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ABSTRACT

Within the past decade many writers and researchers have recognized the importance of including psychological characteristics in managerial decision models. Cognitive styles have been singled out for research attention to determine their importance in information use and the acceptance of the recommendations made by management scientists. Despite the evidence that cognitive styles influence information processing in these contexts, conceptual and methodological weaknesses have seriously hampered the conclusiveness of cognitive syles research. Among the weaknesses evident in cognitive styles research studies are: 1) inadequately formulated theory of cognitive styles, 2) the use of a great many inadequately validated measuring instruments for assessing cognitive styles, and 3) faulty research designs. A review of the cognitive styles literature is presented; then these three problems are discussed and suggestions are made for correcting these limitations in cognitive styles research.

1. INTRODUCTION

Within the past decade, the accounting and mangement information (MIS) design literature has reflected an increased attention to the psychological characteristics of the decision maker. Research in this area has been stimulated by hypotheses such as "the utility of a particular type of information can not be effectively evaluated apart from the users of that information," (15, p. 518), and that "the designers of information systems should not force all psychological types to conform to one type of information system, rather each psychological type should be given the kind of information to which he is psychologically attuned and will use most effectively" (30, p. 478). A number of studies have empirically tested the impact of psychological charactistics on information system acceptance and use. Among the characteristics examined are tolerance for ambiguity (15), dogmatism (25,37), risk-taking propensity (37), and cognitive styles (9).

A recent report of the American Accounting Association Committee on Human Information Processing (2) states that an understanding of the variables and processes involved in human information processing and decision making is a prerequisite to improving human decisions. One of the psychological categories discussed in the above report and one which has received attention in the accounting and MIS literature is "cognitive styles." Witkin (44) defines cognitive styles as "the characteristic, self-consistent modes of functioning which individuals show in their perceptual and intellectual activities." Bariff and Lusk (4) have discussed three types of cognitive style which have relevance for managerial information systems design: 1) cognitive complexity, 2) field independence-dependence, and 3) systematic-heuristic.

These cognitive styles and the research which has investigated their roles in accounting and MIS are examined in this paper. The research evidence

suggests that both problem characteristics and user characteristics influence decision-making strategies and dictate information system design. Simon and Newell have argued that "a few, and only a few, gross characteristics of the human information-processing system are invariant over task and problem solver" (36, p. 148). Although there is some disagreement regarding the relative impact of problem characteristics and problem solver characteristics, the evidence emerging from experimental studies suggests that both problem and decision-maker characteristics influence problem-solving strategies and, moreover, these two sets of characteristics may interact in exerting such influence.

Despite the apparent importance of cognitive styles for managerial decision making and information use, payoff from this line of research has been limited by research which fails to meet adequate standards of quality. The results are evident in the discouragement expressed by Chervany and Dickson (13) regarding cognitive styles research in MIS. Standards for evaluating studies of cognitive styles include: 1) appropriate theory developments, 2) use of reliable and valid measures of cognitive style, and 3) use of research designs capable of yielding conclusive results. In the next sections of this paper cognitive styles research related to accounting and MIS is first reviewed and then evaluated in the light of these standards.

2. REVIEW OF COGNITIVE STYLES RESEARCH RELATED TO ACCOUNTING AND MIS

2.1 STUDIES OF COGNITIVE COMPLEXITY

Cognitive complexity involves differentiation (number of dimensions extracted from the data), articulation (the fineness of the discrimination process), and integration (number of interconnections among rules for combining data).

Schroeder, Driver, and Streufert (35) have done extensive theoretical and experimental work in the field of cognitive complexity. They developed the Paragraph Completion Test (19,35) to measure complex, integrative thinking. Empirical studies (24,35) have shown that integratively more complex individuals can process more conceptual data, derive more clues and search for more information than integratively simple individuals. Such findings are relevant to MIS since the information load appropriate for effective information processing by individuals of different integrative complexity is an important determinant of information system design (31).

Two additional studies relating to cognitive complexity are discussed below. The Decision Style model of Driver and Mock (17) measures cognitive complexity and segregates decision makers in terms of the amount of information they tend to use and the number of solutions they generate. However, two experimental studies (28,34) have failed to support the validity of the model.

McKenney and Keen (29) have developed a model of how decision makers differ in their data extraction modes. Receptive types display a desire to analyze all the detailed raw data before making a decision. Preceptive types look for certain cues, deviations from or conformities with their expectations. The intake of information of a preceptive is dictated by his heuristics for cataloguing what he finds. Tests used to measure these styles are discussed in (21).

