

A DESCRIPTION AND CLASSIFICATION OF SOME
FORMS OF REASON USED BY COLLEGE STUDENTS

By

Daniel Kenneth Stewart

A THESIS

Submitted to the School for Advanced Graduate Studies
of Michigan State University of Agriculture and
Applied Science in partial fulfillment of the
requirements for the degree of

DOCTOR OF PHILOSOPHY FOR COLLEGE TEACHERS

Division of Biological Sciences

1959

ProQuest Number: 10008561

All rights reserved

INFORMATION TO ALL USERS

The quality of this reproduction is dependent upon the quality of the copy submitted.

In the unlikely event that the author did not send a complete manuscript and there are missing pages, these will be noted. Also, if material had to be removed, a note will indicate the deletion.



ProQuest 10008561

Published by ProQuest LLC (2016). Copyright of the Dissertation is held by the Author.

All rights reserved.

This work is protected against unauthorized copying under Title 17, United States Code
Microform Edition © ProQuest LLC.

ProQuest LLC.
789 East Eisenhower Parkway
P.O. Box 1346
Ann Arbor, MI 48106 - 1346

ABSTRACT

Historically, the psyche has been delineated into the three main factors of intellect, emotion, and will. The intellect, in turn, has been subdivided into reason, conception, and judgment. The scope of this thesis concerns itself with that part of the psyche having to do with reason, and, in particular, the manner in which reason may be involved in the communication of ideas.

Language is the chief vehicle for the communication of ideas. It is not the only vehicle, but of all the ways ideas may be communicated, language offers one way which lends itself to empirical analysis.

In ordinary as well as scientific language ideas are combined in various propositional forms or structures, and inferences are made which are determined to be valid or invalid in terms of the laws of logic. But the laws of logic, although they are assumed to be prevalent in all domains of discourse, do not ordinarily receive the attention or examination that the propositions which are instances of them receive. It was the task of this thesis to obtain data on the presence of these laws of logic in groups of college students.

Taking a given number of logical laws, namely, Modus Ponens, Modus Tollens, and Syllogism, we sought to determine how many of these were actually present among Freshmen college students, and, if present, whether some were more prevalent than others. By the preparation of a test instrument such that the linguistic forms involved were reducible to the laws of logic described, evidence was thereby obtained for the

existence of these laws within the populations tested.

The work of this thesis provides two major contributions for research of this type. One is the development of a test instrument for logical reasoning that shows good reliability values, and the second is the production of significant data bearing directly on particular laws of logic, or validity patterns, involved in logical reasoning. Thus, both of these factors are mutually implicative. In order to obtain evidence that the validity patterns were existent in the population, an instrument was devised that would measure these patterns with reliability.

The data of the research were obtained in five separate studies. The first four studies represent steps toward the final development of a test instrument that produced evidence considered to be reliable, and the fifth study was included especially to determine if the test instrument had any predictive value. Three such predictions were made, and by their inclusion external checks were thereby provided for the test instrument.

By indicating the existence of logical laws within the population, some basic research is provided for confirming the hypothesis that the communication of ideas from one mind to another is a function of various validity patterns existent in those minds.

ACKNOWLEDGEMENTS

The writer wishes to express his indebtedness to Professor Chester A. Lawson, Chairman of his Guidance Committee, for interest and advice in the planning and completion of this study. Special assistance and counsel given by Professors William B. Drew, Duane L. Gibson, Donald K. Marshall, and Henrik J. Stafseth is appreciated.

The following members of the Department of Natural Science of Michigan State University also rendered valuable assistance to the writer: Dr. John N. Moore and Dr. Mary Alice Burmester.

TABLE OF CONTENTS

CHAPTER	PAGE
I. INTRODUCTION.....	1
II. HISTORY OF THE PROBLEM.....	4
III. MATERIALS AND METHODS.....	47
IV. DATA AND CONCLUSIONS.....	55
V. THEORY.....	103
A Statement of the BET Theory.....	105
BET Theory and Validity Patterns.....	117
VI. DIRECTION OF FUTURE RESEARCH.....	123
BIBLIOGRAPHY.....	132
APPENDIX.....	135

CHAPTER I

CHAPTER I

INTRODUCTION

Because of the unique nature of this thesis problem, spreading as it does across several fields of endeavor, some preliminary remarks would seem to be desirable. In the first place, the scope of pure subject matter includes the fields of my academic preparation for the Ph.D.; namely, Botany, Microbiology, and Zoology. However, it gains its uniqueness through the application of these subject matters within the framework of logic and philosophy which were the fields of study for my Master's degree.

It is recognized that in many minds science and philosophy are viewed as being worlds apart, and the more complete this dichotomy the better it is for scientists and philosophers alike. However, for my part, nothing could be further from what "ought to be" than this admittedly common opinion. It is my position that the really great scientists of history have also been great philosophers, and that the converse is equally true.

The metaphysical frame-of-reference of the research may best be understood as falling within the philosophic position of Immanuel Kant. His statement, "Gedanken ohne Inhalt sind leer, Anschauungen ohne Begriffe sind blind", best describes my point of view among recent philosophers regarding the nature of reality.¹

¹ Immanuel Kant, Kritik der reinen Vernunft, (Berlin: Mayer and Muller, 1889), section entitled "Idee einer transzendentalen Logik", quotation on p. 100.

This implies that all of reality cannot be reduced to physical phenomena alone any more than it may be reduced to psychical phenomena alone. Moreover, "if we begin by defining life as nothing but physico-chemical interactions, we deliberately block every avenue that might lead to an adequate and comprehensive interpretation of the living 'whole'."²

Thus, the more philosophic aspects of this research may be expressed as an attempt to arrive at a more adequate understanding of the nature of man's mind as it is related to his overt physical behavior.

One of the fundamental tasks in understanding how the mind operates would be to supply factual information regarding the identity of ideas and their organized patterns. However, before we can identify a given idea as belonging to a given subject matter some sort of classification system would seem to be necessary.

Admittedly, any system would be arbitrary that classifies ideas into subject matter groups, and, in fact, there are more than one such system available.³ But the sole point here is to adopt one of them simply to proceed in this investigation in an orderly manner.

The classification system we have chosen is one constructed by Paul Schrecker. Mr. Schrecker has classified all the various kinds of ideas people may have into six general categories. These are (1) ideas concerning the State, (2) ideas about Science, (3) ideas about Language, (4) about Religion, (5) about Aesthetics, and (6) about Economy.

The particular thought patterns sought after in this research fall within the province of Language. This province can be further subdivided

² W. H. Werkmeister, *Philosophy of Science*. (New York: Harper and Brothers, 1940), p. 358.

³ Paul Schrecker, Work and History. (Princeton, New Jersey: Princeton University Press, 1948).

into three general categories: grammar, rhetoric, and logic.⁴ All of these categories have some communicative function, in that the primary function of language itself is for this purpose. And, since it is the last category, dealing with the logical (or rational) use of language that we are interested in, the problem of this research is stated as follows: what are the basic patterns of thought of a given population (Natural Science Students) regarding the use of reason in communication? The hypothesis is that these patterns are expressions of valid forms of inference. Thus, it is with validity patterns, or valid forms of inference, that we are primarily concerned. The task is to identify some of these within the populations examined.

Moreover, in terms of the thesis problem, we recognize that Schrecker's classification system only serves to point out that particular area - of several possible areas - with which this work will deal.

Also, the point is made that the use of language applies to all the other ideational categories as well, in that language is their principal means of explication. In this sense, Language would be a more fundamental category than any of the others. Not only can one have ideas of Language per se, but the fact is that these same ideas are put into practice when explicating the ideas within the other categories.

Thus, the validity patterns that I am searching for in this thesis, although formally a part of the province of Language, are considered to be more fundamental than just applying to this province alone. They would exhibit themselves in the other provinces as well.

⁴ Mortimer J. Adler, editor in chief, The Great Ideas, A Syntopicon of Great Books of the Western World. (Chicago: Encyclopedia Britannica, Inc., 1952), p. 941.

CHAPTER II

HISTORY OF THE PROBLEM

Historically, the psyche has often been delineated into three main factors, namely, the faculty of reason (Intellect), Emotions, and Will. The scope of this thesis deals with that part of the psyche having to do with the faculty of reason, and, in particular, the use of this faculty as applied in the communication of ideas.

Language is the chief vehicle for the communication of ideas. It is not the only vehicle as, for example, sometimes a mere glance between two humans apparently serves to transmit an idea. But the point is that language offers empirically discernible data whereby an analysis of communication may be made. In effect, we are searching for evidence which may shed some light on how communication takes place when it is perpetrated through rational means. Language is the tool employed in this search.

Also, language per se is here recognized as not consisting merely of grammar, that is, merely the correct grammatical construction of sentences.⁵ Rather, in its broad sense, Language may be divided into what is analogous to "social", "emotional", and "rational" uses.

Presumably, this "social" aspect would be an implicit agreement of the majority of English speaking people in regard to accepting some valid system of grammar. This agreement is necessary in the sense that we all must agree, more or less, or otherwise communication will simply

⁵ C. C. J. Fries, The Structure of English. (New York: Harcourt, Brace and Company, 1952), p. 3.

break down in those cases where we choose to employ language as a means of communication. Thus, this "social" aspect of Language pertains to its grammatical structure.

"Emotion" corresponds to the rhetorical use of language. In political utterances, for example, the appeal is made on an emotional level such as glittering generalities, testimonials, band wagon, etc. We note that this sort of "emotion" is of a different type than, say, the emotion one might display when raising his voice in some kind of discourse.

The "rational" use of language corresponds to that which is logical. This usage of language is that type which we think of when we say such and such a person "sounds reasonable." We generally mean by this that the person is being logical.

These three sub-categories of social (grammar), emotion (rhetoric), and rational (logic) were selected as representing the various aspects of language because they summarize nicely the judgments of many other workers who have studied the problems of language as being a function of communication.⁶ In no case, however, should they be considered as all

⁶ Max Black, Critical Thinking. (New York: Prentice-Hall, Inc., 1947), Chapter 9, "The Uses of Language".
 Brand Blanshard, The Nature of Thought. (London: The Empire Press, 1948), Volume II, Chapter 28.
 Ernst Cassirer, The Philosophy of Symbolic Forms: Language. (New Haven: Yale University Press, 1953), Volume I, p. 128.
 Sydney H. Mellone, An Introductory Text-book of Logic. (London: William Blackwood and Sons, Ltd., 1950), 19th edition, p. 7.
 W. H. Werkmeister, Critical Thinking. (Lincoln, Neb.: Johnsen Publishing Company, 1949), pp. 4, 143-145.
 W. H. Werkmeister, The Basis and Structure of Knowledge. (New York: Harper and Brothers Publishers, 1948), pp. 19-22.

inclusive. Herbert Feigl, for example, in his paper "Logical Empiricism" lists six functions of language, viz.,

- | | |
|------------------------|--|
| 1. purely formal | 4. pictorial (imaginative) |
| 2. logico-arithmetical | 5. emotional (effective) |
| 3. factual (empirical) | 6. volitional-motivational (directive) |

The first three, Feigl says, have an informational function, and the last three an emotive-expression and appeal function.⁷ However, since "information" cannot be equated with "communication", in that "information" pre-supposes "communication", to this list must be added the function of language for the communication of ideas. Presumably, Feigl's 'purely formal' and 'logico-arithmetical' categories would include the use of language for reasoning.

Thus, in reviewing the history of this problem we recognize three integrating factors, namely, language, communication, and valid forms of inference. The thesis problem is based upon an hypothesis regarding the nature of the relationship of these three factors, to wit, that the linguistic communication of ideas is contingent upon various valid forms of inference which, per se, are actually the very vehicles of transmission of the ideas. But, of the three factors, it is only evidence for valid forms of inference which is being sought after. Are they significantly prevalent within the population? (If at all?) And if so, which ones are they?

Also, in stating the background of the problem, communication is understood as being the successful transmission of discrete ideas from

⁷ Herbert Feigl, Readings in Philosophical Analysis, article on "Logical Empiricism". (New York: Appleton-Century-Crofts, Inc., 1949).

one mind to another, as we recognize, for example, as being the proper function of any teaching situation. Moreover, these ideas or their organized patterns are explicated in the physical world by language. Thus, "when we use language we do so in order to express our thoughts."⁸ And, there are certainly other ways that ideas are expressed in the physical world, but the point is that among all the ways, language is included.

It follows from this that analysis of the language actually used by people should yield evidence of these organized patterns which the discrete ideas partake of in the mind. In particular, this means that when language is employed in the function of either communication or reasoning, it is expected that an analysis of such language will provide evidence of those particular patterns employed for these purposes. It is the specific intent of this thesis to fulfill this task.

Previous work in this field which offers empirical data on the existence of validity patterns is not in abundance. For example, a logical place where one might expect to find such evidence would be in logic texts. But I have yet to see my first logic text which offers quantitative evidence for the validity patterns explicated therein. This point might be overlooked if it were not for the fact that most of the modern logicians are "positivists" or "analysts" who are disposed to think of themselves as scientific philosophers.⁹ And some even write

⁸ Schrecker, op. cit., p. 89.

⁹ Mortimer Adler, Bulletin of the Atomic Scientists, article on "The Questions Science Cannot Answer." Vol. XII, No. 9, November, 1956.

books on this subject.¹⁰

Strange as it may seem, most of the empirical evidence which is related to the existence of validity patterns has come from persons not trained as logicians. The literature cited includes C. C. J. Fries who is a grammarian, C. A. Lawson who was trained as a biologist, W. J. and A. B. Morgan who are psychologists, and L. C. Repucci who is a psychologist. The research of several other psychologists is also included.

Fries' method was to collect actual language usages on a tape recorder and subsequently to analyze these data.¹¹ His evidence includes fifty hours of diverse conversations by some three hundred different speakers. He states that his work is directed to those who are "interested in learning something about how the English language accomplishes its communicative function - about the mechanism of its utterances."¹² Thus, as is the case in this thesis, Fries' primary interest is in offering evidence which he hopes will throw some light on how communication takes place.

All discourse is analyzed into what he calls "utterance units". These are stretches of speech that are bounded by a change of speaker. These utterance units are classified by him as follows:

¹⁰ Hans Reichenbach, The Rise of Scientific Philosophy. (Berkeley and Los Angeles: University of California Press, 1951).
Phillip Frank, Modern Science and its Philosophy. (Cambridge: Harvard University Press, 1949).

¹¹ Fries, op. cit.

¹² Ibid., p. 7.

A. Communicative Utterances
(predictable response)

Type I. Statements (propositions). Response: attention.

Type II. (a) Questions)
(b) Calls) Response: oral answers.
(c) Greetings)

Type III. Requests (and Commands). Response: action.

B. Non-communicative Utterances
(response not predictable)

For Fries, the total linguistic meaning of any utterance consists of (a) the dictionary meanings of its constituents, and (b) the "structural meanings". The structural meanings are all the logically possible interpretations which can be made upon any concatenation of signs (for example, words). Structural meanings are denoted by structural forms. Fries classifies these forms into classes and subclasses. For example, Class I words are universals, Class II words are inclusion terms and quantifiers.

Thus, Fries' analysis is virtually a logical analysis of speech. He is aiming at, by his structural forms, a clear-cut method to explicate the employment of universals in speech - those common forms by means of which language accomplishes its communication function. He states, "one of the basic assumptions of our approach here to the grammatical analysis of sentences is that all the structural signals in English are strictly formal matters that can be described in physical terms of forms,

correlations of these forms, and arrangements of order.¹³ (Underlining mine).

In terms of validity patterns, Fries uses the expression "function words". "...In order to respond to certain structural signals, one must know these words as itemssignalling particular structural meanings."¹⁴ Whereas Fries describes these 'items' in terms of particular words, he is, in effect, in the language of symbolic logic, describing what is known as logical constants, or, as we state above, universals. I cannot refrain from speculating on what Fries could have done if he only knew something of the language system of formal logic.

Specific examples from Fries, showing their correspondence to formal logic (hence, validity patterns) are given as follows:

"The boys and the leaders were invited"

(logic pattern) _____ . _____

"The boys of the leaders were invited"

(there are two function words here, viz., "of" and "were")

(logic pattern) _____ $\supset$ _____

(this particular form would be " $(x) \cdot Lx \supset Ix$ ")

The relationship to validity patterns is very striking. These forms above, when appearing in speech, would constitute validity patterns. Fries is intending to do more work on "function words" in that he states "a

¹³ Ibid., p. 58.

¹⁴ Ibid., pp. 106-108.

systematic treatment of function words is reserved for a later publication."¹⁵

Dr. Lawson's method of gathering data was similar to Dr. Fries' in that both involved an analysis of language.¹⁶ Lawson's operations stem from his BET Theory which I present formally in Chapter V of this thesis. At this point, however, I wish to state briefly its central idea and discuss the data he has obtained relevant to validity patterns.

The central idea of the BET Theory is that the mind considers ideas in a sequential order in time. The sequence is expressed by the formula S- M- T, where each of the symbols represent ideas of a certain type. The pattern is that a given idea S will cause the elicitation of an idea M which in turn is followed by a third idea T. All of these ideas may be discrete, complex, or mixtures.

In obtaining data for his SMT pattern, Dr. Lawson went to several diverse sources. He studies its exhibition in (a) the Genetic Theory, (b) a religious system, (c) the Declaration of Independence, and (d) the raw data from a group discussion. I will give portions of the data from each of these areas.

A Scientific Theory

The portion I have selected is the analysis of T. H. Morgan's work on sex inheritance.¹⁷

One investigator, T. H. Morgan, was studying inheritance in the fruit fly, Drosophila, in 1910 when he found a

¹⁵ Ibid., p. 92, f.n.

¹⁶ Chester A. Lawson, Language, Thought, and The Human Mind. (East Lansing: Michigan State University Press, 1958).

¹⁷ Ibid., p. 45ff.

single individual with white eyes in a culture of red-eyed flies. This variant, or mutant, fly was a male and was crossed with a normal red-eyed female. The offspring of this cross were all red-eyed, thus indicating the dominance of the red eye color over the white. Crosses made between the hybrid individuals produced both red- and white-eyed flies in the proportion of $\frac{3}{4}$ red to $\frac{1}{4}$ white, as was expected on the basis of Mendelian theory. However, there was one unexpected difference. Normally both dominant and recessive forms are both male and female in approximately equal proportions, but in this case all the white-eyed flies were males. No white-eyed females at all appeared in this generation, no matter how many individuals were raised.

Morgan expected on the basis of deductions that the sex ratio would be 1 to 1 for all characters represented in the offspring (T^C). The actual observation of the offspring (TP) differed in that no white-eyed females were present (d).....
..... In terms of the SMT formula, Morgan had operated as follows:

$$S \rightarrow M \rightarrow T$$

$$S^C \rightarrow MC \rightarrow T^C$$

$$SP \rightarrow MP \rightarrow TP$$

$$\overline{TCTP} \cdot (T^C \neq TP) \rightarrow \sim (S^C \rightarrow MC \rightarrow T^C) \cdot \sim (S \rightarrow M \rightarrow T) \cdot d$$

where $S \rightarrow M \rightarrow T$ = the empirical generalization that crosses between monohybrids will produce offspring of which $\frac{3}{4}$ are dominant, $\frac{1}{4}$ recessive, and with sex equally distributed among both recessive and dominant forms

$S^C \rightarrow MC \rightarrow T^C$ = the specification of dominant by red-eyed flies, of recessive by white-eyed flies, their mating, and the expected consequence of $\frac{3}{4}$ red-eyed flies, $\frac{1}{4}$ white-eyed flies and with males and females in a 1 to 1 ratio of both eye color types

$SP \rightarrow MP \rightarrow TP$ = the actual selection of individual red- and white-eyed flies, their mating, and the observation of their offspring in which there was a 3 to 1 sex distribution among the red-eyed and white-eyed flies

$\overline{T^C TP} = T^C$ is compared with TP

$(T^C \neq TP) = T^C$ is not equal to TP

$\sim (S \rightarrow M \rightarrow T) =$ the negation of $(S \rightarrow M \rightarrow T)$

d = the recognition of the quality or quantity
by which TP differs from T^C , in this case
the absence of females among the white-eyed
flies

Morgan's recognition that T^C did not equal TP had the initial effect of negating the empirical generalization that all crosses between monohybrids will produce offspring with sex equally distributed in each type. This negation was not a denial of its truth in other instances, but a restriction of its application. Here was a case where it did not apply.

The validity pattern involved in Morgan's thinking can be shown by interpreting Dr. Lawson's SMT formulations in the following way:

$S^C \rightarrow MC \rightarrow T^C$

corresponds to

$SP \rightarrow [MP \rightarrow TP]$

where $[MP \rightarrow TP]$ are predicted future states. That is, the comparisons $\overline{MPMC}$ and $\overline{TPTC}$ are expected to be positive.

The ideas existent in Morgan's mind at time t_1 were

$S^C \rightarrow MC \rightarrow T^C,$

$SP,$ and

$S \rightarrow M \rightarrow T.$

$S \rightarrow M \rightarrow T$ is the empirical generalization of Morgan's which he modifies due to the negation of $S^C \rightarrow MC \rightarrow T^C$ which is a specification of the generalization.

Thus, at time $t_2,$

$$\left\{ \underbrace{[(S^c \rightarrow M^c \rightarrow T^c) \cdot SP]}_P \rightarrow \underbrace{[\overline{M^cMP} \rightarrow \overline{T^cTP}]}_Q \right\} \cdot (T^c \neq TP) \text{ implies } \sim (S^c \rightarrow M^c \rightarrow T^c)$$

$$P \quad \supset \quad Q \quad \cdot \quad \sim Q \quad : \quad \supset \quad : \quad \sim P$$

In symbolic logic this validity pattern is called Modus Tollens.

A Religious System

To show the SMT pattern in a religious system, Dr. Lawson selected Roland H. Bainton's biography of Martin Luther, Here I stand -- A Life of Martin Luther. A portion of the analysis is given here.¹⁸

The story of Luther as told by Bainton is one of a sinful man in fear of God's judgment trying one prescribed method after another to ensure his entry into heaven. The explanation of Luther's behavior in terms of the SMT formula is given below, beginning with Luther's "unexpected encounter with death on that sultry July day in 1505.... when sudden lightning struck him to earth. In that single flash he saw the denouement of the drama of existence. There was God the all-terrible, Christ the inexorable, and all the leering fiends springing from their lurking places in pond and wood that with sardonic cachinnations they might seize his shock of curly hair and bolt him into hell. It was no wonder that he cried out to his father's saint, patroness of miners, 'St. Anne help me! I will become a monk!' "

In order to explain Luther's behavior in terms of the SMT hypothesis, it is necessary to assume that Luther had in mind the two basic postulates of the Catholic system, that sinners would be judged by God and sent to hell and that those without sin would achieve heaven, and in addition at least two of the subsystems by means of which a sinner could escape hell. Granting the above and also that the stroke of lightning caused Luther to recognize himself as a sinner, the pattern of his mental behavior up to his exclamation "St. Anne help me! I will become a monk!" can be explained as follows:

¹⁸ Ibid., pp. 66-67.

$$S_L^P \rightarrow (S_I \rightarrow M_I \rightarrow T_I)$$

$$S_{IL}^C \rightarrow M_I^C \rightarrow T_I^C$$

where S_L^P = Luther's recognition of himself as a sinner

S_I = sinner + God

M_I = God's judgment

T_I = sinner in hell

S_{IL}^C = Luther's specification of S including himself as sinner, and God as the other unit in the static relation

M_I^C = Luther's specification of God's behavior

T_I^C = Luther in hell

In terms of validity patterns, the SMT analysis above would be as follows. It is noted that the actual deduction by Luther to T_I^C , including himself within this subclass, was made upon the abstraction $S_I \rightarrow M_I \rightarrow T_I$. In terms of operational logic all that was needed for Luther to reach T_I^C was his own specification within $S_I \rightarrow M_I \rightarrow T_I$. Thus, the validity pattern exhibited by Luther is

general class sequence	specification by Luther	Luther's deduction of himself in hell
$\underbrace{[(S_I \rightarrow M_I \rightarrow T_I)]}_P \supset Q$	$\cdot \underbrace{(S_I \rightarrow M_I)_L^C}_P : \supset : Q$	T_{IL}^C

In logic this pattern is called Modus Ponens.

The Declaration of Independence

An example of the SMT analysis of this system is given as follows.¹⁹

¹⁹ Ibid., pp. 93-94.

A third subsystem was the government represented by the Articles of Confederation.

The relation of the subsystems to the goal-directed supersystem is indicated in the following quotation:

...to secure these rights, Governments are instituted among Men.....That whenever any Form of Government becomes destructive of these ends, it is the Right of the People to alter or to abolish it, and to institute new Government, laying its foundation on such principles and organizing its powers in such form, as to them shall seem most likely to effect their Safety and Happiness.

This quotation can be equated with the SMT formula of the supersystem as follows

$$S \rightarrow M \rightarrow T$$

where S = "...that whenever any Form of Government becomes destructive of these ends..."

M = "...it is the Right of the People to alter or to abolish it, and to institute new Government, laying its foundation on such principles and organizing its powers in such form, as to them..."

T = "...shall seem most likely to effect their Safety and Happiness."

In terms of the operations of the SMT formula, S of the supersystem is interpreted to refer to any situation where the expected consequences (t) of the ideal form of government ($s \rightarrow m \rightarrow t$) is contradicted by the actual consequences (tP) of the government in operation ($sP \rightarrow mP \rightarrow tP$) so that $t \neq tP$.

Whenever such a situation occurs, M of the supersystem directs the people to negate the subsystem in operation, i.e., "...to alter or to abolish it," "...and to institute new Government..."

The validity pattern involved in denying the ideal form of government ($s \rightarrow m \rightarrow t$) is similar to that pattern shown in the SMT analysis of a scientific theory, namely, Modus Tollens, viz.,

$$\underbrace{[(s \rightarrow m \rightarrow t) \rightarrow (t = t^p)]}_P \quad \cdot \quad \underbrace{(t \neq t^p)}_Q \rightarrow \underbrace{\sim(s \rightarrow m \rightarrow t)}_{\sim P}$$

$$P \quad \supset \quad Q \quad \cdot \quad \sim Q \quad : \supset : \quad \sim P$$

A Group Discussion

The group discussion involved the staff of a university department. The discourse was over the content and organization of a proposed course in natural science. It was recorded on tape. Dr. Lawson describes the situation as follows:

In this group discussion where the object of the discussion was to reach agreement concerning the course outline, the ideas proposed by various members of the group were judged in terms of the particular concepts each individual had concerning the properties that a course outline should have. These properties were determined in part by the goal-thoughts of the major system (T_g^C), i.e., by the expected consequences of the teaching-learning situation. Thus, the goal-thoughts (T_g^C) of the major system ($S \rightarrow M \rightarrow T$) served as a guide for the selection of concepts to be used in constructing or selecting the course outline. If the proposed concepts implied a particular goal-thought held by one individual, that individual would agree to the inclusion of the concept. On the other hand, if a proposed concept did not imply a particular goal-thought then the suggested concept was not agreed to.²⁰

A specific example is indicated by the following portion of the tape.²¹

2. B--I think that's the best way to do it. Put down the general theory of relativity, special theory of relativity, quantum theory, Maxwell's theory. Let's see, there are two quantum theories, but they are so far out we can't use them anyhow; Maxwell's theories, and the atomic molecular theory, kinetic theory. I think those are the major ones, aren't they? Now we could add a whole lot of subsidiary ones that fall under

²⁰ Ibid., p. 106.

²¹ Ibid., pp. 108-110.

those; the laws of optics, the laws of mechanics, the laws of conservation, periodic law, the proportion laws in chemistry. Of course, there's the laws of electricity, too.

A responded to B's suggested list of concepts as follows:

3. A--I wonder if there aren't some basic concepts that would reduce most of these or not reduce them but at least into which many of these could be classified?...if we did that it might not be necessary to cover all of these because actually we can't possibly cover all of these in a term. But on the basis of attempting to select something which would demonstrate this basic concept we could pick particular areas. That's the only function of this. Isn't there one basic concept that ties in kinetic theory, atomic molecular theory, quantum theory in a sense and mechanics and these in the concept of the particle and the laws governing the relationship of the particles to each other? Then is there not also a wave concept, which is related to the particle into which we could put, for instance, some of optics, some of mechanics, and so on? And then finally isn't there a field concept? Now is there anything else that belongs in this category? Are there any other concepts which are as basic as these?

A's utterance, 3, can be explained in terms of the BET theory if we assume that A had previously selected his own group of concepts and that he compared his selection with B's after B had vocalized his preference. We must assume also that A's and B's concepts differed and that A rejected B's choice because of the difference. However, because A was not free to reject B's choice without the consent of the group he was required to defend his decision. He did this by pointing out that B's selection, if used in the major $S \rightarrow M \rightarrow T$ system, would lead to a contradiction with the time limits of the system ("....we can't possibly cover all of these in a term").

In terms of validity patterns, A's response to B's remarks made use of the Modus Tollens law. This validity pattern was utilized by A with reference to the major $S \rightarrow M \rightarrow T$ system of which the entire discussion was predicated, namely, that whatever outline was proposed it could be

accomplished within the time-limits of the course. B offered six theories, five different groups of laws, and the periodic law. If B was operating within the SMT system, he presumably thought that all of these could be accomplished within a term. Thus, A's response was actually a denial of this, viz., "...we can't possibly cover all of these in a term."

