AN INVESTIGATION OF COGNITIVE STYLE AND ACCOUNTING INFORMATION STRUCTURES WITHIN TWO EXPERIMENTAL SETTINGS*

Theodore J. Mock
and
Miklos A. Vasarhelyi
Department of Accounting

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*This Working Paper is prepared for discussion purposes and should not be directly quoted as it is not in final form. Suggestions and comments are welcomed.

**This paper presents in greater detail the experimental results contained in Mock and Vasarhelyi (1976).

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Research into behavioral aspects of accounting information and decision making has reached significant levels within the past several years. For example, Hofstedt (1975) estimates that over half of all behavioral accounting research (BAR) within the past ten years has emphasized "information and decision making." The thrust of much of the referenced research and of this paper is a joint study of information and decision making. More specifically this paper summarizes a series of related experimental studies into information value and cognitive style. First, a model that contains the important experimental variables is briefly developed and some previous studies are summarized. Then, some new empirical results are presented. These results reflect the more complex, cross-contextual research design of our current experiments into alternative information structures and cognitive styles.

Previous Research

In previous studies of accounting information, many methodological problems and approaches have been delineated. As many good surveys of the various research areas are available, an extensive literature review will not be presented. For example Hofstedt (1975) reviews recent behavioral accounting research (BAR), Feltham (1968) introduces the basic information economics model and Mock (1974) summarizes experimental studies based on that model. Within the realm of cognitive style, overviews are found for decision style and human information processing (HIP) in Driver and Mock (1975), for decision approach in Mock, Estrin and Vasarhelyi (1972) and Vasarhelyi (1977), and for clinical judgment in Ashton (1974), Hofstedt and Hughes (1974) and in Wright (1975-b). A useful review of human information processing and its implications for accounting is given in Birnberg (1975) who summarizes the current research wisdom as follows (pp. 2 and 3):

> The user or consumer of financial outputs is not a homogeneous class. He differs in his ability to handle abstract concepts, his expertise in the areas of accounting and financial analysis, the data sources open to him and his experience in dealing with the information available for financial decisions. However, for practical purposes, we can assume that all users be they analysts or the ubiquitous "man on the street":
>
> 1. Are better able to process inputs in some forms than others.
>
> 2. Do overload from the sheer volume of information provided even when he knows what data he wants.
>
> 3. Tend toward habitual behavior at least in the short run and, therefore, may require time to adapt to new information and/or new ways of presenting the old information.
>
> 4. But it is likely that he learns and adapts to the conditions in #3 above, in the long run.
>
> 5. Is functioning in an uncertain environment so that (a) he may request more information than he needs in hopes of reducing his uncertainty and (b) show less confidence in preprocessed data than the raw data even when the former is clearly more valuable to him.
>
> Obviously there are interpersonal differences among users that (are) quite independent of prior training and experience. For information processing two differences appear to be paramount.
>
> 1. The degree of abstractness (or complexity) involved in the user's information processing.
>
> 2. The decision style of the individual which affects the way he uses information and the amount of information he requests.

The experimental results reported in this paper consider a number of variables which are alluded to by Birnberg. Specifically, interpersonal differences which are related to the degree of abstractness are contained in two cognitive style classifications (decision style and decision approach). These behavioral factors are evaluated with respect to information structure variables which are experimentally controlled. Some of the relations among these variables are presented in Figure 1 which is drawn from an information systems perspective. Here cues are considered in terms of characteristics controllable by the accountant and some behavioral variables which may impact the way information cues are processed are specified. Research into cognitive models and behavioral factors is helpful if it can be demonstrated that models of human information processing can be used to improve information system design.