2.2 STUDIES OF FIELD INDEPENDENCE-DEPENDENCE

Witkin et al. (44) define field independence-dependence in the following fashion: "In a field dependent mode of perceiving, perception is dominated by the overall organization of the field; there is relative inability to perceive parts of a field as discrete. This global quality is indicative of limited differentiation. Conversely, a field independent style of perceiving, in which parts of a field are experienced as discrete from organized background, rather than fused with it, is a relatively differentiated way of functioning."

Studies by Witkin et al. have shown that field independents have more analytical and structuring abilities compared to field dependent types (45). Central to Witkin's theory is the contention that the ability to "break-up" a configuration reflects not only perception, but also indicates a basic approach to problem solving. Although critics have challenged the validity and value of Witkin's conceptualization of cognitive styles (16,47), there exists strong experimental evidence that the work of Witkin and his associates has uncovered an important pyschological construct to explain managerial information use.

Of the three tests developed by Witkin et al. to measure this cognitive style, the Group Embedded Figures Test (45) was selected for use in experiments on the acceptance of managerial reports and information use.

In summary, the experimental evidence published so far on individual differences as measured by the GEFT indicates that high analyics (field independents) out

perform low analytics (field dependents) in certain problem solving and decision making tasks (8,27). Low analytics prefer disaggregated data (4,27) and perform better with them (8,27), although Lusk (26) observed that low analytics preferred summary reports. High analytics prefer (26), and perform better (27) or equally well (8) with disaggregated data compared to aggregated data.

2.3 STUDIES OF SYSTEMATIC- HEURISTIC STYLES

Systematic-heuristic describes a cognitive style which characterizes different problem-solving approaches. Systematic reasoning refers to a tendency to reduce problem situations to a core set of underlying causal relationships. A more or less explicit model, often stated in quantitative terms, forms the basis for each decision. Heuristic reasoning refers to an emphasis on workable solutions to total problem situations. The search is for analogies with familiar solved problems rather than a system of underlying causal relationships. Common sense, intuition, and unqualified feelings about future developments play an important role to the extent that they are applied to the total situation (9).

There is a great diversity in the psychological instruments used to measure systematic-heuristic styles. The findings of the studies on cognitive complexity and field independence- dependence styles could be compared since they used the same psychological instruments; however, the same is not true for studies based on the systematic- heuristic styles.

The pioneering research into the systematic-heuristic style was conducted by Huysmans (20). He conducted an experiment to measure the impact of cognitive style on acceptance of operation research recommendations. Huysman concluded that implementation was more effective when the manager's style matched the analytic approach used to arrive at the operations research recommendation report.

McKenny and Keen (29) developed a model which distinguishes between systematic and intuitive (heuristic) modes. In a problem solving study Keen (21) found that analytics are more likely to pick planning type problems, and heuristics the kind of problems which involve hypothesis testing.

Mason and Mitroff (30) have proposed the use of the Myers-Briggs Type Indicator to measure psychological types of decision makers. The Myers-Briggs Type Indicator measures 1) perception of objects along a sensing vs. intuition scale and 2) evaluation of objects along a thinking vs. feeling scale.

On the evaluation dimension, the thinking style tends to be based on a logical process, aimed at an impersonal finding. The feeling style bestows on things a personal, subjective value. While thinking types tend to systematize, feeling types tend to take more stands (30).

Vasarhelyi (40) found that the correlations among five different tests measuring systematic-heuristic styles were statistically significant but relatively low. Therefore, he stated that "the measurements of cognitive style do not measure exactly the same feature, but measure interrelated concepts that are operationally defined by the test itself." He observed that a self-evaluation rating (as systematic or heuristic) was more highly correlated to all other tests than any other single test.

In a laboratory experiment Vasarhelyi (41) found that heuristics used less information (presented in aggregrate form) than analytics. Analytics tended to utilize computers in planning more than heuristics did; whereas heuristics expressed more concern with the lack of flexibility of man/machine systems than did analytics.

An analytic-heuristic questionnaire developed at the University of Minnesota was used in six studies to measure the impact of cognitive style on information use (6). Most of these studies were conducted under similar production/ inventory decision making settings. Barrett (6) reported that the analytic-heuristic differences were not significantly correlated with performance in the experimental task. He partly explained this finding by indicating that the instrument used to measure styles is a preference inventory, that is, it does not measure performance abilities.

