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A Preliminary Study of Differences in Inductive Reasoning Ability Among Upper Division College Men

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A PRELIMINARY STUDY OF DIFFERENCES IN INDUCTIVE REASONING ABILITY
AMONG UPPER DIVISION COLLEGE MEN

by
Valerio Ortolani, S. J.

A Thesis Submitted to the Faculty of the Graduate School
of Loyola University in Partial Fulfillment of
the Requirements for the Degree of
Master of Arts

June
1959
VITAE

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From 1950 to 1952 the author taught ethics, mathematics and Latin at Liceo-Ginnasio Arecco, Genova, Italy. From September, 1952 to June 1956, he studied theology at Colegio Maximo San Francisco de Borja, Barcelona, Spain; where in July 1955 he was ordained to the priesthood. On July 1956 he graduated with a Licentiate in theology.

He began graduate studies in psychology at Loyola University in June 1957. At the same time he was studying counseling and psychotherapy in the University of Chicago.
TABLE OF CONTENTS

Chapter                                      Page

I. INTRODUCTION ............................................ 1

The hypothesis stating that the ability for inductive reasoning is connected with scientific mentality—Our purpose with regard to that hypothesis—Our purpose in the concrete—Various definitions of induction—Our definition of inductive reasoning—The tool: the Loyola Induction Study test—The subjects: the upperclassmen majoring in science and the humanities.

II. REVIEW OF RELATED LITERATURE ..................... 8

Literature related to our subject only in a broad sense—Literature related in a closer sense—The most closely related literature—Their findings.

III. EXPERIMENTAL PROCEDURE .......................... 17

The subjects tested—Disciplines considered as sciences and those considered as humanities—Instructions given before administering the test—Amount of time allowed for the test—Raw scores—Procedure adopted in order to control the variable "intelligence"—Procedure adopted in order to find out whether there is any relationship between inductive reasoning and academic performance.

IV. FINDINGS AND INTERPRETATIONS ....................... 20

Table 5, comparing at random; interpretation of the difference—Table 6, comparing groups matched for ACE total score; no significant difference; interpretation—Table 7, comparing means and standard deviation for grade point average before matching the two groups; significant difference; interpretation—Table 8, comparing two groups matched for grade-point average; significant difference; interpretations.

V. SUMMARY AND CONCLUSIONS .......................... 26

Summary of the four preceding chapters—Theoretical conclusions—Practical conclusions for student counselors.
# LIST OF TABLES

<table>
<thead>
<tr>
<th>Table</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>I.</td>
<td>Correlation Between the Primary Mental Abilities and the U. S. Employment Service Batteries</td>
</tr>
<tr>
<td>II.</td>
<td>Correlation Between PMA Sub-Tests and Achievement Tests for 100 Tenth Grade Students in New Zealand</td>
</tr>
<tr>
<td>III.</td>
<td>Median Correlations Between the PMA Reasoning Test and Teacher Grades in Subject Matter Areas</td>
</tr>
<tr>
<td>IV.</td>
<td>Chief Field of Study of 128 Upper Division College Men Whose Tests Were Used in This Research</td>
</tr>
<tr>
<td>V.</td>
<td>Grouped Frequency Distribution of Means and Standard Deviations of LIS Scores for Two Sub-Groups From a Sample of 128 Upper Division College Men</td>
</tr>
<tr>
<td>VI.</td>
<td>Means and Standard Deviations of LIS Scores of Two Curriculum Groups Matched for Age Total Scores</td>
</tr>
<tr>
<td>VII.</td>
<td>Means and Standard Deviations of Grade Points of the Two Curriculum Groups Before Matching</td>
</tr>
<tr>
<td>VIII.</td>
<td>Means and Standard Deviations of LIS Scores of the Two Curriculum Groups Matched for Grade Point Averages</td>
</tr>
</tbody>
</table>
CHAPTER I

INTRODUCTION

There is a widespread opinion that the ability for inductive reasoning is connected with scientific mentality and aptitude. The basis of this opinion is that both inductive reasoning ability and aptitude for the scientific disciplines are fundamentally the same kind of aptitude, that is to say the ability to discover universal principles from already known particular instances.

This thesis intends to find out whether, at least in a restricted class of people, the facts support this hypothesis.

We have limited our study to college upper-classmen majoring in sciences and humanities. We have tried to find out whether there are significant differences in inductive reasoning ability between the members of these two groups.

Theoretically the possible results of our study could be three:

1) That the humanities students would have a significantly greater ability in inductive reasoning than the science students. In such case the hypothesis would be false.

2) That the science students have a significantly greater inductive ability. In such case the hypothesis would be acceptable.

3) That neither group has a significantly greater ability for inductive reasoning than the other. In such a case a careful consideration would be
required before drawing a definite conclusion.

Inductive reasoning is one of the two forms of inference.

Inference, as Francis L. Harmon describes it, is "what is popularly called thinking or reasoning. It is the process by which new facts are attained from concepts and relationships already apprehended. Inference represents the extension of knowledge without the mediation of perception."¹

Inference is divided in deduction and induction. Deduction is the legitimate inference from the more general to the less general, from a law or principle to a particular instance falling under the law or principle. It proceeds from the universal to the particular, from the simple to the complex, from the logical whole to the logical part, from the general law to the individual cases, from the cause to the effect.²

We exclude this form of inference from our study. We are going to concentrate on induction.

