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ASSOCIATIONS BETWEEN INDIVIDUAL COGNITIVE PROGRESSIVE VARIABLES AND BUSINESS GAME PERFORMANCE AND PLAY

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ABSTRACT

Business game players' cognitive structures were studied as they related to environmental perceptions, behaviors, and performance results. An individual's cognitive structure had a relationship on how the environment was perceived independent of its objective state. Cognitive structure was not associated with rare behavior or game performance

INTRODUCTION

Business gaming's cognitive processing elements have continually interested ABSEL's members and its conferences. Goosen [12] has traced the Association's earliest research and publishing interests while a review of ABSEL's most recent 1976-1979 Proceedings issues reveals that approximately 9.3% of their annual content was directly devoted to papers on learning-style models, information acquisition, organization and usage, and certain personality factors would appear to affect participant play and performance. This emphasis is appropriate as (1) experiential learning theory includes a Substantial and pivotal cognitive element [15;21], (2) current learning theory is more process-related than substantive in its approach [13], and (3) the typical gaming situation requires the participant to react rationally to a complex, semi-ambiguous internal/external environment.

Interest in an individual's cognitive processes, however, has even more widespread importance. Contemporary organization theory states that the firm's decision makers do not deal with the real or 'objective' environment but instead that they react to an environment that has been perceptually created [22; 40; 41]. Accordingly, the decision-maker's cognitive equipment could play a vital role in determining what is seen by the organization's environmental scanners. It has also been hypothesized and empirically determined that the fidelity between the firm's enacted environment and its objective one is critical for the organization's ultimate effectiveness and survival [23; 27; 30; 3b; 37]. Downey and Slocum [7], Downey, Hellriegel and Slocum [6], Tosi, Aldag and Storey [38], and Hunsaker [17] all suggest that much of the environmental variability "seen by the organization's decision-makers is cognitively caused by the individual's personal characteristics. Consequently, it is possible that Type I or Type II environmental assessment errors are being made while simultaneously frustrating the organization's needs for rationality.

LITERATURE REVIEW

Business games, simulations, and experiential exercises have often been used as laboratory settings for the study of individual and group decision-making practices [2; 3; 4; 8; 9; 11; 18; 28; 29; 35; 39]. This paper, though, is more concerned with the degree to which a player's outcomes and behaviors in a dynamic and complex business policy type game are affected by personal, cognitive-processing characteristics. It has been reasoned that more cognitively

complex individuals, who simultaneously possess an ability to integrate widely dispersed information cues and stimuli, would perform better in complex and dynamic decision-making situations [8; 9; 29; 35]. Lundberg [24] and Lundberg and Richards [25] specifically treated this general proposition in a policy-making business game. Various elements making up an individual's cognitive style were drawn from students playing Greene and Sisson's [14] "Top Operation Management Game." Those elements were:

- A. Differentiation--the ability to discern a number of dimensions within a complex situation; measured by Bieri's Cognitive Complexity-Simplicity Test [1];
- B. Discrimination--the ability to interpret differences within a dimension; measured by Pettigrew's Category Width Scale [33]; and
- C. Integration--the ability to tie together diverse elements into a whole; measured by Streufert and Schroder's Impression Formation Test [35].

Lundberg's more cognitively complex participants referred to a greater number of game dimensions in their strategy statements while those with greater integrative abilities expressed more integrated strategies.

When behavioral or profit performance measures were considered, however, the results became quite equivocal. Those high in discrimination acted no differently regarding product prices or promotion expenditures than those without high discriminatory powers. While a significant relationship ($p .012$) was found between discrimination and decision quality, there were no relationships between differentiation and decision quality or integration and profit performance.

Although the Lundberg study controlled for team social effects by using only single-member firms, and used psychological instruments of known validity and reliability, the lack of the expected relationships could lie within the particular simulation used in the study. The Top Operating Management Game is a very simplistic simulation and therefore might have been incapable of creating the proper laboratory situation demanded by Lundberg's research questions. The simulation allows only four decisions per round, it is non-interactive, and it is didactic for an optimal "solution" is contained in the game's program. Using Wolfe's [44] measures of game complexity, the Greene and Sisson game would lie at the point of greatest simplicity and would probably manifest the same negative elements attendant with simple games of this type. As recently reviewed by Keys [20, p. 28], "this is a very simple business game... The strategy options are too few and the model sophistication too simple to provide much in the way of an analytical or strategic decision-making exercise."

It appears then that a more complex business game would provide the more appropriate environment for determining the relationships between a player's cognitive processing capabilities and the results obtained in a business game.