3. EVALUATION OF COGNITIVE STYLES RESEARCH RELATED TO MIS

EVALUATING THEORIES OF COGNITIVE STYLE USED IN MIS RESEARCH

Most cognitive styles are loosely defined and based upon only rudimentary theories. For example, there appears to be no simple answer to the question of how many cognitive styles must be postulated to adequately describe the individual. None of the theories of cognitive style which have been applied to MIS have

generated as yet a systematic set of related constructs for incorporating cognitive styles within the framework of personality theory. An isolated measure of a personality construct, not placed within the network of other personality constructs, is of limited value in understanding behavior. The extent to which cognitive styles overlap with other constructs (e.g., general intelligence or spatial perception) is not clear, yet this is important in conceptualizing cognitive styles as a personality construct. While there is little harm in using a construct which overlaps with other constructs in the literature, it does limit the contribution the new construct can make to understanding information processing and decision making.

Crucial to the issue of how many cognitive styles to postulate is the relative generality of these styles. At one extreme, theorists have sought a master cognitive style variable which has primary control over information acquistion and processing activities (e.g., Witkin). At the other extreme, researchers have attempted to specify a number of discrete stylistic variables. While a single master style variable permits simplicity in theories, this parsimony may be gained at the expense of more precise explanation of behavior in specific situations. Yet, extreme specificity can lead to a chaotic and conceptually sterile position of positing a unique cognitive style for each task. The solution to this problem may lie in the organization of cognitive style variables. It is possible that, just as a primary motive or need may subsume a variety of subordinate motives or needs, a more basis cognitive style variable such as field independence-dependence may serve to organize a number of less general cognitive style variables. Nevertheless, this variety of cognitive styles used in MIS research has led to confusion about the nature of the construct and has limited the generalizability of findings from studies using the different measures.

Clarifying the nature of the cognitive styles constructs can be approached by indentifying the dimensionality of the constructs. Yet, despite several attempts to determine the dimensionality of cognitive measures, the results are far from clear. The great number of measures proposed to reflect cognitive styles cannot all be included in a single factor-analytic study, and the studies performed (10,21,39,40,42) have each included relatively few measures of cognitive style. Moreover, as Fiske (18) has demonstrated observing patterns of correlation for scores on two tests administered to the same sample yields little information about the validity of the tests. The Zmud study (48) is an example of this fallacy applied to MIS cognitive styles research.

There is little empirical work which relates various cognitive styles used in accounting and MIS research. Vasarhelyi's (40) study described in the previous section has shown that the correlations among various cognitive style measuring instruments were statistically siqnificant but relatively low. Keen (21) has correlated his systematic-intuitive instrument with the Myers-Briggs Test and reported that, although many of the "thinking" types are intuitive in style, it is apparent that a "feeling" type is unlikely to be systematic. Zmud (48) correlated the analytic-heuristic instrument used in the Minnesota studies (6) with the Myers-Briggs Test. He concluded that the Minnesota instrument primarily measures whether an individual uses a judging or perceptive approach to problem solving; that is, whether a planned or spontaneous strategy is employed. Larreche (24) conducted a factor analytic study which revealed that the Minnesota analytic-heuristic instrument and the Paragraph Completion test were part of the same factor, whereas the Witkin Embedded Figures test was loaded more heavily under a different factor. Apart from indicating the multi-dimensionality of the cognitive styles construct, the factor-analytic studies add little insight into the nature of cognitive styles measures (3). All of these factor-analytic studies showed relatively independent factors tapped by the various tests; thus it is possible to be high on one measure of cognitive style and low on another measure of cognitive style. It is apparent that the various measures of cognitive styles used in the literature are not interchangeable and, presumably, will differ considerably in their implications for MIS design.

The inadequacy of theory development in cognitive styles is evident in view of the great many specific cognitive styles reported in the literature, each allegedly measured by a number of tests. The limited theories that have been developed generally attempt to predict specific information- processing or decision-making behaviors and have not been concerned with a systematic mapping of the psychological domain of cognitive styles. For example, while this approach permits one to assert that heuristics tend to prefer disaggregated reports, it fails to explain why this relationship holds and how the analytic- heuristic cognitve sytles related either to other cognitive styles or to other personality constructs.

