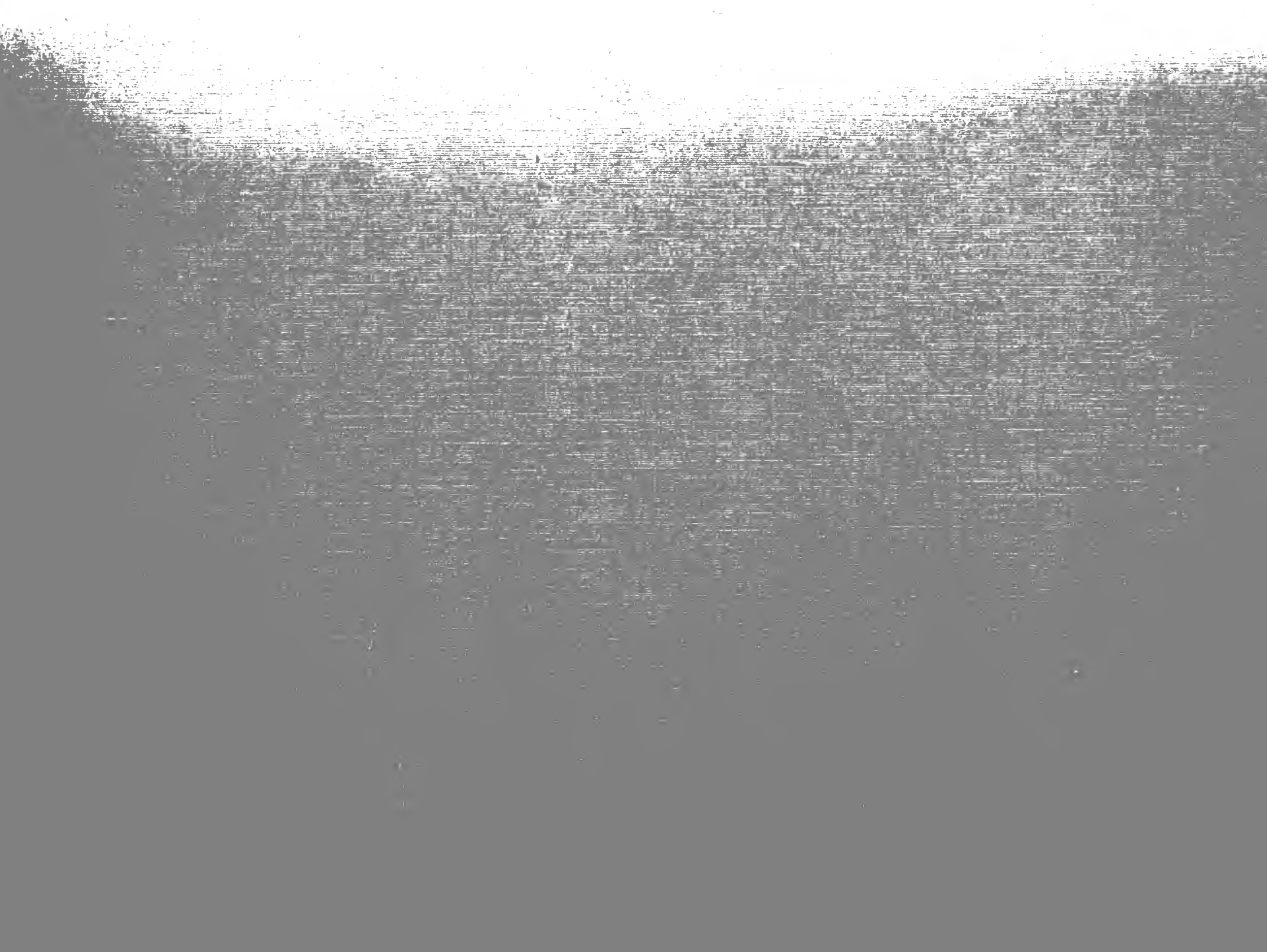

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Diagnostic Inference in Performance Evaluation: Effects of Cause and Event Covariation and Similarity

