LOAD EFFECTS ON THE USE OF STRATEGY IN MOTIVATED PERSONNEL

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While much research employs the concept of "motivation" as a dependent or independent variable, motivation may be viewed in terms of a mediating variable as well. This is the approach taken in the present paper. The primary concern of this manuscript is with the effects of information load on performance in two quite different tasks. Load is, without question, a potential stressor (Streufert and Schroder, 1965; Streufert and Streufert, 1982). It is now well known that overload may diminish performance. However, underload, i.e., information deprivation, may also impair performance (cf. Streufert and Streufert, 1978 and the extensive research program of Suedfeld and associates, e.g. Suedfeld, 1978). Load and its potential stressor components would likely affect performance to a lesser degree (or in some cases not at all) if personnel performing a task were not motivated. Lack of motivation would likely have two quite separate (although interactive) effects: (1) information input would not be taken as seriously, thereby diminishing the effective load level, and (2) performance levels which would be relatively low would provide for lesser differences between diverse load effects (a ceiling effect). The motivated person, on the other hand, would likely be eager to consider all relevant information which he or she receives, and would - if able - achieve his or her optimal level of performance where load levels are conducive so that considerable performance decrements can be measured when load levels represent aversive conditions.

To study the effects of load on performance, we should then consider not only load (as the independent variable) and performance (as the dependent variable) but also stress effects (strain, a mediating variable) and finally motivation. In the present research, motivation levels are held relatively constant at high levels (with one exception mentioned below) by providing environments where incentives for doing well are presented, including competitive challenges and financial rewards. Motivation to perform well can then be assumed to be given (and is demonstrated to exist via manipulation check techniques).

The concept of stress cannot be as easily controlled or held constant if one wishes to study load effects. As stated above, load itself is a stressor. Moreover, its effects are not linear. As described long ago in the Yerkes-Dodson law, stress may be experienced at higher levels both at the low and the high end of the load dimension. Optimal stressor effects may be experienced at intermediate levels.

How does load stress relate to performance? This paper will discuss two sets of research efforts: one is concerned with load effects in complex decision making tasks. The other utilizes a much simpler performance setting: a visual-motor task similar to a video game. For the present purposes the interest is in one specific performance measure: strategic planning (measured as the integration of a current action with a planned future action). Both tasks, despite their considerable differences, allow some strategic planning to occur. We may ask to what degree stress experience (at low, moderate and high levels) induced by diverse information load levels are likely to alter strategic planning across the diverse task conditions. This paper will initially review the data obtained in a research program on a complex decision making task and will then turn to the visual-motor task. Finally, a comparison of the results from these research programs will be made.

Load and Complex Decision Making

With increasing automation, the number of simple decisions which need to be made by organizational, including military, personnel are likely to continue to decline. However, computers are not (at least certainly not yet) able to aid us in making complex decisions in uncertain conditions in response to complex task demands. At best, automation can produce a greater flow of (hopefully more relevant) information. Increased information, however, may imply increased load experienced by the human personnel that must make the final decision. How can this load be dealt with most effectively?

Unfortunately the standard decision making literature is not of much help in answering such questions. Most efforts to describe and predict human decision making processes have been based on providing alternative choices between fixed outcomes with more or less certain implications (or similar sets of relatively "simple" components in the cognitive decision making process and its informational basis).

Complex decision making in the "real world" has rarely corresponded to such models. For example military decision making at command levels necessarily involves degrees of uncertainty which often are not even resolved after a decision has been made. Wohl (1981) has argued this point rather well. Wohl believes that relatively little agreement among researchers has been reached with regard to the decision process. Decision theorists have been prescriptive rather than descriptive (or analytic) in their efforts. Uncertainty has been concerned with decision input, not with the decision making process itself (e.g. Edwards, 1961). On the other hand, military commanders are necessarily concerned with the "creation, evaluation and refinement of hypotheses" with regard to their situation and with options for responses. These processes are not necessarily "rational" in the sense used by standard decision theory (c.f. Janis and Mann, 1977) nor can they be solely determined from the knowledge of information input. Rather a cognitive analysis is needed. Again, following Wohl, when data is of high quality and options can be specified without error, a mapping process can be designed which translates inputs directly into outputs. However, tactical military decision making is generally characterized by data of limited quality and by open-ended or poorly defined options. Rapid hypothesis formation and option processing is consequently needed. Standard decision making approaches do not provide much information about such processes.

Theory (e.g. Streufert and Streufert, 1978) and research (e.g. Streufert, 1970) by Streufert and associates has attempted to explore load effects on complex information processing under conditions of uncertainty which reflect organizational and military environments more appropriately. The missing elements of uncertainty and lack of immediate feedback are provided. A complex, yet experimental simulation technique (c.f. Fromkin and Streufert, 1976) was developed to provide the necessary task environment for the measurement of complex decision making. Data are obtained via statistical analysis of a time/event matrix (c.f., for example, Streufert and Streufert, 1981) which describes the inputs and outputs to and from decision maker(s) over a specified length of time. Data obtained with this procedure have shown high levels of reliability. Validity has been demonstrated in executive settings. Applications to senior level military decision making processes are under way.

