	True	False
$\bar{X}$	7.88	8.88	10.39
SD	3.39	1.30	1.80

These results for matched scales were analyzed for overall differences, and Table 5 gives this analysis of variance.

- 
1. Duncan's Multiple Range Test corroborates these results--between M and T,  $p<.01$ ; and between T and F,  $p<.01$ .

Table 5  
ANOVA for Total Score on 15-Item Tests

Source	S.S.	df	M.S.	F	p
Tests	105.84	2	52.92	9.78	.001
Error	519.02	96	5.41		
Total	624.86	98			

Here, ordered  $t$  tests show that the small difference between the mixed premise test and the true-premise test does not quite reach an acceptable level of statistical significance ( $t=1.61$ ,  $p<.07$ ; one-tailed), but the difference between the false items and the true items is still significant ( $t=3.87$ ,  $p<.001$ ; one-tailed).<sup>2</sup>

In Experiment II, ten-item, well matched scales were developed from the items used in the Experiment I, 15-item analysis; these results might not be expected to be identical to those of Experiment I due to differences in instructions between the two experiments. In addition this data is based on only eight subjects per group and thus the sample sizes between Experiment I and II are clearly different.

Table 6  
Number Correct, Experiment II, 10-Item Tests

	Mixed	True	False
$\bar{X}$	6.50	7.375	7.375
SD	.71	.91	.91

2. Duncan's Multiple Range Test obtains exactly similar results between M and T ( $p<.07$ ), and between T and F ( $p<.01$ ).

Table 7 gives the analysis of variance for overall differences in this data.

Table 7  
ANOVA for Total Correct on Exp. II, 10-Item Tests

Source	S.S.	df	M.S.	F	p
Tests	4.08	2	2.04	2.72	.10
Error	15.75	21	.75		
Total	19.83	23			

Upon close inspection, the results in Table 6 show absolutely no difference between the true and false premises, while a one-tail  $t$  test between the mixed premises and the true premises is significant at  $p < .05$ .<sup>3</sup>

Though no large differences exist between the three groups in Table 6, there are basically two types of items used in each scale: 1. invalid items for which the correct response is "none of the above," and 2. valid items for which a content statement is the correct conclusion. Other investigators have broken these types down for separate analysis (Janis and Frick, 1943), and the present data may be examined more closely for where errors are made by using this division. Table 8 gives the summary of errors when this separation is made.

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3. Duncan's Multiple Range Test shows no significant difference between the T and F material, and the difference between the M and T items has a  $p < .07$ .

Table 8  
Errors separated by Item Type and Premise Type

	Mixed	True	False	Total	%
Invalid	22	15	15	52	74%
Valid	6	6	6	18	26%
<b>Total</b>	<b>28</b>	<b>21</b>	<b>21</b>	<b>70</b>	<b>100%</b>

A Chi-square analysis for error distribution indicates that invalid items account for significantly more errors than valid items as Table 9 shows.

Table 9  
Chi-Square Analysis for Error Distribution

Item Type	Percentage Errors	
	Expected	Observed
Invalid (3 items)	30%	74%
Valid (7 items)	70%	26%

$$\chi^2 = 63.4, p < .001$$

For the analysis of transfer between the true and the false test forms, Table 10 summarizes the results for number of errors.

Table 10  
Number of Errors on Items in T and F Scales by Position

Test Type	Position 1	Position 2
True	21	17
False	21	17

Though overall transfer effects for the two premise types are equal, this result is produced by opposite

effects on valid and invalid items in second position.

#### Effect of Premise Content on Solution Time

Experiment II was also concerned with the measurement of solution times for these three different truth-falsity content syllogism test, and Table 11 gives the means and standard deviations for solution time per item in seconds for the three test forms.

Table 11

Summary of Solution Times in Seconds for Experiment II

	Mixed	True	False
$\bar{X}$	18.54	23.24	27.91
SD	6.08	3.68	4.19

Table 12 gives the analysis of variance summary for the overall differences between the groups on solution time.

Table 12

ANOVA for Solution Time in Seconds on Three Test Forms

Source	S.S.	<u>df</u>	M.S.	<u>F</u>	p
Tests	350.81	2	175.40	4.06	.05
Error	905.87	21	43.14		
Total	1256.68	23			

A two-tailed  $t$  test between M and T premises does not reach acceptable statistical levels ( $t=1.80$ ,  $p<.20$ ), but the predicted difference between F and T is

statistically significant (one-tailed,  $t=2.11$ ,  $p<.025$ ).<sup>4</sup>

In comparing the true and false tests for transfer effects in solution times, Table 13 summarizes the effects of test order.

Table 13

Effects of Presentation Order on Mean Solution Time for T and F premise material

Item Type	Position 1	Position 2
True	23.23 sec.	19.10 sec.
SD	3.68	3.29
False	27.91 sec.	22.70 sec.
SD	4.19	7.35

Table 14 gives the summary of the analysis of variance for this data, and it should be noted that this design uses a repeated measures analysis in the computation (Winer, 1962).

Table 14

ANOVA Summary for Comparison of Position Effects on T and F Premise Syllogistic Reasoning Times

Sources	S.S.	df	M.S.	F	p
Between <u>Ss</u>					
Order	2.68	1	2.68	N.S.	--
Error	399.41	14	28.53		
-----					
Within <u>Ss</u>					
True vs.					
False	133.70	1	133.70	18.96	.001
Order x					
T-F	177.90	1	177.90	25.23	.001
Error	98.63	14	7.05		

4. The more conservative Duncan Multiple Range Test shows only the False premises significantly longer than the Mixed ( $p<.05$ ).

When the interaction between order and true and false premise syllogisms is further investigated, the comparison between false items first versus second on mean solution time yields no statistically acceptable significant difference ( $t=1.66$ ,  $p<.10$ , one-tailed), but there is a significant difference between the true items as a function of position ( $t=2.21$ ,  $p<.025$ , one-tailed). It should be noted here that both types of items appear to be solved more rapidly in second position, but the false premise material has a much larger variance, so the statistical significance is reduced for this comparison. No comparison was made in terms of valid-invalid items within each premise type, as examination of the solution time scores indicated that the valid-invalid dimension did not affect time scores.

## DISCUSSION

These experiments stem very closely from the earlier work of Wilkins (1928), Janis and Frick (1943), and Lefford (1946); and they elaborate on some more recent studies by Frase (1966) and Wilson (1965).