Induction, in its widest sense, can be defined as a process of reasoning by means of which something can be derived from the less universal to the more universal.

There exist two kinds of induction:

a) Complete induction, which requires that each one of all cases be examined. It is an all-inclusive study, whose conclusions are to be applied only to the cases covered and does not allow prediction of anything with regard to other possible cases not studied.

b) Incomplete induction, which studies only some cases from which it draws more or less general conclusions, applicable for cautious prediction to other groups of the same species or class.

Incomplete induction is called "scientific induction" when it fulfills certain requirements that show the conclusions to be legitimate.

The admittance of legitimate universality for the conclusions has been questioned by various schools of thought. Here are their answers:

Leibniz, Laplace, Brentano and others admit a sort of universality based on an estimate of probabilities. After having performed a rather large number of experiments, it seems to them that it can legitimately be expected that the remaining cases will most probably have the same characteristics, especially when the possibility of the contrary is negligible.

Agnostics in general admit universality only as a postulate or mere hypothesis, in order to make nature more intelligible; however, they do not think it is possible to demonstrate that there is an absolute certainty that the universal principles derived from scientific induction are applicable to all cases of the same class or species.

Hume, Mill, Taine, and Pure Empiricists in general, reject universality altogether, and consequently they cannot admit any validity for scientific induction. For them, the study of particular cases can lead only to particular conclusions.

Kant and his followers accept some sort of "universality" based on their own system of preexisting forms in the human mind.

Scholastic philosophy holds that there exist fixed types of beings, which persist in the same way of existing and operating. The constituents of
a being which make it exist and operate always in the same way are called its "nature."

A group comprehending all the beings with the same nature is called a "species."

The concept that a philosopher forms about the nature repeated in all the individuals of the same species is a "universal concept." This universal concept, if legitimately formed, is applicable with absolute certainty to all members of the same species. This applies, of course, to essential natures, and to properties derivable therefrom, not to quantifiable phenomena.

There are three steps leading up to a legitimately formed universal concept through scientific induction:

1) **Observation:** This step consists in studying whether a permanent connection remains, after changing all other factors, between factor "a" and species "S," when it is a matter of trying to discover the nature of a being; or between antecedent "a" and consequence "C" when it is a matter of trying to discover general principles, trends, or laws. This last point is precisely the one that our thesis deals with.

2) **Consideration:** Reflecting on the observed permanent connection, it may well appear that this connection happens to exist out of necessity, i.e., what causes the permanent connection has to cause it, as long as it remains in the same circumstances.

In other words, it becomes evident that we are reaching the nature of factor "a," or the law which regulates the connection between antecedent "a" and consequent "C."

3) **Extension:** Once the necessity of such permanent connection is
known, the legitimate conclusion is that there is a law applicable to all
cases in which there exists the factor "a" in the same circumstances; or that
there is a nature which will be repeated in every individual of the same
species.

The above discussion refers to philosophy, or to the philosophy of
science, rather than to experimental research with observable phenomena.
In this thesis, whenever we use the expression inductive reasoning, we mean
the process of discovering general rules from already known particular data.

The word ability is used here in the sense of aptitude, or according to
Webster's New Collegiate Dictionary, meaning the "quality ... of being
able; power to perform; capacity; skill or competence ... ."

We have used a test specially designed to measure the degree of ability
to perform inductive reasoning. This test, which is called Loyola Induction
Study, is a Number Series Completion test.

At this point it might be well to give a brief account of the origins
of this test. The existence of tests of this kind goes as far back as the
beginning of the group-testing movement. The first Number Series Completion
test as such was constructed in 1917 by a committee appointed by the American
Psychological Association to set up the famous Army Alpha and Army Beta tests
for classifying U. S. army recruits in World War I. The committee was under
the general direction of Robert M. Yerkes; Wells was assigned to take care of
the Number Series Completion test.  \(^3\)

The NSC test was adapted from Miss Rogers' Missing Number test. \(^4\)

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\(^4\) Ibid. p. 300.
Since 1917 the test has been used many times in varied forms, both as a Letter Series Completion and as a Number Series Completion, and for many different purposes.

The general idea of the construction of this test as reported by the Memoirs of the National Academy of Sciences, in its volume XV, p. 300, is:

Number Series Completion. This involves the completion of a series of numbers which is made up according to some definite plan.

And on page 302,

N.S.C. Ten items, introducing in all four different principles. 5

The Loyola Induction Study, referred to hereafter as LIS, a further development of Number Series Completion test, was prepared by Charles I. Doyle, S. J. Its characteristics are as follows:

The LIS is a test with sixty-two items. In each item a series of six numbers is presented. The subject is asked to complete the series with three more. Structure of the several series varies widely; some items present three pairs of two, some a complete series of four, followed by a partial series. Other items contain two related groups of three and so on. In this respect this test differs from other tests, which are briefer and generally require only one or two numbers for the responses. 6

A question may arise as to whether this test is apt to measure inductive reasoning ability. The fact is that the statistical work in verification of the validity and the reliability of the test is still pending. However, the

5 In Appendix I may be found the first NSC test; the instructions for scoring this test and the revision of the test were made by the committee appointed to set up the Army Alpha.

