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CHOICE AND PERCEIVED CONTROL: IMPLICATIONS
FOR THE DESIGN OF DISPLAYS

Richard A. Monty
Human Engineering Laboratory

Lawrence C. Perlmutter
Veterans Administration Learning and Memory Center

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<p>7 This report summarizes several years of research on how offering subjects a choice of task parameters leads to a perception of control over their environment, which in turn can lead to improved task performance. The development of a theoretical explanation of the phenomenon is traced, and implications for the design of displays are deduced and illustrated with hypothetical examples.</p>			
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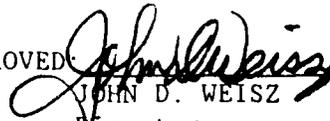
CHOICE AND PERCEIVED CONTROL: IMPLICATIONS FOR THE DESIGN OF DISPLAYS

Richard A. Monty
Human Engineering Laboratory
Aberdeen Proving Ground, MD

Lawrence C. Perlmutter
Veterans Administration Learning and Memory Center
Boston, MA

April 1989

APPROVED



JOHN D. WEISZ

Director
Human Engineering Laboratory

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U.S. ARMY HUMAN ENGINEERING LABORATORY
Aberdeen Proving Ground, Maryland 21005-5001

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CHOICE AND PERCEIVED CONTROL: IMPLICATIONS FOR THE DESIGN OF DISPLAYS

INTRODUCTION

An excessive human workload associated with the growing complexity of man-machine systems has resulted in an increased reliance on automation. While automation sometimes reduces workload, paradoxically it can also degrade performance by transforming the operator's mission from that of system operator to system monitor. System monitoring demands a high level of alertness and vigilance--requirements that often cannot be met by the operator. Moreover, automation reduces human control over the system, but does not reduce the operator's responsibility for the system's performance. This problem has been illustrated by Thackray (1988) who observed that "... the increasingly sophisticated level of air traffic control automation planned for FAA [Federal Aviation Administration] implementation during the next several decades will result in major role changes for the air traffic controllers. It is generally accepted that the controllers will be much less actively involved in routine aircraft regulation, spending much of their time monitoring a system largely controlled by computer." This depersonalization or lack of perception of being in control has even been advanced to account for pilot error in today's modern aircraft, which can result in major loss of life and property (National Transportation Safety Board, 1984).

It appears then, that we are dealing with a double-edged sword. An excessive workload resulting from increasingly complex systems can lead to a breakdown in performance, but on the other hand, excessive automation can lead to too little involvement in the task with similar adverse consequences. Is it possible to strike a balance--to increase perceived control or involvement in the task without overloading the operator? Our research suggests that by offering choices over some features or aspects of the tasks it is possible to increase the perception of control, which results in significant improvements in performance.

The objectives of this report are to examine some of the studies performed to date which show that learning and attention can be improved by providing the operator with the opportunity to choose. We will trace the development of a theoretical explanation for how or why choice affects performance. This report will show that the making of choices strengthens the operator's perception of task involvement, which in turn motivates higher levels of performance. Finally, we will extract principles that might be used to enhance human performance.

THE NOTION OF CHOICE

Our early research used a paired-associate task (PA) that is commonly used by psychologists to study learning and memory. Basically, the task requires the learning of connections between pairs of words, analogous to learning a word in a foreign language in association with a known word in

one's native language. One word is called the stimulus (S) and the other is the response (R). We showed test participants a list of word pairs (S-R pairs) and then on test trials, they were only shown the stimulus words and were asked to recite the response words paired with them. Following the tests, we showed the S-R pairs again for further study. The alternating study-test procedure was repeated as the subjects attempted to recall the correct response to each stimulus.

In order to introduce the element of choice, we modified the paired-associate task in the following way (Perlmutter, Monty, & Kimble, 1971): in the "choice condition" we showed the test participants a set of verbal materials consisting of the stimulus word presented on the left and five "potential" response words on the right. The test participants then chose which response word they wished to associate with the stimulus word. In this manner they perceived some control over the learning situation. We repeated this procedure with each stimulus word along with five new response words until the test participants had constructed a list of 12 word pairs. They then memorized these word pairs in the manner described earlier.

By contrast, in the "force condition" the test participants read aloud the stimulus words and the potential response words, but following the reading, the experimenter announced which response words were to be learned. The assigned response words were those that were chosen by the previous choice condition test participant, thus yoked pairs of individuals learned identical materials. Test participants in the choice condition learned more rapidly and became more proficient (reached a higher level) than did test participants in the force condition. Allowing the individual to choose what is to be learned seemed to benefit performance. While these results were obtained with college-age individuals, subsequent studies with adults who were not accustomed to academic-like test procedures and who generally reported paired-associate task learning to be of little interest, showed that they also benefited from having a choice.

In the experiments just mentioned, test participants chose response words while the experimenter designated the stimulus words. To determine whether choice was effective with the less active (stimulus) component of the S-R pair, another experiment was conducted in which test participants were allowed to choose one of five potential stimulus words to be learned to a designated response word (Perlmutter & Monty, 1973). Choice was effective and performance levels were comparable to those when the test participants chose response words.