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ABSTRACT

The role of information in the process of diagnostic inference required for the evaluation of operational performance was investigated. Assuming the role of a manufacturing division manager, subjects were asked to estimate the likelihoods of four potential causes of an assembly department's labor efficiency variance. The subjects were asked to re-evaluate their causal likelihoods following: 1) evidence concerning the magnitude of the labor variance and the deviations of the four potential causes from their normal levels and 2) evidence concerning the covariation of a potential cause and labor efficiency variances over the past five years. The results generally confirmed a set of hypotheses predicting the effects of cause/effect similarity and cause/effect covariation upon individuals' causal inferences. Additional evidence is presented that supports the notion that the extent of potential cause controllability may modify the assessment of causal likelihood.

Functional Area: Accounting

Methodological Area: Decision Theory

DIAGNOSTIC INFERENCE IN PERFORMANCE EVALUATION: EFFECTS OF CAUSE AND EVENT COVARIATION AND SIMILARITY

Most manager's judgments involve either predicting future events or determining the causes of past events. Judgments concerned with the performance of subsystems under a manager's responsibility also involve these cognitive processes of prediction and diagnosis. The planning and structuring of subsystem performance for future periods involves the forecasting of a variety of events and circumstances (e.g., sales volume given specific economic circumstances). The operation and control of these subsystems over time involves the manager's understanding of the causes of any significant differences between planned performance and actual performance (e.g., the causes of a particular variance from a sales budget). Given a dynamic environment, the processes of prediction and diagnosis are cyclically interconnected. That is, a company's sales budget may begin with prediction of future economic circumstances and expected achievements, but after a period of time the actual sales occur. When actual sales differ from the budget, diagnosis must be made in an effort to understand the cause of such difference. Subsequently, this cycle begins again with estimation of a new sales budget.

The objective of this paper is to focus on the process of diagnostic inference required for the evaluation of operational performance. Specifically, how does information affect a manager's diagnosis of the cause(s) of operational performance? Diagnostic inference is a central component for understanding one's experience with the world. Individuals identify relationships within experienced events and

objects as a result of analyzing specific instances of those events and objects [10]. One's theory of the world is inferred through the repeated diagnosis of experience. The importance of diagnostic inference can be seen in terms of its effect on prediction of events and on choice of action. Prediction depends upon the individual's understanding (inferred theory) of the underlying process that generates outcomes [4]. The actions taken will depend, at least in part, on beliefs concerning the circumstances that caused (or will cause) the event or situation [7]. For example, a manager's understanding of a sales budget variance will depend upon his (her) inferred theory of the processes that generate sales budget variances. Different performance evaluations and control actions will result if a sales budget variance is believed to have been caused by a given circumstance (e.g., a decline in product demand), than if the cause is believed to be a different circumstance (e.g., inadequate production).

In this study, standard labor efficiency variances are employed as accounting reports of operating performances requiring diagnosis prior to formulation of performance evaluations and choice of actions.[1] Subjects were asked to assume the role of a manufacturing division manager. They were given an exhaustive set of potential causes and were asked to estimate the likelihoods that the potential causes were actual causes of labor efficiency variances for assembly departments within their division. The subjects were asked to re-estimate their causal likelihoods after they were given evidence that related to the occurrence of the potential causes during the period of the variance

and again after they were given the frequencies with which the potential cause (chosen by the subject) and labor efficiency variances had jointly occurred in the past.

The following section of this paper develops a conceptual framework for the role of causal judgments in diagnostic inference and formulates hypotheses based upon the conceptual framework. A description of the research design, the experiment, results and discussion, and conclusions are contained in the remaining sections.

CONCEPTUAL FRAMEWORK

Einhorn and Hogarth [2] [3] have developed a theory of diagnostic inference in which causal perceptions are affected by three types of information: (1) the assumed causal background (e.g., level of technical knowledge/expertise required of workers, level of capital intensity within the production process, level of managerial expertise and knowledge); (2) the number and strength of specific alternative causes (e.g., inadequate production management, poor raw material quality, out-of-date labor efficiency standards; and (3) the perceived strength of potential cues-to-causality within the circumstances being evaluated (e.g., the covariation between a potential cause and the reported variance). Within this study the first two types of information will be held constant and the third type of information, the cues-to-causality, will be explored.

