# Empirical Testing of a Dichotomous Cogntive Style Framework

Miklos Antal Vasarhelyi
Department of Accounting
University of Southern California

DRAFT

Comments and suggestions are solicited. This paper is in preliminary form.

In general, the cognitive processes of an individual involve a series of variables such as memory, knowledge and experience. This paper deals with what is called "cognitive style" or decision approach; or, in a management context, management style or decision style. There are basic differences in the ways people approach problems. These varying methods of approaching problems are called cognitive styles and a number of recent studies (i.e., Hamilton et al., 1964; Huysmans, 1968 & 1970; McKenney, 1968; Schroder, et al., 1967; Shakun, 1972) have focused on these differences. In particular, a concept similar to cognitive style was referred to by Cronbach (1960, p. 544) as "perceptual and cognitive style." Emphasis is placed upon the way in which a person organizes information. Cronbach also points out that among the earlier tests related to the measurement of cognitive processes the "Walter Jar" or "Einstellung" (Jung, 1933) can be found. "Einstellung" may be approximately translated as mental set or orientation. This test, slightly modified, was used by Huysmans (1968). We shall call it the "Pitcher test."

This study, when dealing with cognitive styles, will use the heuristic x analytic framework (HA) based on the following mental set descriptions as proposed by Huysmans (1968):

1. Analytic Reasoning. Problems are reduced to a core set of underlying causal relationships. All effort is directed towards detecting these relationships and manipulating the decision variables towards some type of optimal equilibrium. A more or less explicit model, often stated in quantitative terms, forms the basis for each decision.

2. Heuristic Approach. The emphasis is on workable solutions to total problem situations. The search is for analogies with familiar, solved problems rather than for a system of underlying causal relationships. Trial-and-

error, intuition and unqualified feelings of future developments play an important role in decision making.

Cognitive styles have recently become an important issue in information systems design. "If decision approach is an important information system design variable, further research is needed to develop a taxonomy of relevant decision-maker characteristics which can be used to design more individualized information systems. Clearly, the capabilities of modern computer-based accounting systems make such systems feasible (Mock, et al., 1972; p. 147). This further research, however, has been hampered by difficulties with cognitive style measurement instruments. These instruments, necessary for adequate experimental testing of information system variables, must be: (1) administrable in a short amount of time, (2) consistent with other tests measuring the same attribute, and (3) consistent over time. This paper describes the development and comparisons of such tests in relation to the first two requirements just described. Measurements of consistency over time present difficulties that were beyond the scope of the present study.

This paper therefore describes the key features and methodological testing of an instrument designed for testing cognitive style using the HA taxonomy.

## Methodology

Studies of cognitive style and information systems most often involve two key steps--gathering of demographic data (cognitive style and background factors) and information system experimentation. The usage of standard psychological instruments seldom answers the need of the information system researcher, because these tests are extensive in nature and their outcomes are not particularly designed for information

systems issues. This paper describes the studies and experimental anlaysis performed for the development of an information systems-efficient cognitive style test for the study of man-machine interaction using an on-line planning system (see Vasarhelyi, 1973 & 1977).

The key tests available for the testing of the HA framework were the coin and pitcher tests (25 minutes each). Another standard test of wide utilization is the Meyers-Briggs (M.B.) indicator which takes 40-60 minutes to administer. Two basic alternatives were considered. One was to use only one of the dimensions of the M.B. test; the other was to design a questionnaire that would allow the measurement of the subject's cognitive style in a reasonably short time. Later, the description of the subjects' (S's) analytic and heuristic characteristics was incorporated into the experimental design. The procedures in developing the questionnaire are discussed first.

## THE ANALYTIC VERSUS HEURISTIC QUESTIONNAIRE

The Heuristic-Analytic Questionnaire (HAQ) was developed from the descriptions given by Huysmans of cognitive styles. It simply asked the S's how they would behave in certain hypothetical circumstances and what kind of decisions they would make. These questions were administered to 15 different subjects in a pilot run. This pilot was designed to refine the questionnaire and eliminate the non-discriminating questions. Also, subjects were asked to time themselves and to make evaluative comments at the end of their responses.

Questions were evaluated and responses examined. The time taken by the S's seemed to be satisfactory, as none of the S's in the pilot took

longer than 8 minutes (with the mean below five minutes) to complete the questionnaire including the bibliographical data section. Also, the internal consistency of the test was examined and questions were deleted according to this criterion. Rogers (1969) suggests:

> Internal consistency is the degree to which items in a scale measure the same dimension. For the present scale items, internal consistency was determined by correlating each scale item with total scores, because the total scores represent the best available measure of the total concept.