A simple explanation for the results of the experiments (choice of the stimuli and choice of the responses) described above would suggest that the enhanced learning on the part of the choice subjects could be a result of the opportunity to choose specific materials; that is, the choice subjects may have enjoyed benefits that aided in the learning of the associations, while such advantages occurred for force subjects only fortuitously.

Finally, these results are compatible with a choice-induced motivational explanation. Specifically, allowing individuals the opportunity to make choices leads to and strengthens the perception that

they are in control of the task, which in turn heightens their motivation (Perlmutter & Monty, 1977). This hypothesis will be further explored.

The important point to be made at this juncture is that the simple expedient of offering subjects a choice over a portion of the materials to be learned improves subsequent performance relative to the identical task performed in the absence of choice.

Implication

- When displaying information, including some that must be remembered by the operator, we advise that provisions be made to provide some choices over features of the tasks to be performed.

A TEST OF THE MOTIVATION HYPOTHESIS

We have hypothesized that when subjects are given an opportunity to choose, their general level of motivation increases, and this increase should improve performance not only with chosen materials but with other materials as well. To test this notion Monty, Rosenberger, and Perlmutter (1973) allowed one group of subjects to choose (from alternatives) three response words to be associated with the first three stimulus words; the experimenter assigned the remaining nine stimulus-response pairs. A second group also chose three response words, but these were distributed proportionately throughout the list of 12 pairs. A third group chose only the last three response words, while a fourth group chose half (six) of the response words with these proportionately distributed in the sequence of 12. A fifth group chose all 12 response words, while a sixth group was given no choice at all. The mean numbers of correct responses on the paired-associate task learning trials are shown in Table 1. When the first three response words were chosen, the performance was similar to that observed when all 12 response words were chosen. However, when the last three response words were chosen, performance was as poor as when no response words were chosen.

When the chosen response words (three or six) were scattered throughout the list, performance was at an intermediate level relative to the early and late choice conditions and not significantly different from either. The poor performance in the group that chose at the end of the series offers no support for the idiosyncratic hypothesis. That is, if the effects of choice are limited to that which is chosen, early or late choice should have been equally effective. They were not.

Table 1

Correct Responses for Groups With Varying Amounts of Choice

Group	Trials			
	1	2	3	4
Choice of all 12 items	4.80 ^a	6.80	7.70	8.90
Distributed choice of 6 items	4.40	5.05	6.35	6.90
Choice of first 3 items	4.75	6.30	7.65	7.95
Distributed choice of 3 items	4.15	5.40	6.90	7.70
Choice of last 3 items	2.90	4.85	6.40	6.80
No choice	3.40	4.90	5.95	7.15

^aNumbers represent the means of correct responses on four trials of a 12-item stimulus-response pair test.

Overall then, these findings suggest that providing the learner with choice at the beginning of the task aids performance maximally. More important, under the conditions of early choice, the learning of assigned as well as self-chosen items was benefited. That is, when the task is initiated in the absence of control, the exercise of choice in the concluding portion of the sequence fails to improve performance. On the other hand, initiating the task in the presence of control results in an improvement in performance irrespective of subsequent experiences without control.

The effects of choice with a more complex task decidedly less rote in character than paired-associate learning was examined by White (1974). He adapted the basic choice/force procedure into a standardized reading comprehension test. For this test one group chose from each of four pairs of titles, all of the stories to be read. A second group selected three titles from each of the first three pairs with the fourth story assigned. A third group chose only from the fourth or final pair, and the remaining group received only experimenter-designated stories. No stories were read until the entire choice/force procedure was completed; hence, performance on the initial story tested could be attributed to the conditions encountered during the choice/force procedure per se. The first story tested provided a critical evaluation of the motivation hypothesis. For all subjects, the first story tested was the final one in the choice/force procedure.

After reading each story, the experimenter presented five multiple-choice questions. The results indicate that the opportunity to choose elevated the performance on the nonchosen story to the level found when all of the stories had been self-chosen.

The results from the PA learning trials as well as the reading comprehension tests show that the beneficial effects of choice are consistent across tasks and across a broad age range (Perlmutter, Monty, & Chan, 1986). The proffered motivation hypothesis provides the most comprehensive explanation of the effects of choice. Nevertheless, despite the apparent support for the motivation hypothesis, the evidence remains indirect. More direct evidence is derived from a study by Perlmutter, Scharff, Karsh, and Monty (1980) in which, subjects were permitted to choose or were assigned responses to be learned on a PA task. After the choice/force procedure was completed, the subjects performed an unanticipated reaction time (RT) task concurrently with the learning of the S-R pairs. As shown in figure 1, choice subjects not only learned their paired associates better than force subjects but they also reacted significantly faster on the RT task. Such evidence appears to provide the most incontrovertible support for the motivation hypothesis. That is, choice on a memory task generally enhanced motivation which manifested itself in improved reaction times on a secondary task. In another study (Perlmutter et al., 1980, pp. 42-45) subjects performed the RT task following the choice/force procedure but prior to the PA learning trials. Again, the effects of choice are generalized to an unanticipated RT task over which no choice had been permitted (see Figure 2).