Earlier investigators attempted to compare syllogistic reasoning with items of differing content, but many of these proceeding experimenters were plagued with poorly constructed tests. The results which have been presented here are based on tests which are very well-balanced for logical structure and item length. In addition, the premises used in the actual tests were scaled for truth-falsity by subjects from the same general population that would be working on the tests later. Thus the items in the different forms of the tests differ in truth-falsity according to the subjects own scaling--not just a priori scaling by the experimenter.

In Experiment I, both of the analyses which were presented show that mixed premise syllogisms were more difficult than true premise syllogisms which were more difficult than false premise syllogisms (in terms of number correct). These results are not the same as those obtained for premises which differ on "emotional" content (Lefford, 1946), nor do they conform to the work with "familiar and biased" premise content (Wilson, 1965). These items present the subject with the task of finding "a logical conclusion or deduction" from among a number of alternatives, thus the general format of the task separates it from the earlier studies; but in addition

the use of true and false premise material can be sharply divided from the work with attitude laden premise statements. As Henle (1962) has pointed out, errors in syllogistic reasoning may often be a function of failing to understand the task, and her own research indicates that with adequate instruction subjects will do equally well on various types of item content (Henle and Michael, 1956). In this experiment, subjects are told to use only the background information which they are given in selecting a logical conclusion--no statements about the validity of the conclusion reached are made, and thus with the false premise material subjects may be easily able to separate the material given them from all their background biases and reach a logical conclusion fairly accurately. Working with the false premises, as Berlyne (1957) has implied, might produce conceptual conflict or arousal which would lead to greater accuracy. In addition the true premises material has what might be called a "factual conclusion acceptance tendency" which means that subjects tend to accept a conclusion that is not logically correct if it is correct factually. This same tendency is not exhibited on items that have no factually correct alternatives (as judged by the experimenter) to select from, and thus the false items are not so susceptible to what Henle (1962) calls the "failure to accept the logical task." When we examine the results for the mixed premise material, we can expect to see the largest variance in this group due to very low scores by subjects who are in Henle's terms "restating a premise." Exactly these results are obtained, and the relatively large number of low scores so suppress the mean number

correct for this group that it is significantly lower than the other groups. The fact that the mean for the mixed premises is as high as it was (7.88 for the 15 item test, Experiment I) appears to be due to a few high scores; these items should produce some scores similar to the false premise material for subjects who are carefully working through the items and find the test challenging in the same manner as the false premise material.

In Experiment II, ten items from each scale were further selected to be very carefully equated for word length as well as logical structure. While the analysis for number correct or number of errors tells us only that the mixed premise test is harder than the true or false premise items, the real insight comes from inspecting the solution times for the various types of material. The order for solution times follows exactly from that for the number correct in Experiment I. The false premise items take significantly longer than the true premise items which take longer than the mixed premise items, and this confirms  $H_3$ . If we consider solution time another measure of item difficulty, then the false items are more difficult than the mixed premise items. But perhaps a more insightful interpretation might be in terms of information theory, for the false premises carry a considerable information load and thus they should require a relatively long encoding time and solution time, but the true premise material should be relatively rapidly encoded because the information load with familiar information should be comparatively low.

Mixed premise material, if Henle's suggestions about errors is correct, would be encoded quite similarly to the familiar material with one (the false premise) misperceived. From the information analysis for false material in terms of new information, we might conclude that this newly encoded material would be relatively free from habitual response patterns, and consequently the logical relationships between just the material presented would be considered by the subject in selecting the correct conclusion. With the true premise material, subjects may fail to use just the information given in coming to a conclusion and select a true statement, but not a valid conclusion. There appears to be no psychological reason why the mixed premises material should have a shorter solution time than the true premises material, and the two-tail  $t$  test shows no statistically acceptable difference. With a larger sample, this small observed difference might well disappear.

The results of the analysis of the transfer effects between true and false premise material does not accord with the results for emotional and nonemotional syllogisms (Lefford, 1946). Lefford's discussion of the ascendance of the emotional over the rational lacks sound replication with his own material, and with these true and false items, the overall transfer for number correct was identical for both treatment orders. In comparing the effects on solution times, a very interesting result obtains, for false items transfer positively to true items (comparing true items first with true items second,  $t=2.21$ ,  $p<.025$ ) while the effect of true items is negligible ( $t=1.66$ ,  $p<.10$ ); this data confirms  $H_4$ . Here an

interpretation in terms of einstellung seems quite appropriate, for subjects working with false items adapt to encoding quite unusual information and thus may be said to have quite "open" cognitive systems. Subjects working true items first adapt to encoding familiar information, and the transition to false premise material may be somewhat difficult. This difference between transfer results may be somewhat of an artifact though, for the difference between the false-premises-first and false-premises-second barely misses acceptable statistical significance (false premises material has relatively large variances for solution times). A larger sample experiment might find equal facilitation for both treatment orders, and thus this data should be taken only as tentative, and more conservatively due to "warm-up" and familiarity with syllogistic reasoning in general.

In terms of variance in solution times, false premises had a relatively large variance as compared to true premises. This might be a function of differential category accessibility for the false premises. All subjects would be equally familiar with true premises and have roughly similar category development for handling this type of material, but false premises would be handled by much less frequently used categories. The availability of false premise categories would be quite variable across subjects, and thus greater variability would be expected on these items. Mixed premises have the largest variance for solution time, and this might well be a function of the two types of categories that each item involves. Subjects who correctly encode the

premises and then search for a conclusion find the conclusion quite rapidly, while subjects who misread the premises and then search for a conclusion may not find any conclusion that appears to fit "their" premises. If no conclusion is immediately found, a further search or re-reading of the premises may occur, and thus some subjects might be expected to have very long solution times.

The Chi-square analysis for errors as a general function of valid or invalid items also lends some support to Henle's (1962) suggestions of errors as resulting from a lack of task acceptance. Invalid items account for a large percentage of the total errors made, and this appears to be a function of the difference between correct "psychologically" as opposed to correct logically. Subjects select content statements as logical conclusions when the correct logical choice is "none of the above," and this occurs most frequently with true premise material. This suggests that subjects may have difficulty in restraining the basis of their decisions only to the information given.