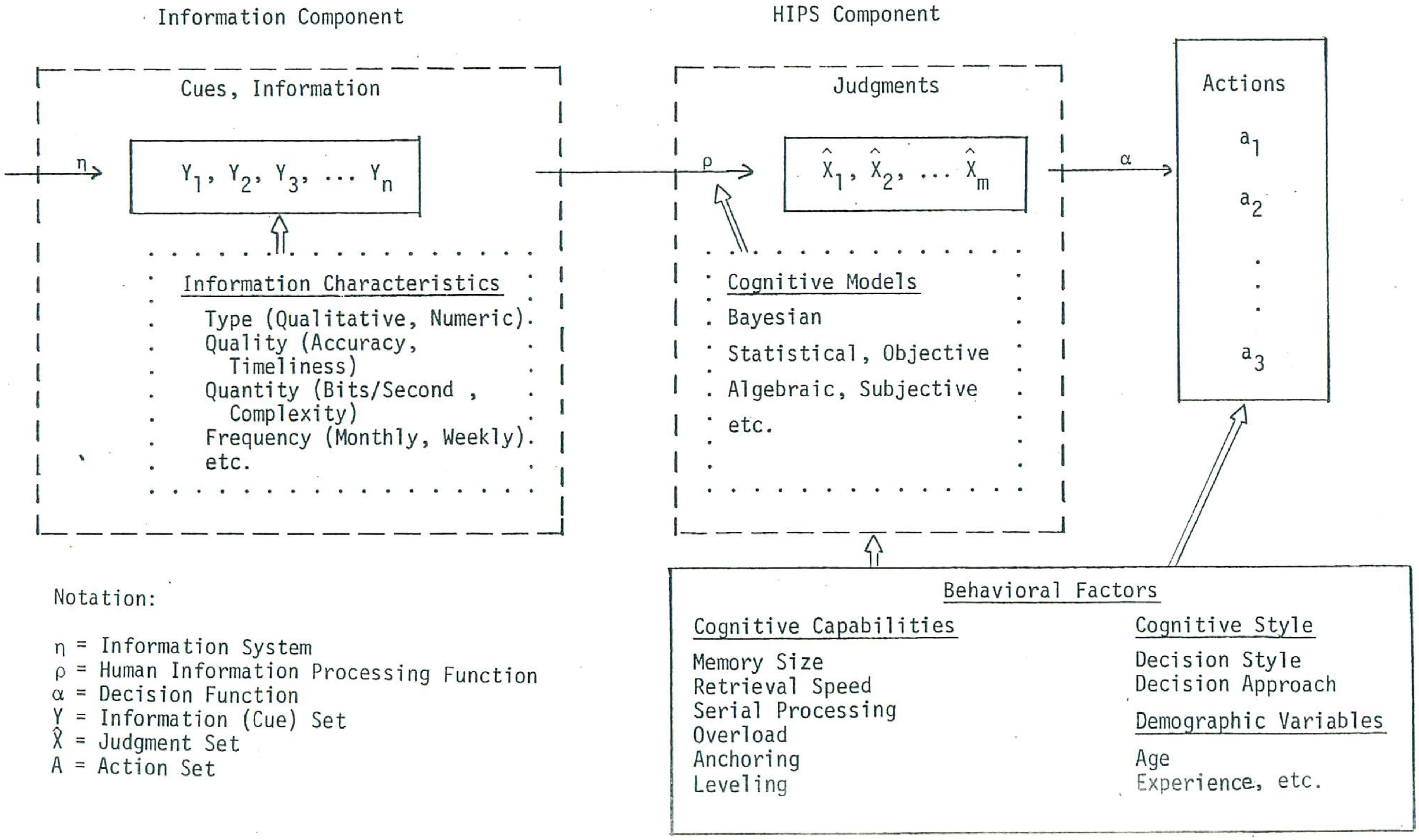
There are a great number of behavioral variables that have been shown to have a significant effect on information processing. For example, Davis (1974) has surveyed a number of studies primarily in the artificial intelligence area. His survey contains a number of behavioral constraints including serial processing, limited short term memory, overload and processing constraints (i.e., Miller [1956]1), and Weber's Law of just noticeable differences. Research in psychology has also identified a number of related behavioral factors including anchoring, the representativeness heuristic, inconsistency and leveling [see Slovic (1974)].

Other studies have suggested ways of dealing with some of these variables. For example, Birnberg (1975) notes that many techniques have been developed in accounting, mostly through trial and error, for coping with information overload. Included are techniques of unfolding the data (first a general description, then graphic display, then aggregate financial statistics and so on), aggregation and precalculation.

FIGURE 1

MODEL OF INFORMATION,

HUMAN INFORMATION PROCESSING AND BEHAVIORAL FACTORS



Notation:

η = Information System
ρ = Human Information Processing Function
α = Decision Function
Y = Information (Cue) Set
$\hat{X}$ = Judgment Set
A = Action Set

Chervany and Dixon (1974) experimentally tried to measure overload situations by comparing two groups of students, one given statistically summarized data and the other raw data. In addition to the overload factor, concepts such as filtering of information, quantity of information, type of information and aggregation of information are found intermittently in the literature as important HIP factors. Other variables such as experience, time pressure, effort and motivation are also pertinent.

The experimental research reported in the next sections is directed at the measurement and evaluation of some of these variables and the interdependence between information system design and behavioral factors. While much research has been conducted on both of these topics, our further comments will be restricted to our own experimental studies. First, a summary of previous studies will be discussed and then the results of our most recent experiments are presented.

Studies Reported During the 1969-1975 Period

An overview of previous studies is presented in this section to facilitate an understanding of longitudinal aspects of the research, to help demonstrate some of the methodological difficulties and enhancements that have occurred and most importantly to present some new interpretations of previous results from the standpoint of human information processing. Within the span of the research, three major types of experimental settings (decision contexts) have been used. In each case a business or economic decision model has been incorporated within a controlled experiment. Table 1 summarizes the methodological differences within each decision context.

