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A REVISION OF THE MORGAN TEST OF LOGICAL REASONING

Fred K. McCoy

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CHAPTER I - INTRODUCTION

Do we learn to reason logically just as we learn grammar or estimating distances? Philosophers usually say we do and have taught logic as a discipline for thousands of years. They are generally not content to teach "about" logic, or in the history of it; they generally state their intent is to teach "logic for everyday thinking". Appendix VI is a personal communication to the author from a philosopher stating this clearly and comparing the skill of logical reasoning with the skill of using grammar.

Or is logical reasoning a relatively inherent trait, as intelligence is generally assumed to be? We all have the subtle feeling that some are more logical than others and usually make this judgment without knowledge of who has been educated in logic. One group of psychologists went so far (31) as to call a reasoning test a "status-free test of intelligence" apparently assuming not only that logic is innate but is also virtually the whole of innate mental ability.

An examination of the psychological literature on logical reasoning starts with the work done in the development of reasoning in childhood, thus far the best

investigated branch of the field. So in the question of whether logic is best to be considered learned or innate, we turn first to the evidence from developmental studies.

A. Development of reasoning.

In 1928 Piaget's JUDGMENT AND REASONING IN THE CHILD (60) noted that there appears to be an orderly development of reasoning ability through childhood to about the twelfth year. This could suggest the possibility that logic is an inherent trait although it does not prove it. Piaget's pioneering observations led to further investigation.

Smedslund (67) gave a logic problem to forty children 5 to 7 years old. The problem was:

Jack prefers Apples to Bananas.

He also prefers Bananas to Chewing gum.

Does Jack prefer Apples or Chewing gum?

Although this simple syllogism is probably the most primitive transitive inference, Smedslund found an almost total absence of ability to make the deduction. The children were influenced by their own preferences or other irrelevant factors. Furthermore, the subjects' own preferences were often not transitive, i.e., they might prefer A to B, and B to C, but C over A!

Related to this study is one by Morino-Abbele (51) with nine children the same age as Smedslund's. She set up a game situation requiring certain simple arithmetic inferences to "win". Although the children had never been taught the concept needed, after a period of unorganized attempts and "a sense of discovery" children invariably derived the needed conclusions.

Glanz (16) noted that transductive reasoning, which is essentially non-logical, prevails at kindergarten age but that some signs of deductive and inductive thinking are also present. These would presumably be the result of individual differences. In similar work Denner (11) noted that the development of thought processes from transductive before school to "reasoning" present by the 4th grade. Gan'kova (15) reported reasoning present by the first grade, but more importantly he found the lack of a one-to-one relationship between age and thinking stage. Since each year of life at these early ages represents quite a bit of maturation, his results suggest that reasoning is at least partly influenced by learning experiences.

Peachee (58) administered a ten-item deductive reasoning test to 140 school children, 20 in each age group five through eleven. He also gave an inductive reasoning test, the Similarities subscale from the Wechsler Intelligence Scale for Children. Intelligence was roughly controlled by using only children judged "average" by their teachers. He found an almost straight line function between age and deductive reasoning ability, but interestingly did not find such a function for the inductive test. There are two design flaws in his study; age groups were taken from different neighborhoods (7 age groups, 7 parochial schools); and he compared group means by a series of t-tests (increasing the possibility of significance), but the regularity of his graphed results tends to lend credence to his results. (See figure 1) Generally, his results show an orderly increase in deductive ability in the absence of direct deductive training.

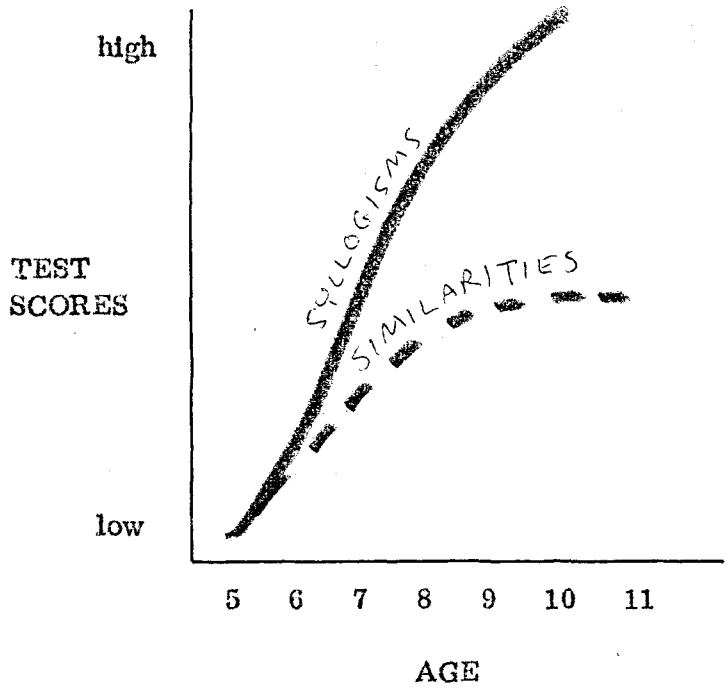

Figure 1. Graphed results of the Peachee study (58) showing the regularity of the score distributions for both the deductive (SYLLOGISMS) and the inductive (SIMILARITIES) tests.

Kostik (30) gave high school students a logic test with deductive items concerning "science" and "home economics". The two types of items were balanced, as his intent was to compare the sexes. Intelligence, previous knowledge of logic, reading ability, practice effect, and certain personality traits were held constant. There was a sex difference and the author concludes "boys' superior ability". This is an important study from the viewpoint of whether logical reasoning is inherent, for if one sex is superior without differential training it strongly suggests a learned cultural difference, which rules heavily in favor of logic as acquired.

On the other hand, when Miller (43) compared high school students who had received instruction in reasoning with those who had not, controlling for grade, scholastic training and standing, mental age, reading ability, and sex, he found none of these factors related to ability on a logical fallacies test. He did find a difference between the trained and untrained groups. So although his results differ from Kostik's in sex, his do suggest that logic is acquired.

Kostik's results in regard to sex differences are difficult to understand. Bieliauskas (4), Peachee (58), and Piaget (60) found no sex difference prior to Kostik's work, and no researcher since has found such a difference. It is possible that the form or type of problems inadvertently favored the boys but this can not now be discerned.

These studies in the development of reasoning ability, and others by Burt (6), and Noelting (56), show a regular and orderly increase in deductive skill with age in children. Those by Morino-Abele and Miller go further in showing an influence

by training, and the Kostik study goes furthest in proposing the influence of a cultural difference. The evidence for inductive reasoning is not as clear, but similar.

The studies from child development are suggestive but not conclusive. As Wechsler points out (83) intelligence, usually assumed innate, is increasing in a regular order at the same time logic ability is rising. A study that would come more directly to the point would be a comparison of logic ability with, say, mental age, rather than chronological age. If logic ability progresses independently of mental age it could be said to be influenced by learning. No such study had been done by 1959.

B. Influences showing an effect on reasoning.

The question of development unsettled, the next reasonable quest would be for environmental influences on reasoning ability. If temporary, lately acquired, or relatively subtle influences are shown to affect reasoning skills, it would tend to suggest that reasoning is acquired. But if logical reasoning is innate, it should be relatively free of environmental stimuli. In fact, much evidence has been advanced purporting to show the effects of various environmental factors. For convenience in examinations, these factors are here divided into three categories: "atmosphere effect", effect of pathology, and physical effect.

1. Atmosphere effect. The first study of this nature is by Throndike in 1922 (77). He reported that changing the content of syllogisms from "neutral" to "emotionally toned" caused the number of logical errors to increase. He had no

control group and made no statistical comparison. In 1928 Wilkins (85) did a similar study with similar results.

In 1936 Woodworth and Sells (87) said that an even subtler influence caused logical inaccuracy. They showed that syllogisms in which the premises contained negative terms (e.g., "No applies are blue" and "This object is not an apple") tended to give a negative atmosphere to the whole syllogism influencing subjects to give a negative conclusion ("This object is not blue") even when invalid. Sells said further that this effect holds even when the items are expressed totally symbolically ($A' \supset B$), named it "the atmosphere effect" and began to generalize widely into personality theory and advertising (65).

Further studies concerning the atmosphere effect seemed to corroborate Sells' principle. In 1943 Janis and Frick (26) reported that attitudes toward the TRUTH of conclusions in reality tended to cause errors in deciding on the logical VALIDITY of them. In 1944 Morgan and Morton (50) said syllogisms were often incorrectly solved when personal convictions were related to the content material.

In 1946 Lefford (32) published the most careful study of the atmosphere effect up to that time adding the control group former experimenters had neglected. His syllogisms test was composed of 20 "emotional" items and 20 "non-emotional" items, emotionality defined by content of the items.* Graphing number of errors with number of items, he shows that the non-emotional items' errors fell into a

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* In unusually conscientious reporting, Lefford published his entire logic test, making it possible to describe the "emotional content" of his items. The "emotional" items are characterized by proper nouns and current events from the news; the "non-emotional" items utilized common nouns and definitions from academic subjects.

J-curve, indicating that most of the subjects missed large numbers of the emotional items. Lefford takes this as evidence of the effect of emotionality on logical reasoning. If his results could be taken as valid, it would constitute the strongest evidence for the atmosphere effect. He did not statistical analysis, noting that none was available for that type of data in 1946.

By 1956 the atmosphere effect was virtually totally accepted by psychologists, receiving favorable mention in such standard texts as Underwood's EXPERIMENTAL PSYCHOLOGY (79), Woodworth and Schlossberg's EXPERIMENTAL PSYCHOLOGY (86), and Stevens' HANDBOOK OF EXPERIMENTAL PSYCHOLOGY (44). In 1957 Richter (62) felt that the effect was clearly enough established to propose that henceforth any tests purporting to measure logical reasoning ability should ask subjects for both VALIDITY and TRUTH judgments. Then, if a subject's TRUTH decisions are good while his VALIDITY choices are poor, he can be said to fail to grasp logical principles. If there is poor judgment on both TRUTH and VALIDITY, it would indicate he is under the influence of the atmosphere effect. If both TRUTH and VALIDITY are good, he is reasoning clearly and logically.*

Richter classified four types of errors in syllogistic tests:

(1) careless marking or non-cooperations

(2) inability to grasp concepts

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* What would Richter have said about good VALIDITY and poor TRUTH? H^{c} could have attributed it to mental pathology, but Arieti (1) would disagree. Perhaps it is the case of the creative non-conformist whose historical position is to change items of accepted TRUTH by demonstrating non-VALIDITY.

(3) failure to differentiate TRUTH and VALIDITY

(4) impairment in classification.

Prior to his proposed the method the 2nd and 3rd types of errors were not distinguishable, lack of logical reasoning ability and the "atmosphere effect" were confounded.

One other study should be added to those categorized with the atmosphere effect. In 1953 Shaklee (66) used a logical reasoning problem as a criterion in a study concerning learning theory. He allowed subjects sundry types of related practice prior to attending to the criterion problem. Those who had several short rest periods during practice (distributed practice) were superior on the problem to those who had one long rest period (massed/spaced practice) and both of these groups were superior to one that had no rest period (massed practice). If an environmental factor as subtle as type of practice influence reasoning performance, this would be the most suggestive of the "atmosphere" studies. However, before accepting Shaklee's results as demonstrating this, it is necessary to take into account his comment that "high solvers" did not differ in their performance regardless of the type of practice.

2. Effect of mental pathology. If logical reasoning is innate, mental pathology itself should not change a schizophrenic's laws of logic. His premises might be based on facts not acceptable to others, making his conclusions bizarre, but his reasoning need not be invalid. If on the other hand logic is acquired along with grammar and estimation of distances, the laws of logic would be subject to change with acquired pathology.