The confusion regarding cognitive styles can be somewhat alleviated by specifying the cognitive styles in a generic sense.

3.2 EVALUATING THE RELIABILITY AND VALIDITY OF COGNITIVE STYLES MEASURES USED IN MIS RESEARCH

To be interpreted meaningfully, measures of psychological characteristics must demonstrate adequate reliability and validity, yet little concern for these essential features of tests is evident in research into cognitive styles. Frequently this information, which is essential for determining the value of the measuring instruments, is not reported in published studies. Exceptions are Vannoy (39), and Barrett (6) who reported reliability figures.

Validity of cognitive styles measures can best be approached by construct validation demonstrating a network of theory-supporting interrelationships among variables. Vannoy (39) provided one example of using the multi-trait multi-method matrix to test for discriminant and convergent validation (11), but he found that the different measures of cognitive styles that he used failed to converge on the construct. Unfortunately, construct validation requires a well-developed theory to specify the placement of cognitive styles variables into a theoretical network of relationships (11, 32). Such a theory has not yet been formulated.

EVALUATION RESEARCH DESIGNS USED IN COGNITIVE STYLES RESEARCH FOR MIS

Research designs typically used to investigate the impact of cognitive styles on information processing are deficient in two important methodological features: 1) generalizability and 2) control.

Adequate provisions are seldom made to insure generalizability of findings to populations of interest. The inadequacies include small sample sizes, failure to randomly assign subjects to treatments, unequal and nonproportionate cell sizes for F-tests, and experimental research limited to laboratory settings.

Since cognitive styles are attribute variables, subjects are assigned to treatments on the basis of attributes they already possess. Similar methodological difficulties are presented in attempting to include other attribute variables (e.g. male vs. female) in experimental designs. One way to partially resolve this difficulty is to measure cognitive styles separately and, then, to randomly assign subjects to treatments. Hence, for each treatment, for example, analytics can be compared with heuristics to determine the effects due to cognitive style.

Covariates (e.g., age, sex, experience) however, may produce artifactual results. It is always possible that other characteristics of subjects which are systematically related to cognitive styles may remain an alternative explanation for the effects attributed to cognitive styles. Some control over artifactual results can be attained either in a priori assignments of subjects to treatments (e.g., matching subjects on the covariates) or by covariate analysis. Yet, a particularly serious problem remains in that subject characteristics may interact with task characteristics in determining performance -- thus limiting the extent to which the findings can be generalized. For example, cognitive style may interact with task requirements for special knowledge (e.g., as in a warehouse expansion problem) in producing task performance. The result is a theory of cognitive style which is complex and difficult to interpret since cognitive style may influence task performance differently for subjects at various levels of experience in the task.

The population of primary interest in managerial information processing and decision making is the organizational manager and it is important to generalize research conclusion with confidence to this population. If other subjects are used (e.g., business students) a central issue is whether these subjects are sufficiently similar to business managers in their information use to justify generalizing findings from research conducted on them to managers. Caution must be exercised when managers, due to different experience, status, or motivations tend to deal with information in ways which differ from processes typical of subjects who have not acquired these skills, status, or motives. An even more serious problem is the possibility that the differences in subject characteristics may interact with experimental treatments, thus threatening both internal and external validity (12). As a consequence of these flaws, experimental designs for cognitive styles research fail to fully captialize upon the ability of experiments to cancel out or control for alternative explanations.

Generally it is assumed that limited availability of subjects of interest and cost of data collection make it advisable to use as few subjects as the requirements of statistical inference and experimental design permit. The experimental design and the accompanying statistical tests specify both the requirements for cell

frequencies and any additonal requirements to meet the assumptions of the statistical tests used; for example, the existence of equal or proportionate cell frequencies. In this sense, the sample size depends on the statistic used, the number of independent variables to be studied simultaneously, and the number of levels to be assigned to each independent variable. Ackoff (1) has presented a useful discussion of this issue and provided a table to generate sample sizes from these considerations.

Sample size can be reduced if the researcher is willing to give up information about certain interactions among the experimental variables. Among the options open to the researcher who has no interest in certain interactions, and thus is willing to have them confounded, are the use of blocks, fractional replication, and latin square designs (23,43). Benbasat (7) provided an example of the use of fractional factorial design in cognitive styles research.