TABLE 1

CLASSIFICATION OF EXPERIMENTAL SETTINGS (DECISION CONTEXTS)
FOR THE ACCOUNTING SIMULATION EXPERIMENTS

	Methodological Differences			
Experiment Name	Decision Setting and Rule (α)	Information System (η)	Information Utilization (ρ)	Behavioral Factors (B)
Information Structure (IS) Experiments	Highly Structured Micro-economic game, Optimizable	Controlled Differences (Timeliness, Coarseness, Completeness)	Specific Information Processing Rules Tested	Decision Approach, Decision Style
Interactive Planning System (IPS)	Unstructured Financial Planning Case, Not Optimizable	Single Structured Planning System	Measures of Type, Amount of Information Used	Decision Approach
Simulated Stock Exchange (SX) Experiments	Capital Stock Market, Theoretical Decision Models (i.e. Portfolio Theory)	Not Controlled	Measures of Type, Amount of Information Used	Decision Approach, Decision Style

The Experimental Settings

Four versions of the Information Structure experiments (denoted IS1, IS2, ...) have been conducted. The IS setting is unique in its emphasis on controlled information differences and in the underlying structure that may be optimized. Complete description and documentation for these experiments may be found in Mock (1969) and Mock and Goodfried (1975).

The second decision setting involves a more complex forecasting problem and a more complex information and decision support system denoted as the Interactive Planning System (IPS). Rather than researching specific information differences, the IPS experiments emphasized the combined effects of cognitive style (specifically analytic versus heuristic decision approaches) and type and amount of information utilization. A more complete description of IPS may be found in Vasarhelyi (1973).

The third decision context that has been utilized involves a Simulated Stock Exchange (SX) which has been run under three specifications (SX1, SX2 and SX3). The cross-contextual research results reported in the following section involve IS4 and SX1. Like the IPS methodology, the stock market simulation emphasizes information utilization and cognitive style differences. But unlike IPS, normative decision models such as portfolio models may be referenced to evaluate performance differences.

Each experiment in Table 1 has dealt in some way with cognitive style. The distinction between decision approach[1] (analytic versus heuristic) and decision style[2] (decisive, flexible, hierarchic, and intergrative) lies in the complexity of the underlying behavioral models. Part of the current research involves an evaluation of various cognitive style models and measurement tools.

Summary of Previous Findings

In Table 2 a summary of the major HIP findings of each previous experiment is given. The results are broken down into the cognitive style variables that were experimentally analyzed. The blanks in the table indicate that the particular variables were not evaluated in the particular experiment.

Three overall results are of note. First, although not included in Table 2, in every case significant information structure effects have been observed. And, as will be seen, this result carries over to the most recent experiments. Of particular note with respect to information structure effects is the interaction between information structure and decision style observed in IS3 [see Mock and Driver (1975)]. Here is some of the first experimental evidence which supports tailored information systems.

The second overall area worthy of note is the mixed results that have been obtained with respect to cognitive style. In fact, neither the decision approach dichotomy nor the decision style model have led to consistent, unambiguous results. In most cases overall variance is not explained to a significant degree. There are of course some encouraging results such as the tendency for the decision approach dichotomy to predict type of information utilized.

The third overall observation concerns the information processing results obtained in IS1 and IS2. In this particular decision setting,

TABLE 2

SUMMARY OF MAJOR EXPERIMENTAL INFORMATION PROCESSING FINDINGS

Experimental Variables	EXPERIMENTS IS1 Mock 1969	IS2 Mock 1973	IPS Vasarhelyi 1973	IS3 Driver & Mock 1975	SX1 and IS4 1976
Cognitive Style - Decision Approach	--	--	Significant differences in Information Utilization (Quantity)	--	Significant (Pre-Test) Differences Information Type and Quantity Preferences
Cognitive Style - Decision Style	--	--	--	Significant Decision Speed Effects	Significant (Pre-Test) Differences Information Type and Quantity Preferences
	Optimal Information Processing Rules Significant	Optimal Information Processing Rules Not Significant	Miller's Hypothesis Supported	--	Optimal Information Processing Rules Significant but Individual Differences Dominant
Primary Focus of Experiment and/or Analysis	Methodology Value of Timely Information	Value of Budget Information	Tailored Decision Support System, Information Utilization	Decision Style Theory, Tailored Accounting Feedback	Cross-Contextual Methodology, Cognitive Style, Information Value

normative information-decision rules were derived and a weak relationship between decisions and available cues was observed. In effect, these relations are composite information processing and decision functions. The important differences between this approach and the Lens model approach [e.g., AAA (1971) and Ashton (1974c)] should be apparent. In most research that has relied on the Lens model, a hypothetical or normative relation between cues and decisions or judgments is not derived. Thus ANOVA and correlational models are used to estimate, but not test, precise theoretical relations. In contrast, in more structured decision situations, such as IS and SX, normative decision theory may be used to postulate information processing and decision functions and to test various HIPS models.[3]

The previous experiments have also generated some evidence on the relationship between information utilization and cognitive style. For example the IPS results indicated significant cognitive style differences in amount of information utilized. Also, when cognitive style was classified in terms of decision style, significant differences in decision times were observed in IS3. This was taken as indicative of differences in amount of information processed.