The validity pattern is stated as follows:

$$[(P \supset Q) \cdot \sim Q] \supset \sim P$$

where P = all the concepts offered by B

Q = the presumption by B that these could be taught in one term

$\sim Q$ = the denial of Q by A

$\sim P$ = the negation of some of B's suggestions.

Other research which has a bearing on validity patterns includes the work of W. J. and A. B. Morgan. Both of these investigators are psychologists. Their work includes tests for logical reasoning as related to (a) training in logic, (b) sex, (c) age, and (d) higher education.²²

The Morgan test consists of seventy-five true-false items in verbal form. There are three more invalid forms than valid forms. Fifty of the items are syllogistic, seventeen are hypothetical or hypothetical disjunctive, seven are conversions, and one is comparative. The scoring formula is right minus wrong, to make allowances for guessing. Three examples from their test are given as follows:

²² W. J. Morgan and A. B. Morgan, "Logical Reasoning: With and Without Training," Journal of Applied Psychology, Volume 37, Number 5, October, 1953.

A. B. Morgan, "Sex Differences in Adults On A Test of Logical Reasoning," Psychological Reports, Number 2, 1956, pp. 227-230.

A. B. Morgan, "Differences In Logical Reasoning Associated With Age and Higher Education," Psychological Reports, Number 2, 1956, pp. 235-240.

- (1) Most executives are college graduates. The majority of executives are Republicans. Therefore, most college graduates are Republicans.

(The testee responds to this by encircling "L" or "NL", for "logical" or "non-logical", respectively)

The form here is

$$(x) \cdot E_x \supset G_x$$

$$(x) \cdot E_x \supset R_x$$

$$(x) \cdot G_x \supset R_x$$

- (2) Many women are high-strung and emotional. A high-strung and emotional temperament is frequently a barrier to clear and logical reasoning. Therefore, many women are unable to reason logically.

The form here is

$$(x) : H_x \cdot E_x \supset \sim C_x \cdot \sim L_x$$

$$(\exists x) : W_x \cdot H_x \cdot E_x$$

$$(\exists x) : W_x \cdot \sim C_x \cdot \sim L_x$$

$$(\exists x) : W_x \cdot \sim L_x \cdot \sim C_x$$

$$(\exists x) : W_x \cdot \sim L_x : (\exists x) \cdot \sim C_x$$

$$(\exists x) : W_x \cdot \sim L_x$$

- (3) Many misguided but sincere idealists are Communists. A sincere idealist, whatever misguided acts he may commit, is never a traitor. Therefore, not all Communists are traitors.

The form here is

$$(\exists x) : M_x \cdot I_x \cdot C_x$$

$$(x) \cdot I_x \supset \sim T_x$$

$$(x) \cdot C_x \supset \sim T_x$$

The first and third examples are not valid. The second is valid provided one permits enthymemic argument; if not, then not.

The results Morgan and Morgan obtained by using this test are stated as follows:

- (a) college graduates with training in logic obtained higher scores than college graduates without training in logic.
- (b) subjects without training in logic did 73% as well, as a group, as those with training.
- (c) sex showed no significant difference in ability to think logically.
- (d) there is a possibility that male college graduates with BA and BS degrees, age 30 to 39, who apply for government employment, are, on the whole, less competent in terms of logical reasoning than younger applicants of equivalent education, whereas male applicants with the master's degree, age 30 to 39, are, generally speaking, about as competent as those with the master's degree age 20 to 29.

In their paper "Logical Reasoning: With and Without Training," Morgan and Morgan state several times that psychologists have not done many experiments on logical reasoning. This is significant in that it is being said by psychologists. For example, they state "whatever may be the reasons for the paucity of experimental studies of logical reasoning, it seems to be a fact that mathematicians rather than psychologists are concerning themselves with logic." And, again, in the same paper, "In view of the absence of too much experimentation on logic by psychologists, it is not surprising to find cropping up some rather far-fetched

notions about the nature of logical reasoning."

In response to these remarks, I believe they are correct in saying that psychologists have not concerned themselves in our age with applied logic. That mathematicians are so concerned, I think is false. The only present day philosophers I know who can also be considered mathematicians are A. N. Whitehead and Bertrand Russell, authors of the Principia Mathematica, and, of course, this work is the "bible" of modern logic.²³ But, whereas there are definitely other mathematicians working with logic, I think the majority of work is being done by the positivists. But these people are not concerned with the collection of data.

Morgan and Morgan's remark about the "far-fetched notions" held by psychologists about logic was in reference to a statement by G. A. Miller, viz., "The fact is that logic is a formal system, just as arithmetic is a formal system, and to expect untrained subjects to think logically is much the same as to expect preschool children to know the multiplication table."

I think this statement by Miller is interesting in the sense of being an opinion shared by many people in many other areas of study. It is well that Morgan's work, based on data, indicates this to be a false opinion.

In general, Morgan and Morgan's work is related to the type of research undertaken in this thesis. They are concerned with the prevalence of logical reasoning within various populations. The fact that

²³ Alfred North Whitehead and Bertrand Russell, Principia Mathematica. (Cambridge: Cambridge University Press, second edition, 1950).

there are all too few investigators in this field leaves me with nothing but praise for their efforts.

Unfortunately, however, it is the case that their test instrument suffers serious defects. One of the most serious difficulties is that it is not a test of logical reasoning at all but rather a comparison test. Stated in the instructions of their test they provide the testee with an example of logical reasoning, viz.,

"all cats have tails. Kitty is a cat. Therefore,
Kitty has a tail."

They tell the testee this is logical and that many of the problems are like this. Thus, the test is already invalidated. When you provide the testee an example of that which you regard as logical reasoning, your instrument merely becomes a test for the ability to make comparisons - not a test aimed at discerning the existence of validity patterns within the mind of the testee. I cannot agree that when the testee is told what a logical argument looks like that he thereby is able to reason logically when he marks all such items accordingly.

Second, there is no uniformity as to the validity patterns being tested. Thus, there was no control in any of the experiments. Ideally, only one variable is permitted in any empirical investigation. And, whereas we recognize this is not always possible, it is possible in tests on logical reasoning at least to control the form. They have, by their own admission, five different forms of which 50 are of one type, 17 of two types, 7 of a fourth, and one of a fifth.²⁴

Nowhere in their papers do they show

²⁴ A. B. Morgan, op. cit., "Differences in Logical Reasoning Associated With Age And Higher Education."

(a) a frequency distribution of each of the logical forms used in the test, nor (b) data concerning the reliability of these forms.

Third, there is no uniformity in the number of unit-thoughts per form. According to the data of this thesis, this may make a difference. Although my results were not significant in this respect at the 1% level, I expect to obtain such a difference in future tests where the number of unit-thoughts will be increased. In any case, I am reasonably certain that there would be a difference in response between Morgan's items "(2)" and "(3)" above - both items imply the predicative Syllogism. They have presented no data regarding this point relative to their test.

Fourth, there is no uniformity as to the exhibition of an item in propositional and predicative logic.

Fifth, some of the items involve enthymematic argument. How does this type of item compare with other items involving the same form? In such arguments, for example, as "(2)" above, how many other forms of the same type are involved in the test? Have these implicit forms been tested? Morgan and Morgan have published no data on these questions relative to their test instrument.

Whereas all of the above are serious mistakes of methodology, the most grievous error is the absence of data relative to the existence of specific validity patterns. Any test that purports to deal with logical thinking must produce evidence on such patterns. It makes no sense to be talking about logical reasoning while failing to produce evidence on that which makes the reasoning logical.

Another investigator whose work is remotely related to logical thinking is Dr. Lawrence C. Repucci, now at Wayne State University, Detroit, Michigan. Dr. Repucci is a psychologist. His article "Do You Think Straight" appeared in a Sunday newspaper.²⁵ Because this article was written for the general public, statistical data on his test instrument was not expected.

The test involved three series of questions. In the first series his method was to provide the testee with a group of items, one item of which did not belong to that group. The task was to eliminate the item which did not belong. A second series of questions involved the elimination - in order - of two items in a group. The third series involved the elimination of three items within the group. The example given below belongs to the first series of questions.

Set 1a

- () shoes
- () socks
- () trousers
- () gloves
- () hat

The correct answer here is "hat" because it is the only item intended to cover a single extremity.

The relationship of Repucci's test to logical thinking and validity

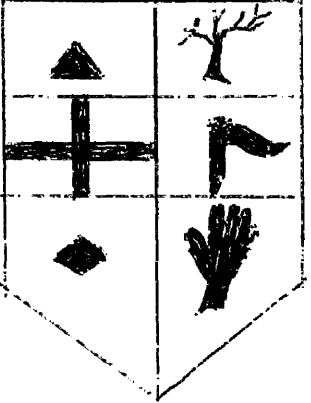
²⁵ L. C. Repucci, "Do You Think Straight", Detroit Free Press, Sunday Magazine, November 20, 1955, p. 2-B.

patterns is fairly remote. However, because he describes it in terms of "Can you think straight?", "clear thinker", "fuzzy thinker", etc., the implication is that it is a test of logical reasoning, and this is false.

It actually is a test in predication, that is, in classification only. And, psychologically speaking, this is a matter of judgment based upon prior experience of the phenomena on which the judgment is made. This is certainly one kind of thinking, but it is not thinking in a logical sense. Logical thinking involves inferences and none of these are sought for in this test.

In 1933, S. N. F. Chant published a paper "An Objective Experiment On Reasoning."²⁶ This study was not unlike most psychological test measuring intelligence in that it was based on a mixture of verbal-pictorial associations. A sample item is given as follows:

Card 1.

Arms of a family of Royal Descent	
Arms of an Earl	
A family of political prominence	
Arms of a Companion of the Bath	
The title was established one century ago	
The title has been discontinued	

²⁶ S. N. F. Chant, "An Objective Experiment On Reasoning," American Journal of Psychology, Volume 45, April, 1933, pp. 282-291.

There were 11 cards altogether. The testee was to determine which item of information belonged to which coat of arms.

Analysis by Chant was in terms of time, viz., (1) the time devoted to the overt comparison of cards with cards, or of cards with answers, (2) the time spent in examination of individual cards, (3) the time spent in recording answers. His conclusions showed "that there were two well-defined methods of reasoning exemplified....the first is an interpretative approach, by means of which answers are derived from previously established associations that are remote from the experimental setting itself. The second is analytical, by means of which answers are derived by comparing cards or cards and answers...."²⁷

The relationship of this test to validity patterns is quite remote. Its value lies in illustrating the general nature of the usual intelligence test. The function of reasoning, as used in this thesis, implies the exhibition of validity patterns. No data on these patterns were presented in Chant's study. As I understand the nature of the intellect, it has three basic functions: reasoning, conception, and judgment. Within this frame of reference it is evident that Chant's "two well-defined methods of reasoning" are not methods of reasoning at all.

Rather, the "interpretative approach" is comparable to the function of judgment in that the psychological fact here involves predication, and, thus, judgment in making the right predication. And the "analytical" type of reasoning would seem to be a matter of both empiricism and judgment, and, thus, not mutually exclusive from his first type

²⁷ Ibid., p. 290.

of reasoning. In any case, the term "analytical" as used by Chant is alien in meaning to logic, namely, validity patterns.

There are several studies on reasoning by N. R. F. Maier. I will point out the aspects of his work relevant to this thesis.

One phase of Maier's paper on "Reasoning and Learning" deals with an attempt to define "learning", "insight", and "reasoning" in experimental terms.²⁸ Of relevance to this thesis is his definition of "reasoning". He states "....behavior resulting from reasoning depends for its integration upon the goal or end..... In reasoning (as it is used in this paper) past experiences are reorganized. That the combination of the essentials of two isolated experiences makes it possible for an animal to reach a goal implies a reorganization in terms of the goal. This ability thus makes reorganization of any experience possible. If two isolated experiences can be organized in terms of the goal, it then follows that two contiguous experiences may be reorganized."²⁹

Thus, reasoning for Maier becomes a function of the reorganization of experiences in terms of reaching specific goals. Thus, it is possible to interpret Maier's work in terms of validity patterns provided the physically explicated reorganization exhibits such patterns. However, no data on this exist in Maier's paper.

In 1937, Maier published a paper on "Reasoning in Rats and Human

²⁸ N. R. F. Maier, "Reasoning And Learning," Psychological Review, July, 1931, Volume 38, pp. 332-346.

²⁹ Ibid., pp. 336-337.

Beings."³⁰ In this paper his purpose is "to formulate a theory of the reasoning process," and, accordingly, it is mostly discussion.

In general, it is a restatement of the paper above of 1931, namely, reasoning has to do with the reorganization of specific events relative to some other event. "By regarding reasoning as a new combination of past experiences, we designate a mechanism which differs from learning and yet utilizes what has been learned."³¹ Again, as with his first paper, if these reorganizations exhibit validity patterns, then there is relevancy of Maier's work to this thesis. As it is, no data exist in his paper on this point.

Maier has three other papers all of which are entitled "Reasoning In Humans" and which were published in 1930, 1931, and 1945, respectively.³² He provides data to show that experience and its proper selection are not enough to account for the appearance of an original solution to a problem. Instead, an organizing principle which he calls "direction" is necessary. This refers to the manner in which a person tries to solve a problem. Thus, "when one gets a new 'direction' in reasoning, a new set of equivalent stimuli are created; and it is for this reason that 'direction' in thinking serves a selective function in thinking."³³

³⁰ N. R. F. Maier, "Reasoning In Rats And Human Beings," Psychological Review, September, 1937, Volume 44, pp. 365-378.

³¹ Ibid., p. 375.

³² N. R. F. Maier, "Reasoning In Humans: I. On Direction," Journal of Comparative Psychology, Volume 10, April, 1930, pp. 115-143.
 N. R. F. Maier, "Reasoning In Humans: II. The Solution of a Problem," Journal of Comparative Psychology, Volume 12, August, 1931, pp. 181-194.
 N. R. F. Maier, "Reasoning In Humans: III. The Mechanisms of Equivalent Stimuli And of Reasoning," Journal of Experimental Psychology, Volume 35, October, 1945.

³³ Ibid., p. 359, (1945).

None of Maier's papers show data relevant to validity patterns. However, his definition of reasoning - as the ability to combine isolated experiences in such a manner as to overcome a difficulty - is not necessarily incompatible with validity patterns. If the recombinations (or reorganizations) show definite forms, these forms may be, in fact, validity patterns. In any case, however, Maier produced no evidence on this point.

In 1945, A. Burton and W. Joel published a paper entitled "Adult Norms For the Watson-Glaser Tests of Critical Thinking".³⁴ This study produced evidence to indicate that the norms for adults are higher than the Watson-Glaser Norms for college seniors. The chief interest of the study is in regards to the test instrument itself, namely, the Watson-Glaser Tests of Critical Thinking. The following is a quotation from the study illustrating the test:³⁵

The tests are arranged in two batteries of four tests each. Battery I to which our report is confined consists of the following four tests: (1) Generalizations; (2) Inferences; (3) Discrimination of Arguments; (4) Recognition of Assumptions.

The following excerpts from the directions may illustrate the nature of the tests, although the sample statements quoted are no indication of the level of difficulty of the tests themselves.

Test 1. Generalizations (20 5-choice items)

All Most Don't Know Few No - doctors are college graduates.

All means every one without exception.

³⁴ A. Burton and W. Joel, "Adult Norms For the Watson-Glaser Tests of Critical Thinking", Journal of Psychology, Volume 19, January, 1945, pp. 43-48.

³⁵ Ibid., p. 44.

Most means definitely more than half but not all, etc.

Test 2. Inferences (50 5-choice items)

Five thousand first-year high school students recently attended a weekend conference, etc.

The students were all between the ages of 10 and 11.

T P(robably)T I(nsufficient) Data PF F

You are to be concerned not with the truth of the statement of fact but only with the truth of the inference to be drawn from it, etc.

Test 3. Discrimination of Arguments (40 2-choice items)

Is it desirable for all young men to go to college?

No; some college men are conceited. Strong Weak

For the purposes of this test regard the argument as true; then decide whether you would call it strong or weak....

Test 4. Recognition of Assumptions (20 4-choice items)

An assumption is something supposed or taken for granted...

Each exercise consists of a main statement followed by four alternative statements about the assumptions involved in the main statement. Only one of these alternatives is true.

I want to be sure I don't get typhoid fever while I'm in South America, so I shall go to my physician and get typhoid injections before I sail.

1. It is assumed in the statement that most people who go to South America and do not take typhoid injections get typhoid fever, etc.

This test, as a measure of logical reasoning, suffers from the same fallacies as the Morgan Test of Logical Reasoning.³⁶ If an investigator is going to claim evidence that his test is an instrument which measures logical ability, then that evidence must be predicated upon inferential activity of the mind. When one speaks of inferences, he is

³⁶ Morgan, op. cit., pp. 20-24.

talking about validity patterns. Thus, any evidence on logical reasoning must be such as to bear directly on the nature of validity patterns. The Watson-Glaser test does not do this.

Other than this major difficulty, there are three additional ambiguities inherent in the test. Ambiguities lead to fallacies of equivocation.

First, their "Test 2" for inference, uses "inference" in a manner alien to the facts of formal logic. Historically, "inference" in their usage is called "immediate inference." And, while avoiding the argument involved with this notion, I wish to state that "inference" in their sense is not the same as the inferences of logical argument. Moreover, any investigator may define "inference" any way he wishes, but whatever he decides upon, its usage must be consistently employed within the test instrument. On the other hand, if this purports to be a test on logical reasoning, then it must use "inference" as it is employed in logic.

Second, "Test 3" purports to test for "Discrimination of Arguments." The fallacy here is in consequence of the fallacy of their "Test 2". Logical arguments involve at least two premises. There is only one in the example given. Thus, actually this would be an example of immediate inference. And, again, this is certainly all right, provided this is what is being measured. But, in any case, it must be unambiguously delineated as such, and employed consistently throughout the test instrument.

Third, "Test 4" comes the closest to testing for validity patterns. But no data are presented for these. The objection here is that there is no control for any given pattern in that the faculty of judgment

is involved in deciding among the four possibilities which is the right one. Thus, on the basis of chance alone, the testee has $\frac{3}{4}$ chance of getting the wrong answer. I point this out because I made the same mistake in one of my earlier tests.

Han-Piao Chen published a paper in 1937 entitled "Studies on Thurstone's Reasoning Tests."³⁷ He applied Thurstone's test to a group of Chinese subjects. Form A was administered to 162 subjects and Form B to 148 subjects.

Form A test consists of 20 syllogistic arguments which deal with heavy-light relations, relations among relatives, relation of debts among three persons, the relation of club membership between two clubs, and the birthday relationship among three persons.

Form B test consists of 32 syllogistic arguments, which deal with the tall-short relationship among three persons, whose actual relative height relationship varies from test item to test item. For example, in one item Brown may be taller than Jones and shorter than Smith, while in another these may be interchanged.

All the arguments in Form A and B are similar in form but no one of them is exactly the same in statement. Chen's results indicate (1) that the difficulty of an argument may vary with the content, data, or category of arguments, and (2) that the kind of relation involved in the argument influences the difficulty of the item, and (3) that the sequence of persons presented within an argument may influence the

³⁷ Han-Piao Chen, "Studies on Thurstone's Reasoning Tests," Journal of Genetic Psychology, Volume 50, 1937, pp. 15-25.

degree of difficulty.

In terms of the work of this thesis, Chen's study would seem to be related to the syllogism validity pattern. However, in regards to the test instrument, in Form A it would appear that 5 different types of relations divided among 20 syll-arguments would be too few for reliability of testing for this form. Form B, consisting of 32 syll-arguments having a single relation, would appear to be too many. The results of my research indicate that around 15 items per validity pattern will give significant results.

The chief criticism that might be made in regards to the Thurstone Reasoning Test is that it is doubtful whether anyone can be said to exhibit reasoning ability while predicating this judgment upon one validity pattern.

In 1953, Gaier, Lee, and McQuitty published a paper on "Response Patterns In A Test of Logical Inference."³⁸ The authors state that the study attempted to demonstrate that variant styles of response characterize the performance of the testee on a test of logical inference. The test instrument was modeled after the Logical Inference Test designed by C. C. Brighan. A portion of their paper is presented here.³⁹

The final form of our experimental measure contained 60 problems in inferential reasoning. These problems were divisible into 20 sets of three questions each, the items of each triad being similar in logical form but different in subject matter. Thus each triad contained three items having different premises and conclusions but sharing common formal structure.

This plan of item construction was followed in order to determine whether different types of logical problems

³⁸ E. L. Gaier, M. C. Lee, and L. L. McQuitty, "Response Patterns In A Test of Logical Inference," Educational and Psychological Measurement, Volume 13, 1953, pp. 550-567.

³⁹ Ibid., p. 554.

tend to elicit distinguishable types of reasoning ability For each item the following five response alternatives were presented: Necessarily True (NT), Necessarily False (NF), Probably True (PT), Probably False (PF), and Undetermined (U). Typical of items making up the test are the following:

1. Premises: - All the boys who go to Central High School live in the city.

John lives in the city.

Conclusion: - John goes to Central High.

Answer: NT NF PT PF U

2. Premises: - Ninety-seven per cent of the people in this town are foreign born.

Conclusion: Most of the people we meet on this street will be native-born.

Answer: NT NF PT PF U

Examples of the syllogistic items are as follows.⁴⁰

1. Syllogistic items:

Triad A. These items set up situations in which a single case is to be judged in relation to premises making an assertion about "all" of the entities or events being considered. Logical analysis suggests that "probable" answers may indicate a judgment intermediate between "necessary" and "undetermined" in this type of pattern.

Example:

Premises: There is not a dish in Elizabeth's tea set which is not nicked or cracked. This cup is both nicked and cracked.

Conclusion: It belongs to Elizabeth's tea set.

Triad B. In these items a single case is to be judged against premises making assertions about

⁴⁰ Ibid., pp. 555-556.

"some" of the events or objects involved. The conclusions appear to be judged in their wider context as more or less probable, since the premises are relatively unrestrictive.

Example:

Premises: Some late-model cars have automatic shifts.
Fred has a late-model car.

Conclusion: Fred's car has an automatic shift.

Triad C. These problems demand conditional reasoning from premises in which the antecedent is denied. "U" responses are quite popular, and suggest that reference is often made to extra-stipulated experience.

Example:

Premises: If a book is well bound and printed it will sell for a high price, but this book is neither well bound nor well printed.

Conclusion: This book will not sell for a high price.

Triad D. The items in this triad set up the transformed proposition as the premise and restore the conclusion. This type of problem is quite difficult and appears to elicit extreme skepticism in the form of preference for the "U" response.

Example:

Premises: All of the unframed pictures are inexpensive.

Conclusion: All of the framed pictures are expensive.

I would like to discuss this test in terms of validity patterns, that is, as a test of logical reasoning. In the first place, it is not

a test of logical inference even though it is purported to be such.⁴¹ Rather, it is a test illustrating the variations of judgments on the part of the testees relevant to the truth-value of various propositions. Whereas I do not deny that a single judgment is necessary in any true test of logical reasoning, all such judgments must be predicated to controlled experiments. There is no control in the above experiment with respect to logical inference.

That the authors were cognizant of this is indicated by their remark "the test therefore did not confine the respondent to the exclusive exercise of formal deductive logic because the answers PT and PF were open even in items having determinate solutions from the strictly deductive point of view." But, in terms of fundamental methodology, this awareness on the part of the investigators only serves to aggravate the seriousness of the fallacy, and, in no case, can supplant the necessity for a controlled experiment.

Moreover, we recognize that psychological phenomena, in general, are most difficult to control, but the fact is that this particular phenomenon is not. Validity patterns are the one thing in experiments of this type which do lend themselves to control. I think it to be a matter of basic methodological procedure for any test, which purports to deal with logical inference, that the patterns upon which the inferences are to be made must be standardized in the test. Not only was no data offered to support the contention that logical inferences were taking place by the testees for given validity patterns, no attempt was

⁴¹ Ibid., p. 554.

made even to standardize the "syllogistic items" within the test per se.

Specifically, the investigators list triads A, B, C, and D as belonging within the class of syllogistic items. But the facts are that each one of the examples given above differ as to form. The suggestion that they are intended as testing for different types of reasoning is irrelevant to the argument. They are presented as belonging to the class of syllogistic arguments, and this is contrary to fact.

In triad A, the form of the example given is this:

$$\begin{array}{c}
 (x) : D_x \cdot \supset \cdot N_x \cdot C_x \\
 N_c \cdot C_c \\
 \hline
 D_c
 \end{array}$$

In the first place, the argument is not valid, which is allowable - provided there exist within the test instrument other forms of the same type which were valid. In the second place, the example involves the psychological functions of abstraction, concretion, as well as inferences involving distribution, simplification, and modus tollens laws. No explanation, not to mention data, was offered as to why analyses on these factors were omitted. But, yet, the test purports to be one of logical inference. Moreover, no mention was made of the type of syllogism which the above example is supposed to be.

The example of Triad B is not a syllogism at all. Nothing can be inferred from two existential propositions.

The form of the example of Triad C is as follows:

$$\begin{array}{c}
 (x) : B_x \cdot P_x \supset S_x \\
 \sim B_a \cdot \sim P_a \\
 \hline
 \sim S_a
 \end{array}$$

This item, as a test for logical inference, suffers from the same objections given for the example of Triad A. Abstraction, concretion, and other laws of logic are involved and of which no data was offered. It is invalid, of course, which is all right - provided there exist within the test other items of the same type which were valid. Moreover, no evidence was offered to show that the inclusion of multiple unit-thoughts in a given form made a difference in ability to use that form.

The form of the example of Triad D is as follows:

$$\begin{array}{c}
 (x) : \sim F_x \supset \sim E_x \\
 \hline
 (x) : F_x \supset E_x
 \end{array}$$

This specimen obviously does not belong to the class of syllogistic arguments. It involves some other laws of logic, namely, transposition, and modus ponens. It confuses "immediate inference" with "logical inference" which is legitimate - provided the former is what is being tested for; but, as we pointed out, the test purports to deal with logical inference. These two uses of "inference" must be unambiguously delineated within the test instrument. The point is that the investigator may use "inference" in any way he chooses, but whatever definition

he decides upon, this must be made consistent throughout the test.

In summary, this test is not an instrument which measures the ability to reason logically, and, therefore, is not related to the research of this thesis. We included it within this chapter only because the study ostensibly dealt with "Response Patterns In A Test of Logical Inference."

In 1946, Arthur Lefford published a paper on "The Influence of Emotional Subject Matter On Logical Reasoning."⁴² Lefford's aim is to determine some of the factors which inhibit logical thinking.

The study was based on a questionnaire of 40 syllogisms given to a group of college students. The test items were divided into two groups of 20 each and which differed only as to the nature of the subject matter. In one group the subject matter of the forms was intended to be of a socially controversial nature designed to excite an emotional reaction, while in the other group the subject matter was intended to be psychologically neutral.

Examples from the test are given as follows:

Non-emotional

1. Good citizens take advantage of their privilege of voting. All members of the North End Political Club, being conscious of their civic duties, are good citizens. Therefore, all members of the North End Political Club will vote on Election Day.⁴³

⁴² Arthur Lefford, "The Influence of Emotional Subject Matter On Logical Reasoning," Journal of General Psychology, Volume 34, April, 1946, pp. 127-151.

⁴³ Ibid., p. 129.

The testee was instructed to judge this in two respects: (a) valid or invalid, and (b) whether they agreed or disagreed with the conclusion. The one above is given as valid. Its form is

$$\begin{array}{c} (x) \cdot C_x \supset V_x \\ (x) \cdot N_x \supset C_x \\ \hline (x) \cdot N_x \supset V_x \end{array}$$

This item was paired with an emotionally loaded syllogism, viz.,

Emotional

1. Man, faced between choosing between life and death, is enobled by the experience. War is a situation in which man must make this supreme choice. War, therefore, is an experience ennobling men to the most exalted degree.⁴⁴

This is given as valid, and its form is

$$\begin{array}{c} (x) \cdot S_x \supset E_x \\ S_w \\ \hline E_w \end{array}$$

A second example of paired responses is given as follows.

Non-emotional

19. Insects are characterized by six paired, jointed appendages which are attached to the thorax. Spiders, however, do not have six paired, pointed

⁴⁴ Ibid., p. 130.

[sic] appendages, but eight. Therefore, spiders are not insects.⁴⁵

This is given as valid. Its form is

$$\begin{array}{l}
 (x) \cdot I_x \supset S_x \\
 (x) : D_x \cdot \supset \sim S_x \cdot E_x \\
 \hline
 (x) \cdot D_x \supset \sim I_x
 \end{array}$$

The above was paired with the following item:

Emotional

19. All peace settlements which are to be lasting settlements must satisfy both sides. No peace settlement is ever satisfactory to both sides. Therefore, no peace settlement can be a lasting one.⁴⁶

This is given as valid, and its form is

$$\begin{array}{l}
 (x) : S_x \cdot L_x \cdot \supset A_x \\
 (x) \cdot S_x \supset \sim A_x \\
 \hline
 (x) \cdot S_x \supset \sim L_x
 \end{array}$$

Lefford's results indicated, in general, that neutrally toned syllogisms were solved more correctly than emotionally toned syllogisms. Also, there was a difference in type of scores obtained when the emotionally toned syllogistic items were presented before the set of neutral

⁴⁵ Ibid., p. 130.

⁴⁶ Ibid., p. 131.

items. He found that presenting the emotionally toned syllogisms first had a deleterious effect on the results of solving neutral syllogisms.