A number of researchers have proposed that individuals use certain cues-to-causality in judging the causal strength of a potential explanation ([2], [3], [9], and [11]). The cues-to-causality include such factors as temporal order, contiguity, covariation, and similarity of

cause and effect. This study will explore individuals' use of two of these cues-to-causality: covariation and similarity of cause and effect.

Similarity of Cause and Effect

Attribution theory employs the rule of similarity by which "properties of the cause are assumed to be similar to properties of the observed effect..., so that the latter can be used to infer the former" ([9], p. 466). This definition of similarity is closely related to the concept in normative logic of *a priori* necessity: knowledge of the effect tells us that the event was produced by the cause [11]. Tversky [13] proposed a model of perceived similarity in which *objects* are represented as collections of features, and similarity judgments result from a feature-matching process in which common and distinctive features are combined linearly. Specification of common and distinctive features is required to generalize Tversky's model from objects to events. Einhorn and Hogarth [2], citing Nisbett and Ross [12], discuss several long-standing, popular notions of cause and event features for similarity, including the notion of congruent lengths and strengths of cause and effect. For example, given a labor efficiency variance that was 30 percent greater than the standard hours allowed (an undesirable event), which potential cause would be perceived as having greater similarity to the labor variance: potential cause A (e.g., raw material quality) that was 2 percent below the level of A used to set the labor efficiency standard, or potential cause B (eg., production worker training) that was 28 percent below the level of B used to set the labor efficiency standard? Although a

specific answer to this question would at least partially depend upon the judge's theory of the underlying production process, the congruity of cause and effect suggests that potential cause B would be perceived as more similar to the labor variance than would potential cause A. Einhorn and Hogarth's diagnostic inference model views similarity as both a compensatory and a non-compensatory cue-to-causality used by individuals in assessing causal strength. That is, there is some minimum level of perceived similarity required for the potential cause to be given any likelihood, but above this threshold, low levels of perceived similarity may be compensated for by higher levels of other cues-to-causality.

When individuals receive evidence about the occurrence of a potential cause during the period of a labor efficiency variance, the evidence will indicate the magnitude of the potential cause's occurrence. This study employed the deviations of the potential causes from their normal levels relative to the magnitude of the labor efficiency variance itself, as cues to the strength of cause and effect. Based upon the congruity of cause and effect:

H1. Judged causal likelihoods will be monotonically increasing with causes whose deviations from normal levels are more similar to the magnitude of the reported labor efficiency variance.

Covariation

Attribution theory employs the principle of covariation by which the effect is attributed to that factor with which it is perceived to covary (c.f., [9]). Einhorn and Hogarth [2] [3] view covariation as a

compensatory cue-to-causality that individuals use in assessing causal strength. Previous research has found that individuals have difficulties evaluating the extent of covariation present in evidence concerning covariation of potential causes and effects ([1] and [12]). The findings indicate that when the evaluations are data-based, individuals tend to underestimate the objective extent of covariation, and when the evaluations are theory-based, individuals tend to overestimate the objective extent of covariation (c.f., [8]). Modeling covariation in a 2 x 2 contingency table where both potential cause and effect are considered to be dichotomous variables (either occurring or not occurring), Einhorn and Hogarth view covariation judgments as linear combinations of the subjectively weighted contingency table cell frequencies. Einhorn [6] and Einhorn and Hogarth [5] discuss difficulties of learning covariation from experience due to not being able to observe all events associated with the contingency table cells (in particular, when a variance does <u>not</u> occur, managers would rarely know if a potential cause did or did not occur).

When individuals receive evidence about the frequencies with which a hypothesized cause and labor efficiency variance have jointly occurred (covariation evidence), the evidence will indicate either positive covariation, negative covariation, or no covariation. When individuals select a specific potential cause as the most likely cause of an event, they form an expectation that the covariation between that cause and the event will be greater than or equal to some minimum level. If subsequent to this evaluation of causal likelihood, the individual receives evidence that indicates the covariation is actually below that level, the individual should reduce the likelihood

of that potential cause. If the subsequent evidence indicates the covariation is actually equal to or above that level, the individual should maintain or increase the likelihood of that potential cause.