Overall, the previous experiments have provided some tentative results for those interested in information structure and human information processing analysis. Although these results are derived from three different settings, no particular variable has been evaluated in an ex ante, multiple setting (cross-contextual) design. The new results reported in the next section do take advantage of an ex ante, cross-contextual design for both cognitive style/performance and cognitive style/information perception analyses. By presenting identical subjects with differing tasks, the generality of any findings should be enhanced.

Some Recent Experimental Results[4]

Experimental Setting and Method

This section describes the results of two experiments (IS4 and SX1) which were conducted under a pilot cross-contextual methodology. The two settings encompass a stock market and micro-economic game (see Table 1). These contexts provided measures of subjects' performance and their attitudes concerning the type and quantity of information available during the experiment. The results are analyzed according to two independent variables - type of information provided (information structure) and cognitive style. The discussion begins with a description of the experiments. Specific hypotheses and their underlying justifications are incorporated within the presentation of results.

The IS4 experiments were performed during the 1974-75 academic year using a population of 130 graduate students and a 2 by 2 factorial design on information structure. The IS4 setting involves a multi-decision, multiple equation game. Subjects are asked to read a case and make decisions concerning advertising, quantity to be produced and materials input. In addition to these decisions, subjects are asked to prepare a budget for each decision period. These decisions are entered into the model through a computer terminal and subjects receive various financial feedback for that specific period. Following this feedback they then make their next decision. This cycle is repeated several times up to the completion of the experiment (three hours or ten decision periods). The controlled or experimental variables in this factorial design were the coarseness of the feedback information and the completeness of budget variance information.

The SX1 experiments are based on a hybrid stock market game. The simulation uses current stock market prices of 50 New York Stock Exchange (NYSE) stocks that may be traded by subjects. Subjects are given the option of investing their own money (up to $20.00) into the game. If so, they receive 10,000 SX dollars for each dollar they invest. In the case where no money is invested, an initial cash level of 100,000 SX dollars is given to the subject. The duration of the game is an academic semester. No puts, calls, margin purchases or short sales are allowed. Subjects trade at the closing price of the trading date, without perfect knowledge of this price. Transaction costs are deducted using the old NYSE rates and subjects are paid a 5% yearly "risk free" rate for average cash balances held. At the end of the simulation, subjects that invest their own funds are repaid their original investment plus (or minus) any proportional gain (or loss) they earn.

Ninety-seven of the 130 MBA students who also had completed IS4 participated in the SX1 experiment throughout the spring of 1975. All transactions were monitored by means of a transaction form. Bio data, pre and post attitudes concerning the stock market and information utilization were obtained through questionnaires. A computer system kept track of portfolio situations and issued biweekly reports. For both experimental contexts, cognitive styles were measured by means of the self-evaluation questionnaire [decision approach, Vasarhelyi (1973)] and the IST test [decision style, Driver and Mock (1975)]. One of our first concerns was whether these two tests were measuring independent or interdependent classifications of cognitive style. As the definitions of analytics and hierarchics are quite similar [see Mock et al. (1972) and Driver and Mock (1975)], a significant correlation among the classifications would be hypothesized. In order to examine these effects a 2 x 5 factorial design was used for analysis. The results of classifying each subject who took both the self-evaluation questionnaire and the IST test into each cognitive taxonomy are given in Table 3. These data indicate significant correlation between the two taxonomies with hierarchics tending to also be classified as analytics and with decisives and integratives tending to be classified as heuristics. As these results are consistent with the construct definitions of each classification, a degree of construct validity is provided.

Cognitive Style Effects

One of the three basic areas researched in these experiments and contained in Figure 1 concerns cognitive style effects. The primary interest in such variables stems from the possibility of tailoring accounting systems (and other aspects of decision making) to the decision maker's cognitive style. Our initial analyses consider the relationship between decision style (D/S) and decision approach (D/A) and the subjects' performance within each experiment. This should help answer questions such as "Is cognitive style a determinant of performance?" The analysis then continues to seek information concerning subjects' perceptions of type and availability of information.

TABLE 3

CLASSIFICATION OF SUBJECTS BY
DECISION APPROACH AND STYLE
(Frequency and Percentage)

	DECISION STYLE				
DECISION APPROACH	D	F	H	I	C
Analytic	8	12	10	6	10
	8.3%	12.5%	10.4%	6.3%	10.4%
Heuristic	15	10	4	14	7
	15.6%	10.4%	4.2%	14.6%	7.3%

Statistics

Chi Square	=	8.46
Significance	=	.076
Cramer's V	=	.30
Contingency Coefficient	=	.28
Lambda	=	.24 (with D/A dependent)
	=	.05 (with D/S dependent)
Uncertainty Coefficient	=	.07 (with D/A dependent)
	=	.03 (with D/S dependent)

Notation

D	=	Decision
F	=	Flexible
H	=	Hierarchic
I	=	Integrative
C	=	Complex
D/A	=	Decision Approach
D/S	=	Decision Style

Table 4 summarizes some of the cognitive style analyses that were performed. Both models of cognitive style were analyzed. Decision Approach partitions subjects into analytics (A) or heuristics (H). Decision Style theory uses the decisive (D) flexible (F) hierarchic (H), integrative (I) and complex (C) decision styles.