Clearly, the optimal choice for measuring the presence and the degree of stressors (as components of load) is physiological arousal, measured, for example, in terms of delta (elevations of) systolic blood pressure, diastolic blood pressure and heart rate. For the earlier data on load effects in a complex simulated decision making environment which will be reported here, physiological data are not available. Scale responses (manipulation checks), however, indicated that stress was highest at overload levels (e.g. when load reached or exceeded one item of information every two minutes), high at underload (information deprivation) levels, (e.g. when load levels were at or below one item of information every six minutes) and moderate or low when load levels approached one item of information every three minutes[1]. In other words, we may assume that stress in complex simulation tasks is less associated with intermediate load levels than with low or high information load levels.

A number of performance measures were obtained in the simulation task. For the present purpose, the focus is on responses reflecting the utilization of strategy (in the popular meaning of that term), i.e. planning for future actions. Credit for planning activity (decision integration) was given when a decision was made (entirely or in part) as the basis for a future decision of a different kind, assuming that future decision was indeed carried out later on. The number of decision integrations were counted separately for a number of playing periods in the simulation. Each period (in random order from participants to participants) presented information at a different load level (e.g. 2, 5, 8, 10, 12, 15, 25 items of information per 30 minute playing period). Optimum integrative decision making performance i.e. the highest level of strategic planning activity, was obtained at load level 10, that is when one item of information was presented every three minutes. Figure 1 represents a typical relationship between load and mean (across 20 groups of subjects) integrative (strategic planning) performance from one series of experiments (carried out in various countries and with various populations). The data obtained show high levels of reliability across the various settings, samples and experimenters.

For performance in complex simulation experiments, then, it appears that load is associated with stress and that stress, probably in part as a mediator variable, has a direct effect on strategic planning performance. It may be mentioned as an aside, that individual differences in cognitive complexity have considerable modifying effects on the observed load effects on performance: While an inverted U shaped curve is obtained for both more and less cognitively complex persons (as in Fig. 1), the elevation at optimal load levels is considerably higher for the more cognitively complex individuals. Further, other measures of performance (e.g. quantity of decision making output and the number of responses which can be characterized as inappropriate to the task at hand) tend to show a curvilinear rise with increasing load levels. They are, in other words, less affected by underload stress.

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[1]A current research program will obtain physiological strain measures for a similar data set.

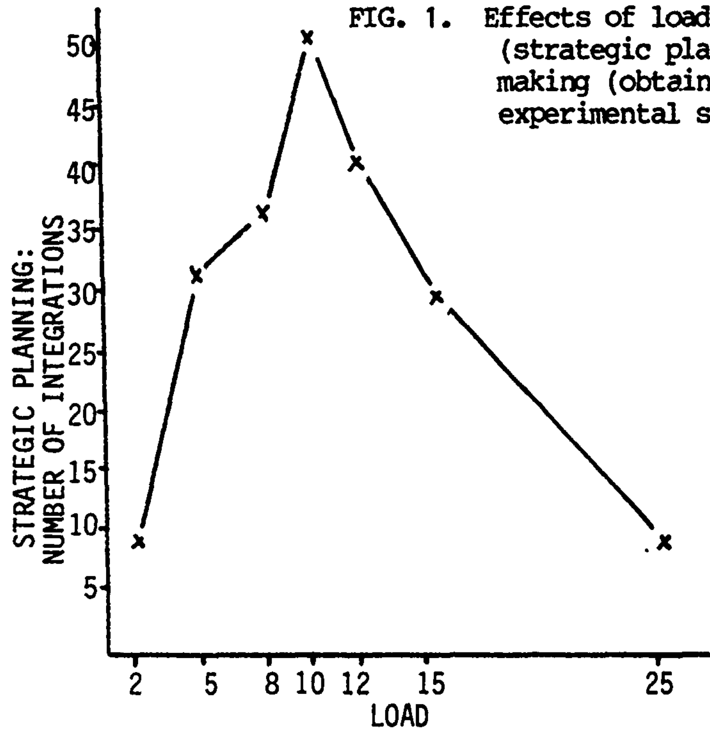

FIG. 1. Effects of load on integrations (strategic planning) in decision making (obtained in a complex experimental simulation) task.