Exactly this contention, that the mental patient operates under a different logic, was introduced in this country in 1944 by Von Domarus (82). He claimed that observations of schizophrenics revealed that they operate with a different set of logical laws than the generally accepted four Aristotelian principles.* Specifically he noted that the schizoid personality is not bound by the law of the excluded middle. The fallacy of the unexcluded middle allows a conclusion linking subjects in identity on the basis of a common predicate. For example:

Napoleon, a powerful man, was short of stature.

I am short of stature.

Therefore, I am Napoleon, a powerful man!

Accepting the fallacy of the unexcluded middle can lead to some interesting conclusions. In one example by Arieti (1) a patient reasoned:

(The head of) Jesus is encircled (by a halo of radiance).

A woman is encircled (by the vulgar sexual glance).

Therefore, Jesus is a woman.

Having proven this, it was no trick at all to show that a woman is a cigar, in as much as cigars are circled by bands. In this example, Arieti points out,

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* Arieti (1) summarizes the four Aristotelian principles: (a) law of identity, A is always A and never something else; (b) law of contradiction, A cannot be A and something else; (c) law of the excluded middle, A is either A or not A; and (d) law of sufficient reason.

the TRUTH of the premises is reasonably acceptable and only a failure in logic accounts for the conclusions lacking TRUTH.*

The observation that schizophrenics commonly commit the fallacy of the unexcluded (or undistributed) middle is called the Von Domarus principle.

Having satisfied himself that schizoid thought does indeed present the Von-Domarus principle, Arieti expanded the meaning of the principle. First defining the logic system that allows the undistributed middle as the "paleologic", he re-states the Von Domarus principle: "Whereas the normal person accepts identity only on the basis of identical subjects, the paleologician accepts identity based on identical predicates". Arieti goes much further than Von Domarus' observation, however; he states that the paleologic was the common form of reasoning prior to Aristotle and is still prevalent in primitive cultures. For example:

> My enemy possessed this hair and these fingernail shreds.
>
> This magic doll now has this hair and these fingernails.
>
> Therefore, harm committed on this doll will befall my enemy.

Arieti also proposes that children are paleologicians before they mature into Aristotelian logic:

> I am at this candy counter in this store.

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* It should be pointed out that the patient did not construct the syllogism. He confined himself to observing that Jesus is a woman and adding that a woman is just like a good cigar. Arieti assumed the reasoning process given here.

This lollipop is at this counter.

So, this lollipop is now mine.

Mythology too, he says is based on the paleologic:

Cassandra speaks prophecies such as no mortals speak.

The gods speak prophecies such as no mortals speak.

Cassandra speaks the prophecies of gods.

Arieti presumes dreams are based on the paleologic:

My wife is a young, light-haired woman.

This person I am strangling is a young, light-haired woman.

Therefore, I am (in this dream) strangling my wife!

Superstitions are examples of the paleologic:

I delayed in dread looking at my cards last time and got a good hand.

This time also I need a good hand.

So, if I just slowly ease these cards apart...

Arieti says we intentionally employ the paleologic in order to create or enjoys humor. ("Since arriving in Moscow, I find Russian is a very guttral language. This morning I belched at breakfast and the pretty waitress slapped me! - Bob Hope)

Indeed Arieti claims that the Freudian interpretation of dreams, sexual symbolism, the "whole Freudian technic" is based on the fact that the subconscious of each of us utilizes the paleologic. If Aristotelian logic is, as Arieti theorizes, limited to the normal, adult, awake, civilized, objective, serious person, then

logic must surely be acquired, acquired since Aristotle, and rather tenaously maintained.

It is not necessary to accept Arieti's contentions on the basis of his arguments. Actually it should not be accepted upon his argument, which contains a logical fallacy (that primitives, children, dreamers, etc. are linked in identity by the common predicate of the fallacy of the undistributed middle)*. Every one of his examples could be just as easily accounted for by assuming the reasoning is VALID but that the premises upon which it is based are not necessarily TRUE. The actual test of his theory is an empiric one, do schizophrenics actually commit the fallacy whereas normals do not? No such test had been made by 1958.

3. Physical effect. If reasoning ability is innate, logic should not show deterioration under stress. When the physical stimuli are sufficient to diminish motivation for the task, or to directly interfere in the performance of it, of course reasoning would be less efficiently expressed, but no change in the manner of the logical process itself would be expected. No experiments have been done directly on the question, but a few have a suggestive relation.

Haag (33) developed a reasoning test to measure decrement in performance with the lack of oxygen, for military application. He was successful in this, suggesting that reasoning performance is more sensitive to hypoxia than are physical

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* Interestingly, his fallacy is the fallacy of the undistributed middle.

measures. A suggestion by the author, however, that the test be used in other stress situations indicates that the experimenter apparently felt the performance was affected by the stress in hypoxia, rather than that there is a direct relationship between acquired reasoning and environmental stimuli.

Phillip (59) found that lysergic acid diethylamide (LSD-25) distorted thought processes, but he didn't clarify whether laws of logic were modified or whether hallucinations added gratuitous data for premises.

Hurst (25) noted that 5 non-schizophrenic patients who ordinarily did not exhibit thought disorder did so when under the influence of intravenous amylobarbitone solution. His interest was in demonstrating that schizophrenic patients should not be interviewed under influence of this drug lest flase diagnoses be drawn, and he did not clarify whether the thought disorder was INVALID logic or UNTRUE premises.

Overall, Brown, and Gentry (57) trained 33 rhesus monkeys in intermediate size discrimination and then subjected them to 5 levels of radiation dosage. A test of transposition was employed to determine the extent of utilizing relationships between stimuli for solution of this animal deductive problem. Relational learning was found to decrease as a linear function of radiation increase. If one is willing to generalize unreservedly from rhesus monkeys to humans in deductive reasoning, the results suggest logic is acquired. The main reservation in such a generalization here is that an animal's expression of the solution to a problem is physical (not verbal) and is thus handicapped to some degree by the radiation dosage. It is not possible to distinguish between the reasoning process and the efficiency of the responses from which the process is inferred.

A unique study of this nature is one by Nelson and Neely (53), who trained mice to select the correct runway for reward by solving a modification of Maier's reasoning apparatus, an acceptable deductive problem for animals. They offered a pulsating magnetic field "18,000 times the earth's magnetic field" in intensity, as a cue to assist the animals in drawing the proper conclusion. It had no effect on their reasoning, apparently, for it didn't aid their performance.

Gordon and Tikofsky (18) tested 40 brain-injured patients on a reasoning test involving both deductive and inductive steps* and analyzed the scores. They divided performance into three factors: spatial perception, Gestalt flexibility, and reasoning ability. If brain injury is assumed to interference with acquired skills, the best that can be drawn from this is that at least some brain-injured patients can continue to reason.

In general, the few studies touching upon reasoning under various physical stimuli add little to the question of the nature of logical reasoning ability. Of course none of them were undertaken with that intent, but such a study could be done relatively simply by steadily increasing a performance degrading stimulus and noting whether the decrement is due to logical fallacies or to deterioration of motivation, perception, or some other such factor. No such study had been done by 1958.

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* The Gottschaldt Embedded Figures Test.

B. Factor analysis of reasoning.

In the 1950's while the possibility of making comparisons of every possible correlation between different factors was highly popular, it was natural that reasoning ability should attract some of this attention. If logical reasoning skills could be broken down into components, it should bear heavily on the question of whether the skill is to be considered acquired or innate. Specifically, if it were composed of other skills, such as intelligence, perceptual acuity, reading skills, and so forth, the evidence for logic as learned would be strong. On the other hand if separation into factors, while peeling off related skills failed to separate the core factor of reasoning, that core factor might be considered innate.

The first review of factor analytic studies of reasoning was by Marron in 1953 (34). Comparing factor analyses to that date, he reported that agreement could be reached that five factors were involved: I. Sequential induction, II. Concrete analytic induction, III. Abstract analytic induction, IV. Sequential deduction, and V. Complex deduction. This added nothing to the subject that would not emerge from a casual conversation with a logic instructor. But it is seen from the titles of the studies that Marron had at his disposal before 1953 that factorial studies had not yet seriously studied logical reasoning.

In 1953 Howie (24) analyzed the results of 13 reasoning tests, intercorrelated scores, and factored separately for the two sexes. He also worked with two types of scores, number right, and number wrong in timed tests. For both sexes and both types of scores he found, among other factors, a "general reasoning" factor. In the

errors/timed analysis he found also a unique factor he tentatively called "caution".

Also in 1953 Green et al. (19) reported an analysis of the scores of 32 tests administered to 283 subjects. Besides isolating four related factors (verbal comprehension, numerical facility, perceptual speed, and visualization) they reported several reasoning factors, two of which they called "general reasoning" and "logical reasoning". They counted "symbol substitution" as a reasoning factor, too. Other reasoning factors they apparently believed were acquired, for they named them, "education of perceptual relations", "education of conceptual relations", and "education of correlates". For the purposes of the present examination it is germane to note that after stripping off non-reasoning and acquired reasoning factors they were left with two relatively "pure" factors.

Factorial studies continued (27,35) and in 1954 Guilford et al. (20) reported the results of a factor analytic study of Navy reasoning tests and the Air Force Aircrew Classification Battery. From 32 experimental tests for the Navy and 22 standard Air Force tests they extracted 16 factors. Twelve were non-reasoning factors and three were considered acquired reasoning skills (education of correlates, education of perceptual relations, and education of conceptual relations). They also were reduced to a basic factor they elected to name "general reasoning."

Also in 1954 Matin and Adkins (36) published a second-order factor analysis of reasoning abilities, and named five factors: precision in formation and use of verbal concepts, general verbal fluency, visualizing spatial constancy during

movement, speed in analysis, and flexibility in analysis. While it appears the latter four are not basic reasoning ability, the first may be open to such interpretation. It is possible to insist that what the authors meant by "precision in formation and use of verbal concepts" is essentially what is meant by logical reasoning itself and could conceivably be used as a definition for logical skill.

In 1956 Kettner et al. (28) attempted to go deeper into the matter by a factor analysis of the factor formerly extracted and named, "general reasoning". From a battery of 23 tests, they extracted and named again several non-reasoning factors (verbal comprehension, numerical facility, visualization, education of patterns, handling complicated procedures, trial and error manipulation, and math achievement). In addition, they identified two factors as "logical evaluation" and "general reasoning". In attempting to explain why they named this factor within the factor "general reasoning" also "general reasoning", they appear to be describing the skill of defining problems.

Frick et al. (13) also attempting to deal more specifically with a formerly extracted factor, broke down "flexibility in reasoning" into "verbal comprehension, originality, ideational fluency," and again, "logical evaluation" and "general reasoning".

In 1956 Guilford, Kettner, and Christensen (21) attempted to explain what factorial studies had yielded about the nature of the general reasoning factor. Apparently it is an unbreakable factor. They feel that it can best be thought of as "the comprehending and structuring of problems in preparation for handling them". This final summary does not answer the question of whether logical ability

is to be considered innate or learned. That successive analyses failed to break up a general reasoning factor is encouraging to the viewpoint of innateness. On the other hand, when the authors describe it as the preparing of problems for handling, it appears certain that the logic professor will contend that this is exactly the core content of his course. The issue remains at this point, nothing having been added from factor analysis since 1956.

* * *

Having examined the evidence up to about 1958, at that point the question of the nature of logical reasoning ability was dominated by Piaget and his students' suggestion from developmental studies that logical reasoning is learned as a child, by Richter's contention that logical reasoning is subject to various atmosphere effects, by Arieti's application of the Von Domarus principle, and by Guilford's summary of factorial studies.

At that point the evidence was strongly for logic as learned, and learned largely outside the logic classroom. By that time testers were bold enough to propose tests that purported to measure reasoning ability. NcNemar (41) and Lefford (32) produced tests for experimental purposes, Wechsler (83) purported to include a reasoning measure in a larger test, and others such as Hertzka and Guilford (23), Morgan and Morgan (49), Burt (6), and Lowry (31) put tests on the market.