METHODOLOGY

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Business college seniors (n=49) in a business policy course played ten simulated quarters of Jensen and Cherrington's The Business Management Laboratory [19] from initially equal starting positions. This simulation has been found to be comprehensive, functionally unbiased, and motivating [42; 41; 44]; it would lie at the complex end of Wolfe's [44] game complexity scale. Participation in the simulation and the results obtained regarding total earnings, ROI and ROE amounted to 55% of the course's final grade. Solo firms were employed to eliminate group decision-making effects and to insure that individual cognitive properties would not be diluted through continual action. Seven industries of equal size were ultimately created. The following measures were drawn before the beginning of play:

A. Cognitive structure-- measured by an instrument created by Zajonc [45]; the instrument produces four measures of a respondent's orientation as applied to a specifically-cued situation. In this case, the subjects were asked to describe the qualities of a job applicant based on his personal letter of introduction. The Zajonc instrument was preferred over the Bieri and Streufert and Schroder tests as these latter tests are basically clinical in nature. Zajonc's four measures are:

1. Differentiation-- the number of attributes given to a cognitive structure; analogous to Lundberg's Differentiation.
2. Complexity-- the number of subdivisions used to define the attributes in a cognitive structure; analogous to Lundberg's Discrimination.
3. Unity-- the degree to which the components of the cognitive structure depend on each other; part of Lundberg's Integration.
4. Organization-- the extent that one part or a cluster of parts dominates the entire cognitive structure; a remaining component of Lundberg's Integration.

B. Ambiguity Tolerance-- measured by McDonald's AT-20 [26]; this instrument determines the degree to which players might flee the initially-ambiguous and psychologically threatening gaining situation. Those with low ambiguity tolerance would be expected to engage in fixation or attempt to clarify or re-structure their environment through the purchase of additional information.

C. Category Width-- measured by Pettigrew's CW scale [33]; this test measures how broadly an individual is tuned to the environment. Wide categorizers cast large data nets to increase their chances of success while simultaneously enveloping greater amounts of irrelevant or confusing material. Narrow categorizers cast small nets to minimize errors but simultaneously limit their successes.

The participants also responded to an instrument (Internal reliability $r_{kk} = 0.65$) designed to elicit certain beliefs and perceptions regarding the environment's decision-making characteristics and strategic imperatives. This Likert-type instrument produced scores on the following:

- A. Clarity-- the degree of ambiguity that is felt to exist in the macro- and micro-economic system.
- B. Causality-- the degree of mechanistic determination felt to exist in the system.
- C. Timespan-- the timeframe or temporality with which the respondent deals comfortably.
- D. Fixation-- the degree to which single problem-solving elements are chosen to the exclusion of more comprehensive and multiplicative solution elements.

As shown in Table 1, the perceptions measured by the instrument were often associated with the more basic

TABLE 1
CORRELATIONS BETWEEN CERTAIN COGNITIVE
VARIABLES AND ENVIRONMENTAL PERCEPTIONS

Cognitive Variables	Clarity	Causality	Timespan	Fixation
Differentiation	-.203 ^a	-.160	-.233	.103
Complexity	-.009	.142	.080	.143
Unity	-.012	.267 ^a	.415 ^b	.271 ^a
Organization	.022	-.088	-.083	-.117
Ambiguity Tolerance	-2.11 ^a	.382 ^b	.155	-.264 ^a
Category Width	.254 ^a	.357 ^b	.249 ^a	-.284 ^a

^a Significant $p < .05$

^b Significant $p < .01$

cognitive processing variables previously obtained from the subjects. Accordingly, these environmental perceptions may be considered to be projections of the individual's own cognitive and personality makeup rather than objectively-accurate appraisals of the environment's objective qualities.

Behavioral measures were collected in the form of the (1) average number of decisions made during the first two periods of play, (2) average number of decisions made during the last two periods of play, and (3) number of special information reports purchased. Quarterly and cumulative firm results in the form of dollar earnings, and rates-of-return on owner's equity and invested capital were also collected. Although the participants played in separate industries for grading purposes, all performance results were converted to standardized z-scores in this study to make possible the merging of industry-derived financial performances.

RESULTS

Environmental Perceptions

Those individuals high in Differentiation described an environment that lacked clarity ($r = .203$); they also worked with shorter timespans ($r = .233$). Individuals possessing strong interdependencies in their cognitive structures believed their causal linkages were more tightly coupled ($r = .267$); they also used longer timespans ($r = .415$) while simultaneously being more fixated regarding their strategic decision elements ($r = .271$). High ambiguity tolerance was associated with low environmental clarity ($r = .211$), weak causality ($r = .382$), and the low degree of fixation employed ($r = .264$). Wide category width was associated with high clarity ($r = .254$), tight causal linkages ($r = .357$), long timespans ($r = .249$), and low fixation ($r = .284$). No associations were found for

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the variables Complexity or Organization. Playing Behaviors

While certain relationships were found between cognitive variables and environmental perceptions, no statistically significant relationships were found to exist between those same cognitive variables and player behaviors. It would be expected that those with low ambiguity tolerances would purchase more information so as to better structure their environment to make it less threatening and more tolerable. We would also expect those high in differentiation and category width to make a larger number of initial decisions in the simulation. Table 2 presents the Pearson correlation coefficients associated with the behaviors measured in this study.