The analysis in Table 4 shows the effect, if any, of cognitive style on performance, type of information preferred, and perceptions concerning quantity of information. The measurement instruments for decision style and decision approach and their validity and accuracy have been discussed in the references cited earlier. However, the consistency and predictive validity of such instruments are always a concern. As cognitive style was determined in an ex post facto manner (subjects were placed in an experimental setting and later tested on their cognitive style), the design resulted in factorial analysis with unequal cell frequencies (see Table 4).

Performance Effects

Both simulations used aggregate performance measures. For the IS4 experiments, average period profit was used. In SX1 performance (ROI) was computed as:

$$P = (V_1 + D + (C \times i) + C_1 - C_o) \div C_o$$

where:

P = the ROI ratio

V_1 = the market value of the portfolio held at the end of the simulation

D = dividends earned during the simulation

C_o = beginning (cash) investment

C_1 = ending cash on hand

C = average cash on hand during the simulation

i = the risk free rate of money for the simulated period

TABLE 4

ONE WAY ANALYSIS OF COGNITIVE STYLE EFFECTS

Performance		DECISION APPROACH A (56)	DECISION APPROACH H (51)	F-Value	DECISION STYLE D (22)	DECISION STYLE F (22)	DECISION STYLE H (16)	DECISION STYLE I (25)	DECISION STYLE C (17)	F-Value
IS4: Profits (in thousands)		102.4	109.7	n.s.	111.0	98.9	113.1	101.0	104.0	n.s.
SX1: ROI (% of Investment)		6.4	4.8	n.s.	5.5	6.9	7.4	5.9	5.6	n.s.
Information Perceptions										
Preference for Quantitative Data 1) (SX1)	PRE	45.7	36.3	2.8	47.9	45.7	32.7	29.2	44.4	1.86
	POST	44.8	38.5	n.s.	41.8	45.9	34.5	36.6	45.6	n.s.
Preference for Qualitative Data 1) (SX1)	PRE	37.3	46.9	3.1	40.2	24.2	45.9	50.7	46.2	2.2
	POST	43.8	52.7	2.4	47.9	48.2	52.7	54.6	45.3	n.s.
Information Sufficiency 2) (SX1)	PRE	3.84	4.08	n.s.	4.1	4.4	3.4	3.8	3.9	n.s.
	POST	4.43	4.23	n.s.	4.0	4.9	4.6	3.6	4.5	3.2
Information Quantity 3) (IS4)	PRE	4.11	3.45	5.6	3.5	3.9	4.7	3.5	3.5	2.1
	POST	4.33	4.00	n.s.	3.6	4.7	4.5	4.2	4.2	2.1

1) What type of information did you use in making your trading decisions (in relative percentages)?
Quantitative? _____ Qualitative? _____ Other (specify)? _____
2) Do you feel you had enough data to make your decision? (Too little = 1, Too much = 7)
3) Please rate the absolute amount of information in the experiment. (Very little = 1, Very much = 7)

A priori, differences in either cognitive style are not expected to result in performance differences. This would be expected for either task and especially for a stock market which may be efficient with respect to publicly available information.

H1: Differences in Cognitive Style are not expected to result in significant performance differences in either decision task.

This hypothesis was tested using a one-way ANOVA for each cognitive style and decision setting. The results show that in neither case was cognitive style a discriminating factor vis-a-vis subject performance. Although the overall averages are not significant, comparison of these results with previous versions of IS is of some interest. In fact, many of the results for both D/A and D/S are contrary to previous findings. For example, while analytics outperformed heuristics in IS1, IS4 shows the opposite tendency. Also note that the decisives performed well in IS4 whereas their overall profit performance was by far the worst in IS3.

Self Perception of Type and Quantity of Information Used

H2: There will be significant differences in the type of information being used by differently cognitively styled individuals.

H3: Cognitive Style differences will determine different perceptions of need and usage of quantity of information.

These hypotheses are based on the findings by previous studies such as Vasarhelyi (1977) and the formulation of the nature of the individuals of different decision style. This cognitive style framework (see Driver and Mock, 1975) uses as one dimension of its classification grid the variable quantity of information used for decisions.

Type of information used, in the qualitative x quantitative dichotomy is rather intuitively allocated to heuristics and analytics. This intuitive allocation was supported by Vasarhelyi (1977) using the IPS framework and is hereby tested under both the IS and the SX settings.