H2. Individuals will assign greater causal likelihoods to potential causes that have a stronger positive covariation with the labor efficiency variances, than to potential causes that have a weaker covariation.

Given the research findings that individuals have difficulties assessing the objective extent of covariation, a summary statistic that describes the objective extent of covariation (e.g., a correlation coefficient) should aid individuals in making covariation evaluations closer to the objective covariation.

H3. Individuals will assign different causal likelihoods when the potential cause and effect covariation relationship is described by a summary statistic.

RESEARCH DESIGN

Experimental Environment

The subjects were asked to assume the role of an assistant manager for an electronic equipment manufacturing division. Within this role, subjects were presented with a standard variance report for an assembly department within their division. Evaluations of the variance report were made with the objective of assessing the quality of control within the assembly department.[2]

The type of standard variance reported was an unacceptable labor efficiency variance. An unacceptable labor efficiency variance was one in which the difference between the hours worked and the hours

allowed for achieved output was greater than 15 percent of the hours allowed. The subjects were told that out of an exhaustive set of four potential causes (workload schedules, raw material quality, worker training, and department manager's efforts), past experience had shown that unacceptable labor efficiency variances were generally produced by two of the potential causes occuring at the same time.

Within this task the information available to the subjects came from three sources. The first source was information from past experience and was presented to the subjects in the form of a background information pamphlet. This pamphlet described the role the subject was being asked to assume, the company and its manufacturing processes, the accounting control system, and the subject's task and objectives within the experiment. The intent of this pamphlet was to give the subjects a common knowledge with respect to the experimental task, partially controlling the subjects' causal backgrounds. Thus, posterior evaluations should not be affected by divergent priors.

The second source of information was the variance report and information available with this report. The variance report consisted of the variance and a list of the four potential causes of labor efficiency variances. Information available with this report included the prior probability of an unacceptable labor efficiency variance and the prior probabilities of each of the four potential causes.

The third source of information was evidence chosen by the subjects. The evidence pertained to the four potential causes and was of two types: similarity evidence and covariation evidence. Similarity evidence indicated the magnitude of the labor efficiency and the

deviations of each of the potential causes from normal levels during the previous eight weeks (including the week of the variance). Covariation evidence indicated the estimated frequencies of occurrence over the past five years of the potential cause chosen by the subject and labor efficiency variances.

Experimental Design

The experimental design, presented in Figure 1, was a 2^3 x 4 x 3 repeated measures design with three between-subjects variables, each at two levels, and two within-subjects variables. The between-subjects variables were covariation strength (either weak or medium), the covariation summary statistic (either provided or not provided to the subject), and the similarity of cause/effect (either the deviation from normal level of raw material quality or of worker training had the greatest similarity to the magnitude of the variance). One within-subjects variable, at four levels, was the potential causes. The other within-subjects variable, at three levels, was the repeated evaluations: first prior to receiving either the similarity or the covariation evidence, second after receiving the similarity evidence only, and third after receiving both the covariation and the similarity evidence.

Insert Figure 1 about here

Operationalization of Variables

Causal likelihood was elicited from subjects using ten-point scales where causal likelihood ranged from most unlikely (-10) to

equally likely as unlikely (0), and from equally likely as unlikely to most likely (10).

The unacceptable labor efficiency variances had prior probabilities equal to 25 percent. One potential cause (workload schedule) had a prior probability equal to 80 percent. The other three potential causes had prior probabilities equal to 30 percent (raw material quality), 25 percent (worker training), and 20 percent (departmental manager efforts). Since prior probability was not an experimental variable, but rather controlled to be common for all subjects, the intent was to establish a set of prior probabilities that appeared valid to the subjects. The causal priors were made approximately equal except for one cause's prior which was set substantially higher as a check on subjects' use of prior probabilities.

Subjects assigned to the weak covariation condition were given covariation evidence that had a correlation coefficient of either 0.22 or 0.31, and those assigned to the medium covariation condition were given covariation evidence that had a correlation coefficient of either 0.59 or 0.51. Subjects assigned to the condition in which the covariation summary statistic was provided were given the correlation coefficient with their covariation evidence (together with an explanation of the meaning of a correlation coefficient). The covariation evidence was presented in the form of a 2 x 2 contingency table of the frequencies over the past five years of a chosen potential cause occurring or not and of labor efficiency variances being unacceptable or acceptable.