6 Appendix II contains a sample of the test with the answers.
fact that L. L. Thurstone and others have been using the Number Series Completion for more than twenty years for the specific purpose of measuring inductive reasoning ability, implies a clear recognition of its value.

The subjects of our study are a random sample of junior and senior students of Loyola University. The reason for choosing juniors and seniors is that these two groups are constituted by students who are more firmly established in the field of their choice, and therefore their characteristics are more clearly defined with regard to aptitude and academic performance.

In the third chapter more information will be given about the details of the design of the experiment. Here it will be sufficient to say that we shall first study the statistical differences between the two groups (humanities students and science students) selected at random. Then, for further study we shall twice re-group the same subjects into matched pairs, matched

1) for general intellectual ability as measured by A.C.E., and
2) by grade-point average.

To summarise the points considered in this chapter:

a. We have established as the purpose of this thesis to discover whether there are differences in inductive reasoning ability between those upper-classmen majoring in science and those majoring in humanities.

b. We have given our definition of inductive reasoning as the process of discovering general rules from already known particular data.

c. We have discussed the test we are going to use for our research, the Loyola Induction Study.

d. We have given a rough idea of the kind of subjects that we used for this study.
CHAPTER II

REVIEW OF RELATED LITERATURE

We do not intend to consider the related literature, in the broad field of testing, because it is too vast for even a brief survey in this thesis.

If we take the literature that is more closely related to our subject, we find that many authors have used the Series Completion test as a sub-test for various purposes within the limits of intelligence testing. Obvious examples are the famous Army Alpha, the A.C.B., the Kuhlmann-Anderson intelligence test, the Shipley-Hartford mental deterioration test, the Thurstone's Primary Mental Abilities and the test of Mental Alertness, etc.

We should mention here that the Series Completion test, in its present form, the Loyola Induction Study, is being used at present in two other research projects: a doctoral dissertation of Mary A. McNeill about adjustment and reasoning, and a master's thesis of Sister M. Colomana, working with children in grades 5 through 8.

The most closely related literature, however, is that referring to studies dealing with inductive ability, whether such studies use the Series Completion test, or other tests to measure inductive ability—as long as the search is for the differences between students of the humanities and of the sciences.

In this last specific sense, the related literature is as follows:
Bernreuter, Robert G., in 1940 applying Thurstone Primary Mental Abilities test to Engineering freshmen found that induction correlated higher with scientific courses (Mathematics .29, Chemistry .23) than with humanistic and artistic courses (English Composition .21, Drawing, .16).¹

Ball, F. J., in the same year, reported correlations of Thurstone's PMA test with first semester point average and grades in nine liberal arts college courses. About the induction factor for Humanities he found: low correlation with Art, .16, French .02, and History .12, and high correlation with English Composition .23, and Political Sciences .31; for Sciences, high correlation with Mathematics .22, with Zoology .24, with Physical Sciences .26 and with Botany .28.²

Hessmer, Marianne, in 1941, in a study similar to Ball's, attempted to determine the predictive possibilities of the Thurstone test in the School of Chemistry and Physics at Pennsylvania State College. For induction she found a correlation of .25 with semester point average and a correlation of -.02 with Inorganic Chemistry.³

Goodman, Charles H., in 1941, studied the predictive value of the PMA test to forecast college success for his engineering students at the completion of their first year in college. Each of the factors was correlated


³Hessmer, Marianne, "The Thurstone Primary Mental Abilities Test in a Study of Academic Success in the School of Chemistry and Physics," an unpublished thesis submitted to the Pennsylvania State College, 1941.
with the first year's semester point average. In first place was Deduction, .36; second was Verbal-Meaning, .34; third place was Induction, .30; then came Number, .26; Space, .18; Memory, .11, and Perception, .08. 4

Stuit, D. B., and H. H. Hudson, in 1942, found the induction factor not essential for professional success in the field of journalism, since the scores for this professional group fell below the average scores of University of Chicago students, while the scores for Engineering and Medicine were above the average score of the entire sample. 5

Jacobs, Robert, in 1948, gave the correlations between the PMA and scores on the ACE Psychological Examination for ninety-seven Tenth grade pupils. The correlations between the ACE total score and the PMA are as follows: Verbal meaning, .67; Space, .32; Reasoning (induction), .58; Number, 139; Word fluency, .44. 6

Mouly, George M., and Robinson, Leslie G. M., in 1949, have reported correlations between the PMA's and the tests in the U. S. Employment Service (USES) General Aptitude Test battery. Both test batteries were administered to 565 students in the tenth grade and 559 students in the twelfth grade of Minnesota high schools. The correlation between series completion and the separate Primary Mental Abilities is as follows: First is Reasoning Ability


with a correlation of .65 for the students of 10th grade, and of .68 for the students of 12th grade; second is Verbal Meaning Ability with .36 for the 10th grade, and .47 for the 12th grade; third is Space-Ability with .30 for the 10th, and .43 for the 12th; fourth is Word Fluency Ability with .32 for the 10th; and .30 for the 12th; fifth is the Number-Ability (arithmetic) with .30 for the 10th, and .31 for the 12th grade.