Obviously, internal consistency should not be the only concept to be considered in developing a measurement tool. A tool with high internal consistency but low discriminating power would not be desirable.

Once the pilot test was completed and the results analyzed a new version of the questionnaire was prepared for the next step in the examination of the HA analysis. This step involved the comparison of several different types of HA measurement tools. Due mainly to time limitations as to the availability of S's, this comparative study was divided into two steps. The first used S's from an undergraduate introductory accounting class while the second used S's from operations management classes.

## THE FIRST HA EXPERIMENT

Accounting 1A is an undergraduate introductory accounting course. The subject population was composed of 2 Freshman, 17 Sophomore, 17 Juniors and 18 Seniors, with a 3 to 1 ratio between males and females.

Parts of three different class sections were dedicated to the different tests. Initially, the S's were asked to take the coin test (Huysmans, 1968). The following week they responded to the HAQ and in the third week the Meyers-Briggs Indicator (MBI) was administered. S's were also asked in the third week to rate themselves on the HA scale.

From the initial 54 subjects only 22 completed all four instruments (coin, MBI, HAQ and self-evaluation) due to absenteeism and other reasons.

MBI scores have standard scoring procedures and follow a normal distribution. HAQ's were rated in several manners in order to find the combination of questions that had better internal and external consistency (and validity) with the other HA tests. Coin tests were rated by two judges. These ratings were compared by Kendall tau correlations and Chi-square tests with both showing very high inter-judge rate of reliability. Exhibit I displays the results of these tests. In the cases where judges did not agree, subjects were given the mean score.

## THE SECOND HA EXPERIMENTS

The second HA experiments were completed by three different sections of an introductory operations management course for undergraduates. Primarily the S's were Juniors, but some were Seniors. All instruments (pitcher, MBI, coin, HAQ and self-evaluation) were administered in the same class section for approximately 60 minutes. In order to avoid order of presentation effects, the instruments were administered in different orders except for the self-evaluation which always had to be last in order to avoid subject bias.

The scoring procedures were the same as for the first experiment except for the pitcher test which had not been administered previously. This was evaluated in the same manner as the coin test. From the initial 55 S's, 42 were used in the data analysis after deletions due to missing questions, incomplete questionnaires and other reasons.

## THE RESULTS OF THE HA EXPERIMENTS

The HA experiments were performed in three basic modes: refining the questionnaire, testing the inter-judge rate of reliability and examining the correlations between the several measurements.

In order to refine the questionnaire, descriptive statistics for the responses of 16 questions were obtained. Two questions (2 and 14) were deleted as they were undiscriminating, but remained in the HAQ as fillers. Ratings in the questionnaire were made by attributing 1 for a yes, 2 for a sometimes and 3 for a no. Questions 3, 6, 7, 8, 10, 14 and 15 were reverse coded. Questions 12 and 17 were also fillers. Exhibit II displays the mean, variance, and standard deviation for these questions. Correlations between possible combinations of questions and the different HA ratings were run and a specific combination was chosen as the best of these combinations and used in the final rating of the instrument. This combination included questions 1, 3, 4, 6, 8, 9, 14, 16 and 18. The criteria used to develop these combinations involved the examination of internal consistency by the level of correlation with the pitcher and the coin tests.

Testing of the inter-judge reliability was done by two nonparametric tests, the Kendall tau correlation coefficient and the Chi-square fit test. Both tests showed high inter-judge consistency.

The correlations between different instruments were calculated using both a Kendall tau correlation and the parametric Pearson's product-moment correlation. It is not the purpose of this paper to discuss the long parametric/nonparametic controversy but both the results for the Pearson's product-moment correlation and the Kendall's tau correlation

coefficient were similar. The literature argues that most nonparametric statistics tend towards parametric results when sample sizes are large enough.

In Exhibit III the four dimensions of the Meyers-Briggs Indicator (MBA, MBB, MBC and MBD) evaluate S's in Jung's (1923) four basic dimensions:

MBA - EI - Extraversion or introversion

MBB - SN - Sensing or intuition

MBC - TF - Thinking or feeling

MBD - JP - Judgment or perception.

In the HA tests (coin, pitcher and self-evaluation) individuals were rated in four categories:

1. Strinctly analytic
2. Weakly analytic
3. Weakly heuristic
4. Strictly heuristic.

Exhibit IV displays the product-moment correlations between the coin, the pitcher, the questionnaire and the self-evaluations.

These correlations are not impressive. There seems to be a consistent correlation between the different instruments; however, this correlation is not definite and the instruments do not seem to be measuring exactly the same concepts. Guilford (1956, p. 145) suggested the following as a rough guide of the magnitude of the correlation coefficient:

Less than .2 slight; almost negligible relationship

.2 - .4 low correlation; definite but small relationship

.4 - .7 moderate correlation; substantial relationship

More than .9 very high correlation; very dependable relationship.