Quantity of information is an extensively explored topic. It is connected to issues such as content of information and information overload (see Chervany and Dixon, 1974; Dixon, et al., 1975). A natural extension of these studies attempts to relate information quantity to cognitive style. Conclusive results in this area might be of major importance in the potential tailorization of information systems.

SX1 tested user perception of usage of quantitative and qualitative information in the simulation. One of the questions requested subjects to break down the type of information used (or expected to be used) between quantitative, qualitative and other using a 100 point fractionation scale. Additional questions asked subjects to rate on a Likert scale (from 1 to 7) the importance of these types of information. The correlations among the fractionation measures and the corresponding Likert scale ratings were high and all significant at the 1% level. Given these high correlations, the analysis of information type used the fractionated data.

The results in Table 4 indicate some differences of cognitive styles in information preferences. For instance on the pre-tests, analytics showed a preference for quantitative information while heuristics emphasized qualitative data. Also, the decision styles that emphasized information (H and I) showed a preference for qualitative information. But these differences are significant in only one case for the post-tests.

Both experimental contexts also asked subjects (again on a pre-post basis) their perceptions about the quantity of information they were being supplied. As Birnberg remarked in the earlier quote, information need perception is an important design constraint for accounting information systems. The results indicate some differences in both information need perception and actual information availability among the different cognitive styles. The pre-questions may be interpreted as measuring information need perception, while post questions tend to indicate the degree of satisfaction with actual information available.

Information Structure Effects

The second major area of analysis facilitated by these experiments was the empirical evaluation of alternative information structures. In fact, IS4 was primarily designed for a two by two factorial study of the coarseness (aggregation) and completeness (variance feedback) of information. Four different information structures were supplied on a random basis to subjects. The four information structures were: I1 = coarse information without complete feedback, I2 = coarse information with complete feedback, I3 = fine information without complete feedback, and I4 = fine information with complete variance feedback. Fine information entailed additional detail concerning manufacturing costs whereas complete variance feedback added absolute and relative accounting variance measures to the financial statements.

This particular research design may be viewed as an extention of earlier studies by Mock (1973) and by Mock and Driver (1975) which analyzed the effect of complete variance information on performance. The current two-way design facilitates analysis of not only more complete variance feedback (I2 and I4) but analysis of finer information and any interaction effects.

Although it may be argued that each information set is payoff relevant, the provision of explicit variance information and finer cost information may provide some attention direction value to the subjects. At the least, the additional feedback eliminates some of the subjects processing needs. Thus, improved performance may be hypothesized for subjects receiving the more complete feedback.

H4: Subjects receiving more complete feedback (I2, I3, and I4) are expected to outperform other subjects.

In Table 5 results of basic profit performance analysis are presented. A two-way analysis of variance shows significant effects for both the main (coarseness and completeness) and interaction effects. (When decision time and number of decisions were analyzed, the main effects were not significant.)

It may be noted that one-way analysis of profits in relation to information structure does not present significant differences (see Vasarahelyi and Mock [1976]). However, once the factorial analysis is introduced, a clear pattern of interaction and separate factor influence can be observed. This pattern indicates the kind of differences in information structures that do influence decision maker performance. These results are consistent with earlier results [Mock (1973)] which attributed superior performance to explicit budget variance information. In Table 5, decision makers being supplied complete budget variance

TABLE 5

EFFECT OF COARSENESS OF INFORMATION AND COMPLETENESS OF FEEDBACK ON PERFORMANCE (IS4 EXPERIMENT)

	Average Profits Earned ($1,000.)	
	Incomplete Variance Feedback n=54	Complete Variance Feedback n=66
Coarse Information (n=56)	$96.1	$124.7
Fine Information (n=64)	97.1	97.4

	F-Values	Significance Level
Coarseness	7.1	.03
Completeness	4.5	.01
Interaction	3.5	.06

information and coarse information showed the higher profit performance. Also of significance is the finding that the finer feedback information (details in the various cost components) did not have a positive effect on profit performance.

Joint Effects of Information Structure and Cognitive Style

The previous analyses have not considered the interactions that may take place between information and cognitive style. For example, if the integrative decision style is indeed more complex and has a preference for a greater amount of environmental load (in this case feedback), integratives may be expected to perform best in I4 conditions. Obviously a number of hypotheses could be formulated for each cognitive style and information set (see, for example, Driver and Mock [1975]). As cognitive style effects were not significant, such hypotheses will not be developed.

The results are as follows. In Table 6, average profits and decision times are computed for each cognitive style and information structure. It may again be noted that because of the ex post facto cognitive style classifications, cell frequencies are quite uneven. This of course leads to a number of statistical problems. Nevertheless, a two way analysis of these two performance variables plus number-of-decisions-completed was conducted. As the results in Table 7 show, only information structure differences are significant.