It is worth while to note that not only does the Series Completion have the highest correlation with Reasoning, but also that no other test has so high a correlation with Reasoning.

We think that the full picture of this statistical work is interesting enough to include here the full data (Table 1) as reported by Moully and Robinson. 7

### Table 1

**Correlations Between the PMA and USES Batteries**

(10th Grade N = 565; 12th Grade N = 559)

<table>
<thead>
<tr>
<th></th>
<th>V</th>
<th>S</th>
<th>R</th>
<th>N</th>
<th>W</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grade</td>
<td>10</td>
<td>12</td>
<td>10</td>
<td>12</td>
<td>10</td>
</tr>
<tr>
<td>USES Battery</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tool Math</td>
<td>.27</td>
<td>.25</td>
<td>.32</td>
<td>.18</td>
<td>.37</td>
</tr>
<tr>
<td>Name Comparison</td>
<td>.54</td>
<td>.54</td>
<td>.20</td>
<td>.17</td>
<td>.45</td>
</tr>
<tr>
<td>Computation</td>
<td>.39</td>
<td>.47</td>
<td>.19</td>
<td>.32</td>
<td>.41</td>
</tr>
<tr>
<td>Series Completion</td>
<td>.36</td>
<td>.47</td>
<td>.30</td>
<td>.43</td>
<td>.65</td>
</tr>
<tr>
<td>Two-Dimensional Space</td>
<td>.26</td>
<td>.35</td>
<td>.49</td>
<td>.48</td>
<td>.45</td>
</tr>
<tr>
<td>Speed</td>
<td>.20</td>
<td>.29</td>
<td>.15</td>
<td>.16</td>
<td>.15</td>
</tr>
<tr>
<td>Three-Dimensional Space</td>
<td>.20</td>
<td>.28</td>
<td>.47</td>
<td>.51</td>
<td>.30</td>
</tr>
<tr>
<td>Arithmetic Reason</td>
<td>.46</td>
<td>.53</td>
<td>.26</td>
<td>.40</td>
<td>.44</td>
</tr>
<tr>
<td>Vocabulary</td>
<td>.69</td>
<td>.77</td>
<td>.14</td>
<td>.31</td>
<td>.41</td>
</tr>
<tr>
<td>Form Matching</td>
<td>.34</td>
<td>.31</td>
<td>.40</td>
<td>.37</td>
<td>.43</td>
</tr>
<tr>
<td>Placing Pegs</td>
<td>.08</td>
<td>.10</td>
<td>.20</td>
<td>.09</td>
<td>.02</td>
</tr>
<tr>
<td>Turning Pegs</td>
<td>.11</td>
<td>.19</td>
<td>.14</td>
<td>.08</td>
<td>.18</td>
</tr>
<tr>
<td>Assemble</td>
<td>.12</td>
<td>.10</td>
<td>.11</td>
<td>.13</td>
<td>.17</td>
</tr>
</tbody>
</table>

*For each USES test, the highest PMA correlation at each grade level is underlined.*
Sexton, J. P., in 1954, presented to a group of 100 tenth-grade boys and girls standard achievement tests of English, spelling, problem arithmetic, and mechanical arithmetic. The achievement scores were then correlated with various PMA tests, and the resulting coefficients are shown in Table 2.

### TABLE 2

CORRELATIONS BETWEEN PMA SUB-TESTS AND ACHIEVEMENT TESTS FOR 100 TENTH GRADE STUDENTS IN NEW ZEALAND

<table>
<thead>
<tr>
<th>PMA SUB-TEST</th>
<th>ENGLISH</th>
<th>SPELLING</th>
<th>ARITHMETIC PROBLEMS</th>
<th>ARITHMETIC COMPUTATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>V  Verbal meaning</td>
<td>.64</td>
<td>.59</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>R  Reasoning</td>
<td>-</td>
<td>-</td>
<td>.52</td>
<td>-</td>
</tr>
<tr>
<td>N  Number</td>
<td>-</td>
<td>-</td>
<td>.45</td>
<td>.51</td>
</tr>
<tr>
<td>W  Word fluency</td>
<td>-</td>
<td>.32</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

*Sexton, J. P., "A Preliminary Examination of the Reliability and value of the Thurstone PMA Test in New Zealand," Ms. in the library of Auckland University College, New Zealand, 1954.
Schneider, Edwin, in 1956, in a study of the relation of PMA to achievement tests, correlated PMA scores with Iowa Tests of Educational Development scores obtained three years later. Schneider's data indicate that the Verbal Meaning and Reasoning tests are the best predictors of all the criteria.

The correlation with Reasoning is as follows: Correctness in Writing 160; General Vocabulary .49; Social Studies Background .46; Reading—Literature .43; Reading—Social Studies .43; Reading—Natural Sciences .38; Quantitative Thinking .32; Natural Sciences Background .31.