The magnitude of the reported labor efficiency variance was 21 percent of the standard labor hours allowed for the work achieved.

For the "high" level of the cause/effect similarity variable, worker training was 19 percent below its normal level and was the cause with the greatest congruence with the magnitude of the labor variance. For the "low" level of the cause/effect similarity variable, worker training was 3 percent below its normal level and was the cause with the least congruence with the magnitude of the labor variance. When worker training was 19 percent below its normal level, raw material quality was 3 percent below, and when worker training was 3 percent below its normal level, raw material quality was 19 percent below.[3]

THE EXPERIMENT

Subjects

The subjects were undergraduate students enrolled in junior/senior level managerial (cost) accounting courses in the business school of a large state university. A fixed payment of $5.00 was offered for participating in the experiment, and a total of 56 volunteer subjects participated.[4]

The subjects were randomly assigned to the between-subjects treatment conditions with the restriction that the cell sizes remained equal. Upon assignment to a treatment condition each subject received the background information pamphlet. Limitations that result from the use of students as subjects are discussed in a later section of this paper.

Procedures

The experiment was conducted in two phases, an experiment phase occurring immediately following a training phase. Both phases were conducted in group sessions ranging from three to ten in size.

The training phase. Training within all treatment conditions consisted of additional written instructions, a period of time in which subjects could ask questions, and a practice labor efficiency variance case.

The experiment phase. The experimental phase consisted of obtaining the subjects' responses to a second labor efficiency variance case. Based only upon the background information booklet and the labor efficiency variance report, the subjects were asked to estimate how likely they believed each of the four potential causes were to have been one of the two actual causes of the department's reported labor efficiency variance.

The subjects were given a report of the deviations of the four potential causes from their normal levels and the magnitude of the labor efficiency variance during the previous eight weeks (including the week of the reported variance), and were then asked to re-estimate their four likelihoods. Finally, the subjects were given a report of covariation between the potential cause of their choice and labor efficiency variances, and were asked to again re-estimate their four likelihoods.

RESULTS AND DISCUSSION

Similarity of Cause and Effect

The hypothesis concerning similarity of cause and effect was tested using the repeated measures ANOVA described above. Prior to receiving similarity evidence, the subjects should evaluate the three most likely potential causes as equally likely.[5] After receiving

similarity evidence, the subjects should evaluate as more likely the potential causes with the greatest deviations from their normal levels (i.e., those most similar to the variance), and should evaluate as less likely the potential causes with the least deviations from their normal levels (i.e., those least similar to the variance). The specific potential causes which have the greatest and least deviations from their normal levels differ between the levels of the cause/effect similarity variable. Within this model, hypothesis one would predict a significant cause/effect similarity by potential cause by evaluation interaction. This interaction was significant,[6] is in the form predicted, and is presented in Table 1.

Insert Table 1 About Here

These results support the hypothesis that perceived similarity of cause and effect, when defined as relative deviations from normal levels, affect individuals' evaluations of causal likelihood. Given a large labor efficiency variance (21% of standard where 15% of standard was the unacceptability threshold), subjects significantly increased their estimates of causal likelihood for potential causes that had large deviations from normal levels, and significantly decreased their causal likelihoods for causes that had small deviations from normal levels. This result was the same between the two levels of the similarity variable in which the potential causes with the greatest deviation differed (i.e., changing the nature of the most similar potential cause did not eliminate the effect of similarity on causal likelihoods).