By 1956 also, the conclusions from the several lines of research here examined had been generally accepted in psychology and were being presented to students. An example is Ruch (63) who in the 1963 edition of an introductory text presented all the

conclusions of 1956. He starts by telling the readers that syllogisms are not limited to "the highly trained thinker" having been learned in everyday experience as per Piaget. He goes on to advise the use of "formal logic" to check opinions implicitly accepting Richter's representation of the atmosphere effect in opinion forming. He then goes on to devote half a page to a proposed aid to setting up problems to be solved diagramatically, as Guilford would recommend. Putting his whole discussion in a section of the textbook designed to help the student aid himself suggests that Ruch agrees with Arieti that logical fallacies are not normal. And in his presumption that half a page of logic instruction in a psychology text could change logical reasoning ability, he clearly reveals that he accepts the skill as an acquired one.

Ruch probably represents the present state of the field in psychology, given the normal lag in publication and teaching. However, the frontier of the topic has changed considerably since 1959, and none of Ruch's assumptions can be unequivocally accepted now. Six studies published since 1959 that have inverted the status of the issue will now be examined.

The so-called "atmosphere effect" was carefully re-examined by Chapman and Chapman (8) who published their results in the Journal of Experimental Psychology in 1959. They noted that all the atmosphere studies since Sells suffered from a serious flaw; all results were based on <u>errors</u> made by subjects who also got other items correct. No account was taken in any analysis of the items correctly decided, and in fact little account was taken of subjects who got nearly all items correct. Subjects who got all items correct, prior to Chapman and Chapman, never contributed anything to tabulations in research on the matter of logical reasoning ability.

Chapman and Chapman constructed a syllogisms test of "negative" and "positive" and also "particular" and "universal" premises. Subjects made a multiple choice of the logical conclusion to be drawn from each syllogism, but no choice was actually valid. Testees had to commit a logical fallacy on every item, and under these circumstances it could easily be determined which, if any, type of error is preferred without trusting to chance that the students who commit the most errors commit them in proportion to those who commit few. They did indeed find preferred errors, but they were of neither the "negative" or "particular" atmosphere effects. They found the most common error, in fact the overwhelming tendency, to be the "fallacy of the undistributed middle" among their 222 college students.

The authors point out that their results strongly disagree with the "atmosphere effect" popular so long. The possibility exists that students who miss more items prefer the type of items that suggest an atmosphere effect. In additions, Chapman and Chapman (8) state:

> "Von Domarus and more recently Arieti suggested that in syllogistic reasoning concluding two things are the same because they share a common quality is distinctively pathological. They say this error is found in schizophrenics, but not in normals. Clearly, our results contradict their suggestion."

Chapman and Chapman were willing to speculate on the appeal of the fallacy of the unexcluded middle to reasoners. They noted that it rises whenever a subject takes the converse of a universal statement. For instance, when the universal premise, "All A are B" is given, people tend to accept its converse, "All B are A", which is a logical fallacy. The authors note that this is generally acceptable in

reality (e.g., All right angles are 90° angles, and all 90° angles are right angles) for ordinary purposes, although it is not acceptable in deductive reasoning. Accepting the converse of "particular" statements is more risky in everyday life (Most executives are Republicans; Most Republicans are executives), and the students did not tend to accept the converse of particular statements.

So essentially, although Chapman and Chapman did not state it this way, what happened was that when problems were unsolvable, the students reverted to their everyday TRUTH system. It seems reasonable to make a certain inference from their study, although they did not specifically compare "neutral" and "emotional" items. When Lefford did so and limited his results to an analysis of errors, he analyzed only those instances in which his subjects were forced to revert to their TRUTH systems, and naturally found a relationship between problem answers and personal convictions. Conspicuously missing from his analysis were those answers the subjects correctly got VALID, although contradictory to their TRUTH beliefs.

An interesting implication of the doubts the Chapman and Chapman study raises about the "atmosphere effect" and the "Von Domarus principle" is that possibly in those studies where the more logical subjects' results were systematically excluded from the tabulations, the results of inherently less logical subjects were used to demonstrate that no one is inherently logical. With this possibility in mind it is illuminating to refer back to the Shaklee (66) study. When he reported that the types of practice had an effect on reasoning performance, he also noted that it did not affect "high solvers".

In this light also, two other studies must be dismissed. Gaier, Lee, and McQuitty (14) gave 674 high school students a test of logical inference and stated the results supported the hypothesis, "that consistent response sets or cognitive styles can be identified by configural analysis of a single test". Analysis was based totally on errors.

That the importance of the Chapman and Chapman study has not been recognized is indicated by a recent book in which McGuire (40) says logical thinking is said to exist in the likelihood of adhering more closely to logical conclusions, and wishful thinking is said to exist in the likelihood of adhering more closely to the "desired" state. It is necessary for him to assume emotional influence to make this statement.

This blind assumption led McGuire to make a serious design flaw in an experiment in social psychology he later reported (39). He constructed 16 syllogisms, then mixed the 16 major, 16 minor premises and the 16 conclusions into a 48 item questionnaire. He had 120 college freshmen rate each item for "probability" and "desirability". Then during the following week, he selectively sent persuasive messages to half the group, and re-arranged the items into syllogistic form. At the end of the week, he re-administered the revised form and reported that for both the persuaded group and the control group the discrepancy between probability and desirability had declined. He explained that the improvement for the control group was because when the items were put together into syllogistic form, the conclusions were made more tenable to the subjects because the two premises and conclusion were "contiguous in a Socratic effect". It is more likely that the discrepancy between probability (VALIDITY) and

desirability (TRUTH) lessened when the problems became solvable. The only reason any discrepancy remained may be because of inherent differences in logical reasoning ability, which differences were assured when McGuire limited his subjects to, as he says, "the lowest 30% of academic achievers". He has made his problems available through the American Documentation Institute and an examination of them suggests that had he used the highest 30% of academic achievers he would have failed to find the statistical difference that he advances to support his hypothesis.

Turning again to the conclusions arising from the research along the line of development of reasoning in children, the question left unsettled was whether reasoning ability was more closely related to the child's learning experiences or to emergence of innate abilities. A study by Beaumariage (2) in 1960 tends to contradict the previously accumulated evidence. He administered both the California Mental Maturity Test and Cyril Burt's graded Reasoning Test to 4th, 5th, and 6th grade pupils. He found Spearman rank difference correlations significant and in the vicinity of .90, which throws some doubts on the previous evidence of orderly development of reasoning with experience. He finds logical ability more closely related to mental age than to chronological age.

Turning again also to the line of research dealing with physical effects on reasoning, a study by Broghammer and Huhnstock (5) tends to contradict in 1960 the previous conclusions. He reports that "Results with ten normal males and females indicate that ability to remember decreases under the influence of LSD-25,

but logical reasoning remains constant." The importance of this study is hard to judge. It is a German experiment; the test used is the Amthauer Intelligence Structure Test; and the original reference is not available. If the author's conclusions may be accepted as they are stated, it is strong evidence that logic remains unchanged under the influence of a physical stimulus, which would favor logical ability as inherent.

By 1960 then, all lines of evidence that had been accumulating for the previous 25 years and largely accepted into the mainstream of psychology had been subjected to severe doubts. By 1960, the issue was again an open one. It is now appropriate to examine the evidence brought since 1960 to determine whether anything further can be brought to bear on the question at hand. For convenience I have divided the more recent evidence into two main lines of research.

One recent line of research I refer to as those attempts that have been made to construct logic tests which will predict criteria, a relatively recent move, for which Stewart (70) is the most active spokesman. The other is the relations of logical ability to other factors, in which Morgan (45)* dominates the field. Those relating to criteria will be examined first.

A. Criteria studies.

The first study in which reasoning scores were validated against independent criteria is one by the U.S. Department of the Army (80) published in 1953 without an author credited. 65 reasoning problems were administered to 225 basic military

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*Actually Morgan did all of her work prior to 1960, but I have included her in the post-1960 section as ahead of her time in the sense that she was free of the bias' prevailing before 1959.

trainees in addition to the standard Army Classification Battery, composed of ten standard tests. All 75 scores were validated against usual military criteria of training success. The best single predictor (.35, significant past .01) was a verbal classification test on the regular ACB, but it was noted that "several reasoning factors appear to offer promise of increasing the predictive efficiency of the ACB." The reasoning factors involved were not discussed, and no further information has been made public.

In 1959 Morgan (47) reported the results of administering a 75-item deductive reasoning test to 97 finalists in the Westinghouse National Science Talent Search over three years. The winners were exceptionally talented youth, so Morgan offered the means of several groups for selection as a control group. Among them were engineers, lawyers, and college graduates selected as "executive potential". The Science Talent winners scored significantly higher (past .01) than any of the control groups and the author concluded the test was successful in measuring the reasoning ability necessary to scientific talent. Her assumption that science is based on deductive logic can be disputed (e.g., Popper (61) says its is based on inductive reasoning) but her results are suggestive to the issue of this discussion. It might mean that inherent logical ability underlies science talent, but when McCoy (37) compared college seniors majoring in science and non-science subjects, holding intelligence constant, he failed to find such a difference. On the other hand Morgan's results may indicate that logic is an inherent trait related to intelligence.

In 1962, Sister Canisia did an exhaustive study (7) among parochial school math students aimed at isolating those factors underlying math ability. Utilizing ten

standardized math tests, plus 36 more of her own, she did a factor analysis. Three factors emerged: education, organization, and reasoning. (She also notes, incidentally, that the "number factor" has no relation to math ability). Later she was able to predict math ability validly for parochial school students from the three factors.

In 1961 Davis (10) in reporting on measurement of mental skills in the Air Force commented, "Arithmetic reasoning items are widely used in Air Force personnel selection tests because of their high reliability and validity for a wide range of performance criteria." Arithmetic reasoning is mainly deductive reasoning.

Valentine (81) reported in the British Journal of Educational Psychology in 1961 that "a reasoning test" administered to over 1,000 applicants to British "university and training college" students was successful in predicting which scholars later earned academic honors. He also noted that the reasoning test "seems relatively independent of education." If it is true that a reasoning test achieved criterion validity and was independent of education, it would be extremely strong evidence in favor of logical reasoning as innate. However, only the Psychological Abstracts summary of Valentine's paper is available for this discussion.

In his doctoral thesis in 1961, Stewart (70) states that he made "perhaps the first attempt at predictive value of a logic test." This is a bit immodest in light of the U.S. Army (80), the Morgan (47), the Canisia (7), and the Valentine (81) attempts, but in any case Stewart's attempt is an unusually well-designed one in the history of

logical reasoning research. He is the first to take note of the three forms of logic problems. Former testers either restricted themselves to syllogisms (2,8,26,32, 50,62,65,77,85,87); mixed deductive problems freely (1,4,7,9,12,27,31,37,38,39, 43,45,46,47,48,49,58); mixed deductive and inductive (5,6,13,18,19,20,23,24,28, 30,35,36,80,83), or failed to report the type of problems used (33,59). Stewart constructed his test of 45 deductive verbal problems; 15 modus ponens, 15 modus tollens, and 15 syllogisms.*

High logic scorers were predicted to do better than low logic scorers on three criteria: reading comprehension, verbal ability, and grade point average, criteria measures being drawn independently. Differences were as predicted and significant. His results do not bear of the issue of innateness for his criterion measures are such high order cognitive tasks that whether logic is innate or acquired it is more basic than they.

Of more interest from his study is another finding. He notes that modus tollens is the type of item most missed. Modus tollens inferences are drawn from the predicate, so that errors in modus tollens are mostly a matter of accepting the converse of a statement, the same popular error that Chapman and Chapman noted.