Correlation of Composite Scores with Verbal Meaning .72; with Reasoning .33; with Number .23; with Space .19 and with Word Fluency .19.

Shinn, Edmund O., in 1956, reported in a study similar to that of Schneider the correlation between the PMA and the Iowa Test of Educational Development for 308 tenth-grade boys and 303 tenth-grade girls.

All correlations were separately computed for the boys' group and the girls' group. We report only the correlation with Reasoning for the boys' group, as our study is limited to this sex. Correctness in Writing .53; Quantitative Thinking .50; Reading—Natural Sciences .48; Reading—Literature .45; Social Studies Background .41; Natural Sciences Background .43; Reading—Social Studies .41; General Vocabulary .27.

Correlation of Composite Scores: Verbal Meaning .68; Reasoning .54.

Number .38; Word Fluency .33; Space .23.

It seems interesting to compare these results with the previous findings of Schneider, and to remember that one of the conclusions of the study of Shinn is that Verbal Meaning Ability and Reasoning Ability are distinctly the best predictors of academic achievement. 9

Wellman, F. E., in 1957, related the PMA to school grades. The correlation of Reasoning with teacher grades in ninth and tenth-grade courses is as follows: Science .52; Mathematics .47; English .47; Total Grade Average .51. 10

Thurstone, Thelma G., in 1957, in a series of studies investigated the relationship of the PMA Reasoning Test and teacher grades in broad subject-matter areas. These studies were based on ninth and twelfth grade groups in Chicago area schools; sample sizes ranged from N = 22 to N = 21h. The results are shown in Table 3.

9Shinn, Edmond G., "Interest and Intelligence as Related to Achievement in Tenth Grade." California Journal of Educational Research, 7 (1956), 217-220.

### TABLE 3

MEDIAN CORRELATIONS BETWEEN THE PMA REASONING TEST AND TEACHER GRADERS BY SUBJECT MATTER AREAS

<table>
<thead>
<tr>
<th>SUBJECT MATTER AREA</th>
<th>NUMBER OF r's</th>
<th>MEDIAN r</th>
</tr>
</thead>
<tbody>
<tr>
<td>English</td>
<td>5</td>
<td>.44</td>
</tr>
<tr>
<td>Foreign Language</td>
<td>7</td>
<td>.47</td>
</tr>
<tr>
<td>Mathematics</td>
<td>11</td>
<td>.35</td>
</tr>
<tr>
<td>Science</td>
<td>11</td>
<td>.43</td>
</tr>
<tr>
<td>Social Studies</td>
<td>4</td>
<td>.36</td>
</tr>
<tr>
<td>Home Making</td>
<td>5</td>
<td>.40</td>
</tr>
<tr>
<td>Commercial</td>
<td>4</td>
<td>.44</td>
</tr>
<tr>
<td>Vocational, Manual</td>
<td>8</td>
<td>.26</td>
</tr>
<tr>
<td>Total Grade Average</td>
<td>6</td>
<td>.43</td>
</tr>
</tbody>
</table>


Most of these samples appear to have been tested, not with number series, but with letter series.
CHAPTER III

EXPERIMENTAL PROCEDURE

The Loyola Induction Study test was administered to sixty-four junior and senior students at Loyola University in the field of sciences and to another sixty-four juniors and seniors in the field of humanities, in the fall of 1958. The students were taken at random from various courses common to both groups.

The disciplines considered as sciences in this thesis are the ones most commonly accepted as such; Mathematics, Physics, Chemistry, Biology, Pre-medic, and Psychology. All the remaining disciplines were considered as humanities, a positive term that seemed more appropriate than the awkward word non-science. The distribution within each sample by chief field of study is shown in Table 4.
Before the administration of the test, the students were given a brief instruction about it. They were told that this was not an intelligence test but an academic study of how people make discoveries. They were given reassurance that their teachers would not know their scores in this test, and that these scores would have no effect upon their class grades. They were urged to make a disinterested contribution to this study.

They were then given sufficient time to try out four sample series of numbers in the first page of the test, and were allowed to ask questions until everybody knew what was expected.

They were instructed not to turn the first page until they were told...
to do so. They were told that they were going to have twenty minutes, starting when the proctor would tell them to begin.

When everybody was ready, the proctor gave the signal to start. He remained in the room all the time, and at the end of twenty minutes he said: "Stop. Everybody stop. This is the end of the test, even if you have not finished all the series."