TABLE 6

Supporting Data for Table 7
Average Profits (P) and Decision Times (T)
Classified by Cognitive Style (C/S) and Information Structure (I/S)

			Information Structure			
Decision Style			I_1 P 95.8 T 23.7	I_2 P 111.9 T 18.8	I_3 P 107.3 T 17.9	I_4 P 96.7 T 25.6
D	P(thousands)	111.0	81.8	66.7	140.6	101.1
	T (min)	23.0	15.6	15.1	23.5	30.9
	(N)		9	2	4	10
F	P	98.9	97.5	113.6	78.9	80.2
	T	22.3	28.5	18.9	15.7	24.2
	(N)		6	7	4	6
H	P	113.1	117.8	126.8	143.2	100.9
	T	28.7	38.6	21.8	15.2	24.1
	(N)		6	2	1	7
I	P	101.0	98.7	129.9	79.5	103.8
	T	21.5	17.8	17.7	12.4	25.8
	(N)		9	1	2	13
C	P	104.0	90.4	142.3	--	90.2
	T	23.7	24.6	20.3	--	22.1
	(N)		8	1	0	16
Decision Approach			I_1 P 98.0 T 21.6	I_2 P 130.9 T 18.1	I_3 P 97.1 T 19.1	I_4 P 95.1 T 24.6
A	P	102.4	100.6	139.6	91.2	94.6
	T	21.6	24.5	18.9	17.1	24.0
	(N)		18	6	8	26
H	P	109.7	95.5	125.1	106.4	95.7
	T	21.4	18.3	17.5	22.3	25.3
	(N)		18	9	5	22

NOTATION:

Information Structure

- I_1 = Coarse & Incomplete
- I_2 = Coarse & Complete
- I_3 = Fine & Incomplete
- I_4 = Fine & Complete

Decision Style

- D = Decisive
- F = Flexible
- H = Hierarchic
- I = Integrative
- C = Complex

Decision Approach

- A = Analytic
- H = Heuristic

MISCELLANEOUS:

- P = Profits
- T = Decision Time
- N = Cell frequencies

TABLE 7

TWO-WAY ANOVA OF INFORMATION STRUCTURE
AND COGNITIVE STYLE (IS4)
F-VALUES
AND SIGNIFICANCE LEVELS

	Average Profits	Number of Decisions	Decision Time
Information Structure	3.3 (.10)	6.9 (.05)	3.1 (.10)
Decision Approach	n.s.	n.s.	n.s.
Interaction	n.s.	n.s.	n.s.

- -

	Average Profits	Number of Decisions	Decision Time
Information Structure	n.s.	7.4 (.05)	3.99 (.05)
Decision Style	n.s.	n.s.	1.57 (.20)
Interaction	n.s.	n.s.	1.95 (.10)

Significance of Factor Price Cues

As the final area where new results will be presented, consider the problem of determining the decision maker's information processing (ρ) and decision (α) functions within an experimental context. As was discussed earlier (see Table 2), regression analysis has been used in IS1 and IS2 to estimate the relationship between factor price cues (i.e. costs of inputs in a manufacturing setting) and actual subject decisions. This analysis is now developed in more detail.

In Figure 1, a subject's chosen action a was specified as depending on a decision function α, an information processing function ρ and an information system η, or

$$a = \alpha[\rho(\eta(x))] \qquad (1)$$

The action that will be analyzed is the material input decision M_t. In the IS experiments, all subjects received one-period-lagged cues concerning factor input prices for labor cost (P_{Lt-1}) and unit materials cost (P_{Mt-1}). Thus in this case equation (1) becomes

$$M_t = \alpha[\rho(P_{Mt-1}, P_{Lt-1})] \qquad (2)$$

Clearly various decision/information-processing models could be formulated and experimental data could be then used to test these models. In IS1, normative decision theory was used to derive a hypothesized model

$$M_t = .5(P_{Lt-1}/P_{Mt-1})^{.5} \qquad (3)$$

This model was consistent with observed results although a great amount of explained variance was not accounted for. The normative formulation is based upon the best linear unbiased estimator (information processing function)

$$\rho^* : P_{Mt} = P_{Mt-1}$$

$$\text{and} \qquad (4)$$

$$P_{Lt} = P_{Lt-1}$$

And an optimal (maximum expected monetary payoff) decision rule

$$\alpha^* \ : \ M_t = .5[\rho^*(P_{Lt-1}/P_{Mt-1})]^{.5} \tag{5}$$

Equation (5) is then the hypothesized material decision and information processing rule. Based upon this formulation, regression analysis results are given in Table 8 for IS4. The analysis was conducted according to the four information structure treatments (I_1, I_2, I_3, and I_4). For each subject population, regressions were run for both M_t and normalized M_t decisions. The latter analysis is an attempt to minimize individual differences in decision strategy which are shown to be significant in Table 9. The normalized M_t are the actual material decisions divided by the individual's mean M decision. By removing some of the individual's differences, overall subject's reactions to cue changes can be more precisely measured. In fact in Table 8, all IS4 subpopulations show a significant relationship (at the .05 level or better) between the factor price cues and the normalized material decisions. But as was noted in earlier experiments, again not much variance is explained.