In terms of theories, it would appear that the Berlyne (1957) conceptual conflict model handles all the data for both time and number correct, but even this model needs the suggestions of Henle (1962) on errors as a function of misperceived premises to fully handle the mixed premises results. No single theoretical formulation fully encompasses this data, and contrary to many other investigations, these two dependent variables do not seem to be measuring the same factor--difficulty. The relationship between number correct and solution time

across the three test forms suggests a positive relation in contrast with time-accuracy relations in other reasoning problems (e.g. anagrams, Johnson, 1966). Future research in this area could further compare the positive relation between number correct and solution time as two separate dependent variables in reasoning problems.

Further investigations in reasoning with various types of item content might profitably investigate the effects of training procedures on errors and solution times for different item content. The test-retest reliability of the solution time scores might be examined, and the effects of various instructions examined in terms of information processing speed for different types of material (e.g. "work these reasoning problems as fast as possible"). The effects of the different item content on arousal might be studied by measuring GSR during the reasoning process.

## SUMMARY

This investigation was concerned with the effects of true premise content, false premise content, and mixed premise content on logical reasoning scores for both accuracy and solution time. Three test forms were developed with items of differing truth-falsity content, but matched for logical structure. In contrast to the development of earlier scales, the truth-falsity of each premise was scaled by a sample of subjects, rather than only by the experimenter.

Experiment I compared the three test forms for number correct with a sample of 99 undergraduate students randomly assigned to test forms. In support of the hypotheses, the false items were found to be easiest, then the true items, and then the mixed premises items.

Experiment II compared the three types of item content for total solution time with 10-item scales matched for word length. A total of 24 subjects were individually tested in this experiment with the items presented with the Johnson Serial Exposure Box. In terms of total solution time, false items take the longest, then true items, and then mixed premise items; this supported  $H_3$ .

A sub-comparison made in Experiment II concerned the relative transfer effects of the true-then-false presentation order as compared to the false-then-true order. For number correct, the transfer for both orders was identical, but the false-then-true order significantly reduced the solution time for the true

items, while the true items did not significantly reduce the solution time of the subsequent false items. This result supported  $H_4$ .

The discussion of the results emphasized the suggestions of Henle (1962) in terms of errors in logical reasoning; and Berlyne's model of conceptual conflict best fit the data for both solution time and number correct. Even the Berlyne model was not completely satisfactory, and an attempt was made at intergrating an information processing model with the Henle (1962) and Berlyne (1957) conceptions to derive a theoretical system that handled all three types of item content for both number correct and solution time. Of some methodological and theoretical interest, it was suggested that solution time and number correct are not the interchangeable dependent variables that they have often been assumed to be, but rather for some problems, at least, they are positively correlated measurements.

Suggestions for further research investigating differential effects of training procedures and instructions on reasoning with varied item content, and for investigating the test-retest reliability of solution time scores were made.

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STATEMENT SCALING FORM --3

Instructions: You are to read the following statements and rate or score them by marking on the accompanying IEM answer sheet a number from one to seven on the scale which you have been instructed to use.

These statements may vary from one end of the scale to the other; your own judgement is the best answer. A statement neither one way or the other or indeterminate should receive a score of four.

Do you have any questions?

DO NOT MAKE ANY MARKS IN THIS TEST BOOKLET !!!!!!!!!!!!!!!!!!!!!

Rating Scale For All the Following Items:

1 - 2 - 3 - 4 - 5 - 6 - 7  
(completely) (1/2 & 1/2) (completely)

Use this scale for each of the following items:

1. Good citizens take advantage of their privilege of voting.
2. Football is a very popular sport here at MSU.
3. Man, faced between choosing between life and death is ennobled by the experience.
4. All cats are mammals.
5. Triangles are members of a class of geometrical figures which are called plane figures.
6. All popular music is played on the radio.
7. The Rapp-Coudert Committee reported that all teachers who are Communists are members of the Teachers' Union.
8. Some psychologists study rat behavior.
9. No politician expects to remain in office forever.
10. Everyone agrees that all unnecessary evils should be avoided if possible.
11. All enemies of a government are justifiable repressed by any measures that government may consider necessary.
12. If a person is a member of Phi Beta Kappa, he must be a college graduate.
13. If the Soviet government favored capitalism, it would want peace.
14. Varsity soccer is more popular than varsity basketball here at MSU.

CHECK TO MAKE SURE YOU HAVE JUST FINISHED ITEM 14 ON THE IEM SHEET!!!

Go On To The Next Page !!!

1. The area of a triangle is given by  $\frac{1}{2} \times \text{base} \times \text{height}$ .

2. The area of a circle is given by  $\pi r^2$ .

3. The area of a rectangle is given by  $\text{length} \times \text{width}$ .

4. The area of a trapezoid is given by  $\frac{1}{2} \times (\text{top base} + \text{bottom base}) \times \text{height}$ .



5. The area of a parallelogram is given by  $\text{base} \times \text{height}$ .

6. The area of a square is given by  $\text{side}^2$ .

7. The area of a rhombus is given by  $\frac{1}{2} \times \text{diagonal}_1 \times \text{diagonal}_2$ .

8. If the temperature rises  $10^\circ\text{C}$ , it means that the weather will continue to remain the same.

9. If a person's car is broken, they should call a mechanic.

10. The process of evolution has been studied for years.

11. The process of evolution is not a linear process and is not completely understood.

12. Nothing is certain in biology as it is a science that is constantly changing.

13. All mammals are warm-blooded.

14. All members of the same species are of the same species.

15. The world is in a state of constant change and is a dynamic system.

16. Some birds can fly better than others.

17. The scientific method is based on observation and experimentation.

18. The scientific method is the best way to gain knowledge and should not be used to solve problems if we want to preserve the quality of the world.

19. No student at PSU should be allowed to graduate.

20. All true men are also good men.

21. All Communists are bad people.

22. All books are worth reading.

23. The world is a big place and there is much to be learned from it.





REMEMBER: You are rating these statements on the following scale:

1 - 2 - 3 - 4 - 5 - 6 - 7  
 (completely) (1/2 & 1/2) (completely)

77. All wars are wrong.
80. Everything worth reading should be given away free.
81. All the laws of science are established through a process of inductive reasoning.
82. Marriage between people of different races is contrary to biological principles.
83. Anything that contains iron is quite durable.
84. All members of a collegiate varsity football team must also be college students.
85. All European wars are serious social evils.
86. Everything that is unbreakable must contain steel.