Although not hypothesized, the nature of the potential cause appeared to modify the effect of similarity on causal likelihood. When raw material quality was the potential cause most similar to the labor efficiency variance, the mean likelihood assigned to raw material quality was significantly greater than that assigned to the department manager's efforts ($t = 4.0319$, 54 d.f., $p < .001$). On the other hand, when worker training was the potential cause most similar to the labor efficiency variance, the mean likelihood assigned to worker training was not significantly greater than that assigned to the department manager's efforts ($t = 0.7867$, 54 d.f., $p < .45$). An underlying difference in the nature of raw material quality and of worker training as potential causes of labor efficiency variances is controllability by the department manager: worker training generally has greater controllability than does raw material quality. The subjects may have interpreted the situation in which raw material quality had the greatest similarity to the labor variance as being less controllable by the department manager (thus, assigning greater causal likelihood to raw material quality than to department manager's efforts), and may have interpreted the situation in which worker training had the greatest similarity to the labor variance as being more controllable by the department manager (thus, assigning approximately equal causal likelihood to worker training and the department manager's efforts). Since these results are post hoc, the inferences drawn from them must be qualified as tentative and subject to future empirical testing. Alternative hypotheses could account for these results.

Covariation of Cause and Effect

The hypothesis concerning covariation of cause and effect was tested using the repeated measures ANOVA discussed above. Prior to receiving covariation evidence (but after receiving the similarity evidence), the subjects' causal likelihoods should be unaffected by the yet to be manipulated covariation variable. After receiving covaration evidence, subjects within the medium covariation treatment should either maintain or increase their causal likelihoods. Subjects within the weak covariation treatment should substantially decrease the likelihood assigned to the potential cause they had considered to be most likely prior to the covariation evidence. Since the potential causes are an exhaustive set, subjects within the weak covariation treatment should, at the same time, increase the likelihood assigned to the potential cause they had considered to be next most likely prior to the covariation evidence. The potential cause considered to be most likely prior to the covariation evidence should differ between the levels of the similarity variable (raw material quality in the low level and worker training in the high level). Within the ANOVA model hypothesis two would predict a significant covaration by similarity by potential cause by evaluation interaction. This interaction was signifcant,[7] is in the form predicted, and is presented in Table 2.

Insert Table 2 About Here

These results support the hypothesis that cause and effect covariation effects perceived causal likelihoods. Prior to receiving covariation evidence, the subjects' causal likelihoods were unaffected by the yet to be manipulated covariation variable. Given evidence

indicating medium covariation between their most likely potential cause and past labor efficiency variances, the subjects did not significantly change the causal likelihoods they had assigned to the potential causes. Given evidence indicating weak covariation between their most likely potential cause and past labor efficiency variances, the subjects significantly reduced the likelihood they had assigned to the most likely potential cause.[8] At the same time, the subjects receiving weak covariation evidence significantly increased the likelihood they had assigned to an alternative potential cause.[9]

Although not hypothesized, the nature of the potential cause appeared to also modify the effect on causal likelihood of the covaration between cause and effect. When raw material quality was the potential cause most similar to the reported labor variance, and the covariation between potential causes and past labor variances was weak, then subjects significantly reduced the likelihood that they had assigned to raw material quality, significantly increased the likelihood that they had assigned to worker training, and <u>increased</u> (albeit not significantly) the likelihood that they had assigned to the department manager's efforts. When worker training was the potential cause most similar to the reported labor variance, and the covaration between potential causes and past labor variances was weak, then subjects significantly reduced the likelihood that they had assigned to worker training, significantly increased the likelihood that they had assigned to raw material quality, and <u>decreased</u> (albeit not significantly) the likelihood that they had assigned to the department manager's efforts. Again, an underlying difference in the nature of raw material quality

and of worker training as potential causes of labor efficiency variances is controllability by the department manager. The subjects may have interpreted the situation in which raw material quality becomes a more likely cause as being less controllable by the department manager, and the situation in which worker training becomes a more likely cause as being more controllable by the department manager. Again, the inferences drawn from these post hoc results must be qualified as tentative and subject to empirical testing.

Summary Covariation Statistic

The hypothesis concerning the summary covariation statistic was tested using the ANOVA model described earlier. Prior to receiving a summary covariation statistic, the subjects' causal likelihoods should be unaffected by the yet to be manipulated variable. Subjects who receive the covariation evidence with a descriptive summary statistic should assign a different likelihood than those who receive the covariation evidence without a summary statistic. Within this ANOVA model hypothesis three would predict a significant summary statistic by evaluation interaction. Although this interaction was not significant,[10] it is in the predicted form.