In scoring the tests, credit was given only when a series was completed correctly; incomplete answers received no credit. The score is the total number of series completed correctly. The four easy "practice" series are counted in the total score. A grouped distribution of scores for all subjects appears in Table 5.
CHAPTER IV

FINDINGS AND INTERPRETATIONS

TABLE 5

GROUPED FREQUENCY DISTRIBUTIONS, MEANS, AND SD'S OF LIS SCORES FOR TWO
SUB-GROUPS FROM A SAMPLE OF 126 UPPER-DIVISION COLLEGE MEN

<table>
<thead>
<tr>
<th>Class Interval</th>
<th>Frequency</th>
<th>Class Interval</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>19-21</td>
<td>3</td>
<td>19-21</td>
<td>2</td>
</tr>
<tr>
<td>22-24</td>
<td>3</td>
<td>22-24</td>
<td>3</td>
</tr>
<tr>
<td>25-27</td>
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<td>25-27</td>
<td>3</td>
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<td>28-30</td>
<td>4</td>
<td>28-30</td>
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<table>
<thead>
<tr>
<th>Humanities Group</th>
<th>N = 64</th>
<th>Science Group</th>
<th>N = 64</th>
</tr>
</thead>
</table>

**Mean** 39.8  
**SD** 10.6

Difference of M's = 4.7  
\[ t = 2.5 \]  
\[ P = .02 \]
The difference between means is significant. We may, therefore, reject the null hypothesis at the 2% level of confidence. That means that the science students have significantly higher scores on LIS than the humanities students when they are chosen at random. Therefore, the popular hypothesis mentioned in the first chapter of this thesis would appear to be true in this specific sense, i.e., that the inductive reasoning ability is characteristic of the science students when they are taken at random. However, this conclusion calls for a reservation. While a percentile score of 60 admitted a student to college for this group, prospective science majors had to reach the 60th percentile. Therefore, in order to control the variable "intelligence," a determining factor in the selection of science majors, it was necessary to exclude several members of each original group so that the result was two restricted groups matched for general intellectual ability. The criterion to match these groups was the total score of ACE for each student. Since in humanities only thirty-one of the sixty-four tested students had taken the ACE entrance test, the sciences group had likewise to be limited to thirty-one students.

TABLE 6

MEANS AND STANDARD DEVIATIONS OF LIS SCORES OF TWO CURRICULUM GROUPS MATCHED FOR ACE TOTAL SCORE

<table>
<thead>
<tr>
<th></th>
<th>HUMANITIES GROUP (31)</th>
<th>SCIENCE GROUP (31)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean</td>
<td>42.48</td>
<td>44.39</td>
</tr>
<tr>
<td>Standard Deviation</td>
<td>10.2</td>
<td>9.7</td>
</tr>
<tr>
<td>Difference between means</td>
<td>1.91</td>
<td>t = .717, not significant</td>
</tr>
</tbody>
</table>
The difference between means is not significant. Consequently, we cannot reject the null hypothesis. There is no evident difference between science students and humanities students on LIS when they are matched for intelligence by total score on entrance test. Therefore, the hypothesis mentioned in the first chapter is not clearly established since, when we compare people of the same general intellectual ability as the students of the humanities. There is some small difference, though not significant, in favor of the science students. It is not the concern of this thesis to discuss the relationship between general intellectual ability and inductive reasoning ability; therefore we leave this matter for further study. Here it is sufficient to interpret the findings by saying that a high degree of inductive reasoning ability is not an exclusive characteristic of the science students, since people of the same general intellectual ability, majoring in humanities, may have almost the same degree of inductive reasoning ability as measured by LIS performance.

The foregoing step was intended to match the two restricted groups with regard to general intellectual ability. Another step was necessary in order to obtain two matched groups with regard to academic performance. This we did by matching two groups of thirty-two each on grade point averages, out of the original group of sixty-four. These groups, of course, did not necessarily coincide with the restricted group paired by scores on entrance tests.

As a preliminary to paired matching on this new approach it was necessary to compare the performance of our two groups as to their respective grade point averages. For this the entire humanities group was
compared with 62 students in the science group. Two of this latter group were excluded, since they were transfer students with few grades from their present college. The results of this comparison are shown in Table 7. These results might have been expected, in view of the higher standard set for admission of students to the several science curricula.

TABLE 7
MEANS AND STANDARD DEVIATIONS OF GRADE POINT AVERAGES OF THE TWO CURRICULUM GROUPS BEFORE MATCHING

<table>
<thead>
<tr>
<th></th>
<th>HUMANITIES GROUP (64)</th>
<th>SCIENCE GROUP (62)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean</td>
<td>2.39</td>
<td>2.63</td>
</tr>
<tr>
<td>Standard Deviation</td>
<td>.435</td>
<td>.438</td>
</tr>
<tr>
<td>Difference Between Means</td>
<td>0.24</td>
<td>t = 3.097</td>
</tr>
</tbody>
</table>

The difference between means is significant, and we may reject the null hypothesis at the 1% level of confidence. That means that the science students have significantly higher grade point averages when chosen at random.

The final step in this comparison of LIS scores was to select from the large groups as many pairs as could be matched for grade point averages. When this was done, the results were similar to those on the first (unmatched) test (Table 5, page 20).

For testing the difference between means of the two groups at random on LIS and on grade point average, we use the formula for independent means. But for testing the difference between means on LIS of the two matched
groups for ACE and for grade point average, we used the formula for correlated means, because this formula includes the correlation term in the standard error of the difference.\(^1\) Table 8 shows the outcome.