One of the most outstanding features of Lefford's paper was his discussion on the difference between "logical inference" and "psychological inference".⁴⁷ In logical terminology, this is equivalent to a discussion between "logical inference" and "immediate inference". Admittedly, it was heartening to see this discussion.

His overall problem is stated within a theoretical framework, and he desires ultimately to "analyze the mechanism of psychological inference and to discover under what conditions it may or may not correspond to a valid logical inference."⁴⁸ His present paper was one phase of this overall problem, and consisted of a study of logical inference as related to the factor of emotion.

It must be said that from a logical point of view his overall methodology was vastly superior to other papers examined over similar material. His recognition for the necessity of a controlled experiment in terms of forms, validity, approximately equal number of verbal signals, of a single valid-invalid judgment, his awareness of the fact that there are two types of "inference", are specific examples of necessary proper methodology. The ideal is to reduce the number of variables to a minimum, and this paper approaches this point. Comparatively speaking, it was unquestionably the best work I have seen on this kind of research.

There are, however, certain difficulties associated with the test

⁴⁷ Ibid., pp. 144-145.

⁴⁸ Ibid., p. 145.

instrument per se. I shall confine my remarks to the actual test items presented above, and to discuss these with relevance to validity patterns.

First and foremost, there were no data offered for the existence of any given validity pattern - in this case, the syllogism pattern. This must be forthcoming if one is to speak about any type of logical inference. If one is testing for inferences, he must show the pattern upon which inferences are made, and upon which the test is presumably predicated.

Secondly, the forms were not kept constant as Lefford had supposed them to be. Specifically, in the first paired syllogisms above, and in terms of formal logic, the first item is an example of the syllogism law but the second item is an example of the modus ponens law. He must show evidence that this is not significant.

In the second paired syllogisms, many more logical laws were involved than just syllogism. I shall demonstrate this by showing the reasoning required to reach the respective conclusions.

'19. (non-emotional)'

1. $I_X \supset S_X$ premise
2. $D_X : \supset : \sim S_X \cdot E_X$ premise
3. $D_X \supset \sim S_X : D_X \supset E_X$ from 2 by distribution law
4. $D_X \supset \sim S_X$ from 3 by simplification law
5. $\sim S_X \supset \sim I_X$ from 1 by transposition law
6. $D_X \supset \sim I_X$ from 4 and 5 by syllogism law

Thus, this item not only tests for syllogism but one of the distribution laws, one of the transposition laws, the modus ponens law

(three times), and the simplification law. Moreover, whether the inferential processes involved here are labeled in terms of their analogues in symbolic logic is not the point - although Lefford does imply this by even talking about the syllogism form. The point is that in whatever language system one selects to talk about these kind of phenomena some such equivalent mental processes must be exhibited before the conclusion can be reached. And these must be tested for, individually, and data on each of them must be existent. Comparisons for significance must be made between all the laws involved taken two at a time, three at a time, etc., and to show that there is no significance between any given group and ability to reason according to the syllogism form alone. If this is a test for the syllogism pattern, then that pattern must be the only significant variable present. The other patterns that are present must be shown to be negligible in psychological effect. The same difficulties apply to the paired mate of the above item, viz.,

'19. (emotional)'

1. $S_X \cdot L_X \supset A_X$ premise
2. $S_X \supset \sim A_X$ premise
3. $\sim A_X \supset \sim (S_X \cdot L_X)$ from 1 by transposition law
4. $S_X \supset \sim (S_X \cdot L_X)$ from 2 and 3 by syllogism law
5. $S_X \supset \sim S_X \vee \sim L_X$ from 4 by interchange
6. $S_X \supset \sim L_X$ from 5 by interchange
7. $(S_X \cdot S_X) \supset \sim L_X$ from 6 by exportation law
8. $S_X \supset \sim L_X$ from 7 by identity law

Again, the explication of these items in terms of formal logic is

given for simplicity purposes alone. The point is that this is one way - of possibly several ways - to talk about the inference patterns involved. In any case, however, whatever symbol system is selected, data must be forthcoming which have a direct bearing on the reasoning patterns indicated to be present in this language system. Any other language system, if it purports to deal with logical reasoning, must have patterns at least equivalent to those of formal logic.

One of the standard tests of intelligence is The Revised Stanford-Binet Scale.⁴⁹ This test is included because it has been used as a standard to which many other intelligence tests are correlated, and, therefore, it is similar in design. But, as we have stated earlier, these tests consist of verbal-pictorial response items and do not measure deductive thinking per se. Thus, this type of test would not be germane to the problem of validity patterns.

⁴⁹ The Revised Stanford-Binet Scale. (Chicago: Houghton Mifflin Company, 1937).

CHAPTER III

MATERIALS AND METHODS

What follows is a presentation of the test procedures used to obtain data on the validity patterns possessed by the populations tested (Natural Science Students) in regard to what they think is logical reasoning.

The materials consisted of three basic types of tests which were given in four different studies:

1. Type A test procedure: analysis of raw data, where the testee was required to supply relevant facts.
2. Type B test procedure: the construction of logical questionnaires.

Type B1: requires the testee to decide whether a particular bit of discourse is reasonable or not.

(Type B2: multiple choice type of test. No test was given which used this method exclusively. When multiple choice items were given they were presented within the Type B1 test)

3. Type C test procedure: analysis of raw data, where the testee was provided with relevant facts.

All tests of all studies are included within the Appendix. Examples of each type of test and the method of analysis is given as follows.

Because of the brevity of the Type A test it is given in its entirety, viz.,

QUESTIONNAIRE

INSTRUCTIONS: This questionnaire aims to find out, in a general way, what you remember about some of the ideas which were presented to you last term in NS 181. In particular, this questionnaire concerns itself with the ideas about heredity.

Although we would like to have you sign your name, you will not be graded on this questionnaire. The remarks you make will not influence your grade in any manner whatsoever.

In one of the lab studies last term, one of the ideas we wanted to communicate to you was that one underlying the mechanism of dominance and recessiveness of some genes. By way of supplying evidence to support this idea a pedigree chart was presented in the manual. This chart (Figure A) has been given below.

The trait in question is either dominant or recessive, and not a blending characteristic. What you are asked to do is to explain why individual II-3 must be recessive.

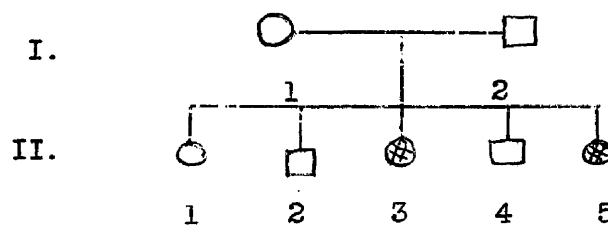


Figure A

EXPLANATION:

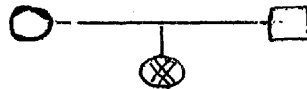
The thing to notice in the following example is the method of analysis. The sample discourse is not intended as typical, the method

of analysis is. The "explanation" which is asked for might appear as follows:

Sample Discourse

In simple dominance, the traits which are passed on to the offspring are either dominant or recessive but not both. This would be like albinism, brown eyes, or tallness in peas.

And we know it to be true that the trait appears in the f_1 but not in either parent, viz.,



Now assume the trait to be dominant. If this is true, then it must also be true that the parents are recessive for this trait, because their phenotype differs from the f_1 individual. But, if the trait were dominant, then the parents must also be dominant as no recessive parents can yield dominant offspring.

This implies that upon the assumption that the trait is dominant, we are led to the conclusion that the parents are both dominant and recessive. Since this conclusion is impossible, it follows that the characteristic in question is not dominant. And since the trait must be dominant or recessive, it follows that the trait must be recessive. Here we have an instance, then, where the phenotype of the f_1 differed from both parents and that its genotype had to be homozygous recessive.

A logical analysis of the above discussion shows that two valid forms of inference were used to communicate the idea. In abbreviated form the logical structure appears as follows:

1. $D \vee R$
2. $D \supset (P \cdot \sim P)$
3. $\sim (P \cdot \sim P)$
4. $\sim D$

$$5. \quad [\sim D \supset R]$$

$$6. \quad R$$

The two valid forms of inference are:

$$\begin{array}{lcl}
 1. \text{ Modus Tollens:} & P \supset Q & \\
 & \sim Q & \\
 & \hline
 & \sim P & \\
 \\
 2. \text{ Modus Ponens:} & P \supset Q & \\
 & P & \\
 & \hline
 & Q &
 \end{array}$$

These valid forms of inference represent validity patterns. And these are the types of patterns sought for among the Natural Science students.

In the Type B test, as in the Type A, logical questionnaires were constructed in such a fashion as to obtain the validity patterns of a person with respect to what he takes to be reasonable discourse.⁵⁰ Two types are given.

Type B1.

EXPLANATION: These problems are designed to help us find out some things about our methods of teaching you a few ideas about Natural Science last term.

We all know that some of you got A's for the course and some of you got lower than A's. We have apparently communicated to a very high degree with those of you who received A's, and correspondingly, have apparently communicated to a lesser degree with those of you who received less than A.

⁵⁰ This particular type of questionnaire is analogous to the questionnaire of Morgan and Morgan (page 19 above), and Lefford (page 40 above).

We want to find out if there is something in our manner of presentation which would possibly account for this variation in communication.

Although we would like to have you sign your name, you will not be graded on this questionnaire. The remarks you make will not influence your grade in any manner whatsoever.

Because of our almost constant exposure to the subject matter of Natural Science we are sometimes inclined to make statements which appear reasonable to us but yet appear unreasonable to you. We feel that the degree of correspondence between what we take to be reasonable discourse and what you take to be reasonable discourse is directly proportional to the amount of communication which is taking place.

DIRECTIONS: The statements below represent hypothetical lecture or lab discourse. Consider each set of statements as complete units of discourse. If you think the point being made is presented in a reasonable manner, blacken your answer sheet in the first space. If you think the point being made is presented in an unreasonable manner, blacken the second space.

1. "You recall that Hardin (text) said that the catesbeiana were frogs. And today in lecture we have talked about frogs. Among other things, we said that frogs were sexual. Putting these bits of information together, we are now in a position to say that the catesbeiana are sexual."

A logical analysis of the above discourse shows the use of a syllogism to communicate the idea that "catesbeiana are sexual." If the discourse was marked "reasonable", this would indicate that the testee possessed the validity pattern of syllogism. In this case, the pattern is expressed as follows:

$$C_x \supset F_x$$

$$F_x \supset S_x$$

$$C_x \supset S_x$$

2. "When we were working in our lab manuals we hypothesized as to what the "gene" actually was. Some of you said it was carried in the chromosome and others of you said it was the chromosome. Now you recall that your lab instructor did not decide for you which of these was the correct hypothesis.

Of all the possibilities concerning the nature of the gene, it appeared to us that the above two were the most likely - it was either one or the other. After working for two or three weeks on heredity, we discovered in the laboratory that genes and chromosomes were different things. Upon finding this out we could reasonably say that genes were carried in the chromosomes."

An analysis of the above shows the use of a valid form of inference known as Modus Ponens, viz.,

1. C V I
2. $\sim C \supset I$
3. $\sim C$

I

3. "In genetics if black was dominant to white, and brown eyes was dominant to blue eyes, then a crossing between two homozygous black cats should not give any white offspring. But, supposing we did get some white offspring. It is consistent to say, in this case, that black is dominant to white, and that brown eyes is dominant to blue eyes."

The correct answer to this is that it is not reasonable. Analysis shows the Modus Tollens law to be involved, viz.,

$$(D \cdot B) \supset \sim W$$

W

$$\sim (D \cdot B)$$

Type B2. (same Explanation as in Type B1 above; this kind of item was given only as a part of the Type B1 test)

DIRECTIONS: In the problems given below, you are asked to identify unstated assumptions in an argument. If the letter corresponding to the assumption you choose for an argument is listed after the argument, draw a circle around it. If that letter is not listed, draw a circle around "none of these."

ASSUMPTIONS

- A. Primitive animals are sexual animals.
- B. Sexual animals are primitive animals.
- C. Primitive animals are frogs.
- D. Sexual animals are frogs.

ARGUMENT

Frogs are sexual for it is well known that they are primitive animals.

Requires assumption A B C D None of these.

The assumption necessary for the validity of the above argument is assumption A. If marked accordingly, this would indicate that the marker possessed the law of syllogism as a validity pattern. In this case, the pattern appears as follows:

$$\begin{array}{r}
 F_x \supset P_x \\
 P_x \supset S_x \\
 \hline
 F_x \supset S_x
 \end{array}$$

ASSUMPTIONS

- A. Unseen things may exist.
- B. Unobservable things are imaginary.
- C. Unseen things which may exist are imaginary.
- D. Imaginary things are unobservable.

ARGUMENT

Since genes have never been seen it follows that they are imaginary.

Requires assumption A B C D None of these.

The assumption necessary for this argument is assumption B. This is another example of the syllogism, and its form appears as follows:

$$\begin{array}{r}
 G_x \supset U_x \\
 U_x \supset I_x \\
 \hline
 G_x \supset I_x
 \end{array}$$

In the Type C test, the method of analysis was the same as for Type A. The Type C test differed, however, in providing the testee with the necessary relevant facts required to reach the requested conclusion.

In Type C, the testee was reminded of a previous laboratory study he had had in genetics where the idea of the study involved the two epistatic genes which control the pigmentation genes. At that point in his study, the testee was under the impression that the epistatic genes were the genes for pigmentation. The testee was asked to explain how it was that "a given individual must have two genes for skin pigmentation." He was provided with a pedigree chart he had had in the previous laboratory study as well as the necessary genetic propositions required to explain the requested conclusion. Thus, Type C test was the same as Type A, except in Type C the necessary facts were provided within the test itself.

The above tests and methods constitute the procedures employed for getting at the validity patterns of the student populations in Natural Science regarding what they think is logical reasoning.

CHAPTER IV

DATA AND CONCLUSIONS

The data in this research were obtained in five different studies. Each of the first four studies represent different attempts to obtain reliable information regarding the existence of validity patterns within the populations investigated. The fourth study employed a more refined test instrument formulated upon the results of the first three studies. The fifth study presents a comparison of the results of a logic test given in Study Four-I with the testees Reading Comprehension, Verbal Abilities, and Grade Point Averages.

There were a total of 1390 students involved in the research, and a total of 23 different test instruments. Two of the test instruments were of the Type A and C tests, twenty-one were variations of the Type B test. All forms of the Type B test were constructed within the framework of three particular validity patterns, namely, Modus Ponens (MP), Modus Tollens (MT), and Syllogism (Syll). Type A and C tests were employed in Study One, and Type B tests were used in Studies Two, Three, and Four.

The work of this thesis can be viewed as providing two major contributions for research of this type. One is the development of a test instrument that finally showed reliability values of significance in Study Four, and the second is the production of significant data bearing directly on particular validity patterns involved in logical reasoning. Both of these factors are mutually implicative. In order

to obtain evidence that validity patterns are existent in the population, an instrument must be devised that will measure these patterns with reliability. Thus, each of the test instruments employed in Studies One through Four were constructed in the light of either deficiencies or outright mistakes of the previous test.

Study One, for example, employed test instruments that called for logical analysis of raw discourse. I started out with this approach because I felt, and still feel, that if any investigator is going to assert that patterns of logical reasoning exist in the population, then these patterns must be physically evident in actual discourse. However, the results of Study One quickly taught me that this was to be considered as an ideal, and, although it was much to be desired, it suffered from two noteworthy difficulties. One was grammar, the other the preponderance of arguments having unstated but necessary premises (to wit, enthymemic argument). Both of these placed a burden upon the investigator with respect to interpreting what it was that the testee intended to say in his discourse. Thus, in this situation, the investigator tends to become a factor in the data. Two examples are given below as an illustration of the types of responses obtained on the raw data tests.

The first is an actual example of a testee's response to the Type A test. It illustrates some grammar difficulty in interpreting the intent of the testee. In this test the testee was reminded of a previous laboratory study he had experienced in genetics where the idea of the study was concerned with the mechanism of dominance and recessiveness of some genes. The test provided the testee with a pedigree chart and his task was to explain why one of the f₁ individuals must be recessive.⁵¹

⁵¹ The complete test is given on pages 48-49 above.

The words enclosed in brackets are mine.

It can only be a recessive [conclusion] , because a recessive is carried by both Parents and their Children Can only carry the same trait as the parent! If the parent were Carrying recessive gene only then Can only transmit recessive gene to their Children. In this case both parents have a dominant gene. II 3 has to be recessive in that it Carries only recessive genes one from each Parent. If it Carried one or two Dominant genes it would be the same as both parents [premise2]. When the offspring Carries recessive genes it has a different appearance than either of the parents [premise1] .

Logical analysis of this discourse indicates the MP law to be present: (this stands as an interpretation of intent by the student)

If the offspring are different in phenotype from the parents, then the offspring are recessive. (premise1)
 II-3 is different in phenotype from the parents.
 (premise2) Therefore, II-3 is recessive. (conclusion)

In symbolic form it would look like this:

$$D_x \supset R_x$$

$$D_{II-3}$$

$$R_{II-3}$$

The following is an example of a testee's response to the Type C test. It illustrates the point that enthymemic argument was frequent in the raw data type of test. In the Type C test the task of the testee was to explain how it is that a given individual must have two genes for skin pigmentation. He was provided with a pedigree chart he had been exposed to in a previous laboratory study as well as provided with the necessary genetic propositions required to reach the requested conclusion. His discourse was then analyzed to see if it contained any validity patterns.⁵²

⁵² The Type C test is described on page 54 above, and presented in full in the Appendix.

The words enclosed in brackets within the discourse are mine.

Each individual in Figure A, as well as every individual, must have two genes for skin pigmentation [conclusion]. This is because each parent gives to its offspring one of his given genes, thus making him an albino or a white [possible premise]. If each person only had one gene for skin pigmentation, the normal people would more or less make albinism extinct [premise]. The one gene for albinism or skin pigmentation is bound to be released in some manner thru 1 gene.

Logical analysis of this discourse is given as follows.

In the "possible premise" it is not clear if the testee wants to have this remark stand as an antecedent to his "conclusion", or if he means it to stand as an antecedent to "thus making him an albino or a white." The latter is what he actually said. However, he did use the words "this is because" which implies that this was to stand as the reason for his "conclusion".

Also, if we interpret the "possible premise" as a proposition integral to the argument, it must be interpreted to mean "if each parent contributes an albino gene to their offspring, then the offspring will be an albino." However, for this to have logical force, another premise must be assumed, namely, that "these particular parents did contribute an albino gene to their offspring." But the fact is that the testee said neither of these propositions. Moreover, even if we interpret the testee to mean "if each parent contributes an albino gene to their offspring, then the offspring will be an albino", the proposition "these particular parents did contribute an albino gene to their offspring" stands as enthymemic. Also, the testee still has not actually stated that the offspring will, therefore, have two genes for skin pigmentation. As the investigator, I would say that this is implied here, but

the point is I would be making the implication not the testee. The statement marked as a "premise" is expressed in logical symbolism as follows:

$$O \supset E$$

But for this to have logical force, we must assume the testee to have understood the following propositions while not bothering to write them down:

1. $O \supset E$ premise
2. $\sim E$ (albinism is not extinct)
3. $\sim O$ (therefore, people do not have only one gene)
4. $\sim O \supset T$ (if people do not have one gene for skin pigmentation, then they have two genes)
5. T (people have two genes for skin pigmentation)

Thus, the point of this second example has been illustrated, namely, the existence of enthymemic argument in the raw data type of tests.

The raw data type of test instrument had the two difficulties of grammar and enthymemic argument associated with it. Both of these factors tended to make the investigator an integral part of the data by placing a burden on him in trying to interpret what it was that the testee actually meant. But the fact is that what I interpret the testee to mean and what he actually meant may be two different things. The only actual facts the investigator has to work with are the very words the testee utters (or writes). When the investigator starts making judgments about "well, this is what he meant", then I think we are no longer in the realm of science.

Moreover, it is a significant fact that none of the previous research on logical reasoning by other investigators has utilized the raw

data type of test instrument. The work of Dr. Lawson was the only exception to this rule. But it must be remembered that he was working with a group of highly educated individuals employed as members of a university faculty.

The Type A test was given to a population of 24 students. Only two kinds of validity patterns were evident from the data, namely, MP and MT. Eight students out of twenty-four exhibited these forms (33% of the population), five exhibiting MP and three exhibiting MT.

The Type C test was given to a population of 28 students. Again, only the two validity patterns of MP and MT were evident from the data. There was an increase, however, in the percentage of students who displayed these forms, to wit, 50% of the population. Thus, there was an increase in the quantity of validity patterns over the Type A test results. The Type A test asked the student to explain a given conclusion while not providing the necessary facts. The Type C test gave both the conclusion and the facts, and asked the student to put them together logically.

Thus, while the raw data type of test instrument has certain difficulties associated with it, the following specific conclusions can be drawn from the data obtained in Study One.

1. Only two validity patterns, MP and MT, appeared in the populations tested. The patterns occurred more frequently where the necessary facts were given than where they were not.

This result suggests the hypothesis that the availability of necessary ideas is an integral factor in the ability to exhibit a given validity pattern relative to some conclusion. This hypothesis is

indicated to be true as shown by results of the Type C test of Study One, as well as the results of Studies Two, Three, and Four. And, whereas the hypothesis is anything but startling, I think this is the first time that data has been presented in its behalf.

2. It is noteworthy that other forms of inference were not displayed. While this test alone does not, in any sense, confirm the possibility that there are only a certain few forms of valid inference employed in reasoning, namely, MP, MT, and Syll, the data do provide one instance where this may be true.

3. The fact cannot be avoided that when the student was assumed to have the subject matter (as in the Type A test) only 20% of the population showed ability for the MP form of inference. But when this knowledge was provided for him (as in the Type C test), the tests showed an increase of MP up to 46%. And when we look at the results of Study Two, the exhibition of MP increased to 100%. That is, no student failed to get at least 30% of this item right, and 26% of the population got 80% correct.

4. Analysis of the raw discourse from Type A and C tests showed a preponderance of enthymemic argument among those testees who displayed validity patterns. Also, sometimes the grammatical construction of the testee's sentences caused difficulty in the interpretation of intent. Primarily because of these two factors, subsequent tests employed the Type B form in the hope of gaining an instrument with greater reliability.

In Study Two the test instrument consisted of a logical questionnaire

(the Type B test). The testee was presented with a series of statements in each test item and his task was to decide, in each case, whether the discourse was "reasonable" or "not reasonable". There were 30 items on the test.⁵³

The test incorporated the three validity patterns of MP, MT, and Syll. There were 10 items per validity pattern. The population size was 362 students. The problem, as in all the studies, was to determine the frequency of each of these patterns in the population.

The test instrument of Study Two was my first attempt at the construction of a logical questionnaire. Even though I made several mistakes in formulating the instrument, several interesting facts were disclosed by the data.

Only one student failed to obtain at least one correct answer for the MT form of inference, while all students demonstrated some ability to use the MP form. Twenty-six per cent of the population obtained a maximum score of sixty per cent for MT and eighty per cent for MP.

As is indicated by the means ($\bar{x}$) in Table I, it is noted that the sequence in number of correct responses to the validity patterns places MP first, MT second, and Syll last.

TABLE I
STATISTICS FOR EACH DISTRIBUTION OF STUDY TWO

Validity Pattern	Mean	Standard Deviation
MP	7.119	1.456
MT	6.129	1.539
Syll	4.950	1.860

⁵³ A description of Test B is given on pages 50-54 above, and presented in full in the Appendix.

The fact that Syllogism showed the lowest scores would seem to be contrary to the opinion that it is the one great law of thought. However, the additional evidence obtained in Study Three indicates that the low Syll scores here were due to the fact that 5 of the test items for Syll were of a multiple 6-choice type. Thus, each one of these items involved 6 separate judgments by the testee. On the other hand, all of the MP and MT items asked the testee to make one judgment on whether the discourse was reasonable or not, or, if a conclusion followed from the premises. Therefore, in the multiple choice type of item, the testee had $1/6$ chance of guessing right. In the "reasonable" - "not reasonable" type of item, he had $1/2$ chance of guessing right. Moreover, aside from the factor of guessing, it is possible that with the increased number of judgments required there was an increase in the number of errors.

The chief significance of the statistics that compared the differences between the means of the distributions in that they provide evidence that there is a genuine difference in ability to think logically relative to given forms of inference, and that some forms are more common than others. These comparisons are given in Table II.

TABLE II
VALUES FOR SIGNIFICANCE BETWEEN THE MEANS FOR
THE VALIDITY PATTERNS OF STUDY TWO

MP and MT	8.684	significant
MT and Syll	9.357	significant
MP and Syll	9.663	significant

Because these values for significance are greater than 2.58 ($\sigma_{\bar{x}}$), the difference between each of the means is significant at the 1% level of chance. Thus, the difference between the means are said to be "real" and not attributable to accidents of sampling.

Specific conclusions that may be drawn from the results of Study Two are as follows:

1. The MP form of inference was the most prevalent in the population. It was followed by MT and Syll in that order of frequency.
2. It is noted that in this type of test (Type B), where the facts and conclusion were both given, that there was a marked increase in response of both MP and MT forms of inference. The student was to decide whether the facts and conclusions were put together logically.
3. It was a mistake to include the multiple choice type of items for Syll. This had the effect of introducing the factor of having a difference in number of judgments required of the testee. In the MP and MT items only one judgment was required per item, while in the Syll items six judgments were required per item. Thus, on the basis of chance alone, this would explain why the data from this test showed Syll to be the least exhibited.
4. In regard to the reliability of the test instrument used in Study Two - this is another matter. Whether any test of logical reasoning can be constructed which would be absolutely reliable is a question not easily answered. For example, the reliability values of the above test for MP, MT, and Syll were .07, .00, and .32, respectively. Does this mean that this test was without value? Again, I do not think this question is easily answered.

On the face of it, these indices would appear to be alarmingly significant in that they seem to say that the test instruments employed in Study Two do not measure what they are supposed to measure. In direct contradiction to this implication, however, are the judgments held by investigators in the fields of psychology, statistics, and sociology. (Four authorities are quoted below). In any case, some explanation is in order.

First and foremost, it must be recognized that the statistical formulas employed for obtaining reliability numbers are predicated upon the normal curve. The fact may be, however, that the decidedly psychological phenomena that are specifically being tested for in this research do not follow the normal distribution pattern. The assumption of the normal distribution of complex mental abilities holds no necessary relationship with known inequalities regarding the distribution of special abilities. The point is that some people are simply "smarter" than other people.

However, this point is more forcefully presented by the following investigators:

(a) H. E. Garrett, Professor of Psychology, Columbia University.

But the striking similarity of obtained and probability distributions should not lead us to conclude that all distributions of mental and physical traits which exhibit a symmetrical form have necessarily arisen through the operation of those principles which govern the appearance of dice or coin combinations. The factors which determine musical ability, let us say, or mechanical skill are too little known to justify the assumption, a priori, that they combine in the same proportions as do the head and tail combinations in "chance" distributions of coins. Moreover, the psychologist usually constructs his tests with the normal hypothesis definitely in mind. The resulting symmetrical distribution is to be taken, then, as evidence of the

success of his efforts rather than as conclusive proof of the "normality" of the trait being measured. The selection of the normal rather than some other type curve is sufficiently warranted by the fact that this distribution generally does fit the data better, and is more useful.⁵⁴

- (b) D. C. Jones, formerly lecturer in mathematics at Durham University.

"....After all, the real and only justification for choosing one curve rather than another to fit any given observations is that it does succeed in fitting them better. But when the further question is asked why the normal curve should succeed in describing some results so well, we must not be tempted by analogy to rush to the conclusion that the causes at work are necessarily independent, and equal, and so on. In short, the theoretical justification and the empirical use of the normal curve are two quite different matters.⁵⁵

- (c) A. H. Hobbs, Professor of Sociology, University of Pennsylvania.

It has never been demonstrated that the assumed distribution of large numbers of cases of discrete, infinitely divisible quantities is applicable to human behavior. Many social scientists look down their noses condescendingly when normal human behavior is mentioned. An indication of this attitude is found in textbooks where normal, as applied to human beings, is frequently placed within quotation marks. Yet these same people accept "normal" curves of distribution as being something real. The "normal" curve of distribution of human behavior traits has never been established, and even for specific quantities it is an abstraction, based largely on a faith that it must be so.... Before correlations can have much meaning, a number of steps must be taken. The units involved must be precisely defined and they must be reduced to quantitative, homogeneous, measurable terms. Human behavior simply has not been reduced to such terms. Wherever desires, whims, hunches, intuitions, hopes, fears, emotions, or practically any other human traits are involved, there is no warrant for statistical treatment based on probability.⁵⁶

- (d) E. L. Thorndike.

⁵⁴ Henry E. Garrett, Statistics In Psychology and Education. (New York: Longmans, Green and Company, 1947), p. 112.

⁵⁵ D. C. Jones, A First Course In Statistics. (London: G. Bell and Sons, Ltd., 1921), p. 233.

⁵⁶ A. H. Hobbs, Social Problems and Scientism. Harrisburg, Pennsylvania: The Stackpole Company, 1953), pp. 229-230.

There is nothing arbitrary or mysterious about variability which makes the so-called normal type of distribution a necessity, or any more rational than any other sort, or even more to be expected on a priori grounds. Nature does not abhor irregular distributions.⁵⁷

Another point can be made with respect to the "reliability" formula per se. It would appear that one reason for the low reliability numbers in Study Two was because of the variance or spread of the distributions, to be precise, the square of the standard deviation (σ_x^2). Thus, the outcome of the reliability (r) values would seem to be more a function of the statistics involved rather than the data alone. To extend any test on logic to the point where one would get a gradual falling off at both sides of the mean ($\bar{x}$) - thus, get a larger standard deviation, may actually be more unreliable, in terms of the facts involved, than any artificially obtained "reliable" number obtained by so doing.