Limitations

A major limitation to the generalizability of results would be the use of student subjects within a hypothetical performance evaluation environment. Because these subjects lacked prior training and experience with performance evaluation and control in business contexts, their causal backgrounds are different from those of actual managers.

The reduction of possible causes of labor efficiency variances to four in number and the assumption that these possible causes were exhaustive is an additional limitation to the generalizability of results. Within an actual performance evaluation/control situation the number of possible causes could be larger and would not be explicitly stated.

The similarity of cause and effect produced greater effect on causal likelihoods than did the covariation of cause and effect. This result may have been produced by the relatively low levels of correlation used in the study and by both a primacy effect (the similarity evidence was received first) and a quantity effect (the similarity evidence related to all the potential causes).

CONCLUSIONS

A major impact of managerial accountants within businesses is on the design and operation of managerial information systems and on the training of individuals to utilize these systems. Knowledge of subjective diagnostic processes is essential to accomplish the objectives of effective system design and adequate individual training. Diagnostic inference within the context of labor efficiency variances can take the form: a significant, negative labor efficiency variance has occurred in Department A. How likely was inadequate worker training, rather than inadequate raw material quality, to have been the cause? This study presents some evidence that a manager's answer to this question can be affected by the perceived strength of particular cues-to-causality within the circumstances being evaluated. Two cues-to-causality were manipulated in this study: similarity and covariation.

Supporting the similarity hypothesis, the subjects' causal likelihoods were significantly greater for potential causes that had deviations from their normal levels similar to the magnitude of the reported variance. Supporting the covariation hypothesis, the subjects decreased the likelihoods they had assigned to causes that proved to have weak covariation, but did not decrease the likelihoods they had assigned to causes that proved to have medium covariation. Providing a summary covariation statistic did not have a significant effect on the subjects' causal likelihoods.

Future research should extend this study as well as address the study's limitations. Of particular importance would be the use of natural subjects within experimental environments based upon their natural environments. Additional avenues of future research would be the study of other potential cues-to-causality and their interactions, the use of more discretionary performance situations (e.g., research and development departments), and the manipulation of information system variables such as the validity of evidence sources, conflicting evidence, as well as the information (evidence) report format, frequency, and level of aggregation. A long-term research objective should be to structure performance evaluation situations and to train individuals who utilize these structures in a manner that will facilitate individual performance within businesses.

FOOTNOTES

[1]A standard labor efficiency variance is defined to be the difference between the labor hours incurred for a particular level of production (actual hours) and the labor hours that should have been incurred for that level of production (standard hours allowed). Although this study employs a production definition of an operation, this is done for purposes of maximizing the structure of accounting information available within the experimental context. The concepts used in this study apply equally when an operation is defined to be the accomplishment of any business task.

[2]The quality of control was defined in terms of the department performances being satisfactory to division management. Subjects were instructed that to accomplish such evaluations they should be interested in gaining an understanding of the circumstances that cause good control and good performance as well as circumstances that cause poor control and poor performance. The subjects were told that this knowledge would allow the division to better train its department managers and to better structure the assembly environment.

[3]For both similarity levels, the workload schedule and the department manager's efforts were 10 percent and 13 percent below their normal levels, respectively.

[4]The subjects included 35 males and 22 females. A total of 65 subjects volunteered to participate, but only 57 completed the experiment. One subject was randomly dropped from the analysis to maintain equal cell sizes in the between-subjects' conditions.

[5]These were the potential causes with approximately equal prior probabilities of .30, .25, and .20. The fourth potential cause had a prior probability of .80.

[6]Within the full model this interaction's $F = 26.4276$ (6 and 288 d.f., $p < .001$) and $\omega^2 = .0529$ with the model $R^2 = .684$. Within a reduced ANOVA model that analyzed only the second level of the evaluation variable (after similarity evidence), the similarity pattern by potential cause interaction was significant with an $F = 72.1932$ (3 and 144 d.f., $p < .001$) and $\omega^2 = .204$ with the reduced model $R^2 = .814$.