Load in a Visual-Motor Task

For a research project which is presently in progress, a visual-motor task has been developed (e.g. Streufert, Streufert and Denson, 1982). The participant in the task, working individually, is introduced to a video-game type setting. He or she must guide a scoop through a matrix presented on a TV screen, collecting stationary squares within the matrix while avoiding circular objects which move randomly through that matrix. From one through nine circular objects may be presented and scoop and objects may move at various predetermined speeds. The participant in the task should, if possible, avoid moving his or her scoop through any corridor in the matrix more than once: points are lost in traversing blank (empty) spaces where squares were already collected previously. More serious, however, is a collision with any one of the circular objects: a collision results in a vibration of the TV screen, a loud noise, and an instant loss of 100 points.

To obtain as high a score as possible, the participant must not let squares stand in locations where longer empty spaces must be traversed at a later time to collect those squares. While the participant is urged to be as effective as possible to obtain as high a score as possible (very high comparison scores supposedly achieved by others are provided) he or she is not told what the best strategy for achieving high scores would be. Load in this task is represented by the number of circular objects with which the participant has to deal. Strategic planning is scored in terms of the number of times a nearby (but not in direct line) square is picked up (positive score) and the number of times the participant fails to make a turn in the matrix which would have provided less costly access to squares later in the task (negative score).

Stress in this task was measured as physiological strain experienced during task performance. Systolic, diastolic blood pressure and heart rate was obtained in intervals of two minutes during all task periods. Following a warm-up trial period (with low speed and only one circular object present), participants worked to erase all squares in the matrix during four additional playing periods. They experienced (in randomized sequence) either 2, 4, 6, or 8 circular objects. Speed during these periods was moderate. The data indicate that load resulted in a linear decrease in systolic blood pressure and heart rate. At the same time, a linear increase in diastolic blood pressure was obtained. Diastolic blood pressure is associated with peripheral constriction any may represent the measured equivalent of nor-epinephrin showers into the bloodstream. In this task, then, increasing load is associated with increasing strain. Manipulation check scale responses collected after each task period confirm that participants felt increasingly stressed as load increased.

Performance (strategy) was inversely related to the strain measure. As load was (randomly) increased, strategy scores decreased. For the higher load levels (6 and 8 circular objects in the matrix), the obtained strategy scores fell to levels below zero, in other words, strategic errors exceeded positive strategy actions. The data are shown in Figure 2. As an aside, it may again be mentioned that other performance scores (in addition to the strategy measure) were obtained as well. Total score (the number of points credited for collecting squares minus points for empty spaces traversed and minus 100 points for each collision) showed a similar effect as did strategy. Risk taking, on the other hand, showed a linear increase with increasing load.

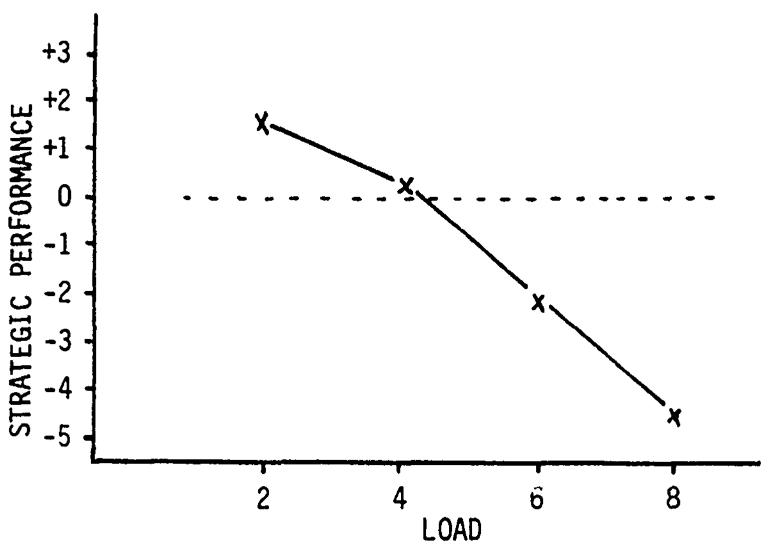

FIG. 2. Effects of load on strategic performance (planning) from a visual-motor task.

Load Effects Across Tasks

The data obtained in both research settings indicate that load does affect strategic performance. It should be remembered, however, that the participants were highly motivated, and that equivalent effects may not be expected in less or in unmotivated persons. For that matter, one study in which motivation was diminished through an experimental manipulation (utilizing the complex simulation task) produced considerably diminished load effects.

Particularly interesting is the reliable association of load effects with perceived stress and/or physiological strain and with strategic performance. Both related to load levels as U shaped vs. inverted U shaped curves for the complex task. Both showed a linear (rising vs. declining) function for the simpler visual-motor task. It then appears likely, that at least strategic (planning) performance due to load in motivated personnel may be mediated directly by strain, i.e. stress experience. Providing training, or making (where possible) changes in the task environment to decrease stress while maintaining motivation may well aid in assuring higher task performance (at least in strategic planning activities) across diverse task settings.

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