With this distinction in mind, Stewart has re-examined the "atmosphere effect" again with the additional control (type of problem) that Chapman and Chapman did

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* Modus ponens: $\frac{P \supset Q \quad P}{\therefore Q}$ Modus tollens: $\frac{P \supset Q \quad \sim Q}{\therefore P}$ Syllogism: $\frac{P \supset Q \quad Q \supset R}{\therefore P \supset R}$

not have. Constructing a test of the three types of problems, subdivided into propositional and assertical forms, and further subdivided into in positive and negative content (73), he found the atmosphere effect operating in all three propositional forms and in assertical modus ponens and syllogisms. The one exception is the assertical modus tollens, which includes the bulk of items in which one is tempted to accept the converse. Since the assertical form is the most common in everyday usage, it would appear at first glance that Stewart found precisely the fallacy most common in the results of Von Domarus and Chapman and Chapman, is the one most resistent to the atmosphere effect, which implies that not only schizophrenics but most people commonly operate outside the Aristotelian law of the excluded middle.

One must look past this first glance, however, for in spite of his many excellent controls, Stewart ignored the example of Chapman and Chapman and based his analysis on errors alone, where correct responses were possible. He allows the possibility that his results are limited, and heavily weighted to, less logical (perhaps inherently) subjects. The end result may be that high solvers may miss a few of the difficult modus tollens, but they are not subject to any atmosphere effect.

Although this keeps Stewart's results from entering the discussion of inherence, it by no means diminishes the important work he has done in demonstrating a necessary new control. His work on control continues; recently he reported (72) on a comparison for reliability between tests of 30, 42, 54, and 66 items with controls for form, type of problem, and emotional tone of content.

Stewart carriesthis control further in another discussion (71). He points out that all tests purporting to measure critical thinking although using a variety of

combinations of logical laws, always use the Principle of Inference. Whitehead and Russell (84) define the principle of inference, "Where P⊃Q is TRUE, and P is TRUE, Q is TRUE." In discussing use of reasoning, or in psychological testing when we say someone does not possess a certain law of logic (say, the excluded middle), we always implicitly assume that he does possess the principle of inference. "It follows then...and the experimental variable in each case is the law from which inferences are made." All the experiments dealing with syllogisms (2,8,26,32,50,62,65, 66,77,85,87) and all those dealing with the fallacy of the undistributed middle (1,8,29, 55,82) are subject to this criticism. In every case they compared skill on syllogisms with lack of skill on syllogisms, by errors. The comparison could have been, Stewart says, with modus ponens as representing a relatively primitive principle of inference. If all the studies were re-examined and the statistical test made this way instead of as they were, the results might be different.

Most of the pre-Stewart studies are not well enough reported to re-examine in this light, but the Chapman and Chapman study is. They found an overwhelming tendency to accept the converse, a failure in modus tollens and in predicative syllogisms. However, if they had found errors in modus ponens to the same extent the principle of inference itself might have been lacking. Looking again at their data it can be seen that errors in modus ponens are virtually lacking. Their results are still significant by Stewart's new standard.

At this point Stewart's results do not bear directly on the issue of whether logical reasoning is innate. But he is apparently still publishing, and if he continues

adding controls in his present vein, he may ultimately develop a test so pure that the question can be answered directly. (That is, a test that people score on in a normal distribution, regardless of training.)

B. Relational studies.

Although concurrent relationships in themselves do not establish causal relationships, they constitute most of the data from which predictive hypotheses are formed, especially, in the behavioral sciences. To this end, the studies showing relationships between logical reasoning ability and other factors will be examined.

In 1956 Morgan (46) published the results of a comparison between a verbal deductive reasoning test and age and education. Interpreting former research as suggesting that acquired abilities remain while more inherent factors decline with age, Morgan compared men in their twenties with men in their thirties, both groups divided between bachelors degree and masters degree holders. The younger group scored significantly higher (.01) for bachelors but not significantly for the masters. This would tend to indicate that logical ability, like intelligence, declines with age and tends to support its inherence. The author does not quickly so conclude, however, on the chance that since all testees were applicants for jobs it is possible that the younger group were on the whole superior for bachelors but not masters. This possibility is speculative, as the author offers no evidence for it. Failing to accept her speculation, the only block to interpreting the experiment as supporting inherence is the question of whether inherent abilities do decline with age. Although Sward (74) found no evidence of decline in superior men, Wechsler (83) is representative of the many researchers who note that the more independent a single skill is of education

the more likely it is to decline with age. Probably the most interesting of these studies is one by Ni and Hsiao (54) in Taiwan. After finding mental declination among 7,397 retired servicemen in a roughly linear decrease on the Beta intelligence test and the Minnesota Spatial Relations Test, they end their article with a note re-affirming their respect for their elders. More closely related, however, is one by Glanzer and Glaser (17). They tested in both cross-section and longitudinally to probe for age-related changes with a battery of 14 mental abilities tests. 8 of 14 showed a decline, but four showed a net increase. Although the authors made no note of it, it is intriguing in the present discussion to note that "numerical computation," "numerica approximation", and "mathematical reasoning" were among the four showing an increase! This presents the most serious block to interpreting the Morgan study on age as supporting innate logical ability.

Another study by Morgan (45) concerned sex differences in logical reasoning. Most other researchers found no sex difference (2,4,6,8,9,12,32,37,38,46,55,58,60, 83) and only Kostik found such a difference (30). Morgan also, found no difference.

Tandon (76) included subtests of "comprehensive reasoning" and "drawing inferences" in a general intelligence test given 120 university students and found the "comprehensive reasoning" scale had a zero correlation with the rest of the subtests, while the "drawing inferences" subscale correlated on the .05 level with others. If it may be assumed that the "inierences" is a purer reasoning measure, these results mildly tend to relate intelligence and reasoning.

Evans (12) added to evidence about logic incidentally when he used programmed symbolic logic in investigating "teaching machine" variables. He reported certain

findings relating to setting up learning programs for the "machine", but of more interest here is that in three criteria of learning logic (time spent, time taken on tests, errors on tests) by college students there was no difference for sex mathematical experience, or class in school. This is some suggestion that logical learning ability is not as much dependent on acquired related experiences as on direct acquisition, or perhaps, inherence.

McCoy (38) made a direct comparison of logical test scores and intelligence. For various verbal intelligence tests the correlation with the Morgan Test of Logical Reasoning for 95 college students was .49, significant past .01; and the correlation between the Morgan Test and the WAIS for 18 students was .70, also significant beyond .01. Interestingly, the Wechsler subtest with the lowest correlation to the Morgan was the Similarities, with an r of .13, not significant. Why the Similarities does not correlate with the Morgan when Wechsler calls the Similarities a reasoning test may be because the Morgan is deductive while the Similarities is inductive. In this respect, the deductive Wechsler subtests (Arithmetic and Object Assembly) are among the highest subtest correlations with the Morgan. McCoy's study suggests that the relation between deductive logic and intelligence may be because both are inherent qualities, but it does not rule out the possibility that intelligence aids in acquisition of logic.

No doubt the most important of all the relational studies reported is one by Morgan and Morgan (48) comparing persons who had completed a course in logic in college with those who had not. This comes the closest a relational study can to the

issue at hand. Two groups of college graduates, 67 in each group, were matched for sex, age, and college degree. Those without training in logic scored much above chance, but significantly lower than those with logic training (.01). The first impression of the study is that the difference is due to training. However, the difference is disturbingly small; those without training scored a mean of 21 compared to 29 for those with, on a test where scores could go as high as 75. Furthermore, about a third of those without training scored higher than the trained group mean. This seems to make clear that is logic is learned, it is primarily learned outside the logic classroom.

The authors were not satisfied with accepting the conclusion that the study showed logic to be acquired. They raised three questions: (1) is logical ability related to intelligence? (Later answered affirmatively by Beaumariage and then McCoy); (2) Do more logical students matriculate into logic classes?; and (3) How much logic is learned in the classroom? The present study bears directly on these latter two questions. If as Morgan and Morgan hint, logic classes teach little logic, then not only might logical ability be inherent, but the Morgan Test of Logical Reasoning may be a new instrument at the disposal of psychologists to measure this inherent quality! Before any further assumptions are made as to the efficacy of logic courses (or half pages on it in psychology texts) the possibilities of the Morgan Test of Logical Reasoning need to be fully explored.

Preliminary to the present paper the author administered the Morgan Test of Logical Reasoning to ten logic classes taught by six different professors in seven

different schools in the period 1958 to 1960. In every case the logic class failed to significantly improve its mean score on the re-test at the end of the course over the pre-test at the beginning of the course! This seems to have given the teaching of logic an adequate opportunity to demonstrate that logical skills are acquired, if the Morgan Test is accepted as a valid measure of logical reasoning. Validity of the Morgan is based on (1) face validity (it is, after all, a test of 75 logic problems), (2) predictive validity in choosing job candidates in personnel practice (no rigorous study made), (3) relation to exceptional scientific achievement in youth, (4) relation to intelligence. This leaves the construct validity of the test still lacking, but the relationships and the distribution of scores show the Morgan Test measures something.

It may measure verbal intelligence. In fact, this is a good possibility, as the test is long and difficult by any standards and high scores are rare. It is reasonable to ask if the Morgan is simply so difficult that it is an intelligence test. The most direct answer to this question is to validate a short form of the Morgan containing the core discriminating ability of the original. This is not to say that the Morgan needs to be revised for applied use* which may sacrifice its unique quality, but is rather meant as a short excursion away from the original to answer the most needling question about it. If a short form Revision can be validated against logic training in the classroom, it would suggest that the long form is simply insensitive to training, probably because it is so long and difficult. If the short form, like its parent, also fails to

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*However, it should be revised in any case, to take into accounr the results of Chapman and Chapman and Stewart, and to make it less cumbersome.

differentiate trained and untrained logicians, it would suggest that the long form measures inherent ability.

Purpose: The purpose of the present study is to validate a short form Revision of the Morgan Test of Logical Reasoning (49) against the criteria that can be derived from the assumption that a regular college course in formal logic improves logical reasoning ability. The purpose will be met if validation is supported per examination of the following three hypotheses:

1st HYPOTHESIS: SCORES OF THE SHORT FORM REVISION ARE CLOSELY RELATED TO SCORES OF THE ORIGINAL MORGAN TEST OF LOGICAL REASONING.

2nd HYPOTHESIS: SCORES OF THE SHORT FORM REVISION ARE HIGHER FOR A GROUP INSTRUCTED IN LOGIC THAN FOR A CONTROL GROUP.

3rd HYPOTHESIS: SCORES OF THE SHORT FORM REVISION ARE CLOSELY RELATED TO SUCCESS IN LEARNING LOGIC.

To meet the immediate purpose of the present study, validation of the short form Revision, will also add evidence to the unique position of the Morgan Test of Logical Reasoning in the larger theoretic question of whether logical reasoning ability is to be considered inherent or acquired. To fail to meet the present purpose might also add evidence in the larger question.

But in either event, the procedure of the present study is confined to the immediate purpose, and any comments on the larger question are left to discussion.

CHAPTER II - PROCEDURE

Construction of the Revision: An item analysis was performed on the Morgan Test of Logical Reasoning. The answer sheets of 258 college students were used. None of the subjects whose answers were used in the item analysis were in the present experiment. The students on the item analysis had attended different schools and had all completed a college course in logic. The sample appeared to be typically distributed as to Morgan scores, i.e., they fell into an essentially normal curve but with some positive skewness.

The 258 answer blanks were divided into three Morgan score levels: high - 40 or over, middle - 10 through 39, and low - 9 or under. The mean Morgan score for college students is about 22. The high group included 70 answer sheets, the middle had 130, and the low was 58. For each item there was tabulated: (1) how many of the testees in the level had completed it, (2) how many of those who had completed it had it correct, (3) the percentage of those who had completed it who had it correct, and (4) the said percentage minus 50. The tabulation in four columns for each level is in Appendix IV.