**TABLE 8**

**MEANS AND STANDARD DEVIATIONS OF LIS SCORES OF THE TWO CURRICULUM GROUPS MATCHED FOR GRADE POINT AVERAGE**

<table>
<thead>
<tr>
<th></th>
<th>HUMANITIES GROUP (32)</th>
<th>SCIENCE GROUP (32)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean</td>
<td>38.09</td>
<td>45.19</td>
</tr>
<tr>
<td>Standard Deviation</td>
<td>11.33</td>
<td>9.74</td>
</tr>
<tr>
<td>Difference Between Means = 7.10</td>
<td>(t = 2.632)</td>
<td>(P = .02)</td>
</tr>
</tbody>
</table>

The difference between means is significant, and we may reject the null hypothesis at the 2% level of confidence. That means that the science students have significantly higher score on LIS when they are matched for grade point average.

We have rejected those students having grades only from other schools. Concerning students with grades both from Loyola and from other schools, we have taken into account only those grades given at Loyola University. This we did in order to obtain as much as possible a classification based on a fairly consistent criterion, the assumption being that the criterion for

---

grades averages out to about the same in all departments of the Arts and Sciences College of Loyola University.

Moreover, there are several disciplines common to the students of science and the humanities, and that is another reason to expect that the same criteria have been used for grades, since the same teachers graded both groups of students on the same subject matter.

In this study, grades are interpreted as an indication of academic performance.

Let us remember that a selection was made of students belonging to the same two original groups of sciences and the humanities, and matched for the same academic performance.

Therefore, the first interpretation would be that the popular hypothesis mentioned in the first chapter is true in this sense, that when we compare students of the same academic performance, the science students have a significantly higher inductive reasoning ability than the humanities students.

As a second interpretation, we can consider this finding from a different point of view and say: These two groups of students, though having a significantly different degree of inductive reasoning ability, have obtained the same academic performance. Therefore, in the field of humanities and in matters common to both humanities and sciences, inductive reasoning ability as measured by LIS greatly influences academic performance. This interpretation is deduced from the fact that science students with significantly greater inductive reasoning ability earn the same academic grades as humanities students with lower inductive reasoning ability.

A further statistical study will appear in Appendix III.
CHAPTER V

SUMMARY AND CONCLUSIONS

The first chapter of this thesis mentions the widespread hypothesis stating that the ability for inductive reasoning is connected with scientific mentality and aptitude. Our thesis takes occasion of that popular hypothesis and proposes to find out whether, at least in a restricted class of people, the facts support it. In other words, the purpose is to discover whether there are significant differences in inductive reasoning ability between upper-classmen majoring in sciences and in humanities.

We assume, as a working definition of inductive reasoning the following: the process of discovering general rules from already known particular data.

In the second chapter attention is focused on some of the most closely related literature, i.e., studies dealing with inductive ability that show the differences in inductive reasoning ability in different academic studies.

The third chapter gives a detailed account of the subjects used in the project (Table 4), the instrument, Loyola Induction Study (LIS), and the experimental procedure.

Chapter IV presents the statistical procedures and findings and their interpretation.

Table 5 compares the means and standard deviations of LIS scores of the two curriculum groups taken at random. The LIS scores of the two groups
appear to be significantly different at the 2% level of confidence. This finding is interpreted as meaning that inductive reasoning ability is characteristic of the science students as a group taken at random.

Table 6 compares the means and standard deviations of LIS scores of a smaller sample of the two curriculum groups that could be matched for ACE total score. Of these matched samples, the differences between means is not great enough to be significant. This finding is interpreted as meaning that inductive reasoning ability is not an exclusive characteristic of the science students, since people of the same general intellectual ability, majoring in humanities, have almost the same degree of inductive reasoning ability.

Table 7 compares means and standard deviation for grade point average of the two curriculum groups before matching and finds a significant difference at the one per cent level. The science students in this project have significantly higher grade point averages.

Table 8 compares means and standard deviations of LIS scores of the two curriculum groups matched for grade point averages. The difference between means is significant at the 2% level. This is interpreted as meaning that the science students have significantly higher inductive reasoning ability when matched for academic performance.

The first interpretation is that the popular hypothesis mentioned in the first chapter is true in the sense that the science students, if compared with the humanities students of the same academic performance, have significantly greater inductive reasoning ability.

A second interpretation could be drawn if we consider these facts from
a different point of view: these students, though having a significantly different degree of inductive reasoning ability, have obtained the same academic performance; therefore, their inductive reasoning ability was not the determinant factor in their academic performance.

Therefore these are the theoretical conclusions that we tentatively present with regard to the differences in inductive reasoning ability among upper division college men:

1) There is a significant difference in favor of the science students if taken at random. This shows that inductive reasoning ability is characteristic of the science students in general.

2) There is no significant difference between the two groups if matched for ACE total scores. This suggests that inductive reasoning ability, though characteristic of the science students in general, is not an exclusive characteristic of the science students.

3) Science students chosen at random have a significantly higher grade point average. But this is, at least partially explained by the fact that a percentile rank of 60 is required for admission in the field of sciences, while a rank of 40 is sufficient for admission to college.

4) Science students have significantly higher inductive reasoning ability when matched for academic performance.

5) Inductive reasoning ability does not appear to influence academic performance for humanities students in their subjects, nor in subjects common to both the humanities and science students.