Bertrand Russell makes the point somewhere that "most people would sooner die than think - in fact they do." His point is that thinking activity is probably the most difficult thing for man to do. And, therefore, the suggestion is strongly made that beyond a certain point, intellectual fatigue would quite likely set in. However, just where this "certain point" occurs would be most difficult to discern quantitatively. In any case, the suggestion is made that by artificially forcing an extension of the data to the point where we could produce a statistic which said our data were "reliable", this statistic may be, in fact, most unreliable in regard to what is actually being tested for.

⁵⁷ E. L. Thorndike, Theory of Mental and Social Measurements. (New York: Teachers College, Columbia University, 1919), pp. 88-89.

Thus, even while the work of this thesis is specifically committed to the production of an instrument that will measure validity patterns reliably, the point is made here that there exist theoretical differences in interpretations of the psychological phenomena being investigated. The reliability statistic is one such theoretical concept, which gains its validity by assuming the existence of a normal curve and which may not be applicable at this level of explanation. In the first place, it depends on how one regards the nature of the mind. If "mind" were equivocated as being of physical matter, namely, brain, then perhaps the assumption of the normal curve would be valid at this level. But then this would be neurophysiology not psychology.

Therefore, this discussion is presented more in the spirit of a cautionary note rather than any sort of rebuttal to the significance of reliability values. Nor have we forgotten our commitment to the production of a test instrument that does have significant reliability values. Even so, in keeping with the judgments of the authorities quoted above, it is barely possible that the type of psychological phenomena being investigated here simply may not be a function of the idealized "normal" curve.

In constructing the test instruments of Study Three, there were two purposes in mind. One was to see how few items per form could be incorporated within a test and still have that test give significant results, and the second purpose was to see if it would be more difficult to reason with a given validity pattern having an increased number of propositions (ideas) as compared with the same validity pattern having

a lesser number of propositions (ideas).

Study Three-I illustrates the effects of reducing the number of items per form, and Study Three-II shows the effect of differences in number of propositions per validity pattern. Both parts employed the use of logical questionnaires (the Type B test). The task of the testee was to decide whether a particular bit of discourse was reasonable or not.

As in Study Two, Study Three tested for the three validity patterns of MP, MT, and Syll. The population sizes consisted of 333 students in Study Three-I and 313 students in Study Three-II.

Actual differences between the test instrument of Study Two and that of Study Three consisted in a reduction in the number of items from 10 per validity pattern in Study Two to 8 per validity pattern in Study Three. Another difference between these two tests was the elimination in Study Three of the multiple choice type of item for the Syll pattern.

The results of reducing the number of items per form are given in Table III. Notice that the mean of the distribution for Syll is 6.742. This is greater than the mean for the same form in Study Two where 10 items per form were used. This increase in correct response to Syll suggests that it was the multiple choice items of Study Two which cause the low Syll scores in that test.

TABLE III

STATISTICS FOR EACH DISTRIBUTION OF STUDY THREE-I

Validity Pattern	Mean	Standard Deviation
MP	6.673	1.229
MT	5.826	1.262
Syll	6.742	1.220

Table IV, below, shows the results of comparing the differences between the means of MP-MT, MT-Syll, and MP-Syll. It is noted that the values for MP-MT and MT-Syll are significant where this is not the case for MP-Syll.

TABLE IV
VALUES FOR SIGNIFICANCE BETWEEN THE MEANS FOR THE
VALIDITY PATTERNS OF STUDY THREE-I

MP and MT	8.916	significant
MT and Syll	9.642	significant
MP and Syll	.775	not significant

Except for the significance value between MP and Syll, the results here confirm the data of Study Two. The evidence is again suggestive that there is a genuine difference in ability to think logically in terms of these three validity patterns. As to why the difference in response to MP and Syll were not significant seems to be related to the small number of items used in the test of Study Three.

Study Three-II was attempting to see what the effects would be if the number of propositions per validity pattern were increased. The test instrument of Study Three-II contained the same number of items per validity pattern as did Study Three-I. However, for each group of 8 items in Study Three-II, 4 items contained a minimum of propositions (ideas) per form and 4 items contained an increased number of propositions (ideas) per form. Thus, everything was constant except the number of ideas per form. A comparison was then made between the scores of these two 4-itemed groups. The results are given in Table V.

TABLE V

STATISTICS OF STUDY THREE II SHOWING VALUES FOR SIGNIFICANCE BETWEEN
THE MEANS OF CORRESPONDING VALIDITY PATTERNS WITH MINIMAL IDEAS (M)
AND INCREASED IDEAS (I)

Modus Ponens (M) and Modus Ponens (I)	3.460	significant
Modus Tollens (M) and Modus Tollens (I)	10.738	significant
Syllogism (M) and Syllogism (I)	3.400	significant

These values indicate that increasing the number of ideas within a form causes an increase in difficulty in using that form. The size of the significance value for the MT comparison was caused by two unreliable items in the MT (M) test.

Before I present the test instrument and data of Study Four, I would like to make some pertinent remarks dealing with two particular problems. One of these arose when the data of Studies Two and Three were compared, and the other concerns itself with the data of Study Three-II.

The first problem is to explain why there was an increased number of correct responses for the Syll items of Study Three-I (Table III) having 8 items for this form as compared with the Syll items of study Two having 10 items for this form (Table I).

The hypothesis offered to explain this is that in Study Two, 50% of the Syll items (items 26-30) were presented in the form of a 6-choice key, requiring the testee to pick out the necessary premise. This was not done in Study Three-I. Thus, the hypothesis is that the multiple

choice type of item in Study Two was the cause of the low scores for Syll in that test.

To test this hypothesis, samples were taken of the multiple choice forms of Syll and comparisons made between the means with the straight "reasonable" - "not reasonable" type of Syll item. The result of this comparison gave a significance value of 9.987. This value indicates that it was the multiple choice items which caused the low scores for the Syll items in Study Two.

The second problem is to explain why, in Study Three-II, there were a greater number of correct responses for the MT items having an increased number of propositions as compared with the MT items having a lesser number of propositions. Normally, we would expect that it would be more difficult to use the MT form of inference having the greater number of propositions. This unexpected difference is indicated in Table VI.

TABLE VI

DATA OF STUDY THREE-II SHOWING MEAN VALUES FOR DISTRIBUTIONS OF VALIDITY PATTERNS HAVING MINIMAL AND INCREASED IDEAS

Validity patterns	mean of patterns having minimal ideas	mean of patterns having increased ideas
MP	3.374	3.128
MT	2.454	3.195
Syll	3.441	3.227

This difference is accounted for by two items in the Modus Tollens (M) test, namely, items 5 and 11, which were shown to be poor items as

follows: a comparison was made of scores on MT in the test of Study Three-I (items 1, 5, 11, 18) with these same items in the test of Study Three-II. There was no significant difference between the means of these distributions as is shown in Table VII.

TABLE VII

COMPARISON OF MEANS OF THE SAMPLE DISTRIBUTIONS

mean value of 4 MT items from Study Three-I	mean value of 4 MT items from Study Three-II	value for significance between the means
2.384	2.454	.986

Because the value .986 is not significant this indicates that the two sample populations were drawn from the same universe. This being so, a comparison was made between items 5 and 11 (Part I) with items 15 and 21 (Part I). Items 5 and 11 were the two hypothesized to cause the low scores. Item 5 had the same form as item 15, and item 11 had the same form as item 21. The two sets differed, however, in subject matter. Table VIII shows that better scores were obtained on items 15 and 21 which indicates that it was the subject matter in items 5 and 11 and not the form of inference which caused the low scores.

TABLE VIII

COMPARISON OF MEANS OF "DIFFICULT" AND "NON-DIFFICULT" ITEMS

mean of "difficult" items (5, 11) from Study Three-I	mean of "non-difficult" items (15, 21) from Study Three-I	value for signifi- cance between the means
.757	1.820	22.146

The value 22.146 is definitely significant and indicates there is a "real" difference between the two sets of items. And, accordingly, suggests the reason why, in Study Three-II, the MT validity patterns having minimal ideas showed lower scores than these same patterns having increased ideas (Table VI).

While working out the possible cause of why there were a greater number of correct responses for the MT forms having an increased number of ideas as opposed to the same forms with a minimum of ideas, I wondered what the comparisons for the three validity patterns might show if the Modus Tollens (M) forms had been free of the two poor items.

To obtain MT (M) items that were considered as being good items, I used four MT (M) items from Study Three-I. Thus, the comparisons that were subsequently made between ideas were based upon a "hybrid" distribution since the MT (M) forms came from Study Three-I.

The construction of this hybrid distribution was done for two reasons.

1. It was felt that a comparison of such a distribution with the MP (M) and Syll (M) distributions may represent a more accurate description of the three validity patterns involved than what has been given from the tests of Study Three-II alone. Accordingly, tests for significance between the three forms may also be more accurate.

2. Also, the test for significance between these hybrid MT (M) forms from Study Three-I having minimal ideas and the MT (I) forms of Study Three-II having increased ideas may be more accurate.

The work involved here depends on the assumption that the two sample populations were drawn from the same universe. This is not

necessarily true, of course, but it was interesting, nevertheless, to see what kind of comparisons did result; and, particularly, to compare this result with the distributions obtained in Study Four. Study Four will actually test the validity of this assumption, and the only reason we are making these comparisons here is to see what we might have gotten if the two unreliable MT (M) items had not been in the test of Study Three-II.

The data in Table IX indicates that there is an increased difficulty in using the MT (M) form having increased ideas as compared with this same form having a minimum of ideas.

TABLE IX

COMPARISON OF MEANS OF HYBRID MT (M) FORMS FROM STUDY THREE-I WITH THE MT (I) FORMS FROM STUDY THREE-II

mean of MT (M) forms from Study Three-I	mean of MT (I) forms from Study Three-II	value for significance between the means
3.447	3.195	4.000

Thus, the value 4.000 indicates a significant difference within the population in ability to respond to the MT pattern when this pattern exhibits an increase in ideas.

It is debatable, of course, whether these statistics involving the hybrid Modus Tollens (M) distribution as well as those for the "difficult" - "non-difficult" distributions are truly meaningful. In the first place, they involve only four items in the case of the Modus Tollens forms, and two items for the "difficult" - "non-difficult"

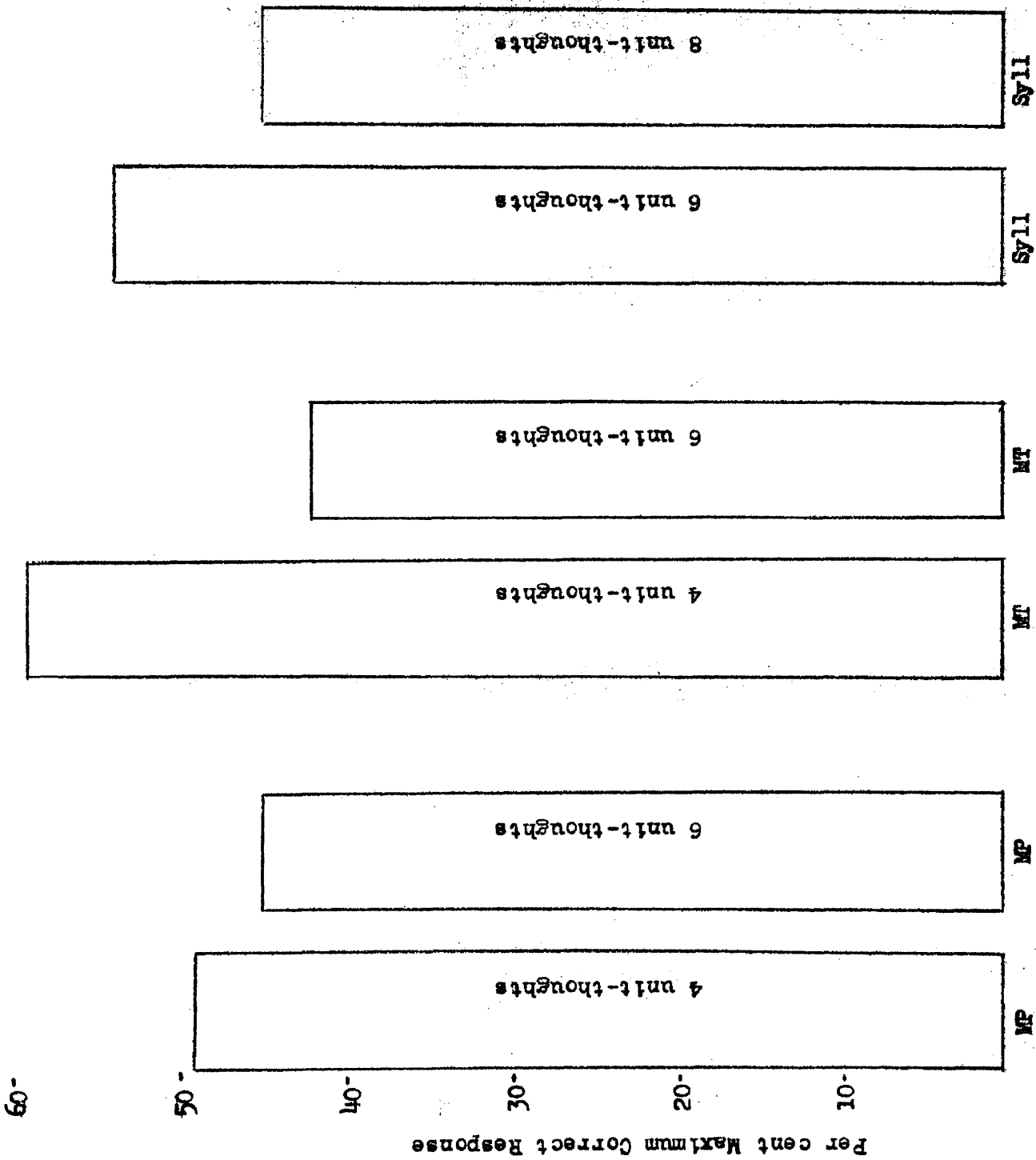
distributions. But, in any case, they are not offered as conclusive evidence for anything, but rather simply to indicate what the comparisons might be if these unreliable items had not been in the test of Study Three-II.

The significance value of 22.146 between the "difficult" and "non-difficult" items does indicate that something has been operating to upset the Modus Tollens distributions of Study Three-II. Probably the most important point of this is that I learned not to make the same mistake when I constructed my tests for Study Four.

Graph A, below, is a histogram which illustrates that there is a decrease in response to a given validity pattern when this pattern contains an increased number of ideas.

Specific conclusions that may be drawn from Study Three can be summarized as follows.

1. There was an increased difference in the number of correct responses for Syll in Study Three-I as compared with Study Two. In Study Two 50% of the Syll items were presented in the form of a 6-choice key. The testee was required to pick out the necessary premise. In Study Three all the items were of the "reasonable" - "not-reasonable" type. Therefore, the multiple choice item for Syll was more difficult to answer than the "reasonable" - "not-reasonable" type. The critical factor here would seem best explained in terms of the mind being able to discriminate sufficiently well between alternative choices offered to it. To explain it on the basis of probability is to assume the testees



GRAPH A. HISTOGRAM FROM DATA OF STUDY THREE SHOWING DECREASE IN RESPONSE TO VALIDITY PATTERNS HAVING AN INCREASE OF IDEAS

were guessing.

2. Increasing the number of ideas per validity pattern has the effect of decreasing the ability to use that pattern.

3. The use of a validity pattern by the mind is inhibited by ambiguity and words not understood. The MT (M) items (5,11) of Study Three-II were of this type. Thus, logical thinking is inhibited by these factors.

4. Reliability values for the test instruments of Study Three are given in Table X.

TABLE X
RELIABILITY VALUES FOR THE TEST INSTRUMENTS OF STUDY THREE

	part I	part II	part III
Syll	.3	.0	.2
MP	.3	.0	.4
MT	.0	-.1	.0

One of the purposes of Study Three was to find out just how few items were necessary to give reliable results. These low values indicate that the test instrument contained too few items per validity pattern. Therefore, we learned that our test instrument for Study Four must have a greater quantity than 8 items per validity pattern.

As was mentioned at the beginning of this chapter, one of the major contributions of this thesis was to produce data for the existence of validity patterns within the population. So far, all of the tests have

indicated this to be true. However, none of the previous tests have produced reliability (r) values within acceptable ranges. Yet, acceptable reliability values and evidence for validity patterns are mutually implicative propositions in the sense that to have one you must have the other. Thus, the production of a test instrument in Study Four that exhibited high reliability values was the second major contribution of this thesis to research of this type.

The test instrument of Study Four was based on the experiences and outright mistakes of the previous studies. Study One taught me that the free response (raw data) type of instrument was not suitable for Freshmen college students. In that type of test instrument the investigator tends to become an integral factor within the data in terms of interpreting the psychological intent of the testee. Study Two was my first attempt at the construction of a logical questionnaire. Here, I made the mistake of including multiple choice items within the test instrument. It is true that there is nothing intrinsically wrong with this approach but it constituted a variable other than validity patterns within the test instrument. This fact, of course, could not readily be foreseen prior to the actual giving of the test. I learned, here, not to include these items in Study Four. Also, the test instruments of both Studies Two and Three had very low reliability values. I attribute this fact to the low quantity of items employed per validity pattern.

The point is that in Study Four, I made use of the experiences and results of the previous studies in the hope of constructing a test instrument that would yield significant data. The fact that the test instrument employed in Study Four actually produced reliable data would seem

to establish the hypothesis underlying this thesis, namely, that certain validity patterns actually exist within the population.

Moreover, to establish further this hypothesis the test instrument was compared with three external factors, namely, scores for Reading Comprehension (RC), Verbal ability (V), and all college grade point averages (G.P.A.). These comparisons constituted the work of Study Five. They all showed positive relationships to the test instrument of Study Four, and, thus, helped to establish its validity.

While preparing the test instrument of Study Four, a preliminary testing program was conducted in three sections of students taking a course in Natural Science at Michigan State University. These sections contained about 30 students per section. The purpose was to determine a scoring formula which would yield the greatest reliability values for the test instruments. As a result of this preliminary study, the formula selected was Rights minus Wrongs. This formula makes allowances for guessing in that if a testee is guessing throughout, he should get a zero score, other things being equal. If a person does not know how to reason logically, he would have to guess on every item, and we would, accordingly, expect him to get a score of zero. Thus, the selection of a scoring formula which made allowances for guessing constituted a difference in this study from previous studies.

A second difference was a marked increase in the number of test items of given validity pattern, namely, 15 per form.

A third difference was a decrease in the size of the populations. In all parts of Study Four, populations sizes are over 94 but less than

132. In Study Three sizes of the populations went as high as 333 per test which is now felt to be unnecessary.

A fourth difference was to test the effects of validity patterns formulated in the predicative logic as compared with the propositional logic.

There were three parts to Study Four, some of them re-testing the major aspects of Study Three, viz.,

Part I, tests for propositional forms of MP, MT, and Syll with minimal ideas.

Part II, tests for predicative forms of MP, MT, and Syll.

Part III, tests for propositional MP, MT, and Syll with increased ideas.

In Part II, all the predicative forms involved a predication, thus, for all validity patterns everything was constant except the form.

With one exception, all the tests of Study Four indicated that there is a genuine difference in ability to use the three forms of inference MP, MT, and Syll. Evidence for this is given in Table XI.

TABLE XI

VALUES FOR SIGNIFICANCE BETWEEN THE MEANS FOR VALIDITY PATTERNS OF
STUDY FOUR

<u>Study Four-I</u> (propositional MP, MT, and Syll with minimal ideas)		
MP and MT	7.910	significant
MT and Syll	3.855	significant
MP and Syll	3.547	significant

<u>Study Four-II</u> (predicative MP, MT, and Syll)		
MP and MT	.520	not significant
MT and Syll	3.900	significant
MP and Syll	4.231	significant

<u>Study Four-III</u> (propositional MP, MT, and Syll with minimal ideas)		
MP and MT	10.557	significant
MT and Syll	4.607	significant
MP and Syll	5.070	significant

Thus, all of the comparisons in Table XI, except one, indicate a difference in ability to use the three validity patterns involved. The lone apparent exception to this conclusion is the comparison between the means of the predicative MP and MT forms in Part II.

Perhaps the explanation of this lies in the fact that the construction of tests for predicative forms involve fewer words than do the

tests for propositional forms. Thus, although the mechanics of predicative logic is able to treat ideas in greater detail than the propositional logic, it requires less verbal signals to explicate predicative forms, at least to the point that their difference in form would be statistically hidden.

The data in Table XII indicate that the order of mental ability to use the propositional forms of validity patterns is MP, Syll, and MT, while the order for predicative forms is MP, MT, and Syll.

TABLE XII

COMPARISON OF MEANS OF THE DISTRIBUTIONS OF STUDY FOUR

	propositional (M) forms from Part I	predicative forms from Part II	propositional (I) forms from Part III
MP	9.495	9.931	9.885
MT	5.358	9.672	4.712
Syll	7.505	7.718	7.269

In Table XII, the possible explanation for the change in sequence in the predicative forms as compared with the propositional forms is that it requires less words, or verbal signals, to explicate a given validity pattern in the predicative logic than it does to explicate this same pattern in the propositional logic. Thus, for a given validity pattern, when this pattern is tested for in the propositional logic, the pattern must take complete declarative statements (propositions) as arguments. Consequently, it takes more words, or verbal signals, to express these statements than it does to test for the same form in the

predicative logic.

Historically, this was the very reason why the predicative logic was developed. Many logical arguments, which actually are invalid in the propositional logic, can be shown to be valid by using the tools of the predicative logic.

All of the reliability (r) values for the 9 tests of Study Four were strong enough to conclude that the tests were measuring what they were supposed to measure, namely, validity patterns. These values are given in Table XIII.

TABLE XIII
RELIABILITY VALUES FOR THE TESTS OF STUDY FOUR

	Part I	Part II	Part III
MP	.788	.870	.721
MT	.783	.821	.835
Syll	.831	.848	.840

Thus, the reliability values shown in Table XIII are quite respectable. We may conclude that increasing the number of items per test to 45 had the effect of increasing the variance of the populations. Since high reliability values are directly correlated with variance, the reliability values above may be accounted for by the increase in number of items to 15 per form per test.

Of particular interest is the results of the tests for significance between the propositional forms of Part I and these same forms having an increased amount of ideas (Part III). See Table XIV. None of them showed

that there was any "real" difference in ability to use a given form. In other words, it suggests that if a person possesses a form, increasing the number of different minimal ideas by one will not interfere with ability to use that form.

TABLE XIV

STATISTICS OF STUDY FOUR SHOWING VALUES FOR SIGNIFICANCE BETWEEN THE MEANS OF CORRESPONDING VALIDITY PATTERNS WITH MINIMAL IDEAS (M) AND INCREASED IDEAS (I)

Modus Ponens (M) and Modus Ponens (I)	.801	not significant
Modus Tollens (M) and Modus Tollens (I)	1.230	not significant
Syllogism (M) and Syllogism (I)	.403	not significant

The conclusion to be drawn from Table XIV is that there is no "real" difference in the ability to use a given form having minimal and increased ideas. At least, this appears to be true with regard to increasing the number of different minimal ideas by one, which we did in this test. In other words, the data here suggest that if a person possesses a given form, increasing the number of ideas by one will not interfere with ability to use that form.

Whether increasing the number to two different ideas per form (or three, etc.) will cause a difference in response is a problem for future research. It is noted, however, by observation of these particular tests, especially those of Part III, that the increased number of words, or verbal signals, for each test item would be a critical factor in such a study. Therefore, there would always be doubt as to whether the difference

(when obtained) would be caused by (a) the ability to use the form with an increase of ideas, or (b) simply difficulty in wading through the amount of words required to express the increased ideas.

Also, it is noted that the results of Study Four (Table XIV) contradict the same comparisons of Study Three (Table V). This is explained by two facts: some of the items of Study Three were statistically determined to be poor items, and secondly, there were too few items employed per validity pattern in Study Three such that the test instruments did not give reliable results.

One of the purposes of Study Four was to test the effects of validity patterns formulated in the predicative logic and to compare these with the propositional forms. The results of these comparisons are given in Table XV.

TABLE XV

VALUES FOR SIGNIFICANCE BETWEEN THE MEANS OF PROPOSITIONAL FORMS (STUDY FOUR-I) AND PREDICATIVE FORMS (STUDY FOUR-II)

Propositional MP and Predicative MP	.832	not significant
Propositional MT and Predicative MT	8.680	significant
Propositional Syll and Predicative Syll	.380	not significant

Thus, the data in Table XV suggest that if a person possesses a given validity pattern, expressing this pattern in either predicative or propositional logic is of no consequence. The apparent exception to this is the MT form. It would be fairly difficult to determine in a

quantitative manner the reason why the MT form should make a difference. I rather suspect, however, that it has something to do with the difference in number of verbal signals in these forms coupled with the fact that the MT validity pattern involves the process of negating the consequence of one of the premises.

At this point I would like to present three graphs (B, C, and D). These graphs illustrate what may be somewhat picturesquely described as the rationality curves of Study Four. Each graph is a distribution of the total scores that the testees obtained on the three validity patterns MP, MT, and Syll.

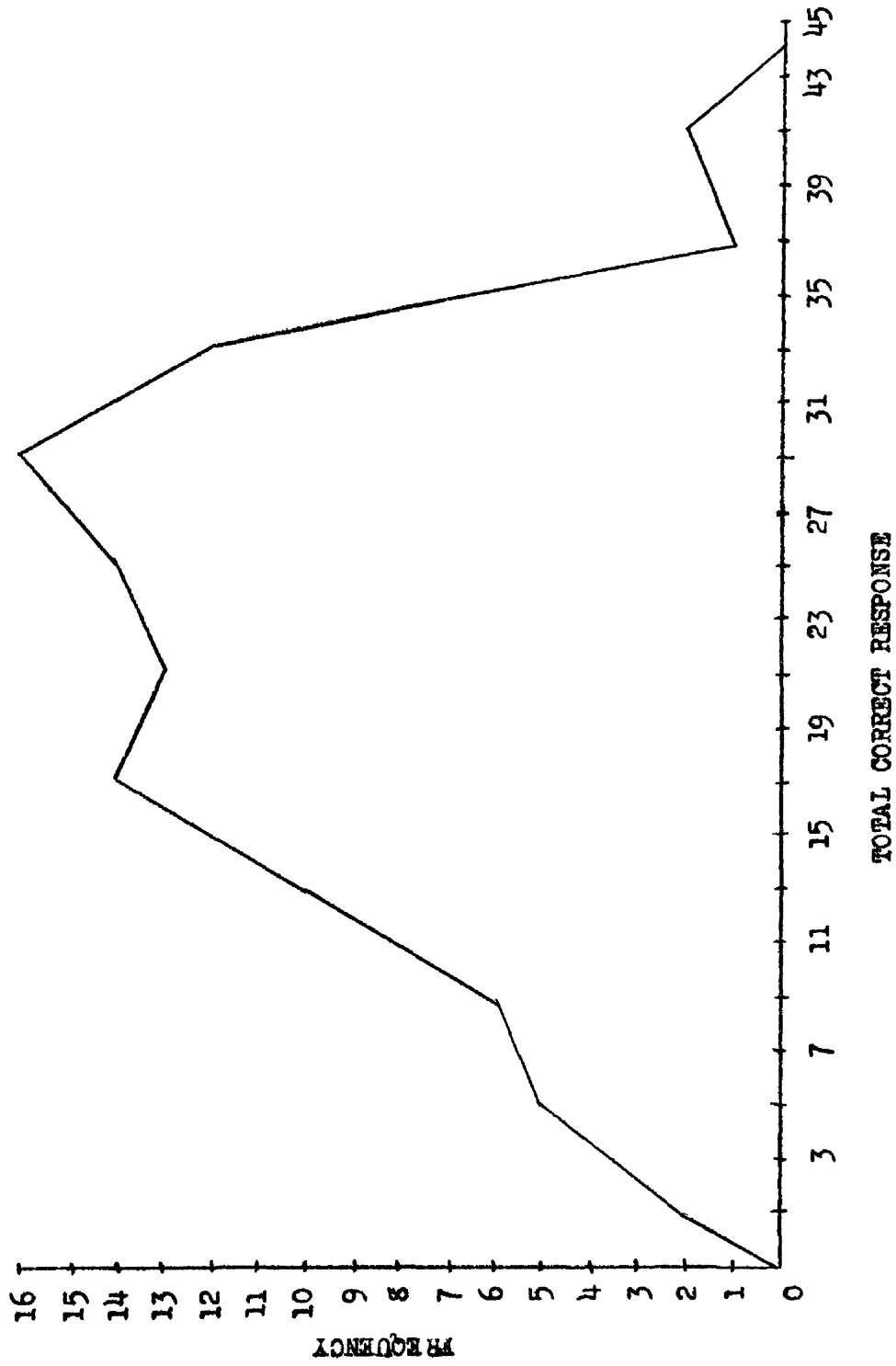
The graphs B, C, and D provide us with a collective picture of the presence of the three validity patterns MP, MT, and Syll within the populations tested. Thus, they indicate the degree of ability to think logically within the scope of these three patterns. More than this, however, the curves will provide us with a singular basis of comparison with other populations, for example, mental patients.