After tabulation, the "value" of each item was computed from the following formula:

$$\text{value} = D_h - \left| D_m \right| - (D_l)$$

where D is the percentage of testees in the level who had the item correct minus 50, and "h", "m", and "l" are high, middle, and low levels. The difference for the

middle group was taken as an absolute value so that any distribution of the middle group other than a 50%-50% split detracted from the item value. The middle term is an addition to the usual formula for item analysis item value and is intended for its effect in degrading the value of items either too difficult or too easy. Usually it is intended in a Revision to retain items of varying difficulty level, but in the present case the task of shortening a 75 item test to a short form required extensive discarding of items while attempting to retain the core discriminating value of the test. By this method the "value" of each of the 75 items on the original Morgan Test of Logical Reasoning was computed; the results are also in Appendix IV.

Seventeen of the twenty problems with the highest item analysis value were selected for the Revision. Three other items of lower value were added to make the test exactly 20 items long for easier scoring.* Items were retained in the same serial order they had in the Morgan. The directions for the Revision were re-written from the Morgan directions to improve clarity. These twenty items and the re-written directions, in mimeograph form, constitute the Revision.

Experimental procedure: The experimental group was an ordinary college logic class. The control group was a college course in introductory psychology. Both were taught in the same school in the same semester. No student was enrolled in both classes. The only pre-requisite for the psychology course was sophomore or higher status; there was no pre-requisite for the logic class, but it included no

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*Failure to use the top twenty items, as intended, was a clerical error.

freshman. The two classes were comparable in distribution of age, sex, and college major.

The first day of the semester the experimenter met each class and explained the exact nature and intent of the experiment, and asked for voluntary cooperation, Students were assured that all logic scores would be withheld from their respective instructors until final grades for the courses were recorded. All volunteered. After the first day, one more student matriculated into the psychology class late and was not used in the experiment.

After the explanation and still during the first class meeting each class was administered the Morgan Test of Logical Reasoning. No time limit was set or mentioned and no one inquired about one. All testees finished before the class period expired, the longest taking 44 minutes. On the second day of class before instruction commenced, each class was given the Revision. No time limit was mentioned; the longest time taken was 22 minutes. During the last week of classes in the semester, each class was again given the Morgan Test. During the examination period and prior to the class exam, each class was administered the Revision. In the re-testing no time limits were set, and the times taken by the slowest students was only slightly more than in the first administrations.

The logic professor agreed to refrain from discussing any item on either test form during the course. He surrendered course grades to the experimenter before being informed of the scores of any students.

The level of motivation of the subjects may be inferred from the fact that 10 of the 20 psychology students and 11 of the 20 logic students addressed postcards made

available to them to be mailed their scores and the outcome of the experiment after the end of the study.

The Morgan scores are number-right-minus-number-wrong, the authors' correction for guessing* (48), and the Revision was scored the same way. A copy of the Revision is Appendix V. The Morgan Test of Logical Reasoning is copyrighted and available from the authors (49).

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* The actual formula to correct for guessing is number right minus $\frac{1}{n-1}$ times the number wrong, where "n" is the number of choices per item. In the case of the Morgan and the Revision there are only two choices so the formula reduces to number-right-minus-number-wrong.

CHAPTER III - RESULTS

Raw scores of both the Morgan Test of Logical Reasoning and its present Revision are presented in Appendix I. The raw score mean for the Morgan Test was 20, very close to the means of 22 and 23 formerly reported for college students (38,46); the standard deviation was 16.3, also in keeping with standard deviation formerly reported (38,45,46). The Revision mean was 0, many of the scores being minus values. The standard deviation of the Revision raw scores was 8.0.

All scores on each test were transformed into z-scores as defined by Underwood (92) and the tabulated z-scores are presented in Appendix II. From this point all further analysis was done solely with the z-scores so that the original Morgan, its Revision, and course grades could be directly compared in spite of difference in means and ranges.

Test and the 1st hypothesis: In its null form (SCORES OF THE SHORT FORM REVISION ARE NOT CLOSELY RELATED TO SCORES OF THE ORIGINAL MORGAN TEST OF LOGICAL REASONING) the first hypothesis concerns how closely the Revision retained the measuring characteristics of the original. The test of this hypothesis is the familiar Pearson product-moment correlation. In this instance it was convenient to apply the z-score form of the correlation technique, as described by Underwood (92). The r yielded is .78, a reasonably high correlation for this type of measurement, and significant beyond the .01 level of probability. The first null hypothesis is held untenable and the close relation of the Morgan and Revision unchallenged. This relationship

establishes nothing about the validity of either form, but is a minimal necessity to demonstrate before proceeding in the analysis. It is recognized that three factors tend to inflate the correlation: (1) it is a whole-part correlation, (2) the procedure allows the possibility of carry-over in memory of items from one form to the next in following-day administrations, and (3) using both pre- and post-scores on 40 subjects for 80 scores. These considerations require that a high and significant r be established before proceeding, and such is the case.

Test of the 2nd hypothesis: In its null form (SCORES OF THE SHORT FORM REVISION OF THE MORGAN TEST OF LOGICAL REASONING ARE NO HIGHER FOR A GROUP INSTRUCTED IN LOGIC THAN FOR A CONTROL GROUP) the second hypothesis raises one possible criterion for concurrent validity of the Revision. The necessary assumption is that those persons who have just completed a college course in logic are in fact somewhat superior in logical reasoning ability to those who have not taken such instruction.

In consideration of the possibility that the two classes might differ in initial logical reasoning ability before instruction begins, the design is analysis of co-variance, as outlined by Lindquist (91). In this case the co-variate is the pre-course scores on the tests of both groups prior to instruction. That is, the means of the two groups are compared after one has received treatment, but with the post-treatment means corrected for the difference in pre-treatment means.

The results of the analysis of variance of the pre-treatment means of the two groups are presented in figure 2. The F is not significant, indicating that the variance of scores between the experimental and the control group could well have been expected

Source of variation	sums of squares	df	mean squares	F
BETWEEN E & C	.18	1	.18	.23
WITHIN GROUPS	29.56	38	.78	
TOTAL	29.74	39		

Figure 2. Analysis of variance, pre-treatment Revision scores.

by chance. The second step in the analysis of co-variance is the analysis of variance of the post-treatment Revision scores of the two groups. This F was significant, but the initial (though non-significant) difference between the two groups is not yet accounted for. This correction is done in the analysis of co-variance and the results are tabulated in figure 3. The F is significant beyond the .01 level. Significance of this F indicates that the difference found between the Logic and Psychology classes after instruction can not be accounted for by pre-instruction plus chance differences.

The second null hypothesis then, is held untenable and the validity of the Revision is supported.

At this point it is interesting to digress from the central intent of the analysis and compare the two classes on the original Morgan Test in the manner just done for the Revision, although this does not bear on the validation of the Revision. It is interesting to do so because in previous studies the Morgan Test has consistently failed to show a post—instruction gain, as the Revision just has (38). This fact in previous studies underlies the present author's hypothesis about the Morgan's insensitivity to logic training. Analyses of variance for pre-instruction and post-instruction differences are tabulated in figures 4 and 5, respectively. Since neither F is significant, it is apparent that the classes did not differ on the Morgan Test before or after the Logic class received instruction. An analysis of co-variance is unnecessary; for the eleventh time the Morgan Test has failed to show any gain in logical reasoning ability for persons who have completed a college logic course!

Source of variation	df	mean squares	F
TOTAL	38		
WITHIN	37	.48	
ADJUSTED MEANS	1	5.49	11.44

Figure 3. Analysis of Co-variance, post-treatment Revision scores.

Source of variation	sum of squares	df	mean squares	F
BETWEEN E AND C	.63	1	.63	.76
WITHIN GROUPS	31.50	38	.83	
TOTAL	32.13	39		

Figure 4. Analysis of variance, pre-treatment Morgan scores.

Source of variation	sum of squares	df	mean squares	F
BETWEEN E AND C	1.10	1	1.10	1.02
WITHIN GROUPS	41.11	38	1.08	
TOTAL	42.21	39		

Figure 5, Analysis of variance, post-treatment Morgan scores.

Test of the 3rd hypothesis: Stated in its null form (SCORES OF THE SHORT FORM REVISION OF THE MORGAN TEST OF LOGICAL REASONING ARE NOT CLOSELY RELATED TO SUCCESS IN LEARNING LOGIC) the third hypothesis raises the logic instructor's estimates of performance in a logic course as a possibly more refined criterion for validity of a test of logical reasoning.

The appropriate test is a correlation of the logic professor's overall course grades with the post-instruction administration of the Revision. To make this comparison it was necessary to transform the professor's grades into z-scores. The logic class grades both in raw form and in z-form are shown in Appendix III. The raw score course grade average was 2.68, and the standard deviation was .86. For this comparison it is also necessary to recompute the mean and standard deviation of the Revision scores, limiting them to those directly concerned in this correlation. In this lesser case the mean is 4.3, which is conspicuously higher than the overall Revision mean of zero. The lesser standard deviation is 7.4, about the same as the overall Revision S.D. of 8.0.

The correlation coefficient is .31 which suggests some relationship and is positive, but is not statistically significant for this N. The likelihood of this relationship having occurred by chance justifies the 3rd null hypothesis, failing to enhance the proposed criterion validity.* Although the range of class grades assigned by the instructor was quite narrow, tending to deflate this correlation, adherence to standards of scientific acceptance dictate dismissal of this relationship as probably not meaningful.

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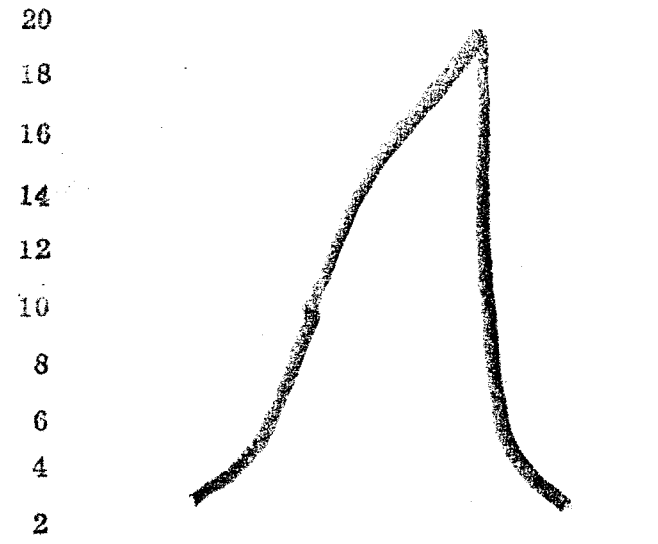
* Correlation of the Morgan post-test scores with instructor grades is .16, also not significant.

CHAPTER IV - DISCUSSION

The high and significant correlation between the Revision and the original Morgan Test of Logical Reasoning certainly shows a high relationship between the two. A high correlation between the whole and a part of the same test would be expected in any case where the Revision is deliberately constructed from the items of the original shown by item analysis to be most contributory to the total test score. The close relationship, then, is not unexpected. A more telling comparison than the correlation is the comparison of distributions of the Morgan and the Revision in this study. The distribution of scores are plotted together in figure 6, and it is seen that the two curves are similar and probably measuring much the same quality. A certain dissimilarity occurs, however, in the low scores, which will be examined further later in the discussion.