YOU SHOULD HAVE JUST COMPLETED IBM ANSWER SHEET NUMBER 1-- NUMBER 86 IS THE LAST STATEMENT ON THE FIRST ANSWER SHEET !!!!!

NOW GO ON TO IBM ANSWER SHEET NUMBER 2, AND CONTINUE EXACTLY AS BEFORE !!!!!

1. Every good scientist should possess a mastery of scientific methodology.
2. War inevitably thwarts a nation's well-being and prosperity.
3. Some convertible topped cars are prone to leaking during rainstorms.
4. Logic is a normative science dealing with the problem of order.
5. An inevitable consequence of communism is a (similar) inefficiency of labor.
6. Some things that travel underwater are birds.
7. It is a fact that the life records of vegetarians show them to have lived to a great age.
8. Any interference with Nature is an evil which should be prohibited.
9. Breaking the "sound barrier" requires a powerful jet engine for propulsion.
10. All great masterpieces designed in the classical period followed the conventional laws of perspective.
11. Stalin signed a non-aggression pact with Hitler.
12. All Male college students could be drafted.

CHECK TO MAKE SURE YOU HAVE JUST COMPLETED ITEM 12 ON THE SECOND IBM ANSWER SHEET

Remember that you are rating these statements on the following scale:

1 - 2 - 3 - 4 - 5 - 6 - 7  
 (completely) (½ & ½) (completely)

13. The U.S.S. America has recently been successfully launched and floated.
14. Prosperity is highly desirable.
15. All masterful artistry should be destroyed so that it does not warp the creativity of future generations.
16. Everyone who is happy is well-paid.
17. All human beings are fallible.
18. All C.I.O. leaders have radical ideas.
19. Some surgeons are successful businessmen.
20. All fish live in the water.
21. The existence of God does not lend itself to scientific investigation and treatment.
22. Any land area that is surrounded by water is a peninsula.
23. Some medical school flunk-outs are car salesmen.
24. Some forms of plant life, like sea-weed, also can live in the water.
25. Some dictators show freedom from arrogance.
26. Spiders do not have six paired, pointed appendages, but they have eight.
27. No peace settlement is ever satisfactory to both sides.
28. With the diversion of machine tools to defense industries, the cost of production of automobiles has not been reduced.
29. The majority of the inhabitants of Austria did not wish their territory to be annexed to Germany.
30. Breaking the "sound barrier" requires special rocket food.
31. Popular sports have large crowds.

---

THIS IS THE END OF THIS TASK--MAKE SURE YOUR LAST RESPONSE WAS ON ITEM  
 NUMBER 31 ON THE SECOND ITEM SHEET--THANK YOU VERY MUCH !!!

## APPENDIX A

STATEMENT SCALING FORM --4

Instructions: You are to read the following statements and rate or score them by marking on the accompanying IBM answer sheet a number from one to seven on the scale which you have been instructed to use.

These statements may vary from one end of the scale to the other; your own judgment is the best answer. A statement neither one way or the other or indeterminate should receive a score of four.

Do you have any questions?

DO NOT MAKE ANY MARKS IN THIS TEST RECIPELET !!!!!!!!!!!!!!!!!!!!!

Rating Scale For All The Following Items:

1 - 2 - 3 - 4 - 5 - 6 - 7  
(completely) (½ & ½) (completely)

Use this scale for each of the following items.

1. Varsity football is a very popular sport here at MSU.
2. Physics is the most popular course of study here at MSU.
3. All television shows are quite educational.
4. Some convertible tops are prone to leaking during rainstorms.
5. Some airplanes fly faster than sound.
6. Some nuclear physicists study the behavior of neutrons.
7. No Americans are astronauts.
8. All foreign cars are inexpensive.
9. Anything which contains iron breaks easily.
10. Some murderers are well-paid and very intelligent men.
11. Some boats fly above the water.
12. All college students are revolutionary radicals.
13. Some doctors (M.D.) are idiots.
14. All mammals are hatched from egg like chickens.

CHECK TO MAKE SURE YOU HAVE JUST FINISHED FORM 14 ON THE IBM SHEET !!

Go on to the next page !!!

Remember that you are rating these statements on the following scale:

1 - 2 - 3 - 4 - 5 - 6 - 7  
 (completely) (½ & ½) (completely)

15. Some idiots are in mental hospitals.
16. All servicemen may be sent to Viet Nam.
17. Popular courses of study are very easy.
18. Some doctors (M.D.) are surgeons.
19. All popular sports have very small crowds.
20. Only astronauts participate in the actual flying of space vehicles.
21. Anything educational should be studied.
22. All liquid is solid.
23. All criminals are lawbreakers.
24. All metal is wet.
25. All Democrats are polo players.
26. No vegetables are limes.
27. All potatoes are vegetables.
28. No girls are male.
29. No books are paper.
30. No amateurs are athletes.
31. No weapons are atomic water purifiers.
32. No snow is wet.
33. All students are zombies.
34. No rectangles are squares.
35. All cats are animals.
36. No wingless creature can fly.
37. All patriots are loyal.
38. All boxes are round.

CHECK TO MAKE SURE YOU HAVE JUST FINISHED ITEM 38 ON THE IBM ANSWER SHEET !!

Go on to the next page !!!

Remember that you are rating these statements on the following scale:

1 - 2 - 3 - 4 - 5 - 6 - 7  
 (completely) (½ & ½) (completely)

39. Some wonderful and intelligent men should be given international recognition.
40. Flying over the water requires wings and a powerful engine.
41. All revolutionary radicals should be arrested.
42. Some solid things are very brittle.
43. Some vegetables are sickening.
44. All newspapers are paper.
45. All athletes are interested in physical fitness.
46. Some wet things are cold.
47. Some dogs are cats.
48. All narcotics are stimulants.
49. Some criminals are sick.
50. All male college students may be drafted.
51. All limes are green.
52. All boys are male.
53. All atomic water purifiers are nuclear devices.
54. Some animals are wingless.
55. Some Frenchmen are not loyal.
56. All felines are animals.
57. Anything round is a cylinder.
58. Some liquid is not wet.
59. Some Democrats are men.
60. All athletes are professional.
61. Some zombies are scholars.
62. Some circles are rectangles.
63. Some partitions are floors.
64. All boxes are barrels.
65. All physical pain is a stimulant.