For the regressions using M_t, the value of $\hat{\beta}$ is of interest as its theoretical value is 0.5 (see equation 5). These results vary from that value but it is apparent that the theoretical model does perform reasonably well.[5]

Both the above and previous results indicate that a number of variables other than changes in factor price cues are affecting subject decisions. It is probable, for example, that some subjects "anchor" on a reasonable estimate of M_t^* and react in a heuristic, trial-and-error manner to factor price changes. The results contained in Table 8 support this scenario.

TABLE 8

Regression Analysis Results for Material Decisions Related to Factor Price Cues (IS4)

Experiment and Subject Population	Dependent Variable (Material Decision)	Independent Variable (Factor Price Cues)	$\hat{\beta}$	t value (significance)	R^2
1. I_1 (n=39)	M_t	$(P_{Lt-1}/P_{Mt-1})^{.5}$	.63	1.67 (α=05)	.01
2. "	M_t Normalized	"	1.65	3.33 (α=.01)	.05
3. I_2 (n=17)	M_t	"	.49	1.6 (α=.10)	.03
4. "	M_t Normalized	"	.98	1.94 (α=.05)	.04
5. I_3 (n=15)	M_t	"	.68	1.49 (α=.10)	.03
6. "	M_t Normalized	"	1.84	3.84 (α=.01)	.17
7. I_4 (n=48)	M_t	"	.36	n.s.	.01
8. "	M_t Normalized	"	1.28	2.79 (α=.01)	.03

In order to evaluate the impact of individual differences and decision period (a surrogate for period factor price changes), one way ANOVA was applied to IS4 material decisions (see Table 9). Consistent with the reported regression results, period effects are more significant for normalized M_t. And as anticipated, for each set of subjects, individual differences accounted for a significant proportion of observed variance.

These results support the necessity of investigating individual models of human information processing and decision (such as cognitive style) if one is interested in a complete specification of the processes contained in the decision and information processing components of Figure 1. The value of a formal, decision theory derivation of possible information processing and decision functions should also be apparent. Without such theoretical guidelines, analyses of human judgment are exploratory.

TABLE 9

1-Way ANOVA of Material Input Decisions According to Period Effects and Individual Difference Effects (IS4)

Experiment and Subject Population	Variable Analyzed Classification (Treatment)	M_t Decision Period	M_t Individual Differences	M_t Normalized Decision Period
I1 (n=39)	F	.91	2.9	2.95
	d.f.	4,38	38,156	4,38
	significance	n.s.	.01	n.s.
I2 (n=17)	F	2.13	3.39	4.04
	d.f.	4,80	16,68	4,80
	significance	.10	.01	.01
I3 (n=15)	F	.78	12.9	6.31
	d.f.	4,70	14,60	4,70
	significance	n.s.	.01	.01
I4 (n=48)	F	.53	2.05	2.18
	d.f.	4,235	47,192	4,235
	significance	n.s.	.01	.10

Summary

The last main section of this paper has examined behavioral and informational variables in two experimental settings. The results indicated consistent information structure effects with less consistent cognitive style effects in terms of information use perceptions.

In summary, this paper has presented material in three areas of interest to researchers concerned with accounting systems vis-a-vis 1) behavioral variables, 2) human information processing rules, and 3) decision rules. The paper began with a review of the literature and a brief introduction to a model (Figure 1) that contained the variables of interest. This model may be viewed as continuing the normative perspective of information economics and more exploratory efforts of describing important behavioral and HIP processes.

The second major segment of this paper then considered the information processing evidence contained in four previous experimental studies. Thirdly, some new experiment results derived from two decision contexts were presented.

The new results may be classified within four areas, two of which were seen to hold of both experimental contexts. In each experiment, cognitive style differences did not explain a significant amount of variation in performance but did result in significant differences in perceptions concerning type and amount of information. In the IS experiment, information structure effects were seen to explain performance differences but only a weak relationship was established between factor price cues and factor input decisions.

The latter result indicates that future research will have to utilize and test more complex models of individual differences (such as cognitive styles) and of human information processing. The experimental separation of both information processing and decision functions should also be attempted. The ultimate goal of such research is an improved model of decision making and thus an increased accounting system design capability.

FOOTNOTES

1. See Mock, Estrin and Vasarhelyi (1972).

2. See Driver and Mock (1975).

3. See Driscoll and Mock (1976).

4. The authors gratefully acknowledge the research assistance of Ms. Donna Driscoll and Mr. Edward Pearson, and the financial support for these experiments by the Accounting Department and the GSBA Research Committees of the University of Southern California.

5. One reason why the regression model does not perform as well in IS4 as in IS1 may be the fewer (5 versus 12) number of decision periods.

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