Concerning the second hypothesis, and the results demonstrating the superiority of the logic-trained students over the control group, the obvious conclusion is that the Revision is validated by this criterion. The first fact to be noted is that the two classes did not differ in logic ability prior to the start of the course. This in part answers the Morgans' question (48) of whether logic classes attract more logical students. The answer here is no, and it is in keeping with unpublished former work by the present author in which a class in logic was compared to a class taught by the same instructor in religion. There also, was no difference in pre-course Morgan scores. McCoy (38) also reported no difference between the mean IQ of logic classes



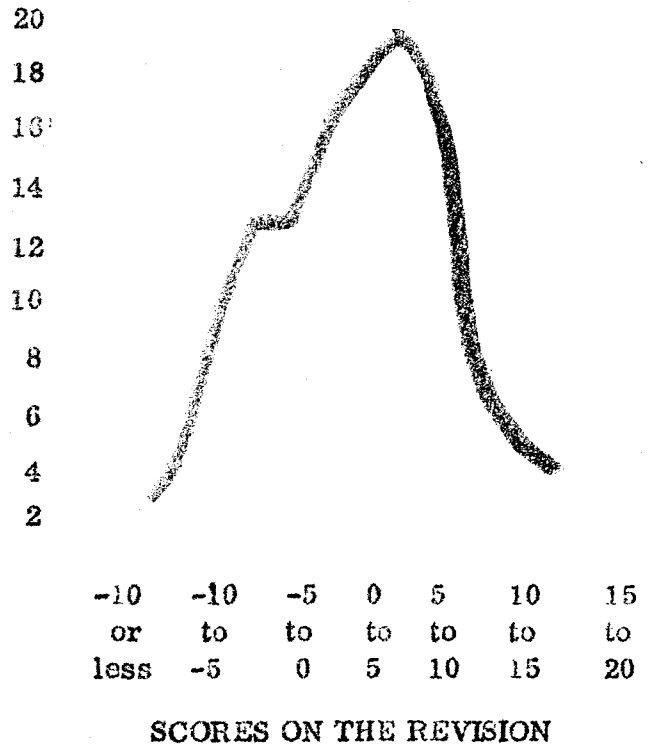


Figure 6. Graphed distribution of frequency of scores on the Morgan Test of Logical Reasoning and on the Revision showing similarity of distributions.

and school mean IQ. And in seven different schools the present author found only one in which a prerequisite was posed for matriculation into the logic course. Generally, then, logic students show no evidence of being superior in logic before taking the course, and this is specifically true in the present study. The fact then that the logic class was here superior on the Revision at the end of the course demonstrates at the least that the class as a whole did improve in logical skill. More important to the immediate purpose of this paper is that the Revision is validated by this criterion, and since at the same time the parent instrument did not show the same gain, the Revision is more sensitive to acquired logic skill.

Turning to the third hypothesis, the logic professor's course grade was in effect an estimate of the student's final reasoning skill, and that both forms of the test failed to agree closely with it is, strictly speaking, against the validity of either form. It is possible to conclude either that the tests failed to measure acquisition sensitively enough, of that the professor's grades were not sensitive enough (possibly because of their narrow range). For the purpose of this paper it has been assumed that the professor's grades do estimate success in learning logic, so it must be concluded that the Revision failed in this criterion of validity.

Why the Morgan failed to measure the effect of the learning while the Revision did may be due to the possible difference in motivation between the two forms. A student who has just finished a course in logic may feel he is ready to solve any logic problem, but when he sees a test which appears to him long and difficult he may not make a complete effort on each item, but may attempt to get through rapidly. This would be plausible if most students typically got many of the first items on the long

form correct, and then began missing items. A glance at the item analysis shows that this is what happens. Observations of testee's behavior in the test session also suggest this; students work slowly at first and then appear to be marking items with little consideration. Another interesting observation may be added to this; on three occasions in preliminary work logic professors sat down with their classes at the end of the course and also took the Morgan. In all three cases they correctly answered all the items they attempted, but one finished only 32, and the other 39 and 41.

A serious detracting fact from the idea of differing motivation is the scoring of the logic students on the present Revision. If time and motivation were the ruling factors, then on the short form which students completed in less than 20 minutes, scores should be quite high. In fact, they were quite low. The mean score of the logic students on the post-course Revision was only 4, out of a possible 20. In this respect the Revision resembles its parent in that high scores are rare.

Setting aside motivation, another explanation might be that the Morgan Test, and its Revision, are both inherently verbal intelligence tests. This is hard to believe in the case of the 20-item test with no variation in type of task, but quite credible in the long and difficult original. In any event, it is obvious that there was a net gain for the class in logic skill and that the Revision registered it.

This completes the discussion of the immediate intent of the present study; validation of the short form Revision was accomplished. But another examination is in order. Both the Morgan Test and the Revision were constructed prior to the excellent work of Stewart (68) on the nature of logic test items. Lack of his controls

does not in any sense invalidate the present study, as both experimental and control groups were subject to precisely the same lack of controls. However, consideration of the types of items employed by the original and the Revision sheds further light on differences between the forms. Stewart distinguished between three types of items (modus ponens, modus tollens, and syllogisms) and two forms (propositional and assertical). The types and forms of the items in the Morgan are stated in Appendix VII.

The Revision is composed of 12 assertical and 8 propositional items, and 10 modus ponens, 5 modus tollens, and 5 syllogisms. The distribution is shown in Figure 7. The Morgan Test has 57 assertical and 18 propositional items, of which 16 were modus ponens, 27 modus tollens, and 32 syllogisms. The distribution is shown in Figure 8. The disparity between the two distributions is enlightening; the Morgan had assertical modus tollens and assertical syllogisms over-represented, while the Revision is lacking in propositional syllogisms and assertical modus tollens.

In light of Stewart's results, that assertical modus tollens is most resistant to the atmosphere effect, and his and Chapman and Chapman's findings that modus tollens is the most difficult type of item, the Revision and the Morgan differ most on the type of item most significant. This is the result of the item analysis which systematically eliminated the most difficult items (largely modus tollens) and the easiest (including propositional syllogisms). In brief, the Revision systematically eliminated the Morgan items most resistant to instruction. This constitutes a serious criticism against assuming that the Revision retained the unique discriminating power of the Morgan. It does not challenge the validity of the Revision, but does suggest that the

	MODUS PONENS	MODUS TOLLENS	SYLLOGISMS
ASSERTICAL	6	1	5
PROPOSITIONAL	4	4	0

Figure 7. Distribution of types and forms of terms, Revision.

	MODUS PONENS	MODUS TOLLENS	SYLLOGISMS
ASSERTICAL	9	18	30
PROPOSITIONAL	7	9	2

Figure 8. Distribution of types and forms of items, Morgan Test of Logical Reasoning.

present author sacrificed the core quality of the Morgan that originally drew attention to the Morgan. This raises the distinct possibility that the Morgan, which in its gross form does not measure logic learning, in a purer form (limited mainly to its modus tollens) might be the exciting instrument its cumbersome form proposes.

This would be the most promising direction for further examination of the Morgan. It is not the direction that Stewart is presently pursuing. By his standards, a test to be comprehensive should include half emotional and half neutral items (32), half universal and half particular (65), half deductive and half inductive (58), half negative and half positive (87), half correct and half incorrect conclusions offered (8), half TRUE and half not (62), and a third modus ponens, a third modus tollens, and a third syllogisms (68). Although no one has suggested it, perhaps half should be verbal and half symbolic. Each category should be equally distributed in equal proportions to all others. With only one item in each category the minimum number of items would be 384. On the other hand, if all former results are accepted, the putative basically most resistant logical ability could perhaps be most closely approached with but a handful of emotional, particular, deductive, negative, incorrectly supplied, unTRUE, verbal, modus tollens items. Interestingly, the Morgan Test includes a disproportionately large number of such items.

The immediate purpose of the present paper thus fully discussed, perhaps it is germane to ask what has been added to the larger question of whether logical reasoning ability can be considered innate or learned. The answer is that the present study failed to add any substantive evidence to the issue. Although the validation proposed was accomplished which was hypothesized as against Morgan's measure being

of inherence, the post facto analysis after Stewart shows that the Revision may have failed to retain the unique core of the Morgan Test. But in the loss of this study to the larger question, a direction for further study is clearly indicated: logic students' performance on modus ponens and subjective syllogisms should be compared with their performance on modus tollens and predicative syllogisms.

CHAPTER V - SUMMARY

Whether logical reasoning ability is inherent or acquired is unsettled. The Morgan Test of Logical Reasoning stands at the top of evidence favoring innateness in that it remains unaffected by instruction in logic. But the Morgan is so long and difficult that it is possibly confounded by motivation or intelligence.

The present study is an attempt to validate a short revised form of the Morgan against the one criterion that would remove the test from its unique position, acquired logic skill. The Revision correlated .78 with the Morgan ($p < .01$), had a similar distribution of scores, and did validate against logic training ($p < .01$). It failed to correlate with another criterion, course grade ($p > .05$). Class differences in logical skill prior to instruction were controlled by analysis of co-variance.

Although the Revision was validated as hypothesized, a closer examination of the types of items in the two forms in the light of recent research revealed that the Revision systematically excluded a type of item possibly giving the Morgan its unique character.

Conclusions are: (1) the present Revision is a valid instrument for discriminating acquired logical skill, but (2) the Revision is not necessarily a true short form of the original Morgan. No conclusions as to the larger issue of innateness are possible from this study, but the most promising direction for further research is suggested.

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Appendix I

RAW SCORES: Morgan Test of Logical Reasoning; Revision

	Experimental Group (Logic class) PRE-TEST		POST-TEST	
	Morgan	Revision	Morgan	Revision
La	23	4	19	4
Lb	23	4	35	12
Lc	15	-2	37	8
Ld	45	12	53	20
Le	9	0	11	6
Lf	21	2	29	4
Lg	7	-10	-3	-2
Lh	23	0	37	0
Li	13	-8	11	-8
Lj	13	-2	-3	-2
Lk	27	-10	11	1
Ll	19	-4	13	-6
Lm	39	14	35	9
Ln	8	-6	23	-2
Lo	25	2	36	18
Lp	28	-2	29	8
Lq	29	6	51	10
Lr	3	-6	22	-6
Ls	19	-2	25	4
Lt	25	0	31	8
Average	20.7	-0.4	25.1	4.3
	Control Group (Psychology class)			
Pa	1	-10	-3	-14
Pb	14	-2	22	0
Pc	13	-2	17	-10
Pd	6	-6	6	-6
Pe	7	-6	7	-2
Pf	1	-12	-1	-10
Pg	18	-2	19	-2
Ph	3	-4	13	-8
Pi	12	0	23	-4
Pj	15	-10	1	-12
Pk	14	0	7	-10
Pl	6	2	17	-10
Pm	31	-6	25	2
Pn	3	-4	13	6
Po	-13	-6	3	-12
Pp	61	20	57	20
Pq	16	2	21	-4
Pr	38	4	33	8
Ps	51	14	57	14
Pt	26	-1	41	2
Average	15.2	-1.7	19.7	-2.6

Appendix II

Z-SCORES: Morgan Test of Logical Reasoning; Revision

	Experimental Group (Logic Class) PRE-TEST		POST-TEST	
	Morgan	Revision	Morgan	Revision
La	.18	.50	-.06	.50
Lb	.18	.50	.92	1.50
Lc	-.31	-.25	1.04	1.00
Ld	1.53	1.50	2.02	2.50
Le	-.68	0.00	-.55	.75
Lf	.06	.25	.55	.50
Lg	-.80	-1.25	-1.41	-.25
Lh	.18	0.00	1.04	0.00
Li	-.43	-1.00	-.55	-1.00
Lj	-.43	-.25	-1.41	-.25
Lk	.43	-1.25	-.55	.13
Ll	-.06	-.50	-.43	-.75
Lm	1.17	1.75	.92	1.13
Ln	-.67	-.75	.18	-.25
Lo	.31	.25	.98	2.25
Lp	.49	-.25	.55	1.00
Lq	.55	.75	1.30	1.25
Lr	-1.04	-.75	.12	-.75
Ls	-.06	-.25	.31	.50
Lt	.31	0.00	.68	1.00
Total	.91	-.99	6.25	10.76
Sum/squares	7.84	12.25	18.79	23.04
	Control Group (Psychology Class)			
Pa	-1.17	-1.25	-1.41	-1.75
Pb	-.37	-.25	.12	0.00
Pc	-.43	-.25	-.18	-1.25
Pd	-.86	-.75	-.86	-.75
Pe	-.80	-.75	-.80	-.25
Pf	-1.17	-1.50	-1.29	-1.25
Pg	-.12	-.25	-.06	-.25
Ph	-1.04	-.50	-.43	-1.00
Pi	-.49	0.00	.18	-.50
Pj	-.31	-1.25	-1.17	-1.50
Pk	-.37	0.00	-.80	-1.25
Pl	-.86	.25	-.18	-1.25
Pm	.67	-.75	.31	.25
Pn	-1.04	-.50	-.06	.75
Po	-2.02	-.75	-1.04	-1.50
Pp	2.52	2.50	2.88	2.50
Pq	-.25	.25	.06	-.50
Pr	1.10	.50	.80	1.00
Ps	1.90	1.75	2.27	1.75
Pt	.98	-.13	1.29	.25
Total	4.13	-3.65	-.37	-6.50
Sum/squares	24.55	18.02	24.28	27.00