Considering the high level of significance of these correlations but still the relatively low level of correlation a basic conclusion might be drawn. The measurements of cognitive style do not measure exactly the same feature but measure interrelated concepts that are operationally defined by the test itself. In the behavioral sciences, dealing with cognitive processes of which so little is known, much lower correlation coefficients are accepted than the ones prescribed above by Guilford.

Finally, an examination of these correlation coefficients shows that the self-evaluation coefficient is more highly correlated to all the other instruments than any other single instrument. Thus for experimental purposes the results obtained recommend the usage of the self-evaluation statement as shown in Appendix 2.

Further research would be desirable for testing the time-series consistency of the instruments here described assuming similar testing environments and constant subject cognitive style.

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EXHIBIT I

COIN TEST RATINGS

| Subject ID | Rating Judge A | Rating Judge B | Mean Rating |
|---|---|---|---|
| 1 | 2 | 3 | 2.5 |
| 3 | 3 | 2 | 2.5 |
| 4 | 3 | 3 | 3.0 |
| 7 | 3 | 3 | 3.0 |
| 8 | 3 | 3 | 3.0 |
| 9 | 3 | 3 | 3.0 |
| 11 | 3 | 3 | 3.0 |
| 28 | 2 | 3 | 2.5 |
| 29 | 1 | 1 | 1.0 |
| 30 | 1 | 1 | 1.0 |
| 31 | 3 | 3 | 3.0 |
| 32 | 2 | 2 | 2.0 |
| 33 | 3 | 4 | 3.5 |
| 34 | 1 | 1 | 1.0 |
| 55 | 4 | 4 | 4.0 |
| 56 | 3 | 3 | 3.0 |
| 57 | 3 | 4 | 3.5 |
| 58 | 2 | 3 | 2.5 |
| 59 | 4 | 3 | 3.5 |
| 60 | 1 | 1 | 1.0 |
| 83 | 1 | 1 | 1.0 |
| 85 | 4 | 4 | 4.0 |
| 86 | 3 | 3 | 3.0 |
| 87 | 3 | 3 | 3.0 |
| 88 | 3 | 2 | 2.5 |
| 89 | 3 | 4 | 3.5 |
| 90 | 1 | 1 | 1.0 |
| 111 | 3 | 4 | 3.5 |
| 112 | 2 | 4 | 3.0 |
| 115 | 2 | 2 | 2.0 |

Pearson's Product Moment = .784
Kendall Tau = .266
Chi-Square = 2.15

EXHIBIT II

DESCRIPTIVE STATISTICS FOR
QUESTIONNAIRE ANSWERS[2]

| Question # | Mean | Variance | Standard Deviation |
|---|---|---|---|
| 1 | 2.047 | .6803 | .8248 |
| 2 | 1.266 | .1982 | .4452 |
| 3 | 1.425 | .3476 | .5896 |
| 4 | 1.771 | .4092 | .6397 |
| 5 | 1.828 | .4621 | .6797 |
| 6 | 2.378 | .6173 | .7857 |
| 7 | 2.109 | .8291 | .9106 |
| 8 | 1.979 | .4936 | .7026 |
| 9 | 2.000 | .4444 | .6667 |
| 10 | 2.359 | .5831 | .7636 |
| 11 | 1.797 | .5454 | .7385 |
| 13 | 1.84 | .5145 | .7173 |
| 14 | 1.922 | .3271 | .5720 |
| 15 | 2.031 | .5704 | .7553 |
| 16 | 2.01 | .5572 | .7465 |
| 18 | 2.203 | .7041 | .8391 |

[2]See Appendix 1 for the questionnaire.

EXHIBIT III

CORRELATIONS AMONG THE DIFFERENT
INSRUMENTS IN THE FIRST EXPERIMENT

| | Pearson's Product-Moment | | | | | | |
|---|---|---|---|---|---|---|---|
| | MBA | MBB | MBC | MBD | Self | Coin | Quest. |
| MBA | 1 | | | | | | |
| MBB | .357* | 1 | | | | | |
| MBC | .084 | .264* | 1 | | | | |
| MBD | .052 | .623* | .567 | 1 | | | |
| Self | .192 | -.161 | -.163 | .341* | 1 | | |
| Coin | .126 | -.292* | -.185 | .148 | .502* | 1 | |
| HAQ | .049 | -.149 | .384* | .117 | .394* | .254** | 1 |

*Significant at 5 percent level
**Significant at 10 percent level

These are based on a sample of 42 S's.