The means of the distributions shown in Graphs B, C, and D are presented in Table XVI. The comparisons indicate that the predicative forms are more prevalent within the populations than the propositional forms.

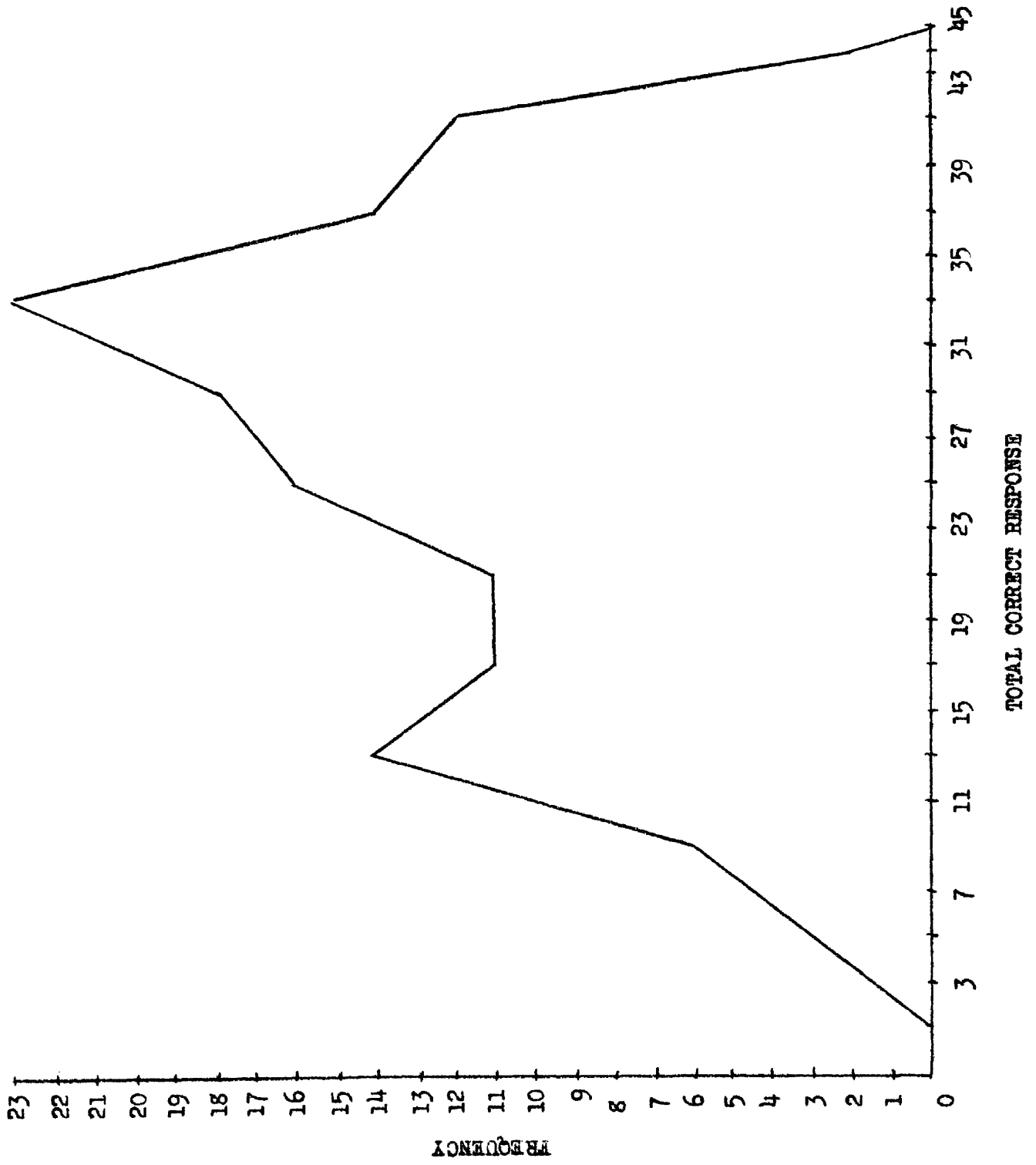
TABLE XVI

COMPARISON OF MEANS OF RATIONALITY DISTRIBUTIONS OF STUDY FOUR

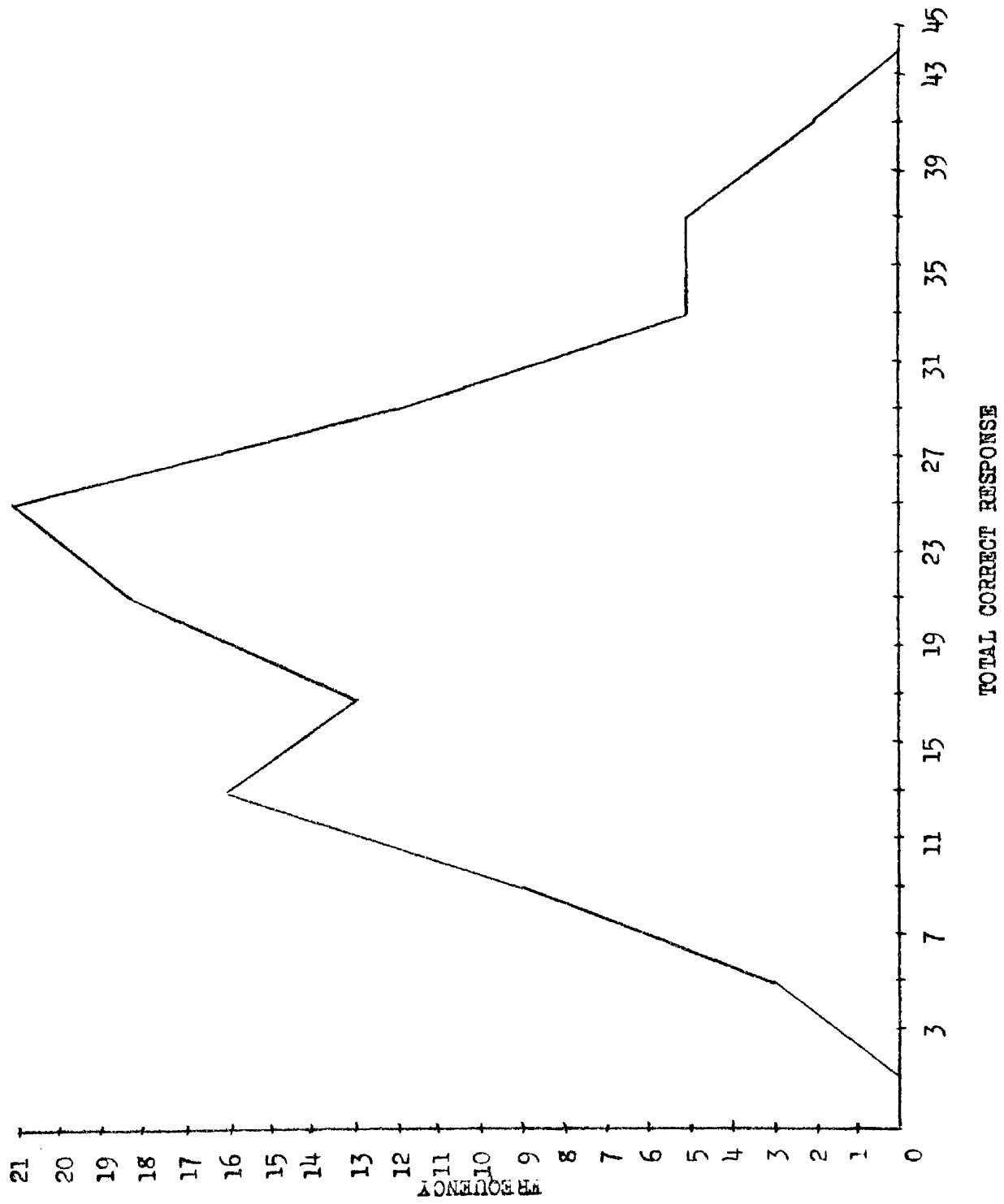
propositional (M) forms	propositional (I) forms	predicative forms
22.358	21.875	27.328



GRAPH B. RATIONALITY CURVE FOR PROPOSITIONAL (M) FORMS OF STUDY FOUR-I



GRAPH C. RATIONALITY CURVE FOR PREDICATIVE FORMS OF STUDY FOUR-II



GRAPH D. RATIONALITY CURVE FOR PROPOSITIONAL (I) FORMS OF STUDY FOUR-III

One of the most important ways to determine the value of a test instrument is in terms of its predictability. And, if this is true, a logic test is not unlike a theory in that you prove its merit in terms of its confirmable consequences. It was just for this very reason that three such predictions and their outcome were included in this thesis. This was the work of Study Five. Study Five was included primarily to determine if the test instrument developed in Study Four had any predictive value.

Specifically, if the logic tests provided in this thesis are reliable, what implications do they hold for general reading comprehension, verbal ability, and the ability to achieve good grades in college? One would hypothesize that if these tests have merit, then there should be a positive relationship between a person's ability to exhibit validity patterns and (a) his reading comprehension, (b) his verbal ability, and (c) his ability to achieve high grades in college. Moreover, the corollaries of these relationships should also be positive. That is, there should be positive relationships between low logic scores and each of these abilities. Therefore, our predictions were that these relationships would hold, and, in so doing, we would be providing outside checks for the value of the test instrument developed in Study Four.

Two groups of students were selected from the logic test administered in Study Four-II of this research, namely, those having high logic scores and those with low logic scores. Tests for significance were computed for each group for

- (a) Reading Comprehension (RC),
- (b) Verbal Ability (V), and

(c) Grade Point Averages (GPA).

The source of the reading comprehension and verbal ability scores were from the Michigan State University entrance examinations that all students take when entering school. The tests involved were the MSU Reading Test (Reading Comprehension) and The College Qualification Test (Verbal Ability). The grade point averages were obtained from the grade records of students recorded at the Administration Building at Michigan State University.

The logic test upon which the tests for significance was made was taken from Study Four-II. Only those students with an average of 87% or better on all three forms were selected for the "High Logic Group", while only those with an average of 33% or less on all three forms were selected for the "Low Logic Group".

I employed the instrument dealing with the predicative forms because they seemed to be more universally prevalent within the population than the propositional forms (as the means of Table XVI indicate). Also, the reliability values were slightly higher for this instrument than were the values for Parts I and II (Table XIII).

The fundamental question is this: do those people who do better on the logic test also do better on the RC and V tests, and get better grades, as compared with those students who get lower logic scores? If they do, then it can be said that there is a positive relationship between ability to exhibit validity patterns and reading comprehension, verbal ability, and grade point averages. If a person gets a high logic score, he will likely be high in these other factors. If he gets low logic scores, he will likely be low in these other factors.

In the High Logic Group there were a total of 16 students. Two students were omitted from this group - one because he had no scores for the RC and V tests, and a second because there was no name on his answer sheet of the logic test.

In the Low Logic Group there were a total of 21 students. Two students were omitted from this group - one because he was a transfer student, and a second because he had no scores for the RC and V tests. The examiners of the RC and V tests state that the scores for transfer students "must be interpreted with caution." As a matter of fact, beginning with the tests for Fall Term 1958, transfer students were not used in setting the norms of these tests.

The RC and V scores are derived scores and ranked from 1 to 10. This scale is interpreted to mean that a person with a score of 9, for example, ranks at a position such that 96% of the Freshmen at MSU would have a lower score. Derived scores less than 9 would have corresponding lesser percentages.

Table XVII compares the means of the two logic groups relative to the RC, V and GPA scores achieved by the students within these groups.

TABLE XVII

COMPARISON OF MEANS OF RC, V, and GPA SCORES ACHIEVED BY HIGH AND LOW LOGIC GROUPS

RC mean of High Logic Group	6.875
<u>RC mean of Low Logic Group</u>	4.714
V mean of High Logic Group	6.973
<u>V mean of Low Logic Group</u>	4.762
GPA mean of High Logic Group	2.745
GPA mean of Low Logic Group	1.888

The data in Table XVII provide evidence for showing that a positive relationship exists between ability to think logically and (a) ability for reading comprehension, (b) verbal ability, and (c) ability to achieve a grade point average around 2.75. In terms of the grading system employed at Michigan State University, this value is in the upper C grade range.

The corollary to this was also shown, namely, that there was a positive relationship between a lack of ability to think logically and (a) ability for reading comprehension, (b) verbal ability, and (c) the attainment of a grade point average around 1.89. This last value is in the upper D grade range.

To determine whether the differences between the mean values given in Table XVII were meaningful, tests for significance were calculated and the results are given in Table XVIII.

TABLE XVIII

VALUES FOR SIGNIFICANCE BETWEEN THE MEANS OF RC, V, AND GPA SCORES
ACHIEVED BY HIGH AND LOW LOGIC GROUPS

Significance value for RC means	4.493	significant
Significance value for V means	4.013	significant
Significance value for GPA means	4.869	significant

By determining the significance between the means of RC, V, and GPA scores achieved by the High and Low Logic Groups (Table XVIII) evidence is provided for establishing a positive relationship between

ability to think logically and

- (a) ability for reading comprehension,
- (b) verbal ability, and
- (c) grade point averages.

Thus, the predictions that were made upon the basis of the test instrument of Study Four were confirmed, and in so doing, provide outside checks for establishing the merit of the instrument per se. Because if these comparisons had turned out otherwise, specifically, if the differences between the means had turned out to be not significant, then little could be said for the discriminatory ability of the test instrument by failing to show a significant difference in the means of high and low logic groups for RC, V, and GPA scores, as well as failing to establish a positive comparison of the results of the instrument with the results of other long established tests.

Thus, the "chips were down", so to speak, when these predictions were made. The fact that they were confirmed provides evidence for the merit of the test instrument.

At this point, I would like to present a discussion - which is offered as an hypothesis - for the existence of only three laws of thought, namely, MP, MT, and Syll.

There are two reasons for presenting this discussion at this time: first, because I am sure it must seem peculiar to some that my test instruments only employed the three validity patterns MP, MT, and Syll, and secondly, because historically the three laws of thought have always been taken to be the laws of contradiction, identity, and excluded

middle. By the following discussion I hope to provide justifiable reason for supposing that the MP, MT, and Syll validity patterns may be the only "laws of thought", and that the laws of contradiction, identity, and excluded middle stand as governing principles to logical thinking instead of "laws of thought" per se.

The fundamental unit of any reasoning process is the implication sign with its two arguments. Thus, in thinking activity concerned with inferential activity (that is, reasoning), as distinct from other types of thinking, namely, judgment and conception, always there is present some implicative proposition. Always there appears to be one unit-thought implying some other unit-thought. Thus, $P \supset Q$, where P and Q are general or particular, unique or complex.

Moreover, there appears to be only certain things which can happen to this sequence of unit-thoughts from the standpoint of valid inferential activity.

- (a) its antecedent can be affirmed,
- (b) its consequence denied, or
- (c) its consequence implies some third unit-thought.

Thus, these constitute the fundamental forms of valid inference. And where complex arguments are entertained by the Self, any or all of these forms may be employed to arrive at a given conclusion.

To explicate this point physically, the tool of symbolic logic may be used. A word of caution is in order, however, in that one does not confuse the artificial logistic manipulation of the symbols with the mental activity they are intended to portray.

In logic, there are standard procedures for solving certain proofs:

Case I (where we wish to replace one element of a sequence by its implicate in a second sequence)

to prove: $A \supset B \supset C$

given: $A \supset B \supset D$

and $D \supset C$

proof

1. $A \supset B \supset D$ premise
2. $D \supset C$ premise
3. $D \supset C \supset : B \supset D \supset . B \supset C$ substitute $D/q, C/r, B/p$
in $q \supset r \supset : p \supset q \supset . p \supset r$
4. $B \supset D \supset . B \supset C$ from 1 and 3, MP and Inference
5. $A \supset B \supset C$ from 1 and 4, Syll and Inference

Case II (where we wish to replace one element of a sequence by its implicant in a second sequence)

to prove: $A \supset B \supset C$

given: $A \supset D \supset C$

and $B \supset D$

proof

1. $A \supset D \supset C$ premise
2. $B \supset D$ premise
3. $B \supset D \supset : D \supset C \supset . B \supset C$ substitute $B/p, D/q, C/r$
in $p \supset q \supset : q \supset r \supset . p \supset r$
4. $D \supset C \supset . B \supset C$ from 2 and 3, MP and Inference
5. $A \supset B \supset C$ from 1 and 4, Syll and Inference

The point in illustrating these two cases is that they are standard

forms of procedure or methods in arriving at desired conclusions of a great many logical proofs. There are many variations of these standard forms. But, notice that all of them involved two particular patterns of valid inference, namely, those forms we call MP and Syll.

This fact of there being three major forms of valid inference was brought out when I tried to test for the transposition law ($P \supset Q, \sim Q \supset \sim P$). As the items were all similar in form, a sample will illustrate the point:

If grasshoppers don't have creatine phosphate in their muscles, then they are not chordates.

Question: Does this mean that if they are chordates, then they have creatine phosphate in their muscles?

The form of inference involved here is actually MT, viz.,

$$\begin{array}{c} \sim P \supset \sim C \\ C \\ \hline P \end{array}$$

But notice - and this is to the point - even if the form was as follows

$$\begin{array}{c} \sim P \supset \sim C : \supset : C \supset P \quad (\text{transposition law}) \\ \sim P \supset \sim C \\ \hline C \supset P \end{array}$$

the form of inference would actually be an instantiation of MP.

Thus, the test for the autonomy of the three forms of inference used in this thesis appears to be negative in the sense that nobody has

produced examples to the contrary. The only defense is that we have no idea what it would be like to think inferentially except in accordance with these forms.

If this hypothesis is borne out in future research, it implies that these forms are the true laws of thought - as testified by the fact that they (at least one) must be present for any inference to take place. Any other law used in logical thinking - where an inference is involved - apparently always takes one of the valid forms of inference above.

This implies further that the so-called "laws of thought", historically speaking, contradiction, identity, and excluded middle, would actually, and formally, be a part of the metalanguage of any inferential activity of the mind.

Finally, this hypothesis implies that what are known in logic as definite laws are actually variations made upon the initial singular implication sign from which these three forms of inference may operate.

But, yet, in apparent contradistinction to the above hypothesis regarding just three forms of inference (MP, MT, and Syll), according to Russell and Whitehead, inference follows this pattern:

where $P \supset Q$ is asserted as true, and P is asserted as true,
we may then assert Q as true

This would imply that the forms of inference MT and Syll, viz.,

$\begin{array}{c} P \supset Q \\ \\ \sim Q \\ \hline \sim P \end{array}$	and	$\begin{array}{c} P \supset Q \\ \\ Q \supset R \\ \hline P \supset R \end{array}$
--	-----	--

would not be forms of inference at all, rather the laws of these would have to be present before inference could occur, that is,

$$P \supset Q \cdot \sim Q : \supset : \sim P$$

$$P \supset Q \cdot \sim Q$$

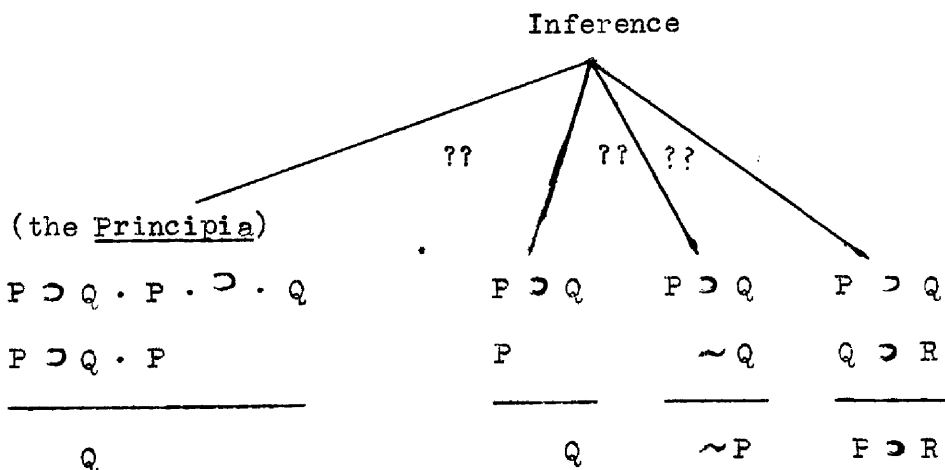
etc.

$$\sim P$$

But, yet, John Cooley does speak of MP, MT, and Syll as being definite forms of inference.

According to the Principia, therefore, the forms above of MT and Syll would not be forms of inference.⁵⁸ But, according to Cooley they would.⁵⁹

But, for all of this, the psychological problem is which way does the mind work in practice, that is, does it infer in the formal way of the Principia - actually laying out the laws - or does it use the forms that Cooley speaks about? Obviously, this problem is not easily answered. What is at stake here is a consistent definition of inference. As it stands now we have something like this:



⁵⁸ Whitehead and Russell, op. cit., pp. 8-9.

⁵⁹ John C. Cooley, A Primer of Formal Logic. (New York: The Macmillan Company, 1949), p. 14.

In terms of this thesis we have assumed the position of the Principia, and it is because of this that we have spoken of MP, MT, and Syll interchangeably as referring to the forms of inference and their respective laws. In the test items we have used only the three forms, while assuming the existence of the law in the mind of the testee.

Moreover, it is granted that the entire question is somewhat recondite, but this alters in no way its necessary answer for any significant psychology. What has to be done is to construct a test which would empirically discriminate a given law from those unit-thoughts within the law when the latter are considered apart from the law.

In summary, the data of Studies One through Four showed confirmation of the hypothesis regarding the existence of validity patterns. The patterns specifically tested for in this thesis were those particular kinds employed in logical thinking, and otherwise known as valid forms of inference.

Each of the studies represented steps toward the final development of a test instrument that produced evidence considered to be reliable. Three predictions were made from this instrument to establish further its merit.

By indicating the existence of valid forms of inference, the basic research had been provided for confirming the hypothesis that communication of ideas from one mind to another is a function of various validity patterns existent in those minds. It is clear that before one can speak about validity patterns relevant to communicable discourse, empirical evidence must be existent regarding such patterns. This research has produced such evidence.

Specifically, what has been shown is that certain deductive forms of inference are existent in the population. For the problem of communication, this evidence is most encouraging. Because if the evidence had turned out to be otherwise, that is, if it had shown that these forms of inference were not significantly prevalent in the population, then the hypothesis regarding the nature of communication would have been negated. For it is our contention that the communication of ideas from one mind to another takes place via deductive systems-of-thought, and, validity patterns, of course, constitute the basis of such systems.

CHAPTER V

THEORY

In this chapter I would like to show the relationship of the above data to the theoretical frame of reference from which is directed the entire research program.

Thus far, I have stated my position to be that language, communication, and validity patterns are inextricably related. The working hypothesis of this thesis has been that the linguistic communication of ideas is contingent upon various validity patterns, the latter of which are asserted as constituting the very vehicles of transmission of ideas. It was these "vehicles" that we were after in the work of this thesis.

The task now, however, is (a) to state a few general remarks about the theory, (b) to state formally the theory, and (c) to show subsequently where the data of this thesis confirm certain aspects of it.

It is called the BET Theory.⁶⁰ Because it is offered as an explanation of the mind, it is a theory of psychology. As a psychological theory, its uniqueness lies in the fact that it treats of the mind as a psychical entity composed of organized patterns of discrete ideas. These organized patterns exhibit a single generalized sequence described as SMT. Discrete ideas or their organized patterns are reflected in the physical world by language.

Thus, the BET Theory assumes that there exists a mind, that a

⁶⁰ Lawson, op. cit., Chapter two.

physical world exists outside of mind, that language is a part of this physical world, and that an analysis of language should yield evidence of the organized patterns which the discrete ideas partake of in the mind. Such an analysis, therefore, constitutes the basic working hypothesis of this theory.⁶¹

In the BET Theory an "idea" is conceived as a "static unit-thought" having the property of an unchanging entity. We realize, however, in declaring this definition, that there are many other hypotheses regarding the nature of ideas. For example, Brand Blanshard lists eight points of view held by eminent people concerning them, viz.,⁶²

1. The copy theory, or ideas as images. (Locke, Berkeley, and Hume).
2. Ideas as sensations. Abstract ideas, beliefs, emotions, desires are all reducible to sensations. (B. Russell).
3. Ideas reduced to reactions of the body (behaviorism, or identity-materialism).
4. Ideas as instruments to practical ends (pragmatism).
5. Ideas as "mental acts" (thoroughgoing realism).
6. Ideas as essences (critical realism).
7. Ideas consist of three aspects; images, content, and meaning. (F. H. Bradley).
8. Ideas as partially realized purposes (Brand Blanshard).

For my part, I am not sure I appreciate the logical distinction between all of these, but, in any case, the sole point in listing them

⁶¹ Ibid., pp. 1, 2.

⁶² Blanshard, op. cit., Volume I, Book II, Chapter 15.

is simply to show, in their number, that not much is really known about the nature of ideas.

For us, ideas (or unit-thoughts) are static, possess being, are absolute. An idea at time t_1 is identical with its recollection at time t_2 , contingent only upon the fallibility of the memory. The phrase "changing of one's ideas" can only significantly mean the adoption of a new and different idea (or belief) regarding the same subject matter, as in "I used to believe such and such ($idea_1$) about so and so, but now I believe this and that ($idea_2$) about so and so." It is hoped that by observing the consequences of this definition of idea, within the framework of the BET Theory, we will come to a better understanding regarding them.

Also, "ideas" apparently can be organized or grouped according to their degree of abstraction or order, as, for example, the concept of "relation" would be of a higher order than the concepts holding argument position in a given relation. "Salmonella" is an argument to the relational predicate "bacteria", as in "Salmonella are bacteria."

In the BET Theory, the mind comprises a system which includes (at least)

1. A "place" where active thoughts and patterns of unit-thoughts are given attention by the intellect,
2. Unit-thoughts (ideas), (in this theory the term "idea" is used synonymously with "unit-thought"),
3. A "Self", and
4. A memory which stores unit-thoughts and patterns of same.

The "Self", in the words of the founder of this theory, "introduces a non-mechanical element into what is otherwise essentially a mechanical model. Whether someone in the future can remove this non-mechanical element remains to be seen."⁶³ Properties of the Self would include consciousness or awareness, and co-ordination.

For purposes of analysis, the mind may be thought of as consisting of three parts, viz.,

Mind I - this is the residence of active thoughts. They are designated SP, S^m, or S, etc., depending on their source.

Mind II - this is the memory, the "place" of storage of unit-thoughts and the patterns of same.

(Mind III - this refers to generalized unit-thoughts. Thus, it is not to be considered as a "place" of residence as are Minds I and II. Generalized unit-thoughts are derived by the process of abstraction from particulate unit-thoughts by the Self).

The primary purpose of this division is to direct attention to the "place" of residence of given unit-thoughts, and is, accordingly, an arbitrary division.

Still another way to describe the situation would be as follows:

Mind I - this is where the intellect contemplates unit-thoughts.

Thus, all unit-thoughts here are said to be active.

The sources of these active unit-thoughts are

⁶³ Lawson, op. cit., p. 18.

1. from perceptions (designated SP, MP, TP), or
2. from memory (designated S^m, M^m, T^m, S, M, T)

Mind II - this is the memory; the storage "place" of unit-thoughts.

These unit-thoughts may be

1. particular, or
2. general.

(Mind III is not formally posited)

Those unit-thoughts which arise as a result of an immediate perception are called "immediately-perceived-thoughts" (IPT). These are stored in that part of the mind called memory, and they may be shuffled within the mind to produce new unit-thoughts that may or may not have any reference to past perceptions; and these latter, when the object of attention of the intellect are designated accordingly as "active thoughts".

Thus, the mind consists of at least two parts, intellect and memory. And the two sources of active thoughts are sensory stimulation, that is, some neurophysiological excitation, and memory. The inclusion of the memory as a source of active thoughts means, of course, that all such thoughts are not from perceptions. Memory thoughts are tagged with a superscript "m" if they describe a particular sequence of particular events, and are without superscripts if they describe a particular sequence of general events.

Also, the mind consists of unit-thoughts. Unit-thoughts, when actively considered by the intellect, are called "active thoughts." There are two sources of active thoughts, viz., (a) perceptions, in which case the active thoughts are called "immediately-perceived-thoughts" (IPT), and (b) memory.

Unit-thoughts may be "ordered" in two ways, viz.,

1. by abstraction, (the ordering here always involves the memory either by (a) with reference to particular unit-thoughts within memory, or (b) with reference to some generalized unit-thought within memory), and
2. by temporal sequence (ordering in this case refers not to the logical abstraction of ideas but to the time sequence in which active thoughts are experientially existent in the mind).

This second type of ordering is hypothesized as forming a particular generalized pattern in the mind, no matter whether the source of the active thoughts are from (a) perceptions, or (b) memory. This pattern, without the superscripts indicating their source, is symbolized as

$$S \rightarrow M \rightarrow T$$

where "S" refers to the initial active thought in some sequence of active thoughts, "M" refers to that (or those) active thought which follows "S" in time, and "T" refers to that (or those) active thought which follows "M" in time.

Thus, this second type of ordering is offered as an hypothesis of the manner in which ideas are actively considered by the mind relative to each other. Active thoughts always have conscious existence, in the sense that they are the immediate object of attention by the self.

Because there are two sources of active thoughts, they may be distinguished from each other in terms of these sources. Those elicited

from memory may be tagged S^m or S, etc., and those caused by perceptions may be tagged SP , etc.