TABLE 2
PEARSON CORRELATIONS BETWEEN COGNITIVE
VARIABLES AND GAME BEHAVIORS

Cognitive Variables	Initial # Decisions	Ending # Decisions	Special Reports
Differentiation	-.048	-.134	-.117
Complexity	.018	-.041	-.171
Unity	.148	.018	-.020
Organization	.067	-.064	-.146
Ambiguity Tolerance	.198	-.140	-.140
Category width	.190	-.053	.035

TABLE 3
SECOND ORDER CORRELATIONS AFTER CONTROLLING
FOR COGNITIVE VARIABLES

Cognitive Variables	T Beginning vs. End States		
	Number of Decisions	Environment	Earnings
Differentiation	.090	-1.34	.250 ^a
Complexity	.086	-.145	.253 ^a
Unity	.087	-.113	.241 ^a
Organization Ambiguity	.091	-.117	.263 ^a
Tolerance	.068	-.102	.247 ^a
Category Width	.082	-.131	.246 ^a

^asignificant p (.05)

Given that decision-making is a dynamic process which moves one from one point to another, Table 3 presents the results of a further analysis of second order correlations to discover any possible cognitively-induced moderations on the decision-making process. Hotelling's test [16] found that the correlation coefficients obtained after partialing the data were no different than those obtained before controlling for the cognitive variables examined here.

Substantive Result

The data in Table 4 demonstrate that no significant relationships were found between the variables studied and the players' financial results. Additionally, respective multiple r-squares for earnings, ROE, and ROI were only .051, .061, and .055 which leaves approximately 95% of the

variance in firm output to be explained by factors other than those investigated here.

DISCUSSION

This study has produced evidence that certain cognitive variables affect how the environment is perceived. These perceptions appear to be independent of the environment's objective nature. As incorrect as these perceptions are, however, these errors had no association with the differential results obtained by the game players. As found elsewhere, other variables such as scholastic achievement, high aptitude, and rational decision-making practices have a large impact on performance results. These findings are basically supportive of the programmed aspect of experiential learning theory-- that is, structure leads to behavior. If the simulation is (1) rich in learning experiences, (2) comprehensive and complete, and (3) conscientiously applied, favorable learning outcomes will result.

TABLE 4
PEARSON CORRELATIONS BETWEEN COGNITIVE VARIABLES
AND FIRM FINANCIAL RESULTS

Cognitive Variables	Earnings	ROE	ROI
Differentiation	-.044	-.152	.029
Complexity	-.072	-.180	-.054
Unity	.056	-.004	.040
Organization	-.159	-.057	-.122
Ambiguity Tolerance	.093	-.100	.066
Category width*	.030	-.090	.013

This study's findings should also bring solice to those who must bear the brunt of students complaints about the particular game they have been forced to play. It appears that those statements are basically anxiety verbalizations rather than true statements regarding the game's objective reality. Game administrators should also find comfort in the fact that players were not handicapped by the particular cognitive equipment they possessed.

Another Implication of this study is that actual behaviors and/or objective results are more valid evaluative criteria in a business game than are students' statements of intent or rationalizations of results. Students' perceptions at the least appear to be contaminated by individualistic cognitive Structures while an unbiased simulation is indifferent to these corruptions because it coldly rewards and reacts only to a player's decisions.

While outside the immediate scope of this study, our evidence regarding the discontinuities between the perceived environment and the objective one should render questionable a typical organizational research strategy. Researchers such as Dill [5], Duncan [10], Lawrence and Lorsch [23], Negandhi and Reimann [31], Osborn and Hune [32], and Schmidt and Cummings [34]

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have used manager's environmental perceptions as either correct or necessary statement of a particular decision-making situation. In reality it appears that the decision-maker's environmental perceptions (1) are strongly influenced by personal cognitive equipment, (2) have relatively little impact on the results obtained from the decision-making process, and (3) that structural elements are very important in determining the behaviors and results obtained by managers.

SUMMARY

Cognitive structure was found to be related to the environment perceived by game participants. These perceptions had no effect on how they played or the results they obtained. The study's results were interpreted as being supportive of complex business games as comprehensive and unbiased learning environments.

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