EXHIBIT IV

CORRELATIONS BETWEEN THE DIFFERENT INSTRUMENTS IN THE SECOND EXPERIMENT

Pearson's Product-Moment

| Pitcher | Coin | Self | Quest. |
|---|---|---|---|
| 1 | .2765* | .2917* | .4706* |
| .2765* | 1.0 | .3876* | .3472* |
| .2917* | .3876* | 1.0 | .2314** |
| .4706* | .3472* | .2314** | 1.0 |

*Significant at the .1 level
**Significant at the .05 level

Appendix 1

Starting time:

INSTRUCTIONS

Please answer these questions at face value. Do not try to read anything into them. Do not take a long time to decide on an answer. Respond with your first impression.

There are no right or wrong answers to this questionnaire.

Respond to questions sequentially and do not return to earlier questions.

Name: _____

Address: _____

_____

Phone number: _____

Highest degree obtained: B.S.____ M.S.____ Ph.D.____ Other _____

Years of professional working experience: _____

Present position: _____

If working towards a degree state which: _____

Age: _____ Sex: _____

Marital Status: Single____ Married____ Divorced____ Widowed____ Separated____

Years of military service: _____

QUESTIONNAIRE

1. Do you have a fixed rule for tipping? Yes ( ) Sometimes ( ) No ( )

2. Do you analyze a situation and act the way you think to be the best?
Yes ( ) Sometimes ( ) No ( )

3. If you got a "hot tip" on a stock from a broker but the financial reports of the firm in question seemed unfavorable, would you buy the stock?
Yes ( ) Sometimes ( ) No ( )

4. Do you value statistics when making your personal decisions?
Yes ( ) Sometimes ( ) No ( )

5. Do you try to reduce a problem to a series of causal relationships?
Yes ( ) Sometimes ( ) No ( )

6. When dealing with a problem do you search in your mind for analogies or rather do you try to find mathematical relationships between the elements of the situation?
Analogies ( ) Unclear( ) Mathematical ( ) Relationships ( )

7. Your friend shows you that paying theft insurance on your car throughout the next 30 years would cost as much as buying a new car and that the likelihood of your car being stolen in the next thirty years is only 30%. But, your wife has the feeling that the car will be stolen. Would you buy theft insurance for your car?
Yes ( ) Maybe ( ) No ( )

8. Do you make most of your repetitive decisions by trial and error?
Yes ( ) Sometimes ( ) No ( )

9. Do you like to have a mathematical model on which to base your decisions?
Yes ( ) Sometimes ( ) No ( )

10. In a flirtatious situation do you act more the way you feel like acting rather than the way a cold analysis of facts would lead you?
Yes ( ) Sometimes ( ) No ( )

11. Do you try to build a model of a typical situation if that is possible?
Yes ( ) Sometimes ( ) No ( )

12. Do you find it difficult to make decisions?
Yes ( ) Sometimes ( ) No ( )

13. A careful analysis of the financial statements of a firm provides more information for a stock purchase decision than your feelings about the management of the firm after interviewing its members?
Yes ( ) Sometimes ( ) No ( )

14. Do you make your decisions on your intuitive feelings about a situation?
Yes ( ) Sometimes ( ) No ( )

15. Is it true that you don't trust formulas to solve real life problems since they tend to oversimplify complex problems?
Yes ( ) Sometimes ( ) No ( )

16. Do you tip percentually? Yes ( ) Sometimes ( ) No ( )

17. If you were buying a car, rank in order of importance to you the following factors (from 1 the most important to 5 the least important):

a. A friend's strong favorable recommendation _____

b. A technical report about it in Consumer Reports _____

c. Your feelings about the car _____

d. The car's technical specifications such as weight, torque, gallons per mile, horsepower, acceleration, etc. _____

e. Appearance of the car _____

18. A large and conservative bank just agreed after a very long and difficult negotiation to double the outstanding loan of C.D., Inc. This firm has been in financial trouble for the last two years and you were told that it would not be able to sell enough of its new executive jets (product on which its economic success relies) to break even. On the other hand, you noticed that its profits are in the upswing having been in the black for the last two quarters. It is selling at a very low price/earnings ratio in an industry of high ratios. Would you buy C.D.I.'s stocks?
Yes ( ) Sometimes ( ) No ( )

Appendix 2

An analytic decision maker is a person who reduces a problem to a core set of causal relationships and tries to find an "optimal" solution by using formulas and "models" (fixed rules).

A heuristic decision maker is someone who emphasizes workable solutions to solve problems. He tries to solve problems through his intuitive feelings and by trial and error.

How would you describe yourself?

(1) analytic

(2) weakly analytic

(3) weakly heuristic

(4) heuristic