Thus, the SMT sequence is hypothesized as the temporal sequence by means of which unit-thoughts are actively considered by the mind. Because active thoughts are from two sources, perceptions and memory, they can be tagged as above. Moreover, any given temporal sequence may have mixtures as to the sources of the active thoughts, viz.,

$$SP \rightarrow M^m \rightarrow T^m, \quad S^m \rightarrow MP \rightarrow T^m, \quad SP \rightarrow M \rightarrow T, \text{ etc.}$$

The concept of abstraction is regarded as a mental process the product of which is a new kind of unit-thought. It involves the separation or isolation of a part from a larger whole, and the unit-thoughts which result therefrom are said to be universal or general - as opposed to the particulate unit-thoughts from which they were derived.

Because the process of abstraction is performed by the Self on unit-thoughts in the mind, it presumably is a conscious activity, and, therefore, occurs in Mind I. However, particular unit-thoughts, which are the objects of abstraction, may originate - as all unit-thoughts - either from perceptions or memory.

Therefore, the general unit-thoughts found in Mind II are the result of an abstractive process which has occurred in Mind I and subsequently stored in Mind II. Those particulate unit-thoughts found in Mind II represent simply the stored equivalents of some previous particulate active thought. But for all of this, the process of abstraction is recognized as basically the problem of induction. The presumption

here offered is stated simply as a working hypothesis.

Mind III serves as a useful concept in the delineation of possible orders among unit-thoughts. The significant point is that it contains those generalized unit-thoughts which are derived by activity of the Self on particular unit-thoughts, whatever may be their point of origin, memory or perception.

Thus, formally speaking, Mind I is that region where unit-thoughts are considered by the Self and such thoughts are designated active thoughts. As always, active thoughts may be from two sources, memory or perception. Also, the process of abstraction, as a conscious activity by the Self, occurs here in Mind I.

Mind II is that region where active thoughts are stored, and thus, when stored, are called, simply unit-thoughts. Such unit-thoughts are of at least two kinds, particular or general. They are particular if they represent the stored equivalent of some non-generalized unit-thought (that is, they are particular if they are not general), and they are general if they are the products of abstraction.

Mind III, because it refers simply to different logical orders or classes of unit-thoughts, and because the unit-thoughts of Mind III may exist in either Mind I or II at any given time, cannot be construed in the same sense as Minds I and II. Mind III simply designates different orders of unit-thoughts whose specific source is the process of abstraction. Thus, there are now seen to be at least three sources of active unit-thoughts: perception, memory, and abstraction.

Abstract unit-thoughts are organized in two ways, viz.,

1. according to type theory, when given relative to each

other, and

2. into deductive systems-of-thought.

(A "system-of-thought" is a coherent, orderly arrangement of ideas or beliefs regarding some given subject. A "system-of-explanation" is a system-of-thought expressed in terms of symbols, usually words).

The consideration of deductive systems-of-thought relative to BET Theory means that abstract unit-thoughts are organized by the Self into different systems with respect to differences in subject matter.

Thus, because the original source of all unit-thoughts is presumed to be the physical world via IPT's, while even recognizing that these in turn may be the source of other unit-thoughts, namely, those resulting from abstractions, it is further presumed that the contents of these systems-of-thought will vary from person to person, depending on the physical and cultural environment in which the person is born and develops. Therefore, not only would different environments be the immediate cause of differences in systems-of-thought from one person to another, but, also, these differences may result from differences in perceptual apparatus of people within the same environment.

It is understood that any classification of these systems-of-thought would be arbitrary. But, as in the case of classifying abstractions into Mind III, such a classification is useful if for no other reason than being able to analyze those specific patterns of SMT's which are elicited by some given active thought.

The classification system that we are employing in this research has been that of Paul Schrecker's.⁶⁴ In the BET Theory the six categories

⁶⁴ Cf., p. 2, Chapter I.

of ideas that Schrecker speaks of are designated as taxonomic-deductive systems, or, simply, systems-of-thought.

If the SMT sequence is true, then the following phenomena of the mind should be explained in terms of it and in the manner here indicated. Specifically, it should explain

1. Prediction,
2. Error,
3. Explanation.

Prediction

Given SP as referring to the total picture given through perceptions:

Case I.

If the particular sequence of events had been experienced before, then

$$SP \rightarrow (S^m \rightarrow M^m \rightarrow T^m)$$

Where

S^m = a similar SP in memory

M^m = the memory of the succeeding motion of what happened in this case

T^m = the memory of the end result

Case II.

If these particular events had not been experienced before although situations of this general type had been, then

$SP \rightarrow (S \rightarrow M \rightarrow T)$ where



generalized situations
of the type SP

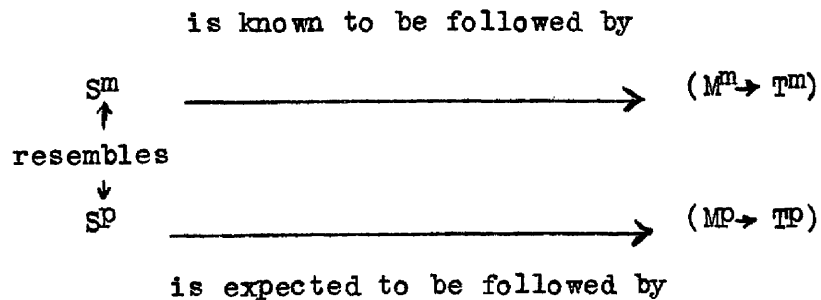
Case III.

If there were no particular or general previous experiences, then no prediction is possible.

In either Case I or II, the partial sequence $M \rightarrow T$ is called the prediction part of the total temporal sequences $SP \rightarrow (S^m \rightarrow M^m \rightarrow T^m)$ and $SP \rightarrow (S \rightarrow M \rightarrow T)$.

Prediction, therefore, is something like an analogy. In regards to particular unit-thoughts from memory, the analogy would appear as follows:

SP resembles S^m , that is, identical with it, and S^m is known to be part of the temporal sequence $(S^m \rightarrow M^m \rightarrow T^m)$. Thus, SP is predicted to have the temporal sequence $SP \rightarrow [MP \rightarrow TP]$, or, in other symbolism,



Thus, $M^m \rightarrow T^m$ directs the expected sequence of active thoughts resulting from the IPT, SP , namely, $[MP \rightarrow TP]$, where $[MP \rightarrow TP]$ is the predicted

succeeding sequence in time.

Note that $\overline{MP \rightarrow TP}$ is a predicted future state. Also, all the active thoughts at time t_1 originate from memory except SP. Thus, at time t_1 , $SP \rightarrow MM \rightarrow TM$. But, $MM \rightarrow TM$ is the predicted temporal sequence of SP which was elicited from memory by external events still going on. If these predicted events actually occur, then a temporal sequence of $SP \rightarrow MP \rightarrow TP$ will exist in the mind at some future time, say t_2 . At time t_2 , $\overline{MP \cdot MM}$ and $\overline{TP \cdot TM}$, where the operator " $\overline{\quad}$ " refers to a comparison of these two ideas by the Self. If they are the same, then our prediction that the sequence $\overline{MP \rightarrow TP}$ will follow SP is confirmed. If they are different, that is, if $TP \neq TM$, then our predicted sequence was in error.

Still another way to view prediction relative to the SMT ordering mechanism is as follows:

At time t_1 the only active thoughts before the intellect are SP and

$SM \rightarrow MM \rightarrow TM$

Since SP is what produced SM, it is presumed that SP is a valid substitution instance of SM. This can be symbolized exponentially, viz.,

$\overline{SM \rightarrow P} \supset \overline{(M^{MP} \rightarrow T^{MP})}$, where $\overline{SM \rightarrow P} = \overline{SM} \cdot \overline{SP}$,

$\overline{M^{MP}} = \overline{M} \cdot \overline{MP}$,

$\overline{T^{MP}} = \overline{T} \cdot \overline{TP}$, and the

results of the predicted comparisons are expected to be positive.

Note that the unit-thoughts MP and TP are not existent in the mind at t_1 , therefore, these particular comparisons cannot be made at t_1 . Nonetheless, S^m and SP are existent, and this comparison, $\overline{S^m + P}$, has already been made and affirmed positively (rightly or wrongly).

Therefore, the mental specification of $\overline{(M^m + P \supset T^m + P)}$, based on the affirmed similarity of S^m and SP , is, in effect, a prediction of a future state. It is expected that these comparisons, when made at time t_2 , will also turn out positively. If they do, then the prediction is confirmed; if not, then not.

Note that M^p and T^p are not ordinary IPT's. In fact, they are not IPT's at all - at time t_1 . Rather, the active thoughts at t_1 are $\overline{M^m \cdot M^p}$ and $\overline{T^m \cdot T^p}$. The comparison operator " " is what refers MP and TP to future time, namely, t_2 . The Self must await t_2 before making the comparison, and M^p and T^p , in $\overline{M^m \cdot M^p}$ and $\overline{T^m \cdot T^p}$, simply indicate the source of the expected IPT's.

This interpretation of prediction shows the logical form involved to be as follows:

$$\begin{array}{ccc} \left[S^m \supset (M^m \supset T^m) \right] & \cdot & SP : \supset : \quad (\overline{M^m + P} \supset \overline{T^m + P}) \\ \underbrace{\hspace{1.5cm}} & & \underbrace{\hspace{1.5cm}} \\ P \supset Q & \cdot & P : \supset : \quad Q \end{array}$$

In logic this is called the Modus Ponens law. It is one of the validity patterns we sought after in this thesis.

The Mechanism of Error

(the illustrations use, as examples, particular unit-thoughts from memory)

In $S^{\overline{m+P}} \rightarrow M^{\overline{m+P}} \rightarrow T^{\overline{m+P}}$, let $\overline{T^{\overline{m+P}}}$ be negative at t_2 . This means that $T^{\overline{m}} \neq TP$, and that the original temporal sequence $S^{\overline{m}} \rightarrow M^{\overline{m}} \rightarrow T^{\overline{m}}$ which gave rise to the prediction was not the correct sequence for the TP actually experienced; that is, the $S^{\overline{m}} \rightarrow M^{\overline{m}} \rightarrow T^{\overline{m}}$ sequence and the $S^P \rightarrow M^P \rightarrow TP$ sequence were recognized as not being identical in that $T^{\overline{m}} \neq TP$. Thus, $S^{\overline{m}} \rightarrow M^{\overline{m}} \rightarrow T^{\overline{m}}$ was not the correct sequence of active thoughts for this prediction.

This interpretation of error shows the logical form involved to be as follows:

$$\begin{array}{ccc}
 S^{\overline{m}} \cdot \supset \cdot M^{\overline{m}} \supset T^{\overline{m}} : SP : \supset : & \overline{M^{\overline{m+P}}} \supset \overline{T^{\overline{m+P}}} : & \\
 \underbrace{\hspace{10em}}_P & \supset & \underbrace{\hspace{10em}}_Q \\
 \\
 \sim (\overline{M^{\overline{m+P}}} \supset \overline{T^{\overline{m+P}}}) :: \supset :: & \sim (S^{\overline{m}} \cdot \supset \cdot M^{\overline{m}} \supset T^{\overline{m}} : SP) & \\
 \underbrace{\hspace{10em}}_{\sim Q} & : \supset : & \underbrace{\hspace{10em}}_{\sim P}
 \end{array}$$

In logic this is called the Modus Tollens law. It is another one of the validity patterns sought after in this thesis.

The same idea can be expressed in a more compendious manner as follows:

$$\begin{array}{c}
 \overline{S^{M+P}} \supset \overline{M^{M+P}} \supset \overline{T^{M+P}} : \supset : \overline{T^{M+P}} : \sim TP \therefore \supset : \\
 \underbrace{\hspace{10em}} \\
 P \qquad \supset \qquad Q \qquad \cdot \sim Q \therefore \supset : \\
 \\
 \sim (S^{M+P} \supset \overline{M^{M+P}} \supset \overline{T^{M+P}}) \\
 \\
 \sim P
 \end{array}$$

The SMT sequence as an explanation of explanation

Explanation is defined as the mental specification of some as yet non-active S and M (in some SMT sequence), relative to some active thought, namely, TP, TM, or T. When the sought after S and M become genuine active thoughts in the SMT sequence, then explanation is said to have been accomplished.

For example, some active thought, TP, is said to be explained when it lies in consequence of other active thoughts, S and M, in the temporal sequence $S \rightarrow M \rightarrow TP$.

BET Theory and Validity Patterns

In this section I would like to show how the validity patterns obtained in the data of this thesis relate themselves to the BET Theory, and, in so doing, provide evidence for the theory itself.

Since reasoning is a function of valid forms of inference (validity patterns), the task is to show how these forms of inference appear in terms of the SMT sequence. The relationship is given as follows:

S = the unit-thoughts in the antecedent of some valid form of inference.

M = the forms of valid inference. These are also unit-thoughts, but necessarily are the products of abstractions and, thus, are generalized.

T = the unit-thoughts in the consequence of some valid form of inference.

The act of inference is made by the Self. It is, therefore, non-mechanical. In terms of the form of inference involved, the consequence of this form contains or carries those unit-thoughts which become our expectations due to the very existence of the form itself. What this means in particular is that through the force of the very vehicle of communication, namely, the form of inference involved, some T, which is the idea to be communicated, becomes our expectation.

Accordingly, in terms of SMT, communication, and validity patterns, our formula is revised to appear as

$$S \begin{array}{c} \cdot \quad \cdot \\ \cdot \quad \cdot \\ \cdot \quad \cdot \\ \cdot \quad \cdot \\ \cdot \quad \cdot \\ \cdot \quad \cdot \end{array} T$$

where our M is the method or means of going from S to T. Thus, M is implicit in the sense of not appearing in the formula. But, yet, under formal analysis, the M must appear as being the very vehicle for passage by the mind from S to T, where S and T are complex.

An example

$$P \supset Q \cdot P : \supset : Q$$

where the P's and Q's represent unit-thoughts. But note the form by means of which Q is detached (through inference by the Self) is also a unit-thought, namely, some M, viz.,

$$\underbrace{" _ _ _ \supset \cdot _ _ _ : \supset : " }_M$$

Thus, M is a generalized unit-thought which has a meaning of its own.⁶⁵

Whether M actually exists consciously within the active mind (Mind I) is a moot question, just as is the same question, as applied to any $S_m \rightarrow M_m \rightarrow T_m$. Specifically, the Self does make judgments, comparisons, and abstractions in thinking activity while basing these judgments, comparisons, and abstractions many times upon only hazy, vague, and indiscrete unit-thoughts. Moreover, such unit-thoughts as the latter many times have as their sole explicated referents such things spuriously described as feelings and habits.

However, even though this may be true, it is also noted that when a person is asked to produce more explicitly the rationale (unit-thought) implicit within any given utterance unit he attempts to do so with reference to some pattern, specifically, some M that he has judged as being valid - whether it really is or not. Therefore, to deny the existence in BET Theory of such things as feelings and habits would be as fallacious as asserting they were the objects per se of communicable discourse.

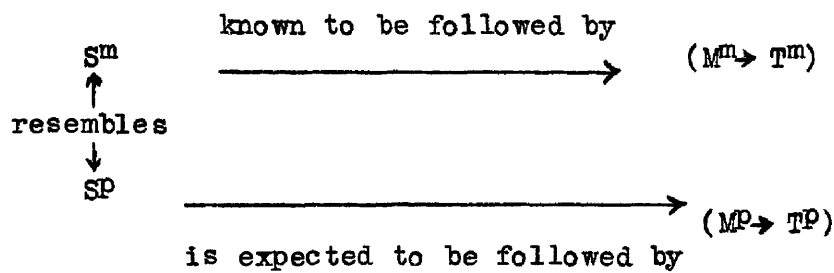
⁶⁵ C. R. Morris, Idealistic Logic. (London: Macmillan and Company, 1933), p. 26.

Susanne Langer, Introduction to Symbolic Logic. (New York: Dover Publications, Inc., 1953), pp. 23-29.

Black, op. cit., p. 44.

More interesting is the question regarding the relationship of the type of prediction involved in the communication of a unit-thought via a form of valid inference, and the type of prediction involved when comparing two SMT sequences, one from memory, the other from perceptions. The answer to this question is given as follows:

Case I. Prediction by comparing two SMT sequences.



that is,

$$\begin{array}{ccc}
 \underbrace{[S^m \supset (M^m \supset T^m)]}_{P \supset Q^1} & \cdot \quad SP : \supset : & \underbrace{(M^{m+p} \supset T^{m+p})}_{Q^2} \\
 \underbrace{\hspace{10em}} & & \underbrace{\hspace{10em}} \\
 \text{(existent in mind at } t_1) & & \text{(predicted to exist in mind at } t_2)
 \end{array}$$

Note that there is no violation of type here as might be presumed when construing the meanings of S^m and SP , M^m and MP , T^m and TP in terms of their symbols. The psychological fact is that the referents for S^m and SP , etc., are active thoughts, and, moreover, that they are identical, at least presumed so, rightly or wrongly, by the Self. The superscripts, as always, merely indicate the sources of the unit-thoughts.

If Q^2 prevails at t_2 , then its antecedent is strengthened as a belief. If Q^2 is false, its antecedent is weakened.

Case II. Prediction via forms of valid inference.

Prediction, here, is identical to Case I above, as is shown by the generalized unit-thought involved, that is, as is shown by its valid form of inference, viz.,

$$[S^m \supset (M^m \supset T^m)] \quad . \quad SP \quad : \supset : \quad (M^{\overline{m}+P} \supset T^{\overline{m}+P})$$

$$\underbrace{\quad \supset \dots \cdot \quad \quad : \supset : \quad \dots \quad ,}$$

this is the vehicle or form, the particular M involved in this prediction. Thus,

$$\begin{array}{ccc} S & \begin{array}{c} \cdot \quad \cdot \\ \cdot \quad \cdot \\ \cdot \quad \cdot \\ \cdot \quad \cdot \\ \cdot \quad \cdot \end{array} & T \\ \text{(complex)} & \begin{array}{c} \cdot \quad \cdot \\ \cdot \quad \cdot \end{array} & \text{(complex)} \end{array}$$

Explanation in terms of validity patterns and BET Theory

Given Case I or II above, explanation is said to have taken place within a given mind (that is, for some person) when the unit-thought T lies in necessary consequence to some complex S in the SMT derivative

$$S \begin{array}{c} \cdot \quad \cdot \quad \cdot \\ \cdot \quad \cdot \quad \cdot \\ \cdot \quad \cdot \quad \cdot \\ \cdot \quad \cdot \quad \cdot \\ \cdot \quad \cdot \quad \cdot \end{array} T.$$

Summary statement

By showing the existence of the validity patterns known as Modus

Ponens and Modus Tollens, the data offer evidence for the mechanisms of prediction and error.⁶⁶

By showing the existence of these two validity patterns, as well as the Syllogism pattern, the data offer evidence for the mechanism of explanation.

⁶⁶ Cf., pp. 108-109, Chapter VI.

CHAPTER VI

THE DIRECTION OF FUTURE RESEARCH

In the course of doing this research there arose several interesting problems which were not immediately connected with the basic task, but, nonetheless, were generated by it. Whenever certain results gave rise to such problems I wrote them down. My list came to 35. What I want to do is not to list all of these, but rather to list their three general areas.

1. In the field of communication (of ideas), the fundamental task is to determine quantitatively which basic laws of logic are involved in the successful communication of ideas. This thesis, of course, is directly related to this basic work. If our results had not shown that a positive relationship existed between the forms of inference we tested for and the RC, V, and GPA scores, future research along these lines would appear to be fruitless.

One point that needs to be mentioned (in regard to the value of logic in thinking and communication) is the many varied opinions on this subject. For example, some opinions would be expressed as "of course logic is positively related to thinking and communication, this is what we would expect to find." But, yet, others believe that "logic is nothing more than a game", or "most forms of logic being primarily deductive in character have little in common with science." But, in either case, I see no evidence that would substantiate either type of opinion.

If successful communication is really a function of deductive systems-of-thought, as is indicated in this thesis, this means that evidence must be forthcoming regarding such systems relevant to given disciplines of study. The existence of the forms of logic tested here, while promising, do not prove the nature of the disposition of a given idea. The ideas possessed by an individual regarding a given subject matter may be existent in the mind in an unorganized (non-logical) frame-of-reference. My hypothesis is that any given idea, in terms of understanding, must exist in some deductive system-of-thought. But, again, where is the evidence for this hypothesis?

Moreover, I would suppose that many people think the latter hypothesis, too, is obvious. But, if it is so obvious, why is not there any evidence to prove it? A. N. Whitehead makes the point somewhere that analysis of the obvious is the most difficult thing there is. I believe him. And, maybe this difficulty is why there is little evidence for these deductive systems-of-thought.

Therefore, the direction of future research in communication theory is to provide further evidence for

- (i) the existence of such hypothesized systems-of-thought, and
- (ii) to show the relationship between that system held by some speaker as related to some interpreter's system and the amount of communication of ideas accomplished thereby.

While investigating the literature dealing with these future problems regarding communication, I was particularly impressed by a publication of Philip J. Runkel. Dr. Runkel's paper comes the closest to my own

hypotheses regarding the nature of communication, and it is for this apparent similarity in our philosophies that I include brief sketches of his work at this time.

Runkel's paper is entitled "Cognitive Similarity In Facilitating Communication."⁶⁷ Runkel defines "cognitive field" as designating the possibilities of response, and "the total communicative process as an interaction between cognitive fields."⁶⁸ Thus, for Runkel, "communication" refers to the interaction between the possibilities of response.

If we overlook the ambiguity of this definition for the moment it is of some interest to consider a section of Dr. Runkel's paper, viz.,⁶⁹

It follows from this view that communication cannot fruitfully be conceived as a sequence in which self-contained packets of information are exchanged. It is not a process in which one person merely adds to the belongings of another by "giving" him information.

It is rather a kind of guessing game. Each person carries with him his cognitive field as a map of the world. He responds not to the world, but to the map. When the communication fits readily, one's confidence in his map of the world is increased.

Since the effects of a communication depend on the manner in which it "meshes" with an existing cognitive map, we might entertain the notion that these effects will take place more readily when the cognitive maps of the communicators are similar in structure. In fact, the general

⁶⁷ Philip J. Runkel, "Cognitive Similarity In Facilitating Communication," Sociometry, Volume 19, Number 3, September, 1956.

⁶⁸ Ibid., p. 178.

⁶⁹ Ibid., pp. 178-179.

hypothesis of this paper is that similarity of structure between two cognitive fields increases the efficacy of communication between them.

In its general form, this hypothesis is no doubt as old as communication. The contribution of this paper to the problems of communication lies not in the general terms of the problem chosen for study, but rather in the forms [emphasis mine] by means of which quantification has been applied to similarity of cognitive structure. In the present study, the particular index which furnishes operations for assessing similarity of cognitive structure is one which I have labeled "co-linearity" and which will be explained below.....

When two communicating individuals utilize the same underlying attribute in forming their judgments, we shall say that their orientations are co-linear. When they utilize attributes which would give at least some conflicting judgments, we shall say that their orientations are non-co-linear.

Runkel's test instrument consisted of 5 statements, presented in groups of three, of which the testee was instructed to mark the statement with which he most agreed and the statement with which he least agreed.

Runkel gave his test to 5 different groups of students taking introductory psychology at the University of Michigan. He gave the same test to the five teachers of these students. Each teacher's rank order was then compared with the rank order given by each of his students, and the teacher student pair was then categorized as co-linear or non-co-linear. The hypothesis was that students co-linear with the teacher

would get higher grades on quizzes than students non-co-linear with the teacher. This hypothesis was supported by the results.

Except for one important ambiguity in Dr. Runkel's definition of "cognitive field" I see nothing incompatible between our two approaches to the nature of communication. The ambiguity is as follows.

The term "cognitive" implies "idea" or some mentation of the mind. Thus, "cognitive field" implies some ideational complexity. However, Runkel defines "cognitive field" as "possibilities of response" or "the set of all potential responses which the individual might at some moment make toward stimulus A or a set of stimuli containing stimulus A." Now, if Dr. Runkel restricts these "responses" to linguistic utterances, then I see his work as being consistent. The necessary assumption here is that language reflects ideas.

However, if he permits physical behavior of any other sort to be included within the category of "responses", then he has committed a fallacy. This would assume that the mind-body problem had been solved, and, of course, it would be incumbent of Dr. Runkel to show data on this. But I saw nothing in his study, other than this ambiguity, that would logically permit me to imply that he did commit this fallacy. I was really quite delighted to find his paper, for I have the feeling that his "co-linearity" concept is not unrelated to validity patterns, and that his "multidimensional response spaces" are related to systems-of-thought, and that persons who are "co-linear" (or "on the same line" as he says) communicate more readily due to similarity of validity patterns within these systems-of-thought.

2. In the field of education, the general problem is to investigate formally the relationship among discourses which are logical, indeterminate, or illogical and the successful communication of a given idea by the lecturer. This, of course, is directly related to the above problem in communication theory. It differs, however, in its implications for consistency in a given lecture. How important is consistency for the successful communication of a given idea? Are grades more a reflection of the ability of students to adopt the patterns of thought - logical, indeterminate, or illogical - of the instructor than mastery of the subject matter?

All of us have had professors "whose mind seems to wander", who seems to be inconsistent", or "are hard to understand". My hypothesis is that the problem is basically a logical one. The task is to test this hypothesis.

Therefore, the direction of research here is to gather data on

- (i) specific lectures, that is, get verbatim transcripts
 - of specific lectures intended to convey specific ideas,
- (ii) test the lecturer for specific logical laws,
- (iii) test the students for specific logical laws, and
- (iv) compare all three of these factors in terms of
 - (a) the successful communication of the ideas involved,
 - and
 - (b) grades received by the students. Specifically,
 - what relationship exists between the grades of a student who possesses certain logical laws and this student's lecturer who does not possess them?

In conjunction with the results of Study Five, where a comparison was made of logic scores and RC, V, and GPA, a follow-up study should be made to provide evidence for answering the following questions:

- (a) What is the relationship of those students who performed well on the logic test and their success in their chosen field of study? For example, toward the end of their Senior year, of those students who went into Zoology, what is the relationship between their high logic score and their GPA for courses in Zoology? for all-college GPA?
- (b) Will further refinement of the test instrument in terms of adding additional logical laws be more discriminatory for RC, V, and GPA?
- (c) How well would graduate students of various departments perform on given logic tests (with appropriate subject matter)? How would biology graduate students compare with psychology or education graduate students?

3. In the field of mental health, the basic problem involves an analysis of various systems-of-explanation (or belief) held by committed mental patients. This aspect of the research, for my part, gets to the very heart of the psychological theory involved. Any theory of mind, including the BET Theory, is measured only in terms of its testible consequences. And, whereas communication theory and educational psychology are, themselves, implications from the BET Theory (and, hence, their verifiable consequences help establish the BET Theory), those implications regarding the pathological forms of mind provide the acid

tests of the theory per se. Even as genetic abnormalities are in part explained by chromosomal aberrations, so it is that psychological abnormalities may be explained by logical aberrations. For my part, the strongest test that can be made of a theory is its ability to maintain consistency within the scope of apparently contradictory facts. When all else is said and done, these contradictions must be explained.

Furthermore, those psychological theories which explain the nature of mind in terms of sex or various neurophysiological aspects of the central nervous system manifestly have not been fruitful in curing mental illness. Electroshock, insulin shock, hydrotherapy, psychoanalysis, etc., seem to work on some patients but not on others. Today, there is apparently no way of predicting whether any one treatment is going to work for any given patient; and even if one should work, nobody knows why.

It is because of this state of affairs, perhaps, that the term "insanity" is largely a matter of legal definition. And, in view of this, it would seem self-evident that a different hypothesis ought to be offered and investigated regarding the nature of mind.

Therefore, the direction of research in terms of the BET Theory is to investigate the significance of applied logic as related to committed mental patients.

It is understood that mental patients are many times very logical in their thinking. But, yet, patients are primarily, if not solely, committed on the basis of their contradictory behavior with the accepted systems-of-behavior of their society. The perennial problem in mental illness has always been to resolve these two systems within the mind of the patient.

Specifically, the initial data must be on

- (i) the discourses of committed mental patients (I speak, of course, in regard to those patients who are capable of communicating),
- (ii) analyses regarding such data as to both logical structure and truth-value of primitive propositions, and
- (iii) analysis of what happens when certain of their primitive propositions (thought to be true) are successfully communicated to them as being false.

One may well ask if this approach could only result in a variation of the "talk cure" (or psychoanalysis). The answer - in absence of evidence - is not known. However, the primary virtue of this method is that it does have an objective standard, namely, logical forms, which, in violation of, patients are committed.

BIBLIOGRAPHY

BIBLIOGRAPHY

Adler, Mortimer, "The Questions Science Cannot Answer," Bulletin of the Atomic Scientists, 12, No. 9, November, 1956.

_____, editor in chief, The Great Ideas, A Syntopicon of Great Books of the Western World. Chicago: Encyclopaedia Britannica, Inc., 1952.

Black, Max, Critical Thinking. New York: Prentice-Hall, Inc., 1947.

Blanshard, Brand, The Nature of Thought. London: The Empire Press, 1948.

Burton, A. and W. Joel, "Adult Norms for the Watson-Glaser Tests of Critical Thinking," Journal of Psychology, 19, January, 1945.

Chant, S. N. F., "An Objective Experiment On Reasoning," American Journal of Psychology, 45, April, 1933.

Cassirer, Ernst, The Philosophy of Symbolic Forms: Language. New Haven: Yale University Press, 1953.