Appendix III

LOGIC CLASS GRADES: raw grades assigned, and transformation to z-scores

Student	Grade	(Grade)	z-score
La	C	2.0	-.81
Lb	B--	2.6	-.11
Lc	C	2.0	-.81
Ld	A	4.0	1.51
Le	A-	3.8	1.28
Lf	B-	2.8	.11
Lg	C	2.0	-.81
Lh	D--	0.6	-2.44
Li	A--	3.6	1.04
Lj	C	2.0	-.81
Lk	B	3.0	.35
Ll	C	2.0	-.81
Lm	A-	3.8	1.28
Ln	C	2.0	-.81
Lo	C+	2.2	-.58
Lp	C+	2.2	-.58
Lq	B	3.0	.35
Lr	B	3.0	.35
Ls	B	3.0	.35
Lt	A	4.0	1.51
	Total	53.6	
	Mean	7.18	
	Sum/squares	158.48	
	Standard deviation	.86	

18	70	70	100%	50	130	92	71%	21	58	36	62%	12	50-/21/-12 = 17
19	70	53	76%	26	128	110	86%	36	58	26	45%	-5	26-/36/-(-5) = - 5
20	70	62	89%	39	127	126	99%	49	58	35	60%	10	39-/49/-10 = -20
21	70	58	83%	33	127	73	57%	7	57	41	72%	12	33-/7/-12 = 14
22	70	17	24%	-26	127	112	88%	38	57	33	58%	8	-26-/38/-8 = -72
23	70	68	97%	47	126	109	87%	37	57	42	74%	24	47-/37/-24 = -14
24	70	64	91%	41	126	101	80%	30	57	19	33%	-17	41-/30/-(-17) = 28
25	70	70	100%	50	126	100	79%	29	57	23	40%	-10	50-/29/-(-10) = 31
26	70	35	50%	0	125	51	41%	-9	57	18	32%	-18	0-/-9/-(-18) = 9
27	70	70	100%	50	125	110	88%	38	57	52	91%	41	50-/38/-41 = -29
28	70	67	96%	46	124	106	85%	35	56	27	48%	-2	46-/35/-(-2) = 13
29	70	70	100%	50	121	99	82%	32	54	12	22%	-28	50-/32/-(-28) = 46
30	70	66	94%	44	120	73	61%	11	54	26	48%	-2	44-/11/-(-2) = 35
31	70	36	51%	1	120	89	74%	24	54	39	72%	22	1-/24/-22 = -45
32	70	50	71%	21	120	21	18%	-32	54	9	17%	-33	21-/-32/-(-33)= 22
33	70	61	87%	37	119	92	77%	27	54	23	43%	-7	37-/27/-(-7) = 17
34	70	64	91%	41	119	99	83%	33	54	31	57%	7	41-/33/-7 = 1
35	70	30	43%	-7	116	27	23%	-27	53	12	23%	-27	-7-/-27/-(-27) = -7
36	70	59	84%	34	114	62	54%	4	53	18	34%	-16	34-/4/-(-16) = 46
37	70	42	60%	10	114	68	60%	10	53	30	57%	7	10-/10/-7 = -7
38	70	57	81%	31	114	47	41%	-9	53	4	8%	-42	31-/-9/-(-42) = 64
39	70	65	93%	43	113	95	84%	34	53	33	62%	12	43-/34/-12 = -3
40	70	24	34%	-16	112	27	24%	-26	53	1	2%	-48	-16-/-26/-(-48) = 6
41	70	67	96%	46	110	102	93%	43	53	41	77%	27	46-/43/-27 = -24

42	70	60	86%	36	110	79	72%	22	53	14	26%	-24	36-/22/-(-24) = 38
43	70	61	87%	37	110	89	81%	31	53	29	55%	5	37-/31/-5 = 1
44	70	69	99%	49	106	96	91%	41	53	28	53%	3	49-/41/-3 = 5
45	70	67	96%	46	105	43	41%	-9	53	9	17%	-33	46-/-9/-(-33) = 70
46	70	70	100%	50	104	96	92%	42	51	32	63%	13	50-/42/-13 = -5
47	70	61	87%	37	100	41	41%	-9	50	17	34%	-16	37-/-9/-(-16) = 44
48	70	66	94%	44	100	50	50%	0	50	25	50%	0	44-/9/-0 = 44
49	70	67	96%	46	100	87	87%	37	50	25	50%	0	46-/37/-0 = 9
50	69	61	88%	38	100	65	65%	15	50	23	46%	-4	38-/15/-(-4) = 27
51	69	69	100%	50	100	91	91%	41	50	38	76%	26	50-/41/-26 = -17
52	69	53	77%	27	98	61	62%	12	50	16	32%	-18	27-/12/-(-18) = 33
53	68	54	79%	29	95	23	24%	-26	50	15	30%	-20	29-/-26/-(-20) = 23
54	68	49	72%	22	95	40	42%	-8	50	0	0%	-50	22-/-8/-(-50) = 64
55	68	59	87%	37	95	59	62%	12	50	21	42%	-8	37-/12/-(-8) = 33
56	67	63	94%	44	95	48	51%	1	50	28	56%	6	44-/1/-6 = 37
57	65	61	94%	44	95	65	68%	18	50	15	30%	-20	44-/18/-(-20) = 46
58	65	8	12%	-38	92	6	7%	-43	50	13	26%	-24	-38-/-43/-(-24) = -57
59	65	60	92%	42	89	30	34%	-16	50	21	42%	-8	42-/-16/-(-8) = 34
60	63	42	67%	17	89	29	33%	-17	50	32	64%	14	17-/-17/-14 = -14
61	62	37	60%	10	90	46	51%	1	50	38	76%	26	10-/1/-26 = -17
62	62	60	97%	47	90	71	79%	29	50	43	86%	36	47-/29/-36 = -18
63	62	58	94%	44	90	62	69%	19	49	43	88%	38	44-/19/-38 = -13
64	60	60	100%	50	90	68	76%	26	48	32	67%	17	50-/26/-17 = 7

65	59	57	97%	47	86	59	69%	19	46	25	54%	4	47-/19/-4 = 24
66	59	57	97%	47	84	71	85%	33	46	36	78%	28	47-/35/-28 = -16
67	59	54	92%	42	84	67	80%	30	45	18	40%	-10	42-/30/-(-10) = 22
68	56	55	98%	48	84	39	46%	-4	44	35	80%	30	48-/-4/-30 = 14
69	55	55	100%	50	75	65	87%	37	44	34	77%	27	50-/37/-27 = -14
70	54	40	74%	24	75	39	52%	2	44	26	59%	9	24-/2/-9 = 13
71	53	39	74%	24	72	54	75%	25	44	11	25%	-25	24-/25/-(-25) = 24
72	52	37	71%	21	72	43	60%	10	44	34	77%	27	21-10/-27 = -16
73	51	36	71%	21	72	60	83%	33	44	21	48%	-2	21-/33/-(-2) = -10
74	51	47	92%	42	70	35	50%	0	41	6	15%	-35	42-/0/-(-35) = 77
75	50	44	88%	38	70	15	21%	-29	41	5	12%	-38	38-/-29/-(-38) = 47

Appendix V

MORGAN TEST OF LOGICAL REASONING

William J. Morgan, Ph.D.
Antonia Morgan, M.A.

APTITUDE ASSOCIATES, INC.
Merrifield, Virginia

EXPERIMENTAL REVISION

School _____ Date_____

Name_____

Age_____ Sex_____Year in College _____

Major field of study _____

Have you ever completed a course in logic?_____

* *

Number done_____

Number right_____

Number wrong_____

Score (R-W)_____

DIRECTIONS

This is a test in logical reasoning ability. It consists of problems requiring logical reasoning. All the problems have one or more premises, and then a conclusion beginning with the word "therefore". You are to judge whether the conclusion follows logically from the premises using only the evidence given in the premises. When you decide, circle "L" for "logical" or "NL" for "non-logical."

EXAMPLE:

All cats have tails. Kitty is a cat.
Therefore, Kitty has a tail..... L NL

In this example the conclusion, "Therefore, Kitty has a tail." does follow logically from the premises, so "L" should be circled.

LOGICAL or NON-LOGICAL, not TRUE or FALSE

Some of the premises are only assumptions for the sake of the problem and are not true in reality. Likewise, some of the conclusions are not actually true. Do not let this confuse you; as you are to judge whether the conclusion follows from the premises regardless of whether or not they are true.

MEANING OF TERMS

If you have not thought of it before, you can see that in logic there can be only three possible quantifiers: ALL, NONE, and SOME. Some means "one or more". Terms such as "many, a few, frequently, a number of" and so forth, are all synonomous with "some".

SCORING

Each correct judgment is a point added to your score, and each incorrect judgment is a point subtracted from your score, so you should NOT guess. An omission is better than an incorrect guess, but of course a correct decision is better than an omission.

* * * *

This is a logical reasoning test; you should think clearly and accurately. GO AHEAD.....BEGIN NOW.

11. If we rearm Germany, the French will oppose us, and if we fail to maintain air bases in East Anglia we shall incur the resentment of the British. But it is essential to retain the good will of either France or Britain. Therefore, we must either maintain Anglian air bases or else abandon plans for the rearmament of Germany ..... L NL

12. If you don't go by train you will not arrive on time, and if you don't travel Pullman you will get no sleep. But you have a berth on the express train. Therefore, you will arrive promptly and have a good night's sleep on the way. ..... L NL

13. No people interested in human behavior have failed to read William James' book on psychology. No people who have failed to read James' book are psychologists. Therefore, some people interested in human behavior are not psychologists ..... L NL

14. If the average citizen of this country were dishonest, democratic government in the U.S. would be impossible. And if the average citizen of this country were not stupid, then U.S. foreign policies would not be inconsistent. But in fact, the U.S. has been a democracy since the revolution and its foreign policies have always been inconsistent. Therefore, the average citizen of this country is a fool but not a knave..... L NL

15. All the houses on this street are unsightly. Every house built since the war is an eyesore. Therefore, some of the houses on this street were built after the war..... L NL

16. Most executives are college graduates. The majority of executives are Republicans. Therefore, most college graduates are Republicans..... L NL

17. Only a very conceited person or one of ripe years and wide experience would presume to tell others how they should order their private lives. Therefore, all family relations counselors are either of ripe years and wide experience or conceited ..... L NL

18. No person interested in treating human ailments has failed to study Prof. Pavlov's book on the nature of the digestive system...abook which won the Nobel prize. No person who has failed to study Prof. Pavlov's book is a physician. Therefore, although they may have other interests, it can be said that all physicians are interested in treating human ailments.. L NL

19. No pilot with less than ten hours flying time is permitted to fly alone without an instructor. Captain Martin has two thousand hours of flying time. Therefore, Capt. Martin is permitted to fly along without an instructor.... L NL

20. You can fool some of the people all the time. You can fool all of the people some of the time. Therefore, you cannot fool all the people all the time ..... L NL

Appendix VI

PERSONAL CORRESPONDENCE from philosopher to present author

University of Virginia
Corcoran Dept. of Philosophy
Cabell Hall, Charlottesville, Va.