The class of experiments using subject characteristics as independent variables appears to be increasingly used in behavioral science research, yet the problem of maintaining control over potential confounding when attribute variables are used is a difficult one (38). Whereas subjects can be assigned to experimental groups on the basis of type of cognitive style possessed, when there are two or more attribute variables in an experiment it is difficult without using artificial means (e.g., eliminating some subjects from the analysis) to have equal or proportionate cell frequencies. This is because, as in the case of cognitive styles and general intelligence, such variables are likely to be correlated, not independent.

A related problem is that partitioning a continuous variable such as cognitive styles, as generally conceptualized, into high and low cognitive style (heuristic vs. analytic, perceptive vs. receptive, etc.) loses information. Dichotomizing a continuous variable can mean reduction in between cell variance and nonsignificant results when, in fact, the tested relationships may be statistically significant. A better method is to use interval or ordinal scales which represent more accurately the continuous cognitive style variables.

One approach for overcoming these difficulties in cognitive styles research is the use of multiple regression analysis. Multiple regression analysis employs the dichotimous variables (if there are any) as independent variables using dummy variables in which 1's and 0's are assigned to subjects depending on whether they possess or do not possess a characteristic. Continuous variables can be included as such rather than being partitioned. Similarly, experimental treatments can be handled as variables. Unequal n's are still a problem with multiple regression analysis, but much less so than is the case with analysis of variance. Also, it is still possible (as in the use of analysis of covariance with experimental designs) to statistically control the effects of certain variables on relations of interest. Both Darlington (14) and Kerlinger and Pedhazur (22) provide insightful discussions of the use of multiple regression in this type of research.

Control difficulties have also plagued cognitive styles research. Experimental designs for cognitive styles research seldom contain adequate control groups. Especially questionable is the issue of determining to what extent subject characteristics interact with treatments (mentioned above) without also determining base rates for the observed information-processing behaviors. Design of an experiment rests upon understanding both the sources of error that may mislead the researcher and the procedures available for either controlling error or compensating for uncontrolled error (12,33). A strength of the experimental approach is that it does permit direct control over potential sources of error -- the control group is a central feature in experimentation and permits any observed differences in the experimental results to be attributed to the influence of the treatment.

While the full experimental designs provide more conclusive research findings, a class of quasi-experimental designs has been developed for conditions where there is limited possibility of manipulating the experimental variable and little control over alternative explanations for research findings through random assignment of subjects to treatments. Quasi-experimental methods such as field experiments (5), nonequivalent control groups (12), cross-lagged panel correlations (46), and time-series designs attempt to simulate manipulation, provide controls over confounding variables, and probe for causal relationships. For elaboration of the features and relative merits of these designs for the reader is referred to discussions by Campbell and Stanley (12) and Taylor and Vertinsky (38). Such quasi-experimental designs may assume an even more important role in cognitive styles upon complex MIS designs.

4. CONCLUSIONS

Based upon the critique of cognitive styles theory and methodology used in empirical research of this variable, a number of conclusions seem appropriate. First, the generic term "cognitive styles" subsumes a great variety of specific cognitve styles and, while useful in indicating the entire class of cognitive styles, its use to refer interchangeably to specific cognitive styles is confusing and misleading. The specific cognitve style measured in a study should be indicated; such as cognitve complexity, field independence-dependence, or systematic-heuristic. It should be kept in mind that tests included in each class may not be measuring the same things. Research should press forward to determine just what the cognitive styles do measure and the dimennsions represented in the multitude of tests currently in use.

Tests of cognitive styles must be adequately validated if they are to be used to make decisions concerning either the selection and training of decision makers or the design of information systems. The proliferation of unvalidated tests of cognitive styles has added to the confusion regarding the implications of cognitive styles for MIS design and use.

Finally, research designs used to investigate the role of cognitive styles in information system design must be improved. The difficulties are due to 1) the sampling and data analysis problems introduced by using an attribute (nonmanipulated) variable, such as cognitive styles, in experimental research, and 2) the failure to provide appropriate experimental or statistical controls. Multiple regression is advocated as a solution to many of the difficulties introduced by the use of cognitve styles in experimental research. Provision of control groups will be even more important as research into the impact of cognitive styles upon information system design and use is performed in field sites.

Far from sharing the pessimism expressed by Chervany and Dickson (13) regarding the future of cognitive styles research in MIS, the authors believe that the potential payoffs from sound research into the psychological characteristics of information system users are high. Unless the theoretical and methodological aspects of such investigations are improved, however, the full benefits of this line of research will not be realized.

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