As practical conclusions for student counselors, the following ones can be drawn:
1) A student with a low score in inductive reasoning should not be recommended to enter the field of science. The reason is that in such a field there are proportionately many more students with a high degree of inductive reasoning ability, and consequently he will be in a condition of inferiority precisely in a matter characteristic of the field.

2) A student with a high degree of inductive reasoning ability ought, other things being equal, to be told that he has an opportunity to take advantage of this specific ability if he enters the field of sciences. On the contrary, if he goes into humanities, his ability would be less useful. The reason is that individuals without a high degree of inductive reasoning ability seem to obtain the same success in humanities as individuals with a higher degree obtain in sciences.
BIBLIOGRAPHY


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Shinn, Edmond C., "Interest and Intelligence as Related to Achievement in Tenth Grade," California Journal of Educational Research, 7 (1956) 217-220.


------. The Nature of "Intelligence" and the Principles of Cognition.


Thurstone, L. L., "Primary Mental Abilities," Supplement to Psychometric Monographs No. 1, Chicago, 1938.


Thurstone, Thelma G. Technical Supplement for the SRA Test of Educational Ability, Chicago, 1957.


APPENDIX I

TEST 8, NUMBER SERIES COMPLETION

Five number and completion by one number.

Example:

\[ 2, 4, 6, 8, 10, \ldots 12. \]
\[ 11, 12, 14, 15, 17, \ldots 18 \ldots 1 \]

Directions for scoring:

(Score is the right number)

1) If only one number is written, give no credit.
2) If only one of the number is right, give no credit.
3) If four numbers are written, as frequently happens with certain items (i.e., 33, 11, instead of 3, 3) give full credit.\(^2\)

Revision of Number Series Completion:

Test 8: Changes:

1) They were revised so as to include more samples. The statement of instructions was also simplified with the view of having the subject understand the task through concrete illustration.

2) The subject is required to write two additional numbers instead of one for each item, the purpose being to insure that a correct response indicates a complete understanding of the problem.

---

\(^1\)Memoirs of the National Academy of Sciences, vol. XV, p. 128.

\(^2\)Ibid., p. 162
3) Time extended from two to three minutes.

4) The number of items was changed from 15 to 20. The first items are intended to be easier than those of examination "a", and those at the end of the test very much harder.

5) The effort was made to equalize the difficulty of the test in the various forms by systematic inclusion, in each form, of the same types of problems. Became test 6 of the examination alpha.

This test proved of greatest value with officers, but the distribution of scores was unsatisfactory. As it stood, the test was too much of the "all or none" type. The addition of both easier and harder items was made to eliminate this defect.3

3Ibid. p. 341.
APPENDIX II

A SAMPLE OF THE LOYOLA INDUCTION STUDY TEST, WITH ANSWERS
APPENDIX III

In an effort to determine the influence of quantitative reasoning ability on LIS scores as the former is measured by the ACE, it was necessary to calculate the ratio between the Q and the L scores on all subjects for whom ACE scores were available. This ratio or quotient (Q/L) was then correlated with LIS scores with the following results. Rank-difference coefficients were derived for science and humanities groups separately and a product-moment coefficient for the entire group combined. The results are shown in the following table.

**CORRELATION COEFFICIENTS BETWEEN Q/L RATIOS AND LIS SCORES**

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<th></th>
<th>N</th>
<th>Correlation between Q/L and LIS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Humanities</td>
<td>35</td>
<td>( .49 )</td>
</tr>
<tr>
<td>Science</td>
<td>44</td>
<td>( .41 )</td>
</tr>
<tr>
<td>Whole group</td>
<td>79</td>
<td>( .42 )</td>
</tr>
</tbody>
</table>
Since a higher Q/L ratio implies superiority in quantitative thinking, a high correlation between LIS and Q/L ratio would seem to indicate dependence of LIS upon Q proficiency. On the other hand, it is noteworthy that LIS scores correlate higher with Q/L ratio for the humanities group than for the science group. The reason for this apparent contradiction is not evident.
LOYOLA INDUCTION STUDY

Name_________________________  Date________

Student at______________________________

Highest year of school completed (circle one)
6 7 8 9 10 11 12 13 14 15 16 ___

What is your favorite study or your major field?

INSTRUCTIONS

This is not an intelligence test. It is part of a study of how people make discoveries.

There are some easy examples below. Please read each row of figures and then write in the three blank spaces at the end of each row the numbers that should follow.

2 4 6 8 10 12 14 16 18
9 8 7 6 5 4 3 2 1
1 7 2 7 3 7 4 7 5
2 2 3 3 4 4 5 5 6

N.B. Please do not turn this page until you are told to do so.

Copyright 1958, by Loyola University, Chicago
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APPROVAL SHEET

The thesis submitted by Valerio Ortolani, S.J. has been read and approved by three members of the Department of Psychology.

The final copies have been examined by the director of the thesis and the signature which appears below verifies the fact that any necessary changes have been incorporated, that the thesis is now given final approval with reference to content, form, and mechanical accuracy.

The thesis is therefore accepted in partial fulfillment of the requirements for the Degree of Master of Arts.

June 1, 1959
Date

[Signature of Adviser]