28 January 1960

Mr. Fred K. McCoy
Department of Psychology
University of Richmond

Dear Mr. McCoy:

I regret that I cannot consider cooperating with you in your research concerning logical reasoning ability, as I shall not be teaching elementary logic during the next several semesters. But there are two comments that I might make.

In describing your work, you speak as though you were attempting a general study of logical reasoning ability; and you seem to suppose that the Morgan Test is a test of general reasoning ability. But this is a bit too pretentious, I think. When we talk of logical reasoning ability we are talking about a whole group of abilities of different though related kinds. Ability in logical reasoning surely embraces both ability in contructing good arguments and ability to recognize good arguments; it surely involves ability with deductive arguments and ability with inductive arguments. The Morgan Test evidently tests primarily the ability to recognize certain types of deductive arguments. Before you would be entitled to claim that the Morgan Test is indeed a way of testing logical reasoning in general, you would first need to show that this special ability which it tests is closely correlated with the other kinds of abilities that go to make up logical reasoning.

You seem to suppose that if taking logic courses does not improve students' Morgan scores, then this shows that logical reasoning ability is "primarily innate" or "inherent". But this I think is misleading. The ability to reason logically, like the ability to speak and write correctly, is a very general sort of ability which a student gradually builds up as a cumulative result of all his intellectual experiences. Students who can not write or speak grammatically are usually only very slightly improved by a semester's study of English; yet we do not infer from this that grammar is an innate capacity. We know that grammar is learned, but that the learning of it is slow, painful, and starts in infancy. So one ought perhaps to beware of basing any sweeping conclusions on the observation that a semester of logic leaves many students unaffected.

Your project is an interesting one, and I wish you all success with it.

Yours truly,

S. F. Barker

Appendix VII

CLASSIFICATION OF ITEMS: Morgan Test of Logical Reasoning

1.	$E \supset D$ $\underline{(E)}$ $\therefore D$	Assertical	Modus ponens	subjective
2.	$R \supset M$ $\underline{\quad (M)}$ $\therefore R'$	Assertical	Modus tollens	predicative
3.	$I \not\supset T$ $\underline{\quad (T')}$ $\therefore I'$	Assertical	Modus Tollens	predicative
4.	$G \supset M$ $\underline{\quad (M)}$ $\therefore G$	Assertical	Modus tollens	predicative
5.	$A \supset Y$ $\underline{(A)}$ $\therefore Y$	Assertical	Modus ponens	subjective
6.	$C \supset R$ $\underline{R \supset P'}$ $\therefore C \supset P'$	Assertical	Syllogism	subjective
7.	$N' \supset H'$ $\underline{\quad (H')}$ $\therefore N'$	Assertical	Modus tollens	predicative
8.	$D \supset E'$ $\underline{D'}$ $\therefore E'$	Assertical	Modus ponens	subjective
9.	$H \supset D'$ $\underline{\quad D}$ $\therefore H$	Assertical	Modus tollens	predicative
10.	$C \supset X$ $\underline{C'}$ $\therefore X'$	Propositional	Modus Ponens	subjective

11.	T⊃G' S ⊃T' ∴S⊃G'	Assertical	Syllogism	subjective
12.	M ⊃H S'⊃M ∴S' ⊃H	Assertical	Syllogism	subjective
13.	P'⊃T P ∴ T'	Propositional	Modus ponens	subjective
14.	GE⊃T T⊃Y' ∴GE⊃Y'	Assertical	Syllogism	subjective
15.	U⊃S U⊃B' ∴TS⊃B'	assertical	Syllogism	predicative/subjective
16.	GS⊃S H⊃GS ∴S⊃H	Assertical	Syllogism	predicative
17.	FBI⊃La D ⊃FBI ∴D ⊃LA	Assertical	Syllogism	subjective
18.	W'⊃C W ∴ C	Propositional	Modus ponens	subjective
19.	S ⊃W W⊃Y' ∴Y⊃S'	Assertical	Syllogism	predicative
20.	A⊃Q' K ⊃A ∴K ⊃Q'	Assertical	Syllogism	subjective
21.	S⊃H TV⊃S ∴T⊃H	Propositional	Syllogism	subjective
22.	C⊃ROCC C ⊃T' ∴T⊃C	Assertical	Syllogism	predicative

23.	AC⊃H' M⊃H ∴M ⊃ AC'	Assertical	Syllogism	subjective/predicative
24.	A⊃F F⊃P' ∴A⊃P'	Assertical	Syllogism	subjective
25.	G'⊃S B⊃R' G E' ∴ S' ∴ R	Assertical	Modus ponens	subjective
26.	E⊃D' D'⊃PS' ∴PS⊃E	Assertical	Syllogism	predicative
27.	C'⊃F' F ∴C	Assertical	Modus tollens	predicative
28.	40⊃S S' ∴40'	Assertical	Modus tollens	predicative
29.	P⊃C' P' ∴ C	Assertical	Modus ponens	subjective
30.	C⊃E E' ∴ C	Assertical	Modus tollens	predicative
31.	AF⊃A' S⊃B' A B ∴AF' ∴ S'	Propositional	Modus tollens	predicative
32.	L⊃Ad' Ad'⊃Ag ∴Ag⊃L	Assertical	Syllogism	subjective
33.	C⊃S S⊃T' ∴C⊃T'	Assertical	Syllogism	subjective
34.	M⊃T' S⊃A' T A ∴M' ∴S'	Assertical	Modus tollens	predicative

35. CS⊃I
I
∴CS — Assertical — Modus tollens — predicative

36. W⊃Y'
Y
∴W' — Assertical — Modus tollens — predicative

37. Pr⊃Pe'
F⊃Pr
∴F⊃Pe' — Assertical — Syllogism — subjective

38. Sl⊃R' Sh⊃L'
R' L'
∴Sl ∴Sh — Propositional — Modus tollens — predicative

39. I⊃U
T⊃I
∴T⊃U — Assertical — Syllogism — subjective

40. T⊃S
T'
∴S' — Assertical — Modus ponens — subjective

41. WB⊃T'
T
∴WB — Assertical — Modus tollens — predicative

42. G⊃F
F'
∴G — Propositional — Modus tollens — predicative

43. B⊃C'
B⊃O
∴C⊃O — Assertical — Syllogism — predicative/subjective

44. sM⊃K
K⊃I
∴sM⊃I — Assertical — Syllogism — subjective

45. M⊃NE
NE⊃PF'
∴M⊃PF — Assertical — Syllogism — subjective

46. B⊃S
S⊃I
∴B⊃I — Assertical — Syllogism — subjective

47.	$AV \supset V$ $\underline{H \supset AV}$ $\therefore V \supset H$	Assertical	Syllogism	predicative
48.	$G \supset F'$ $AB' \supset B'$ $\underline{F}$ $\underline{B}$ $\therefore G'$ $\therefore AB$	Propositional	Modus tollens	predicative
49.	$T \supset MS$ $\underline{MS \supset U}$ $\therefore T \supset U$	Assertical	Syllogism	subjective
50.	$Tr' \supset Ti'$ $P' \supset S'$ $\underline{Tr}$ $\underline{P}$ $\therefore Ti$ $\therefore S$	Propositional	Modus ponens	subjective
51.	$24 \supset A$ $\underline{I' \supset 24}$ $\therefore I \supset A$	Assertical	Syllogism	subjective
52.	$B \supset WJ$ $\underline{P \supset WJ}$ $\therefore B \supset P'$	Assertical	Syllogism	subjective/predicative
53.	$N \supset P$ $\underline{P \supset A'}$ $\therefore A \supset P'$	Assertical	Syllogism	predicative
54.	$D \supset G'$ $S' \supset I'$ $\underline{G}$ $\underline{I}$ $\therefore D'$ $\therefore S$	Propositional	Modus tollens	predicative
55.	$S \supset U$ $\underline{W \supset U}$ $\therefore S \supset W$	Assertical	Syllogism	subjective/predicative
56.	$E \supset G$ $\underline{E \supset R}$ $\therefore G \supset R$	Assertical	Syllogism	predicative/subjective
57.	$P \supset C\text{-}WE$ $\underline{P}$ $\therefore C\text{-}WE$	Propositional	Modus ponens	subjective
58.	$W \supset E$ $\underline{L' \supset E}$ $\therefore W \supset L'$	Assertical	Syllogism	subjective/predicative

59.	W⊃H' G'⊃C' H C ∴W' ∴G	Propositional	Modus tollens	predicative
60.	G'⊃F R'⊃B' G R ∴ F ∴ B	Propositional	Modus ponens	subjective
61.	B⊃E' C'⊃H' B' C' ∴ E ∴ H	Propositional	Modus ponens	subjective
62.	Re'⊃Run' S'⊃P' Run P ∴Re ∴S	Propositional	Modus tollens	predicative
63.	LW⊃C' C' ⊃ ND ∴LW⊃ND'	Propositional	Syllogism	subjective
64.	E⊃H H⊃N ∴N⊃E	Assertical	Syllogism	predicative
65.	I⊃G' S⊃B' G B ∴I' ∴S	Propositional	Modus tollens	predicative
66.	S⊃A A⊃M' ∴M⊃S'	Assertical	Syllogism	predicative
67.	G⊃C' L'⊃R' C R ∴G' ∴L	Propositional	Modus tollens	predicative
68.	T'⊃Pav' Pav'⊃Phy' ∴Phy ⊃T	Assertical	Syllogism	predicative
69.	D⊃L' D' ∴ L	Assertical	Modus ponens	subjective

70.	$D \supset AvB$ $E \supset AvD$ $A \supset C$ $C \supset E$ $A \supset D$ $D \supset B$ $B \supset F$ $D \supset AvB$ $E \supset AvD$ $D \supset B$ $A \supset D$ $\therefore A \supset D$ $\therefore E \supset D$ $\therefore A \supset C \supset E \supset D \supset B \supset F$	Assertical	Modus ponens	subjective
71.	$I \supset ND$ $ND \supset S$ $\therefore I \supset S$	Assertical	Syllogism	subjective
72.	$F \supset H$ H $\therefore F$	Assertical	Modus tollens	predicative
73.	$B' \supset P'$ P $\therefore B$	Assertical	Modus tollens	predicative
74.	$T' \supset F'$ T $\therefore F$	Assertical	Modus ponens	subjective
75.	$sP \supset aT$ $aP \supset sT$ $\therefore aP \supset aT'$	Assertical	Syllogism	subjective

VITA

The author completed 42 undergraduate hours in psychology at the University of Richmond while working full-time in a Richmond factory. He graduated cum laude, vice-president of the Psi Chi honorary fraternity in psychology, in 1958 with a Bachelor of Arts degree in psychology, and was immediately accepted into the Graduate School of the University of Richmond with a Williams Fellowship.

He completed 27 graduate hours in psychology and presented a paper to the Virginia Academy of Sciences his first year in graduate school while continuing the factory job. In his second and third years in graduate school, he worked as a clinical psychologist for the Mobile Psychiatric Clinic in Richmond, worked part-time occasionally for Psychological Consultants, Inc. of Richmond, completed three more graduate hours, and presented three more papers to the Virginia Academy of Sciences.

In 1961 he left school and was an intelligence officer in the U.S. Marine Corps for a little over three years. Returning to school in 1964 with a wife and three year old child he completed three more hours and worked a year as a clinical psychologist for the Department of Corrections of the District of Columbia. Completing the present thesis in 1965, he began work as a Research Associate for Technical Operations, Inc. In 1966 he completed another three hours and was awarded a Master of Arts degree in psychology.