Remember that you are rating these statements on the following scale:

1 - 2 - 3 - 4 - 5 - 6 - 7  
(completely) (1/2 & 1/2) (completely)

- 66. All autobiographies are biographies.
- 67. No women are queens.
- 68. No queens are women.
- 69. Some lies are interesting stories.
- 70. No females are cows.
- 71. Some elephants are gray animals
- 72. No roses have thorns.
- 73. Some trout are fish.
- 74. All donkeys are man-eaters.
- 75. No violets are roses.
- 76. All assistant professors are faculty members.
- 77. No chickens are birds.
- 78. No dogs are animals.
- 79. No busses are carriers.
- 80. All voters are female.
- 81. No snow is wet.
- 82. All men are animals.
- 83. All Americans are human beings.
- 84. All animals are humans.
- 85. All snowmen are abominable.
- 86. No partitions are walls.

YOU SHOULD HAVE JUST COMPLETED IBM ANSWER SHEET NUMBER 1 --NUMBER 86 IS THE LAST STATEMENT ON THE FIRST ANSWER SHEET !!!!!

NOW GO ON TO IBM ANSWER SHEET NUMBER 2, AND CONTINUE EXACTLY AS BEFORE !!!!

- 1. All barrels are cardboard.
- 2. All drugs are stimulants.

CHECK TO MAKE SURE YOU HAVE JUST COMPLETED ITEM 2 ON THE SECOND IBM ANSWER SHEET !!

Then, Go on to the next page!!

Remember that you are rating these statements on the following scales:

1 - 2 - 3 - 4 - 5 - 6 - 7  
(completely) (1/2 & 1/2) (completely)

- 3. All biographies are books.
- 4. Some secretaries are queens.
- 5. No lie is true.
- 6. No elephants are cats.
- 7. All roses are thorny.
- 8. All cows are giraffes.
- 9. No gray animal is a mammal.
- 10. No fish are chickens.
- 11. All man-eaters have four legs.
- 12. All department heads are faculty members.
- 13. All thorny plants may scratch small children.
- 14. Some roosters are chickens.
- 15. All animals are organisms.
- 16. All carriers are motor vehicles.
- 17. Some women are not female.
- 18. All white objects are abominable.
- 19. Some human beings are blonds.
- 20. All ostriches are animals.
- 21. All wet things contain water.
- 22. Some females are under 21 years of age.
- 23. Some humans are bald-headed.

THIS IS THE END OF THIS TASK -- MAKE SURE YOUR LAST RESPONSE WAS ON ITEM NUMBER 23

ON THE SECOND IBM SHEET -- THANK YOU VERY MUCH !!!

# MICHIGAN STATE UNIVERSITY

NAME \_\_\_\_\_ DATE \_\_\_\_\_ STUDENT NO \_\_\_\_\_ SEX M F

COURSE NAME \_\_\_\_\_ COURSE NO. \_\_\_\_\_  
 SECTION \_\_\_\_\_ INSTRUCTOR \_\_\_\_\_  
 NAME OF TEST \_\_\_\_\_ FORM \_\_\_\_\_

STUDENT NUMBER										
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	0	1	2	3	4	5	6	7	8	9
	0	1	2	3	4	5	6	7	8	9

BE SURE YOUR MARKS ARE HEAVY AND BLACK  
 ERASE COMPLETELY ANY ANSWER CHANGED

1	2	3	4	5	6	7	8	9	10	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86
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## APPENDIX B

1. The following are all true:
  - a. The "eggplant that ate Chicago" is sick.
  - b. Current popular music is undergoing a "novelty phase."
  - c. All popular music is quite entertaining.
  - d. The only way to hear entertaining music is to buy specific records.
  - e. None of the above.
2. All popular music is played on the radio.  
All radio music is quite entertaining.
  - a. The "eggplant that ate Chicago" is sick.
  - b. Current popular music is undergoing a "novelty phase."
  - c. All popular music is quite entertaining.
  - d. The only way to hear entertaining music is to buy specific records.
  - e. None of the above.
3. All of Australia is surrounded by water.  
Any land area surrounded by water is an island (or a continent).
  - a. Australia is a member of the British Commonwealth.
  - b. Australia is a wealthy country.
  - c. Australia is an island (or a continent).
  - d. Australia is too large to be an island (or a continent).
  - e. None of the above.
4. Some psychologists study rat behavior.  
Some studies of rat behavior are trivial, unimportant research.
  - a. All psychologists waste too much time.
  - b. Some rat behavior is not as important as human behavior.
  - c. The psychological study of human behavior merits the interest of more psychologists.
  - d. Some psychologists do trivial, unimportant research.
  - e. None of the above.
5. No politicians expect to remain in office forever.  
All dictators expect to remain in office forever.
  - a. No politician is a dictator.
  - b. Dictators are frequently assassinated.
  - c. Politicians fight hard for reelection.
  - d. Both dictators and politicians exercise power over their countrymen.
  - e. None of the above.
6. All football players are strong and healthy.  
All strong and healthy people are much above average in intelligence.
  - a. All professional football players are well paid.
  - b. All football players wear protective clothing while playing.
  - c. All strong and healthy football players would like to be professionals.
  - d. All football players are much above average in intelligence.
  - e. None of the above.
7. It has been found that all steel contains iron.  
Anything which contains iron is quite durable.
  - a. Steel is quite durable.
  - b. Both iron and steel rust.
  - c. Steel contains other metals besides iron.
  - d. Iron is the base for many metallic compounds.
  - e. None of the above.

8. Some automobiles have convertible tops.  
Some convertible tops are prone to leaking during rainstorms.
- a. Some automobiles leak during rainstorms.
  - b. Some automobiles may not leak during rainstorms.
  - c. Some convertible tops are no good.
  - d. All convertible tops are inferior to normal tops.
  - e. None of the above.

9. Some airplanes fly faster than sound.  
Breaking the sound barrier requires a powerful jet engine for propulsion.
- a. Some jet engines are used in racing boats.
  - b. A rocket engine is more powerful than a jet engine.
  - c. Some airplanes have powerful jet engines.
  - d. Some airplanes have propeller-type engines.
  - e. None of the above.

1. All servicemen may be sent to Viet Nam.  
All male college students may be drafted.
  - a. All male college students, after drafting, may be sent to Viet Nam.
  - b. Servicemen prefer to go to Viet Nam.
  - c. All male college students prefer to stay in college.
  - d. Male college students have 2S deferments.
  - e. None of the above.
  