Chen, Han-Fiao, "Studies On Thurstone's Reasoning Tests," Journal of Genetic Psychology, 50, 1937.

Cooley, John C., A Primer of Formal Logic. New York: The Macmillan Company, 1949.

Feigl, Herbert, "Logical Empiricism," Readings in Philosophical Analysis. New York: Appleton-Century-Crofts, Inc., 1949.

Frank, Phillip, Modern Science and Its Philosophy. Cambridge: Harvard University Press, 1949.

Fries, C. C. J., The Structure of English. New York: Harcourt, Brace and Company, 1952.

Gaier, E. L., M. C. Lee, and L. L. McQuitty, "Response Patterns in a Test of Logical Inference," Educational and Psychological Measurement, 13, 1953.

Garrett, Henry E., Statistics in Psychology and Education. New York: Longmans, Green and Company, 1947.

Hobbs, Albert H., Social Problems and Scientism. Harrisburg, Pennsylvania: The Stackpole Company, 1953.

Jones, D. C., A First Course in Statistics. London: G. Bell and Sons, Ltd., 1921.

Kant, Immanuel, Kritik der reinen Vernunft. Berlin: Mayer and Muller, 1889.

Lawson, Chester A., Language, Thought, and the Human Mind. East Lansing: Michigan State University Press, 1958.

Lefford, Arthur, "The Influence of Emotional Subject Matter On Logical Reasoning," Journal of General Psychology, 34, April, 1946.

Maier, N. R. F., "Reasoning and Learning," Psychological Review, 38, July, 1931.

_____, "Reasoning in Rats and Human Beings," Psychological Review, 44, September, 1937.

_____, "Reasoning in Humans: I. On Direction," Journal of Comparative Psychology, 10, April, 1930.

_____, "Reasoning in Humans: II. The Solution of a Problem," Journal of Comparative Psychology, 12, August, 1931.

_____, "Reasoning in Humans: III. The Mechanisms of Equivalent Stimuli and of Reasoning," Journal of Experimental Psychology, 35, October, 1945.

Mellone, Sydney H., An Introductory Text-book of Logic. London: William Blackwood and Sons, Ltd., 1950.

Morgan, W. J. and A. B. Morgan, "Logical Reasoning: With and Without Training," Journal of Applied Psychology, 37, No. 5, October, 1953.

Morgan, A. B., "Sex Differences in Adults On a Test of Logical Reasoning," Psychological Reports, No. 2, 1956.

_____, "Differences in Logical Reasoning Associated With Age and Higher Education," Psychological Reports, No. 2, 1956.

Reichenbach, Hans, The Rise of Scientific Philosophy. Berkeley and Los Angeles: University of California Press, 1951.

Repucci, L. C., "Do You Think Straight," Detroit Free Press, Sunday Magazine, November 20, 1955.

Revised Stanford-Binet Scale. Chicago: Houghton Mifflin Company, 1937.

Runkel, Philip J., "Cognitive Similarity in Facilitating Communication," Sociometry, 19, No. 3, September, 1956.

Schrecker, Paul, Work and History. Princeton, New Jersey: Princeton University Press, 1948.

Thorndike, Edward L., Theory of Mental and Social Measurements. New York: Teachers College, Columbia University, 1919.

Werkmeister, W. H., Philosophy of Science. New York: Harper and Brothers, 1940.

_____, The Basis and Structure of Knowledge. New York: Harper and Brothers, 1948.

_____, Critical Thinking. Lincoln, Nebraska: Johnsen Publishing Company, 1949.

Whitehead, Alfred North and Bertrand Russell, Principia Mathematica. Cambridge: Cambridge University Press, 1950.

APPENDIX

Type A

QUESTIONNAIRE

INSTRUCTIONS: This questionnaire aims to find out, in a general way, what you remember about some of the ideas which were presented to you last term in NS 181. In particular, this questionnaire concerns itself with the ideas about heredity.

Although we would like to have you sign your name, you will not be graded on this questionnaire. The remarks you make will not influence your grade in any manner whatsoever.

In one of the lab studies last term, one of the ideas we wanted to communicate to you was that one underlying the mechanism of dominance and recessiveness of some genes. By way of supplying evidence to support this idea a pedigree chart was presented in the manual. This chart (Figure A) has been given below.

The trait in question is either dominant or recessive, and not a blending characteristic. What you are asked to do is to explain why individual II-3 must be recessive.

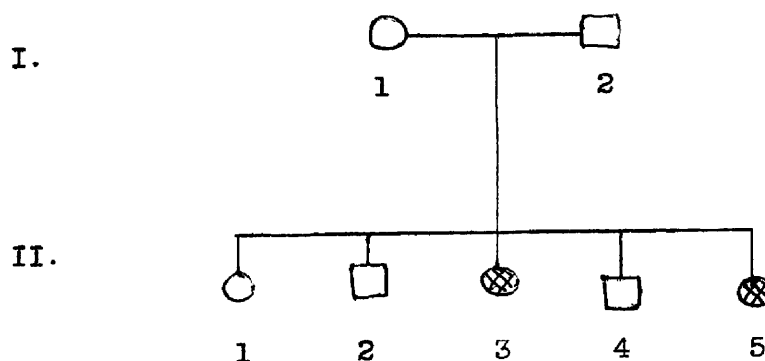


Figure A

EXPLANATION:

Type B

QUESTIONNAIRE

The problems stated below are designed to help us find out some things about our methods of teaching you a few ideas about Natural Science this past year.

We all know that some of you get A's for the course while some of you get lower than A's. We apparently communicate to a very high degree with those of you who receive A's, and correspondingly, communicate to a lesser degree with those of you who receive less than A.

We want to find out if there is something in our manner of presentation which would possibly account for this variation in communication.

Although we would like to have you sign your name, you will not be graded on this questionnaire. The remarks you make will not influence your grade in any manner whatsoever.

Because of our almost constant exposure to the subject matter of Natural Science, we are sometimes inclined to make statements which appear reasonable to us, but yet appear unreasonable to you. We feel that the degree of correspondence between what we take to be reasonable discourse and what you take to be reasonable discourse is directly proportional to the amount of communication which is taking place.

DIRECTIONS:

1. Please do not mark on these questionnaires.
 2. When you finish, turn in both question sheet and answer sheet.
 3. Try to answer each question void of personal opinion.
- .

For questions 1 through 15, consider each set of statements as complete units of discourse. If you think the point being made is presented in a reasonable manner, blacken your answer sheet in the first space. If you think the point being made is presented in an unreasonable manner, blacken the second space.

1. Since a "fault" is any surface of the earth along which movement has taken place, it follows that if we did not have such a fractured surface a fault would not be present.

Is the above reasonable or not?

2. If we actually knew that the earth was spherical, and if we also knew that this implied that it was flat, we could deduce that the earth was flat.

Is the above reasonable or not?

3. Supposing it were a fact that no one who believes in evolution was an atheist and that some people who did believe in it were clever people, it would follow that there are some clever people in this world who are not atheists.

Is the above reasonable or not?

4. The grasshopper is not in the phylum chordata because if an animal does not have creatine phosphate in its muscles - and the grasshopper doesn't, then that animal is not a chordate.

Is the above reasonable or not?

5. Since environmental resistance always decreases the slope of a growth curve, it follows that there is no environmental resistance when we have an increase in the slope.

Is the above reasonable or not?

6. Penicillin is expensive because it is hard to produce, and all things which are hard to produce are expensive.

Is the above reasonable or not?

7. Any argument worthy of logical recognition must be such as would occur in ordinary discourse. It will be found that no argument in ordinary discourse is found in newspapers. Hence, no argument found in newspapers is worthy of logical recognition.

Is the above reasonable or not?

8. If men believe in evolution, then they will not show reverence for those matters which are beyond their understanding. However, in classes in Natural Science some instructors often show reverence for such matters. Therefore, it is clear that some instructors do not believe in evolution.

Is the above reasonable or not?

9. If philosophers are inquisitive people, then Socrates is inquisitive.

Is the above reasonable or not?

10. Some fools speak the truth; whoever speaks the truth deserves to be imitated; therefore, there are some who deserve to be imitated who are nevertheless fools.

Is the above reasonable or not?

11. If students had good taste, then they would not read the State News in lecture. But since some students do read the State News in lecture, it follows that they, in particular, lack good taste.

Is the above reasonable or not?

12. Animals having a dorsal and ventral side are bilaterally symmetrical. Some crayfish have dorsal and ventral sides, and since all crayfish have an areola, it follows that some things which are bilaterally symmetrical also have an areola.

Is the above reasonable or not?

13. People who haven't been here very long can't be expected to know their way around, therefore, Freshmen can't be expected to know their way around.

Is the above reasonable or not?

14. Since amphibia are cold-blooded, no amphibia can be mammals if cold-blooded animals are not mammals.

Is the above reasonable or not?

15. If there's a will there's a way and if there's no way, then there's no will.

Is the above reasonable or not?

For questions 16 through 25, a few statements are given which are followed

by a question. If you think the answer to the question is "yes," then blacken space one on your answer sheet. If "no", then blacken space two.

16. If life is possible on Mars, the planet has warmth sufficient for protoplasmic metabolism; but the planet does not have sufficient warmth.

Question: According to these remarks, is life possible on Mars?

17. Even if the theory of evolution is true, there can still be a God; and the facts do seem to support the truth of the theory.

Question: According to these remarks, can there still be a God?

18. If the myriapods are protozoa, then they will be unicellular and microscopic. They are not unicellular.

Question: Are the myriapods protozoa?

19. If ignorance is bliss, 'tis folly to be wise; and ignorance is bliss.

Question: Does this imply that it is folly to be wise?

20. If every man has his limitations, then intelligent people are occasionally confused. Sam admits that he has his limitations.

Question: Does it follow that Sam is occasionally confused?

21. If every species tends to increase indefinitely, the earth would be covered by a mass of animal life; but the earth is not so covered.

Question: According to this, does it follow that every species does not increase indefinitely?

22. If science furnishes useful facts or if its study exercises the reasoning powers, it is worthy of being cultivated; and since it is true that it both furnishes useful facts as well as exercise the reasoning powers, does it not logically follow that it is worthy of being cultivated?

23. If the presence of segments implies the existence of what is known as "metameres," and if the ascaris does not have these metameres, can we validly assert that the ascaris does not have segmentation?

24. If men are immoral or irreligious, then they will be happy here but punished hereafter. Men are immoral.

Question: Do the above statements logically imply that these men will be punished hereafter?

25. If black is dominant to white, then a black cat crossed with a white

cat should yield offspring with black coats. But supposing this did not happen.

Question: In this particular case, could we say that black is not dominant to white?

For questions 26 through 30, you are asked to identify unstated assumptions in an argument. If the number corresponding to the assumption you choose for an argument is listed after the argument, then blacken that number on your answer sheet. If the letter is not listed, then blacken the number "seven" space on your answer sheet (which will indicate "none of these.")

ASSUMPTIONS FOR QUESTIONS 26 through 30

1. "Primitive animals are sexual."
 2. "Sexual animals are primitive."
 3. "Sexual animals have appendages."
 4. "Primitive animals have appendages."
 5. "Animals with appendages are sexual."
 6. "Animals with appendages are primitive."
26. "Animals with appendages are sexual for it is well known that they are primitive."
Requires assumption 1, 2, 3, 4, 7 (none of these)
27. "Since animals with appendages are always sexual it follows that they are primitive."
Requires assumption 2, 3, 4, 6, 7 (none of these)
28. "I know all primitive animals are sexual because they invariably have appendages."
Requires assumption 1, 3, 4, 5, 7 (none of these)
29. "If a sexual animal is primitive then he certainly has appendages."
Requires assumption 1, 4, 5, 6, 7 (none of these)
30. "Of course primitive animals have appendages - being sexual they can't help it!"
Requires assumption 1, 2, 4, 5, 7 (none of these)

Type B
(Study Three-I)

QUESTIONNAIRE

The problems stated below are designed to help us find out some things about our methods of teaching you a few ideas about Natural Science.

We all know that some of you will get A's for the course while some of you will get lower than A's. We apparently communicate to a very high degree with those of you who receive A's, and correspondingly, communicate to a lesser degree with those of you who receive less than A.

We want to find out if there is something in our manner of presentation which would possibly account for this variation in communication.

Although we would like to have you sign your name, you will not be graded on this questionnaire. The remarks you make will not influence your grade in any manner whatsoever.

Because of our almost constant exposure to the subject matter of Natural Science, we are sometimes inclined to make statements which appear reasonable to us, but yet appear unreasonable to you. We feel that the degree of correspondence between what we take to be reasonable discourse is directly proportional to the amount of communication which is taking place.

DIRECTIONS

1. Tear off the answer sheet from the back of this questionnaire.
2. When you finish, turn in both question sheet and answer sheet.
3. Try to answer each question void of personal opinion.

In each of the problems a few statements are given which are followed by a question. If you think the answer to the question is "yes", then blacken space one on your answer sheet. If "no", then blacken space two.

1. Since a "fault" is any fractured surface of the earth along which movement has taken place, it follows that if we did not have such a fractured surface a fault would not be present.

Question: Is the above reasonable or not?

2. If we actually knew that the earth was spherical, and if we also knew that this implied that it was not elliptical, we could deduce that the earth was not elliptical.

Question: Is the above reasonable or not?

3. Primitive animals are sexual, and animals with "arms and legs" are primitive.

Question: Does it follow that animals with "arms and legs" are sexual?

4. If grasshoppers don't have creatine phosphate in their muscles - and they don't, then they are not chordates.

Question: Is the grasshopper a chordate?

5. If black is dominant to white, then a crossing between two black cats should not give any white offspring. But supposing we did get some white offspring.

Question: In this particular case, could we say that black was dominant to white?

6. If evolution doesn't explain the origin of man, then man is eternal. It is a statement of fact that evolution does not explain the origin of man.

Question: Does it follow from these remarks that man is eternal?

7. Amphibia are cold-blooded animals. If cold-blooded animals are not mammals, can we deduce that amphibia are not mammals?

8. If life is possible on Mars, then this planet has warmth sufficient for protoplasmic metabolism. The planet does not have sufficient warmth.

Question: According to these remarks, is life possible on Mars?

9. Even if the theory of evolution is true, there can still be a God;

and the facts do seem to support the truth of the theory.

Question: According to these remarks, can there still be a God?

10. All atoms are systems of energy. The ultimate particles obtainable by chemical analysis are atoms.

Question: Are these particles systems of energy?

11. If the lack of "metameres" on an animal implies the lack of segments; and given an animal with segments, can we validly assert that it possesses "metameres"?
12. Because sexual animals are primitive, and since animals with appendages are always sexual, does it follow that animals with appendages are primitive?
13. If a man is not right-handed, then he doesn't have the genes for right-handedness. Since John is not right-handed, does it follow that he isn't likely to have the genes for right-handedness?
14. Animals that suckle their young are not fish, but whales do suckle their young.

Question: Are whales fish?

15. If a man has type AB blood, he can have no type O offspring. John's first child was type O.

Question: Is it likely that John has type AB blood?

16. The doctor said that if John didn't have type A blood, then he would be permitted to give blood to Bill.

Question: As it turned out, John didn't have type A blood but the doctor still refused to let him give blood to Bill. Was the doctor being consistent?

17. If blood types are produced by the presence of certain antigens, and if these antigens are produced by genes, can we say from this that blood types are produced by genes?
18. If a man doesn't have genes for albinism, then he will have pigment in his eyes.

Question: If John's eyes lack pigment, does it follow from this that he may have albino genes?

19. If you had a brown bean plant, could you say that it doesn't have recessive genes when you also knew that if a bean plant is brown, then it couldn't have recessive genes?

20. If you could give blood to Doug, then you couldn't give it to Wilma.

Question: If we knew that anyone with John's type of blood could give blood to Doug, could John give blood to Wilma?

21. If sperm did not originate in the testes of a frog, then they would not pass directly into the sperm ducts.

Question: Since we know that they do pass directly into the sperm ducts, does it follow that they originate in the testes?

22. If a man has curved fingers, then he has at least one dominant gene for this trait.

Question: According to this, if John had curved fingers would it be likely that both his genes were recessive for this trait?

23. Knowing that electricity is made up of matter, and that matter consists of atoms, can we deduce that electricity is made up of atoms?

24. If genes do not physically exist, then they simply are a figment of someone's imagination. But genes are not simply a figment of someone's imagination.

Question: According to these remarks, do genes physically exist?

Type B
(Study Three-II)

QUESTIONNAIRE

The problems stated below are designed to help us find out some things about our methods of teaching you a few ideas about Natural Science.

We all know that some of you will get A's for the course while some of you will get lower than A's. We apparently communicate to a very high degree with those of you who receive A's, and correspondingly, communicate to a lesser degree with those of you who receive less than A.

We want to find out if there is something in our manner of presentation which would possibly account for this variation in communication.

Although we would like to have you sign your name, you will not be graded on this questionnaire. The remarks you make will not influence your grade in any manner whatsoever.

Because of our almost constant exposure to the subject matter of Natural Science, we are sometimes inclined to make statements which appear reasonable to us, but yet appear unreasonable to you. We feel that the degree of correspondence between what we take to be reasonable discourse is directly proportional to the amount of communication which is taking place.

DIRECTIONS:

1. Tear off the answer sheet from the back of this questionnaire.
2. When you finish, turn in both question sheet and answer sheet.
3. Try to answer each question void of personal opinion.

In each of the problems a few statements are given which are followed

by a question. If you think the answer to the question is "yes", then blacken space one on your answer sheet. If "no", then blacken space two.

1. Since a "fault" is any fractured surface of the earth along which movement has taken place, it follows that if we did not have such a fractured surface a fault would not be present.

Question: Is the above reasonable or not?

2. If we actually knew that the earth was spherical, and if we also knew that this implied that it was not elliptical, we could deduce that the earth was not elliptical.

Question: Is the above reasonable or not?

3. Primitive animals are sexual, and animals with "arms and legs" are primitive.

Question: Does it follow that animals with "arms and legs" are sexual?

4. If grasshoppers don't have creatine phosphate in their muscles - and they don't, then they are not chordates.

Question: Is the grasshopper a chordate?

5. If black is dominant to white, then a crossing between two black cats should not give any white offspring. But supposing we did get some white offspring.

Question: In this particular case, could we say that black was dominant to white?

6. If evolution doesn't explain the origin of man, then man is eternal. It is a statement of fact that evolution does not explain the origin of man.

Question: Does it follow from these remarks that man is eternal?

7. Amphibia are smooth-skinned and cold-blooded animals. If smooth-skinned, cold-blooded animals are not mammals, can we deduce that amphibia are not mammals?

8. If life is possible on Mars and the Moon, then these planets have warmth sufficient for protoplasmic metabolism. The planets do not have sufficient warmth.

Question: According to these remarks, is life possible on Mars and the Moon?

9. Even if the theory of evolution is true, there can still be a god;

and the facts do seem to support the truth of the theory.

Question: According to these remarks, can there still be a God?

10. All atoms are systems of energy. The ultimate particles obtainable by chemical analysis are atoms.

Question: Are these particles systems of energy?

11. If the lack of "metameres" on an animal implies the lack of segments; and given an animal with segments, can we validly assert that it possesses "metameres"?
12. Because sexual and cold-blooded animals are primitive, and since animals with appendages are also sexual and cold-blooded, does it follow that animals with appendages are primitive?
13. If a man is bald and not right-handed, then he wouldn't have the genes for right-handedness. Since John is bald and not right-handed, does it follow that he isn't likely to have the genes for right-handedness?
14. Animals that suckle their young are not fish, but whales do suckle their young.

Question: Are whales fish?

15. If a man has type AB blood and is Rh positive, then he couldn't have any type O offspring. John's first child was type O.

Question: Is it likely that John is both AB and positive?

16. The doctor said that if John didn't have type A blood, then he would be permitted to give blood to Bill and Mary.

Question: As it turned out, John didn't have type A blood but the doctor still refused to let him give blood to Bill and Mary. Was the doctor being consistent?

17. If blood types and antibodies are produced by the presence of certain antigens, and if these antigens are produced by genes, can we say from this that blood types and antibodies are produced by genes?
18. If a man doesn't have genes for albinism, then he will have pigment in his eyes.

Question: If John's eyes lack pigment, does it follow from this that he may have albino genes?

19. If you had a brown bean plant which also had broad leaves, could you

say that it doesn't have recessive genes when you also knew that if a bean plant is brown and had broad leaves, then it couldn't have recessive genes?

20. If you could give blood to Doug, then you couldn't give it to Wilma.

Question: If we knew that anyone with John's type of blood could give blood to Doug, could John give blood to Wilma?

21. If sperm did not originate in the testes of a frog, then they would not pass directly into the sperm ducts and kidneys.

Question: Since we know that they do pass directly into the sperm ducts and kidneys, does it follow that they originate in the testes?

22. If a man has curved fingers and is bald, then he has at least one dominant gene for each of these traits.

Question: According to this, if John had curved fingers and was bald, would it be likely that both his genes were recessive for each one of these traits?

23. Knowing that electricity and magnetism are made up of matter, and that matter consists of atoms, can we deduce that electricity and magnetism are made up of atoms?

24. If genes do not physically exist, then they are purely mental and imaginative. But it is false that they are both mental and imaginative.

Question: According to these remarks, do genes physically exist?

Type B
(Study Four-I)

QUESTIONNAIRE

The problems stated in this questionnaire are designed to help us find out some things about our methods of teaching you a few ideas about Natural Science.

We all know that some of you get A's in the course while some of you get lower than A's. We apparently communicate to a very high degree with those of you who receive A's, and correspondingly, communicate to a lesser degree with those of you who receive less than A.

We want to find out if there is something in our manner of presentation which would possibly account for this variation in communication.

Although we would like to have you sign your name, you will not be graded on this questionnaire. The remarks you make will not influence your grade in any manner whatsoever.

Because of our almost constant exposure to the subject matter of Natural Science, we are sometimes inclined to make statements which appear reasonable to us, but yet appear unreasonable to you. We feel that the degree of correspondence between what we take to be reasonable discourse and what you take to be reasonable discourse is directly proportional to the amount of communication which is taking place.

PROCEDURE

1. This is not a test to see how much you remember. All the necessary information is already presented in the questions.

2. Also, we are not concerned with the truthfulness of the

information given in the questions, all we want to know is whether you think the discourse is reasonable or not.

3. Each question consists of a set of statements. Consider each set as complete units of discourse. If you think the point being made is presented in a reasonable manner, blacken your answer sheet in the first space. If you think the point being made is presented in an unreasonable manner, blacken the second space.

4. Put your name and student number on your answer sheet.

1. If Bill had curved fingers, then he would have at least one dominant gene for this trait. According to this, since Bill actually has curved fingers, all his genes are recessive for this trait.

Question: Is the above reasonable or not?

2. If we have no controlled experiment, then the results can never be conclusive. But, if the results were conclusive, we could then deduce the presence of a controlled experiment.

Question: Is the above reasonable or not?

3. If green pea plants can't give rise to dominant-type offspring, then they will yield fewer peas per pod. But if green peas are recessive, they cannot give rise to any dominant-type offspring. If all this is true, it follows that if green pea plants are recessive, they will yield fewer peas per pod.

Question: Is the above reasonable or not?

4. Some students don't understand meiosis. Because if they don't study it - and they don't, they don't understand it.

Question: Is the above reasonable or not?

5. In frogs if the eggs fail to pass through the oviducts, then they will degenerate within the body cavity. According to this, if the eggs do not degenerate within the body cavity, we can say they failed to pass through the oviducts.

Question: Is the above reasonable or not?

6. If arguments are found in ordinary discourse, then they are not found in the State News. But, if arguments are worthy of logical recognition,

then they are found in ordinary discourse. Hence, if arguments are worthy of logical recognition, they are found in the State News.

Question: Is the above reasonable or not?

7. If evolution doesn't explain the origin of man, then man is eternal. Since it is a statement of fact that evolution does not explain the origin of man, it follows from these remarks that man is eternal.

Question: Is the above reasonable or not?

8. If John has type AB blood, he can have no type O children. But since he has type O children, it's reasonable to say John has type AB blood.

Question: Is the above reasonable or not?

9. If hereditary traits are determined by genes, then the 48 number of chromosomes for humans is determined by genes. But, if there are 48 chromosomes in humans, then hereditary traits are determined by genes. According to these remarks, the existence of 48 chromosomes in humans implies that this number is determined by genes.

Question: Is the above reasonable or not?

10. If bacteria are present, then John doesn't have curved fingers. Since bacteria were found, it is reasonable to say that John has curved fingers.

Question: Is the above reasonable or not?

11. If phenol red is a watery solution, then it can be used to detect the presence of certain gases. And if it can't be used as such, it would follow that it wasn't a watery solution.

Question: Is the above reasonable or not?

12. If science promotes tyranny, then Americans don't know the meaning of the 4th of July. If science is atheistic, then it promotes tyranny. According to these remarks, we are able to say that if science is atheistic, Americans do not know the meaning of the 4th of July.

Question: Is the above reasonable or not?

13. Even if the theory of evolution is true, there can still be a God; and the facts do seem to support the truth of the theory. Therefore, according to these remarks, there can still be a God.

Question: Is the above reasonable or not?

14. If the absence of ovaries implies the absence of a perfect flower, the presence of a perfect flower enables us to say ovaries are absent.

Question: Is the above reasonable or not?

15. If oxygen were not present on the earth, then living plant cells would soon die. But, if plant cells die, cows will stop giving milk. Therefore, if oxygen were not present on the earth, cows will stop giving milk.

Question: Is the above reasonable or not?

16. If Clarence doesn't have genes for "6-toes", then he will have pigment in his eyes. If Clarence's eyes lack pigment, it follows from this that he doesn't have genes for "6-toes".

Question: Is the above reasonable or not?

17. If someone has anti-A antibodies, then he cannot give blood to people having red hair. However, if someone has type B blood, he also has anti-A antibodies. According to these remarks, if someone has type B blood, he can give blood to another person having red hair.

Question: Is the above reasonable or not?

18. Clarence was telling the truth. But, if he is telling the truth, then he simply can't be trusted. It follows, therefore, that Clarence can be trusted.

Question: Is the above reasonable or not?

19. If it's true that living cells require oxygen, then we would expect that there would be no decrease of oxygen where dead cells were located. But supposing there was a decrease of oxygen with the dead cells. According to these remarks, we could deduce that it's false that living cells require oxygen.

Question: Is the above reasonable or not?

20. If some animals are primitive, then some animals are not sexual. But, if some animals have "arms and legs", then some animals are primitive. It follows, then, that if some animals have "arms and legs", then some animals are sexual.

Question: Is the above reasonable or not?

21. If George were not right-handed, then he wouldn't have the genes for right-handedness. Since George isn't right-handed, it follows that he isn't likely to have the genes for right-handedness.

Question: Is the above reasonable or not?

22. If life is possible on Mars, then it has warmth sufficient for protoplasmic metabolism; but the planet does not have sufficient warmth. Therefore, it is reasonable to say that life is possible on Mars.

Question: Is the above reasonable or not?

23. If students don't read the State News, then they are smarter than some of their teachers. Moreover, if students have good taste, they don't read the State News. It follows from these remarks that if students have good taste, they are smarter than some of their teachers.

Question: Is the above reasonable or not?

24. Bacteria have no visible nucleus. If this is true, then they would differ from other living cells. It follows, then, that bacteria are not different from other living cells.

Question: Is the above reasonable or not?

25. If sperm don't have fins, then they would not pass directly into the sperm ducts. Since we know that they do pass directly into the sperm ducts. According to this, they must have fins.

Question: Is the above reasonable or not?

26. Since Zoology is avoided by students, it must be beneficial for the mind. Moreover, because it isn't easy to learn, it is avoided by students. From these remarks we can deduce that since Zoology is not easy to learn, it must be beneficial for the mind.

Question: Is the above reasonable or not?

27. If vinegar were an acid, then it should turn blue litmus paper red. Knowing that vinegar actually is an acid, we can deduce from this that it will turn blue litmus paper red.

Question: Is the above reasonable or not?

28. Genes physically exist; because if they do not physically exist, then they simply are a figment of someone's imagination. But genes are not simply a figment of someone's imagination.

Question: Is the above reasonable or not?

29. If anyone can give blood to Doug, then no one can give blood to Wilma. But, if Doug has type B blood, then anyone can give blood to him. It is possible to say, therefore, that if Doug has type B blood, then someone can give blood to Wilma.

Question: Is the above reasonable or not?

30. If sperm pass through the urethra, then obstructions would prevent fertilization. If this is true, it follows that obstructions prevent fertilization, if we actually knew that sperm pass through the urethra.

Question: Is the above reasonable or not?

31. If animals are primitive, they reproduce sexually. And, if animals are aggressive, then they are primitive. It follows, then, that if animals are aggressive, they reproduce sexually.

Question: Is the above reasonable or not?

32. In genetics if black is dominant to white, then a crossing between two homozygous black cats will not give any white offspring. But supposing we did get some white offspring. It is consistent to say, then, that black is dominant to white.

Question: Is the above reasonable or not?

33. If John didn't have type A blood, then the doctor said that he would be permitted to give blood to Bill. As it turned out, John didn't have type A blood but the doctor still refused to let him give blood to Bill. According to these remarks, the doctor is consistent.

Question: Is the above reasonable or not?

34. If higher plants reproduce, they don't do it asexually. But, if they don't reproduce asexually, then pistils must always be present. According to these remarks, we can say that if higher plants reproduce, then pistils are always present.

Question: Is the above reasonable or not?