[7]Within the full model this interaction's $F = 13.3537$ (6 and 288 d.f., $p < .001$) and $\omega^2 = .0262$ with the model $R^2 = .684$. Within a reduced variable (after covariation evidence), the covariation by similarity pattern by potential cause interaction was significant with an $F = 21.8226$ (3 and 144 d.f., $p < .001$) and $\omega^2 = .0958$ with the reduced model $R^2 = .739$.

[8]The decrease in mean likelihood within low level of the similarity variable had a $t = 5.5465$, 26 d.f., and $p < .001$. The decrease within the high level had a $t = 5.9534$, 26 d.f., and $p < .001$.

[9]The increase in mean likelihood within the low level of the similarity variable had a $t = 3.7178$, 26 d.f., and $p < .001$. The increase within the high level had a $t = 5.3729$, 26 d.f. and $p < .001$.

[10]Within the full model this interaction's $F = 0.2263$ (2 and 96 d.f.). Within a reduced ANOVA model that analyzed only the third

level of the evaluation variable (after both covariation and similarity evidence), the covariation by summary statistic interaction was also not significant with an $F = 0.5952$ (1 and 48 d.f.).

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Figure 1. Experimental Design.

COVARIATION	COVARIATION SUMMARY STATISTIC	WORKER TRAINING/ LABOR VARIANCE SIMILARITY*	EVALUATIONS											
			Prior To Evidence				After Similarity Evidence Only				After Similarity and Covariation Evidence			
			CAUSES				CAUSES				CAUSES			
			A	B	C	D	A	B	C	D	A	B	C	D
Medium	Provided	High												
		Low												
	Not Provided	High												
		Low												
Weak	Provided	High												
		Low												
	Not Provided	High												
		Low												

*In the low conditions, raw material quality/labor variance have high similarity.

Table 1. Similarity of Cause/Effect Results on Causal Likelihood Evaluations.

WORKER TRAINING/ LABOR VARIANCE SIMILARITY	EVALUATIONS							
	Prior to Evidence				After Similarity Evidence Only			
	CAUSES				CAUSES			
	Workload Schedule	Raw Material Quality	Worker Training	Manager Efforts	Workload Schedule	Raw Material Quality	Worker Training	Manager Efforts
High	-1.00 (9.70)	3.04 (3.67)	2.25 (5.08)	2.07 (10.14)	-3.32 (6.60)	0.89 (3.73)	6.50 (0.93)	6.21 (2.77)
Low	-1.17 (15.26)	2.32 (3.04)	2.68 (3.86)	2.10 (5.88)	-3.21 (9.87)	6.96 (1.67)	1.07 (4.59)	5.61 (1.50)

Notes: Each cell contains 28 subjects. The boxed cells identify thecause/effect similarity manipulations.

Table 2. Covariation of Cause/Effect Results on Causal Likelihood Evaluations.

COVARIATION	WORKER TRAINING/ LABOR VARIANCE SIMILARITY	EVALUATIONS: After Similarity Evidence Only — CAUSES: Workload Schedule	Raw Material Quality	Worker Training	Manager Efforts	EVALUATIONS: After Similarity and Covariation Evidence — CAUSES: Workload Schedule	Raw Material Quality	Worker Training	Manager Efforts
Medium	High	-3.43 (5.65)	**0.93 (4.38)**	**6.29 (0.99)**	6.36 (1.32)	-3.36 (4.55)	**1.07 (4.36)**	**6.57 (1.34)**	6.43 (1.03)
Medium	Low	-3.29 (10.22)	**6.64 (1.48)**	**1.14 (3.36)**	5.71 (1.60)	-3.29 (10.22)	**6.86 (1.21)**	**1.36 (3.02)**	5.64 (1.32)
Weak	High	-3.21 (8.03)	**0.86 (3.36)**	**6.71 (0.84)**	6.07 (4.38)	-2.93 (6.53)	**3.79 (1.80)**	**1.64 (9.32)**	5.07 (8.99)
Weak	Low	-3.14 (10.29)	**7.29 (1.76)**	**1.00 (6.15)**	5.50 (1.50)	-2.86 (9.67)	**1.93 (11.30)**	**3.93 (2.53)**	5.64 (7.32)

Notes: Each cell contains 14 subjects. The boxed cells identify the cause/effect similarity manipulations.