2. Some doctors (M.D.) are surgeons.  
Some surgeons are successful businessmen.
  - a. Some doctors are quite poor.
  - b. Some doctors are extremely wealthy.
  - c. Some doctors are successful businessmen.
  - d. Some doctors and surgeons have successful practices.
  - e. None of the above.
  
3. All cats are mammals.  
All mammals have teeth.
  - a. All mammals can see well at night.
  - b. All mammals give birth to live young.
  - c. All cats have furry skins.
  - d. All cats have teeth.
  - e. None of the above.
  
4. All criminals are lawbreakers.  
Some criminals are sick.
  - a. Some criminals are in hospitals.
  - b. Some criminals are never caught.
  - c. Some lawbreakers are sick.
  - d. Some lawbreakers are in prison.
  - e. None of the above.
  
5. No vegetables are limes.  
All limes are green.
  - a. Limes are fruits.
  - b. Limes are not yellow.
  - c. Some vegetables are not green.
  - d. Some vegetables may be green.
  - e. None of the above.
  
6. No weapons are atomic water purifiers.  
All atomic water purifiers are nuclear devices.
  - a. Some nuclear devices are weapons.
  - b. Some nuclear devices are not weapons.
  - c. Atomic bombs are nuclear weapons.
  - d. Nuclear powered hydroelectric plants are not weapons.
  - e. None of the above.
  
7. No girls are male.  
All boys are male.
  - a. No girls are boys.
  - b. All girls are female.
  - c. No boys are female.
  - d. Girls and boys are different.
  - e. None of the above.

8. No wingless creature can fly.  
Some animals are wingless.
- a. The flying squirrel glides from tree to tree.
  - b. The bat is a flying animal.
  - c. Some animals cannot fly.
  - d. Some animals can fly.
  - e. None of the above.
9. All patriots are loyal.  
Some Frenchmen are not loyal.
- a. Some Frenchmen are not patriots.
  - b. De Gaulle is a French patriot.
  - c. Most Frenchmen are loyal.
  - d. Brigitte Bardot is a very loyal "Frenchman."
  - e. None of the above.

1. All cats are mammals.  
All dogs are mammals.  
a. All cats are dogs and all dogs are cats.  
b. All cats are not dogs.  
c. All dogs are cats.  
d. Dogs are not cats.  
e. None of the above.
2. All autobiographies are biographies.  
All biographies are books.  
a. Some books are autobiographies.  
b. Some biographies may be movies.  
c. Some books may be novels.  
d. Some autobiographies may not be written.  
e. None of the above.
3. Some lies are intentional.  
Lies are true.  
a. Some intentional lies are not true.  
b. Some intentional lies are true.  
c. Some intentional lies are not true.  
d. Lies are not true.  
e. None of the above.
4. Some elephants are reptiles.  
No elephants are cats.  
a. All cats are reptiles.  
b. Some elephants are cats.  
c. Some cats are not reptiles.  
d. Some cats are elephants.  
e. None of the above.
5. No violets are roses.  
All roses are thorny.  
a. No violets are thorny.  
b. Some violets may be thorny.  
c. Some roses are red.  
d. No violets are black.  
e. None of the above.
6. No fish are chickens.  
Some trout are fish.  
a. All trout are fish.  
b. All chickens are birds.  
c. Some chickens are not trout.  
d. No chicken is a trout.  
e. None of the above.
7. All assistant professors are faculty members.  
All department heads are faculty members.  
a. Most department heads are full professors.  
b. Some department heads are assistant professors.  
c. All faculty members are teachers.  
d. Some assistant professors are involved with research projects.  
e. None of the above.

8. All men are animals.  
All animals are organisms.  
a. All men are organisms.  
b. All men are homo sapiens.  
c. All bacteria are organisms.  
d. All organisms are alive.  
e. None of the above.
9. All Americans are human beings.  
Some human beings are blonds.  
a. Some Americans are blonds.  
b. Most Americans are not blonds.  
c. Many blonds are not "natural."  
d. Some blonds are movie stars.  
e. None of the above.

1. **Physics is the most popular course of study here at MSU.**  
Popular courses of study are very easy.
  - a. Physics is very easy here.
  - b. Elementary education is easier than physics.
  - c. Physics is very difficult here.
  - d. Physics students are very intelligent.
  - e. None of the above.
  
2. **All popular music is highly acclaimed by experts as masterful artistry.**  
All masterful artistry should be destroyed so that it does not warp the creativity of future generations.
  - a. All popular music should be kept for posterity.
  - b. All popular music should be destroyed.
  - c. All popular music is quite faddish.
  - d. Masterful artistry serves as a stimulus to further creativity.
  - e. None of the above.
  
3. **All of the United States is surrounded by water.**  
Any land area that is surrounded by water is a peninsula.
  - a. The U.S. land area is a part of the North American continent.
  - b. The U.S. land area is not surrounded by water.
  - c. The U.S. land area includes an island group and other areas in addition to the area on the North American continent.
  - d. The U.S. land area is a peninsula.
  - e. None of the above.
  
4. **Some rats are much smarter than some psychologists.**  
Some psychologists are "more intelligent" than practically anybody.
  - a. Some rats are good experimental animals.
  - b. Some psychologists do much research with rats.
  - c. Some rats learn maze problems very well.
  - d. Some rats are more intelligent than practically anybody.
  - e. None of the above.
  
5. **No students at MSU study hard for their classes.**  
Only idiots study hard for their classes.
  - a. No students at MSU are idiots.
  - b. No students at MSU do very well on national achievement tests.
  - c. There are no idiots in any college.
  - d. Working hard is a sign of a desire for achievement--a very good thing in these times.
  - e. None of the above.
  
6. **All books are worth reading.**  
Everything worth reading should be given away free.
  - a. All good books are worth paying for.
  - b. Money is a small measure of the value of a book.
  - c. Knowledge is beyond the price of dollars and cents.
  - d. All books should be given away free.
  - e. None of the above.
  
7. **All glass is unbreakable.**  
Everything that is unbreakable must contain steel.
  - a. All glass is a special form of steel.
  - b. Steel is not transparent like glass.
  - c. All glass contains steel.
  - d. Many plastic compounds are unbreakable too.
  - e. None of the above.