35. If a "fault" is a geological feature, then there are fractured surfaces of the earth along which movement has taken place. If we did not have such a fractured surface, we could deduce from this that a "fault" is a geological feature.

Question: Is the above reasonable or not?

36. Theories are not directly testable. But, if this is true, then the theory of evolution is philosophy. It follows that the theory of evolution is philosophy.

Question: Is the above reasonable or not?

37. If organisms can photosynthesize, they feed themselves. But, if organisms are without cell membranes, they can photosynthesize. Hence, if all this is true, it follows that if organisms are without cell membranes, they can't feed themselves.

Question: Is the above reasonable or not?

38. If animals lack segments, they lack separated body parts. But if animals possess separated body parts, it follows, then, that they possess segments.

Question: Is the above reasonable or not?

39. If cells have a nucleus, then they also have a membrane. We can deduce, therefore, that they have a membrane, provided we know they have a nucleus.

Question: Is the above reasonable or not?

40. If atoms have a nucleus, they are systems of energy. If the ultimate particles obtainable by chemical analysis are atoms, then atoms have a nucleus. It follows from these remarks, therefore, that if the ultimate particles obtainable by chemical analysis are atoms, then atoms are systems of energy.

Question: Is the above reasonable or not?

41. If organisms are bacteria, they will not reproduce sexually. If the organisms do reproduce sexually, it would follow that they are bacteria.

Question: Is the above reasonable or not?

42. It follows that grasshoppers are chordates; because if grasshoppers don't have creatine phosphate in their muscles - and they don't - then they are not chordates.

Question: Is the above reasonable or not?

43. If electricity doesn't consist of matter, then some concepts of science are spiritual. But since scientists try to be truthful, electricity doesn't consist of matter. These remarks enable us to say that since scientists try to be truthful, some concepts of science are spiritual.

Question: Is the above reasonable or not?

44. If living cells are able to produce carbon dioxide, then oxygen is present in the environment. If this is true, and if oxygen were actually not present, it would follow that living cells are not able to produce carbon dioxide.

Question: Is the above reasonable or not?

45. If brown bean plants contain dominant genes, it would be possible to deduce that they don't carry any recessive genes; provided we also knew if brown bean plants contain dominant genes, then they don't have recessive genes.

Question: Is the above reasonable or not?

Type B
(Study Four-II)

QUESTIONNAIRE

The problems stated in this questionnaire are designed to help us find out some things about our methods of teaching you a few ideas about Natural Science.

We all know that some of you get A's in the course while some of you get lower than A's. We apparently communicate to a very high degree with those of you who receive A's, and correspondingly, communicate to a lesser degree with those of you who receive less than A.

We want to find out if there is something in our manner of presentation which would possibly account for this variation in communication.

Although we would like to have you sign your name, you will not be graded on this questionnaire. The remarks you make will not influence your grade in any manner whatsoever.

Because of our almost constant exposure to the subject matter of Natural Science, we are sometimes inclined to make statements which appear reasonable to us, but yet appear unreasonable to you. We feel that the degree of correspondence between what we take to be reasonable discourse and what you take to be reasonable discourse is directly proportional to the amount of communication which is taking place.

PROCEDURE

1. This is not a test to see how much you remember. All the necessary information is already presented in the questions.

2. Also, we are not concerned with the truthfulness of the

information given in the questions; all we want to know is whether you think the discourse is reasonable or not.

3. Each question consists of a set of statements. Consider each set as complete units of discourse. If you think the point being made is presented in a reasonable manner, blacken your answer sheet in the first space. If you think the point being made is presented in an unreasonable manner, blacken the second space.

4. Put your name and student number on your answer sheet.

1. If a man has curved fingers, then he has at least one dominant gene for this trait. According to this, if John had curved fingers, it is likely that both his genes are recessive for this trait.

Question: Is the above reasonable or not?

2. The lack of segments on an animal implies the lack of separated body parts. Since a crayfish is an animal having separate body parts, we can deduce that it possesses segments.

Question: Is the above reasonable or not?

3. Salmonella is without a cell membrane but has the ability to digest raw meat. But, anything without a cell membrane is bad for the blood. It is reasonable to say from this, therefore, that Salmonella has the ability to digest raw meat, but it's still bad for the blood.

Question: Is the above reasonable or not?

4. New people on campus can't be expected to know their way around, and since Freshmen are new it follows that they can't be expected to know their way around.

Question: Is the above reasonable or not?

5. If any organism is without a backbone, then it must be an invertebrate. The organism Lepus californicus is not an invertebrate. We can say, therefore, that Lepus californicus has a backbone.

Question: Is the above reasonable or not?

6. If anything isn't interesting, it's not found in the newspapers. Some wars are certainly uninteresting, but yet they command our attention. Therefore, we can say some wars are not found in the newspapers, they nevertheless command our attention.

Question: Is the above reasonable or not?

7. If men are not moral, they will be happy here but punished hereafter. According to this, since Clarence is not moral, it follows that he is happy now but will be punished hereafter.

Question: Is the above reasonable or not?

8. The organism Homarus americanus reproduces sexually. If organisms are bacteria, they do not reproduce sexually. Hence, the organism Homarus americanus is an example of bacteria.

Question: Is the above reasonable or not?

9. Crayfishes are arthropods which have their eyes on stalks. But the arthropods are joint-footed. It follows, then, that crayfishes are joint-footed as well as having their eyes on stalks.

Question: Is the above reasonable or not?

10. While knowing that bacteria were not the cause of the fever, we could deduce that the streptococci found were not causing the fever - provided we also knew that streptococci are bacteria.

Question: Is the above reasonable or not?

11. Myriapods are not protozoa because we know that protozoa are unicellular, and myriapods are not unicellular.

Question: Is the above reasonable or not?

12. Supposing it were a fact that anyone who believes in evolution was not an atheist, and that since Clarence does believe in it as well as being a clever person, it would follow that even though Clarence is a clever person, he is still an atheist.

Question: Is the above reasonable or not?

13. It follows that penicillin is expensive; because all things which are hard to produce are expensive, and we know it's hard to produce.

Question: Is the above reasonable or not?

14. In geology, if there was no fractured surface of the earth along which movement had taken place, then a "fault" would not be present. However, in the town of Copper City, Michigan, a "fault" is present. This means that we could find a fractured surface of the earth there.

Question: Is the above reasonable or not?

15. Genes are not explainable in terms of physical matter, but are still

believed to be the physical cause of traits. But, yet, anything not physically explainable is of a psychological nature. Therefore, genes are believed to be the physical cause of traits and are of a psychological nature.

Question: Is the above reasonable or not?

16. Everyone not having genes for albinism will have pigment in his eyes. If Clarence's eyes lack pigment, it follows that he has albino genes.

Question: Is the above reasonable or not?

17. If anyone does not possess type B antigens, he doesn't have a pleasant personality. Clarence doesn't have type B antigens, although he does have the genes for brown eyes. It follows, then, that Clarence has the genes for brown eyes as well as having a pleasant personality.

Question: Is the above reasonable or not?

18. Acids will not turn red litmus paper blue. It follows that vinegar will not turn red litmus paper blue, because it is an acid.

Question: Is the above reasonable or not?

19. If men believe in evolution, then they will not show reverence for those matters which are beyond their understanding. However, Clarence often shows reverence for such matters. Therefore, from these remarks it follows that Clarence does not believe in evolution.

Question: Is the above reasonable or not?

20. Since Dan is a fool who speaks the truth; and because whoever speaks the truth deserves to be imitated; it follows that Dan deserves to be imitated even though he is, nevertheless, a fool.

Question: Is the above reasonable or not?

21. The doctor said that if anyone didn't have type A blood, then he could give blood to Bill. As it turned out, John didn't have type A blood but the doctor still refused to let him give blood to Bill. The doctor was being inconsistent.

Question: Is the above reasonable or not?

22. When carbon dioxide gas comes into contact with a phenol red solution, the solution turns from red to yellow. Since one of the solutions in an experiment in Natural Science 181 did not turn yellow, it would follow that the gas in the experiment was carbon dioxide.

Question: Is the above reasonable or not?

23. If amphibia are cold-blooded animals with moist skins, and if cold-blooded animals are not mammals, it follows that amphibia have moist skins but still are not mammals.

Question: Is the above reasonable or not?

24. Any animal not having creatine phosphate in its muscles is not a chordate. Since grasshoppers don't have creatine phosphate in their muscles, it necessarily follows that they are not chordates.

Question: Is the above reasonable or not?

25. The tulip is described as a perfect flower. It would be reasonable to say, therefore, that the tulip possesses ovaries, if we also knew that the absence of ovaries implies the absence of a perfect flower.

Question: Is the above reasonable or not?

26. Checker-playing is a no-credit course, and is quite boring to play. But no-credit courses are good for the appetite. Therefore, checker-playing is boring to play but is good for the appetite.

Question: Is the above reasonable or not?

27. Since Socrates was a philosopher, and because philosophers are by nature inquisitive people, it follows that Socrates was inquisitive.

Question: Is the above reasonable or not?

28. In cats, if the gametes don't travel down the oviducts, then they go into the abdominal cavity. One of the instructors in Natural Science 181 has a female cat called "Prissy" in which the gametes did not go into the abdominal cavity. It follows, therefore, that the gametes of "Prissy" didn't travel down the oviducts.

Question: Is the above reasonable or not?

29. If anything isn't a chromosome, then it wouldn't carry genes. The chromatin material isn't a chromosome, but it does give rise to them. According to this, the chromatin material gives rise to chromosomes but still doesn't carry genes.

Question: Is the above reasonable or not?

30. It's a fact that every theory contains concepts which are not empirically testable. Hence, if what is offered as the "cell theory" were truly a theory, we could reasonably deduce that it will contain concepts not empirically testable.

Question: Is the above reasonable or not?

31. Because happy animals are primitive, and since apes are happy as well as having large brains; it is possible to deduce from this information that apes are primitive animals with large brains.

Question: Is the above reasonable or not?

32. If anyone has type AB blood, he can have no type O offspring. Since John's first child was type O, we can deduce that John has type AB blood.

Question: Is the above reasonable or not?

33. Those students that don't study meiosis will be late in getting out of the exam. Since we knew that George didn't study, it follows that he will be late.

Question: Is the above reasonable or not?

34. Animals that suckle their young are not fish; but whales do suckle their young and still live in water. Therefore, even though whales live in water, they are still fish.

Question: Is the above reasonable or not?

35. If biological cells are to produce carbon dioxide, then they must be alive. If this is true, and knowing that the outer surface of the skin consists of dead cells, it would follow that they would not produce carbon dioxide.

Question: Is the above reasonable or not?

36. If a man is not right-handed, then he doesn't have the genes for right-handedness. Since John is not right-handed, it follows that he isn't likely to have the genes for right-handedness.

Question: Is the above reasonable or not?

37. If anyone doesn't believe in evolution, then he must be an atheist. Clarence goes to church but doesn't believe in evolution. It follows that even though Clarence goes to church he is still an atheist.

Question: Is the above reasonable or not?

38. If we have no controlled experiment, then the results can never be conclusive. Since this is true, and since we know that Francisco Redi's experiments on spontaneous generation were conclusive, we could deduce from these remarks alone that he had a controlled experiment.

Question: Is the above reasonable or not?

39. If every man has his limitations, then intelligent people are occasionally confused. Sam admits that he has his limitations. Hence, it follows that Sam is occasionally confused.

Question: Is the above reasonable or not?

40. If blood types are produced by both antigens and genes, and if anything produced by genes is inherited from the parents, it follows that blood types are produced by antigens as well as being inherited from the parents.

Question: Is the above reasonable or not?

41. Since Clarence is ignorant, we can say he is happy when we know that anything happy isn't ignorant.

Question: Is the above reasonable or not?

42. Anyone not right-handed, doesn't have genes for right-handedness. Since George isn't right-handed, it follows that he isn't likely to have the genes for right-handedness.

Question: Is the above reasonable or not?

43. If anyone could give blood to Doug, then he couldn't give it to Wilma. Since John can give blood to both Doug and members of his church, it follows that John can give blood to members of his church but not to Wilma.

Question: Is the above reasonable or not?

44. If there is a will there is a way, and since there is no way for Clarence it follows from this that he has no will.

Question: Is the above reasonable or not?

45. If a man isn't bald, he doesn't have the genes for baldness. If this is true, and since John isn't bald, it follows that he doesn't have the genes for baldness.

Question: Is the above reasonable or not?

Type B
(Study Four-III)

QUESTIONNAIRE

The problems stated in this questionnaire are designed to help us find out some things about our methods of teaching you a few ideas about Natural Science.

We all know that some of you get A's in the course while some of you get lower than A's. We apparently communicate to a very high degree with those of you who receive A's, and correspondingly, communicate to a lesser degree with those of you who receive less than A.

We want to find out if there is something in our manner of presentation which would possibly account for this variation in communication.

Although we would like to have you sign your name, you will not be graded on this questionnaire. The remarks you make will not influence your grade in any manner whatsoever.

Because of our almost constant exposure to the subject matter of Natural Science, we are sometimes inclined to make statements which appear reasonable to us, but yet appear unreasonable to you. We feel that the degree of correspondence between what we take to be reasonable discourse and what you take to be reasonable discourse is directly proportional to the amount of communication which is taking place.

PROCEDURE

1. This is not a test to see how much you remember. All the necessary information is already presented in the questions.
2. Also, we are not concerned with the truthfulness of the

information given in the questions; all we want to know is whether you think the discourse is reasonable or not.

3. Each question consists of a set of statements. Consider each set as complete units of discourse. If you think the point being made is presented in a reasonable manner, blacken your answer sheet in the first space. If you think the point being made is presented in an unreasonable manner, blacken the second space.

4. Put your name and student number on your answer sheet.

1. If Bill had curved fingers and Alice was in Detroit on Monday, then George has one dominant gene for baldness. According to this, if Bill has curved fingers and Alice was in Detroit on Monday, it follows that George doesn't have any genes for baldness.

Question: Is the above reasonable or not?

2. If it's not true that sperm have fins and the worker fouled up the experiment, then MSU will not win the Big Ten Basketball championship. But, if MSU wins the Big Ten championship, it would follow that sperm have fins and the research worker did foul up the experiment.

Question: Is the above reasonable or not?

3. If electricity doesn't consist of matter, then some concepts of science are spiritual and this thought makes Clarence happy. Since scientists try to be truthful, electricity doesn't consist of matter. These remarks enable us to say, then, that since scientists try to be truthful, some concepts of science are spiritual and this thought makes Clarence unhappy.

Question: Is the above reasonable or not?

4. Some students don't understand meiosis, and some don't even understand genetics. And the reason they don't is because if they don't study - and they don't - they will not understand them.

Question: Is the above reasonable or not?

5. If Clarence doesn't have genes for albinism, then he will have pigment in his eyes as well as being governed by moral principles. Since it isn't true that Clarence has pigment and is governed by moral principles, it would follow that he doesn't have albino genes.

Question: Is the above reasonable or not?

6. If science is atheistic, then it promotes tyranny and injustice. But, if it promotes these things, then Americans do not know the meaning of the 4th of July. According to these remarks, we are able to say that if science is atheistic, Americans do not know the meaning of the 4th of July.

Question: Is the above reasonable or not?

7. If evolution doesn't explain the origin of man, but the theory of Special Creation does, then man is eternal. Since it is a statement of fact that evolution does not explain man's origin but that it is explained by the theory of Special Creation, it follows from these remarks that man is eternal.

Question: Is the above reasonable or not?

8. If it's true that living cells require oxygen but release carbon dioxide, then we would expect that there would be no decrease of oxygen where dead cells were located. But, supposing there was a decrease of oxygen with the dead cells. According to this, we could deduce that it's false that living cells require oxygen and release carbon dioxide.

Question: Is the above reasonable or not?

9. If some animals are wild and reproduction is normal, then some animals are not sexual. Also, if some animals have "arms and legs", then some animals are wild and reproduction is normal. It follows from this, that if some animals have "arms and legs", some animals are sexual.

Question: Is the above reasonable or not?

10. In this instance, Clarence happened to be telling the truth. But if he is telling the truth, then he cannot be trusted and should be tarred and feathered. It follows, then, that Clarence can't be trusted and should be tarred and feathered.

Question: Is the above reasonable or not?

11. If life were possible on Mars and Clarence was in Chicago the night of the crime, then Jupiter has warmth sufficient for protoplasmic metabolism. Since Jupiter doesn't have sufficient warmth, it is consistent with these remarks to say that life is possible on Mars and that Clarence was in Chicago the night of the crime.

Question: Is the above reasonable or not?

12. If anyone could give blood to Doug, then no one could give blood to Wilma and the doctor would leave town. But, if Clarence was the ringleader of the mob, then anyone could give Doug blood. It is reasonable to say, therefore, that since Clarence was the ringleader of the mob, no one could give blood to Wilma and the doctor would leave town.

Question: Is the above reasonable or not?

13. If cells have a nucleus as well as a nucleolus, then the doctor will stay in town. Therefore, we can say from this that the doctor will leave town; provided we know that cells actually have a nucleus and nucleolus.

Question: Is the above reasonable or not?

14. If it isn't true that animals have segments and are able to think, then they must not have separated body parts. Thus, if they possess separated body parts, it follows, then, that they possess segments and are able to think.

Question: Is the above reasonable or not?

15. Because Zoology is avoided by students, it must be beneficial for the mind but is not a required subject for medical school. Moreover, because it isn't easy to learn, it is avoided by students. It's reasonable to say, then, that because Zoology isn't easy to learn, it must be beneficial for the mind as well as being required subject for medical school

Question: Is the above reasonable or not?

16. It's reasonable to say that genes physically exist. Because if they don't, then they are simply the figment of someone's imagination as well as being a hoax played upon the scientific world. But we know that they are not imaginings and hoaxes. Thus, it follows that genes physically exist.

Question: Is the above reasonable or not?

17. If arguments are found in ordinary discourse, then they are not found in the State News and the students read other newspapers. But, if arguments are worthy of logical recognition, then they are found in ordinary discourse. According to this, if arguments are worthy of logical recognition, they are found in the State News and the students read other newspapers.

Question: Is the above reasonable or not?

18. It is true that brown bean plants contain dominant genes, and some

traits are determined by chromosomes. But if both these things are true, then purple-eyed flies have no dominant genes. Therefore, it follows from these remarks that purple-eyed flies have dominant genes.

Question: Is the above reasonable or not?

19. In genetics if black was dominant to white, and brown eyes was dominant to blue eyes, then a crossing between two homozygous black cats should not give any white offspring. But, supposing we did get some white offspring. It is consistent to say, in this case, that black is dominant to white, and that brown eyes is dominant to blue eyes.

Question: Is the above reasonable or not?

20. If atoms have a nucleus, then they are systems of energy and no home should be without them. If the ultimate particles obtainable by chemical analysis are atoms, then atoms have a nucleus. It would follow from these remarks, therefore, that if the ultimate particles obtainable by chemical analysis are atoms, then atoms must be systems of energy and no home should be without them.

Question: Is the above reasonable or not?

21. If George did not have "6-toes", but had brown eyes, then he wouldn't have the genes for right-handedness. Since George doesn't have "6-toes", but does have brown eyes, it follows that he does have the genes for right-handedness.

Question: Is the above reasonable or not?

22. If a "fault" is a geological feature and present in Michigan, then there exist fractured surfaces of the earth along which movement has taken place. If we did not have such a fractured surface, we could deduce that it isn't true that a "fault" is a geological feature and present in Michigan.

Question: Is the above reasonable or not?

23. If higher plants reproduce, they don't do it asexually and geneticists use the fungus Neurospora in their research. But, if higher plants don't reproduce asexually and geneticists use Neurospora for research, then pistils must always be present. According to these remarks, we are able to say that if higher plants reproduce, then pistils are not always present.

Question: Is the above reasonable or not?

24. Bacteria have no visible nucleus, and they are the cause of disease.

But, if these things are true, then they differ from other living cells. It follows, then, that bacteria are different from other living cells.

Question: Is the above reasonable or not?

25. If we have no controlled experiment, then the results can never be conclusive and truth is a matter of probability. But it's not true that results can never be conclusive and truth only probable. Therefore, we must not have had a controlled experiment.

Question: Is the above reasonable or not?

26. If organisms can photosynthesize, then Albert was propagandizing. But, if organisms are without cell membranes and are capable of respiration, then they can photosynthesize. Hence, if all this is true, it follows that if organisms are without cell membranes and are capable of respiration, then Albert was not propagandizing.

Question: Is the above reasonable or not?

27. If the theory of evolution is true and man is a descendent of the apes, then many scientists are politically minded. Since the facts seem to support the truth of the theory as well as showing the descendancy of man from the apes, it would follow from these remarks, that many scientists are politically minded.

Question: Is the above reasonable or not?

28. If the organisms are bacteria and the weather is cold, then graduate students are gifted people. However, if it's not true that graduate students are gifted, we could reasonably say, then, that it was false that the organisms were bacteria and the weather cold.

Question: Is the above reasonable or not?

29. If someone has anti-A antibodies, then he cannot give blood to people having red hair. However, if someone has type B blood and raises rabbits for a living, then he also has anti-A antibodies. According to these remarks, if someone has type B blood and raises rabbits for a living, he can give blood to people with red hair.

Question: Is the above reasonable or not?

30. If bacteria are present and Clarence has bad breath, then he is not free of the disease. Since bacteria were found to be present, and because it's well known that Clarence has bad breath, it is reasonable to say that Clarence is free of the disease.

Question: Is the above reasonable or not?

31. If heredity traits are determined by genes, then the 48 number of chromosomes for humans is determined by genes and the theory of evolution will turn out to be true. But, if there are 48 chromosomes in humans, then hereditary traits are determined by genes. According to these remarks, the existence of 48 chromosomes in humans implies that this number is determined by genes and the theory of evolution will turn out to be true.

Question: Is the above reasonable or not?

32. If John has type AB blood as well as brown hair, then he can have no type O children. But since he does have type O children, it's reasonable to say John has type AB blood and brown hair.

Question: Is the above reasonable or not?

33. It's a fact that no theory in itself is empirically testable, and that much of science is built upon faith. But, if these things are true, then the theory of evolution is philosophy. From these remarks, it follows that the theory of evolution is philosophy.

Question: Is the above reasonable or not?

34. If green pea plants can't give rise to dominant type offspring, then they will yield fewer peas per pod but the farmers will not ask their congressman for a government subsidy. However, if green peas are recessive, they cannot give rise to any dominant type offspring. Thus, if all this is true, it follows that if green peas are recessive, then they will yield fewer peas per pod, and the farmers will ask their congressman for a government subsidy.

Question: Is the above reasonable or not?

35. If living cells are able to produce carbon dioxide and heat, then oxygen is present in the environment. If this is true, and if oxygen were actually not present, we could say from this that it is not true that living cells are able to produce carbon dioxide and heat.

Question: Is the above reasonable or not?

36. If John didn't have type A blood, then the doctor said that he would be permitted to give blood to Bill and that Mary could leave the hospital on Wednesday. As it turned out, John didn't have type A blood, but the doctor still refused to let him give blood to Bill and Mary didn't leave the hospital on Wednesday. Thus, the doctor is consistent.

Question: Is the above reasonable or not?

37. If oxygen were not present on the earth, then plant cells would soon die and cows would stop giving milk. But, if plant cells die and cows stop giving milk, then children will develop rickets. It follows, therefore, if oxygen were not present on the earth, children will not develop the rickets.

Question: Is the above reasonable or not?

38. If no ovaries and stamens are present, then we wouldn't have a perfect flower. Therefore, according to this, if we actually had a perfect flower, we could assume the presence of both ovaries and stamens.

Question: Is the above reasonable or not?

39. If vinegar were an acid, then it should turn blue litmus paper red and prevent the growth of bacteria. If vinegar really is an acid, it follows that vinegar will turn blue litmus paper red as well as prevent the growth of bacteria.

Question: Is the above reasonable or not?

40. If pigs are primitive, then apes reproduce sexually and cats are very fertile. However, if animals are wild-eyed, then pigs are primitive. It would follow, then, that if animals are wild-eyed, apes reproduce sexually but cats are not very fertile.

Question: Is the above reasonable or not?

41. In frogs if the eggs fail to pass through the oviducts, then they will stay within the body cavity and Clarence will admit he is ignorant. But, according to this, if these things didn't happen, it must be that the eggs failed to pass through the oviducts.

Question: Is the above reasonable or not?

42. Grasshoppers are not chordates. Because if grasshoppers don't have creatine phosphate in their muscles as well as not having hair on their legs - and they don't have either of these, then they are chordates.

Question: Is the above reasonable or not?

43. If students don't read the State News, then they are smarter than some of their teachers. Also, if students have good taste and have come to college to be educated, then they don't read the State News. It follows from these remarks that if students have good taste and have come to college to be educated, then they are smarter than some of their teachers.

Question: Is the above reasonable or not?

44. If phenol red is a watery solution, then it can be used to detect the presence of gases and bacteria. However, if it isn't true that it has such uses, it would follow that it isn't a watery solution.

Question: Is the above reasonable or not?

45. If sperm travel through the urethra and pass out through the penis, then any obstructions would prevent fertilization. If this is true, it follows that any obstructions would prevent fertilization; provided we knew that sperm do pass through the urethra and pass out through the penis.

Question: Is the above reasonable or not?

Type C

QUESTIONNAIRE

INSTRUCTIONS:

This questionnaire aims to find out, in a general way, what you remember about some of the ideas which were presented to you last term in NS 121. In particular, this questionnaire concerns itself with the ideas about heredity.

Although we would like to have you sign your name, you will not be graded on this questionnaire. The remarks you make will not influence your grade in any manner whatsoever.

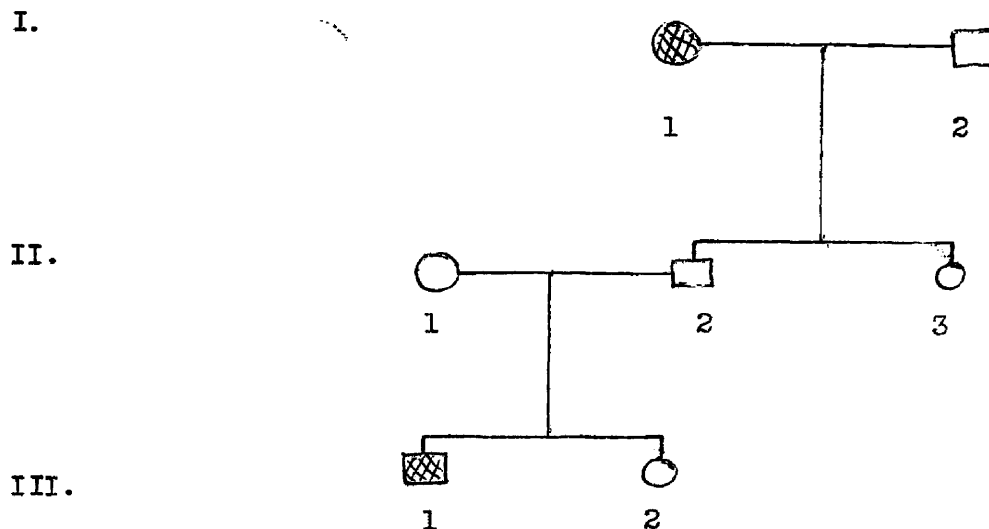
In one of the lab studies last term, one of the ideas we wanted to communicate to you was that genes for skin pigmentation occur in pairs in the individual. By way of supplying evidence to support this idea a pedigree chart concerning skin pigmentation was presented. This chart informed you of many facts concerning the genetic make-up of the individuals in it.

In particular, we wanted to communicate to you, via these facts, the idea that a given individual in the pedigree must have two genes for skin pigmentation. These facts are stated below, along with the pedigree chart involved.

What you are asked to do is to review the given facts and to explain how it is that a given individual must have two genes for skin pigmentation.

THE FACTS

1. In Figure A, individuals I-1 and III-1 are albinos; the others are normal.

Figure A

2. If only one gene was needed, then at least one of the parents of III-1 must show albinism.
3. At this point in our studies we knew that either one gene was needed to express the trait for skin pigmentation or that two genes were needed.
4. The parents of III-1 do not show albinism.

With regard to the above facts, explain how it is that a given individual must have two genes for skin pigmentation.

EXPLANATION:

DEFINITIONS OF SYMBOLS

The letters P, Q, R, etc., refer to propositions. In English grammar these are described as declarative statements which may be true or false.

The symbol " $\supset$ " stands for the English words "implies" or "then". Where one declarative statement implies another, this would be expressed in logical symbolism as " $P \supset Q$ ".

The symbol " $\cdot$ " stands for the English word "and". Thus, when two declarative statements are asserted conjointly, this is expressed in logical symbolism as " $P \cdot Q$ ".

The symbol " $\vee$ " stands for the English word "or". When two declarative statements are asserted as alternatives, this is expressed as " $P \vee Q$ ".

The symbol " $\sim$ " is the logical expression for the English word "not". When a proposition is asserted as being false, it is expressed as " $\sim P$ ".

"Validity pattern" refers to the form a logical argument may take. For example, the Modus Ponens form is exhibited by the following argument:

If Clarence is a member of the committee,
then the cards are stacked against us.
Clarence is a member of the committee.
Therefore, the cards are stacked against us.

this is expressed in logical symbolism as

$$\begin{array}{c} P \supset Q \\ \hline P \\ \hline Q \end{array}$$

and its form is

$$\begin{array}{c} _ \supset \dots \\ _ \\ \hline \dots \end{array}$$