8. Some trucks travel underwater.  
Some things that travel underwater are birds.
- a. Some trucks are birds.
  - b. Some birds can fly.
  - c. Some trucks are not birds.
  - d. No truck is a bird.
  - e. None of the above.
9. Some men run faster than sound.  
Breaking the "sound barrier" requires special rocket food.
- a. Some men eat special rocket food.
  - b. There is no such thing as special rocket food.
  - c. The fastest runner in history did not even achieve 30 miles per hour.
  - d. High speed running requires much training.
  - e. None of the above.

1. All servicemen in Viet Nam are happy.  
Everyone who is happy is well paid.
- All servicemen in Viet Nam are well paid.
  - All servicemen in Viet Nam are poorly paid.
  - Some servicemen in Viet Nam are happy.
  - Some servicemen in Viet Nam are unhappy.
  - None of the above.
2. Some doctors (M.D.) are medical school flunk-outs.  
Some medical school flunk-outs are car salesmen.
- Some medical school flunk-outs may return to medical school.
  - Some doctors are car salesmen.
  - Some doctors almost flunked out of medical school.
  - Some car salesmen later become doctors.
  - None of the above.
3. All mammals are cats.  
All cats hunt elephants.
- All ivory hunters kill elephants.
  - All mammals hunt elephants.
  - Cats hunt mice.
  - All elephants are larger than cats.
  - None of the above.
4. All metal is wet.  
Some liquid is not wet.
- Some liquid is not solid.
  - Some liquid is quite thick.
  - Some liquid is not metal.
  - Some metal is very hard.
  - None of the above.
5. All Democrats are polo players.  
Some Democrats are men.
- Democrats form one of the major political parties.
  - Democrats are different from Republicans.
  - Some polo players are men.
  - All polo players are men.
  - None of the above.
6. All students are zombies.  
Some zombies are scholars.
- Some scholars are students.
  - Some students are scholars.
  - All students are young scholars.
  - Zombies do not really exist.
  - None of the above.
7. No amateurs are athletes.  
All athletes are professionals.
- No amateurs are professionals.
  - Many athletes are amateurs.
  - No amateur receives money for his participation.
  - Many professionals are not athletes.
  - None of the above.

8. The number of vertices

of a polygon is 20. How many

- a. Diagonals does it have?
- b. Are rectangles less than or equal to it?
- c. How many circles can be drawn?
- d. How many sides does it have?
- e. How many angles does it have?

9. How many sides does a polygon

have if it has 10 diagonals?

- a. Is it a square?
- b. Is it a rectangle?
- c. Is it a rhombus?
- d. Is it a trapezoid?
- e. Is it a parallelogram?

1. The first step in the process of...  
2. The second step is to...  
3. The third step is to...  
4. The fourth step is to...  
5. The fifth step is to...

6. The sixth step is to...  
7. The seventh step is to...  
8. The eighth step is to...  
9. The ninth step is to...  
10. The tenth step is to...

11. The eleventh step is to...  
12. The twelfth step is to...  
13. The thirteenth step is to...  
14. The fourteenth step is to...  
15. The fifteenth step is to...

16. The sixteenth step is to...  
17. The seventeenth step is to...  
18. The eighteenth step is to...  
19. The nineteenth step is to...  
20. The twentieth step is to...

21. The twenty-first step is to...  
22. The twenty-second step is to...  
23. The twenty-third step is to...  
24. The twenty-fourth step is to...  
25. The twenty-fifth step is to...

26. The twenty-sixth step is to...  
27. The twenty-seventh step is to...  
28. The twenty-eighth step is to...  
29. The twenty-ninth step is to...  
30. The thirtieth step is to...

31. The thirty-first step is to...  
32. The thirty-second step is to...  
33. The thirty-third step is to...  
34. The thirty-fourth step is to...  
35. The thirty-fifth step is to...

Some objects are not familiar.

- a. Some objects are not familiar.
- b. Some objects are simple.
- c. Some objects are not visible.
- d. All objects must be registered.
- e. None of the above.

All objects are identifiable.

All objects are identifiable.

- a. Some objects are identifiable.
- b. A single object is identifiable.
- c. The identifiable object is the only one.
- d. All objects are identifiable.
- e. None of the above.

1. Varsity football is a very popular sport here at MSU.  
All popular sports have very small crowds.
  - a. Varsity football here has large crowds.
  - b. Varsity football here has small crowds.
  - c. Varsity football here is not very popular.
  - d. Varsity football here provides much income for the University.
  - e. None of the above.
  
2. All television shows are quite educational.  
Anything educational should be studied.
  - a. All television shows should be studied.
  - b. All television shows should be censored.
  - c. All television shows should be upgraded in quality.
  - d. There are only a few educational television shows.
  - e. None of the above.
  
3. All of the United States is surrounded by water.  
Any land area surrounded by water is an island (or a continent).
  - a. The United States is not surrounded by water.
  - b. The United States is part of the North American continent.
  - c. The United States includes an island group--Hawaii.
  - d. The United States is an island.
  - e. None of the above.
  
4. Some nuclear physicists study the behavior of rats.  
Some studies of rat behavior are trivial, unimportant research.
  - a. All physicists waste too much time.
  - b. Some rat behavior is not as important as research in atomic energy.
  - c. Some physicists can learn much about rat behavior.
  - d. Some physicists do trivial, unimportant research.
  - e. None of the above.
  
5. No Americans are astronauts.  
Only astronauts participate in the actual flying of space vehicles.
  - a. No Americans actually fly space vehicles.
  - b. Some Americans have flown space vehicles.
  - c. No Americans are cosmonauts.
  - d. Only Americans are space pilots or astronauts.
  - e. None of the above.
  
6. All foreign cars are inexpensive.  
The Rolls Royce is an English car.
  - a. The Rolls Royce is very expensive.
  - b. The Rolls Royce is quite inexpensive.
  - c. The MG is also an English car.
  - d. The Volkswagen is probably the most famous foreign economy car.
  - e. None of the above.

7. It has been found that all steel contains iron.  
Anything which contains iron breaks easily.
- Steel is quite durable.
  - Iron is very heavy and strong.
  - Steel breaks easily.
  - Glass also breaks easily.
  - None of the above.
8. Some murderers are wonderful and intelligent men.  
Some wonderful and intelligent men should be international recognition.
- Some murderers should be given international recognition.
  - Some murderers should be executed.
  - Some murderers are not wonderful and intelligent men, but brutal killers.
  - No murderers can possibly be wonderful and intelligent men.
  - None of the above.
9. Some boats fly above the water.  
Flying over the water requires wings and a powerful engine.
- Some airplanes have wings and a powerful engine.
  - Some boats have wings and a powerful motor.
  - Only airplanes have wings and fly.
  - Some boats cruise slowly across the oceans.
  - None of the above.

1. All village students are revolutionaries.  
All revolutionary radicals should be arrested.  
a. All college students should be arrested.  
b. All college students are not revolutionaries.  
c. Some college students should be arrested.  
d. All college students will be arrested.  
e. None of the above.
2. Some doctors (M.D.) are idiots.  
Some idiots are in mental hospitals.  
a. Some doctors run mental hospitals.  
b. Some doctors should be in mental hospitals.  
c. Some doctors should not be prescribed any medicine.  
d. Some of the idiot doctors work in Olin.  
e. None of the above.
3. All cats are mammals.  
All mammals are hatched from eggs like chickens.  
a. All cats are born alive.  
b. All cats and mammals give birth to live young.  
c. All cats are hatched from eggs.  
d. All cats are taken care of by their mother after birth.  
e. None of the above.
4. All liquid is solid.  
Some solid things are very brittle.  
a. All liquid things are very brittle.  
b. All liquid things are not brittle.  
c. Some liquid things are not brittle.  
d. Some liquid things are very brittle.  
e. None of the above.
5. All potatoes are vegetables.  
Some vegetables are sickening.  
a. All potatoes are sickening.  
b. Some potatoes are sickening.  
c. Most potatoes are sickening.  
d. No potatoes are sickening.  
e. None of the above.
6. No amateurs are athletes.  
All athletes are interested in physical fitness.  
a. No amateurs are interested in physical fitness.  
b. No amateurs become professional.  
c. No one interested in physical fitness is an amateur.  
d. Many amateurs are athletes.  
e. None of the above.
7. No books are paper.  
All newspapers are paper.  
a. No newspapers are books.  
b. No books are movies.  
c. All books are paper.  
d. All newspapers are based on the news items.  
e. None of the above.

8. Snow is white.  
Some wet things are cold.
- a. Snow is cold.
  - b. Some things which are cold are wet.
  - c. All wet things are cold.
  - d. Snow is really wet.
  - e. None of the above.
9. All cats are animals.  
Some dogs are cats.
- a. Some cats are not dogs.
  - b. Some dogs are animals.
  - c. All dogs are animals.
  - d. No dogs are cats.
  - e. None of the above.

1. All boxes are round.  
Anything round is a cylinder.
  - a. All boxes are square.
  - b. All boxes are cubes.
  - c. All boxes are cylinders.
  - d. All barrels are cylinders.
  - e. None of the above.
  
2. All narcotics are stimulants.  
All physical pain is a stimulant.
  - a. All physical pain is a narcotic.
  - b. Some narcotics are not stimulants.
  - c. Some stimulants are not narcotics.
  - d. All stimulants produce more effect than modify the following.
  - e. None of the above.
  
3. No women are queens.  
Some secretaries are queens.
  - a. No secretaries are kings.
  - b. No secretaries are queens.
  - c. Some women are secretaries.
  - d. Some queens are women.
  - e. None of the above.
  
4. Some elephants are gray mammals.  
No gray animal is a mammal.
  - a. All elephants are mammals.
  - b. Some elephants are mammals.
  - c. No elephant is a mammal.
  - d. Mammals are not determined by external color.
  - e. None of the above.
  
5. No roses have thorns.  
All thorny plants may scratch small children.
  - a. No roses can scratch small children.
  - b. All roses can scratch small children.
  - c. No thorny plants are really dangerous.
  - d. All roses are very harmless plants.
  - e. None of the above.
  
6. No chickens are birds.  
Some roosters are chickens.
  - a. All chickens are birds.
  - b. All roosters are chickens.
  - c. No roosters are birds.
  - d. Some roosters are not birds.
  - e. None of the above.
  
7. No snow is wet.  
All wet things contain water.
  - a. All snow contains water.
  - b. Some snow contains water.
  - c. No snow contains water.
  - d. Snow is just another form of water.
  - e. None of the above.

8. All voters are female.  
Some females are under 21 years of age.
- a. Some voters are under 21 years of age.
  - b. All voters are over 21 years of age.
  - c. Some voters are male.
  - d. All voters are not female.
  - e. None of the above.

9. All animals are humans.  
Some humans are bald-headed.
- a. All animals are bald-headed.
  - b. No animals are bald-headed.
  - c. Some animals are bald-headed.
  - d. All animals are not humans.
  - e. None of the above.

MICHIGAN STATE UNIVERSITY

NAME \_\_\_\_\_ DATE \_\_\_\_\_ STUDENT NO. \_\_\_\_\_ SEX M F

COURSE NAME \_\_\_\_\_ COURSE NO. \_\_\_\_\_

SECTION \_\_\_\_\_ INSTRUCTOR \_\_\_\_\_

NAME OF TEST \_\_\_\_\_ FORM \_\_\_\_\_

BE SURE YOUR MARKS ARE HEAVY AND BLACK  
ERASE COMPLETELY ANY ANSWER CHANGED

STUDENT NUMBER										
0	1	2	3	4	5	6	7	8	9	
0	1	2	3	4	5	6	7	8	9	
0	1	2	3	4	5	6	7	8	9	
0	1	2	3	4	5	6	7	8	9	
0	1	2	3	4	5	6	7	8	9	

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100	101	102	103	104	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120	121	122	123	124	125	126	127	128	129	130	131	132	133	134	135	136	137	138	139	140	141	142	143	144	145	146	147	148	149	150	151	152	153	154	155	156	157	158	159	160	161	162	163	164	165	166	167	168	169	170	171	172
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## APPENDIX C

TABLE OF ITEM NUMBERS FROM EXPERIMENT I FOR MATCHED  
ITEMS AND ITEMS USED IN EXP. II

Item Number	Used in Exp. I Matched Analysis	Used in Exp. II
1	X	X
2	X	X
4	X	X
5	X	X
6	X	X
7	X	X
8	X	X
9	X	X
10	X	
11	X	
12	X	X
15	X	
22	X	X
25	X	
27	X	

## APPENDIX D

	Encoding ( $T_1$ )	Choice ( $T_2$ )	Response
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			
11			
12			
13			
14			
15			

True      False

	Encoding ( $T_1$ )	Choice ( $T_2$ )	Response
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			
11			
12			
13			
14			
15			

True      False