In summary, the relationship between choice and motivation is not willy-nilly. While choice benefits performance on self-chosen portions of tasks as well as on completely nonchosen tasks, the positive effects of choice are not manifest if the opportunity to choose is withheld until the end of the task. That is, the location or placement of choice in the task determines its effectiveness. Choice at the start of the task is effective while the same quantity of choice in the concluding portion of the task is no more effective than not choosing at all. Furthermore, choosing as little as 25 percent of the material to be learned is as effective as choosing 100 percent.

Implications

- The amount or quantity of choice is not nearly as important as when the choices are made within the task.
- An opportunity to exercise choice should be given at the beginning of a task.
- Allowing the operator choices late in a task will probably not benefit performance.
- When choices are made on one task, beneficial effects generalize to other tasks performed in temporal proximity.

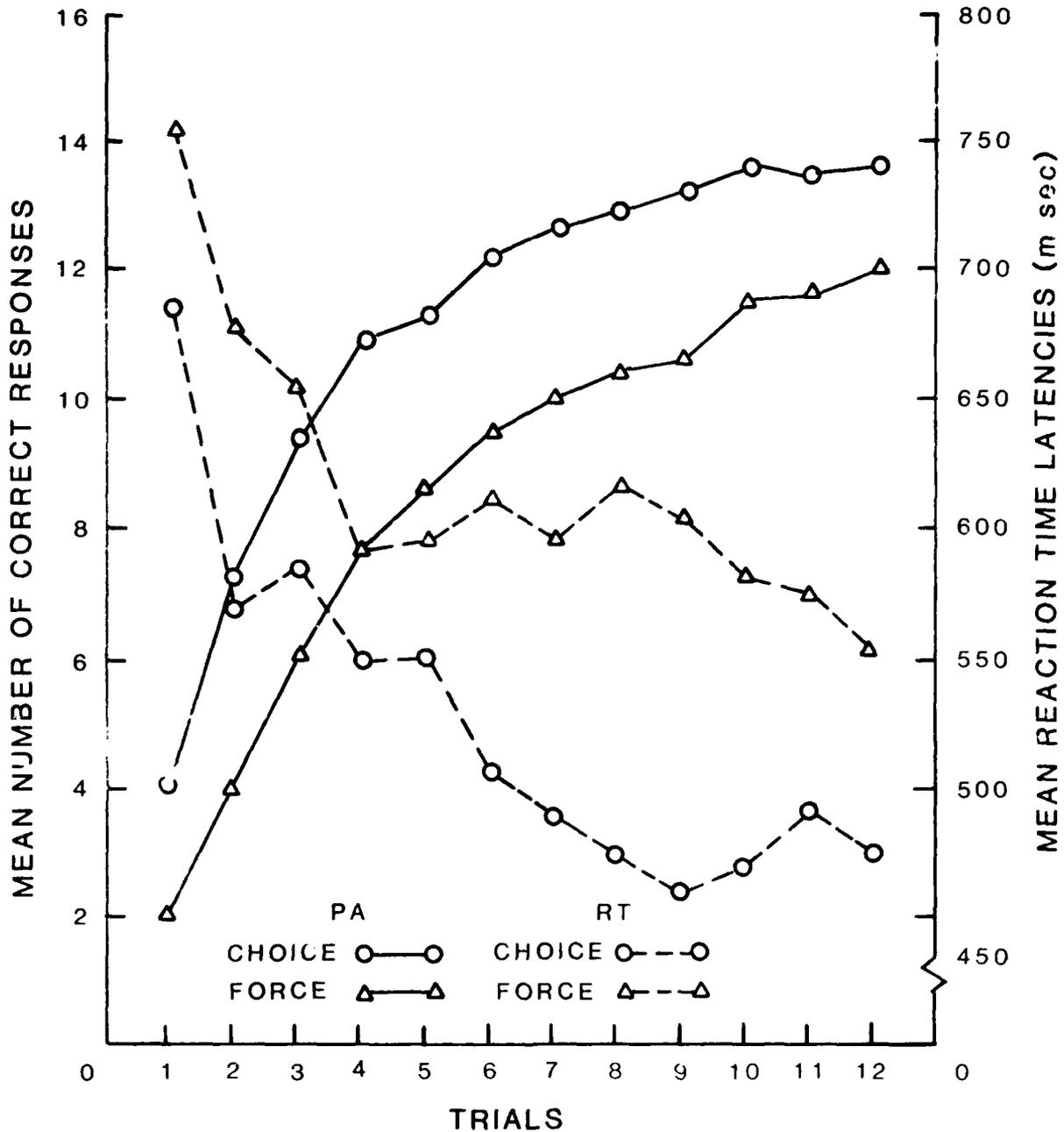


Figure 1. Correct responses and reaction times. (Mean number of correct responses on PA task [left ordinate] and mean reaction time latencies [right ordinate] for the choice and force groups.)

Note. From "Perceived Control: A Generalized State of Motivation" by L. C. Perlmutter, K. Scharff, R. Karsh, and R. A. Monty. 1980, *Motivation and Emotion*, 4, p. 40.

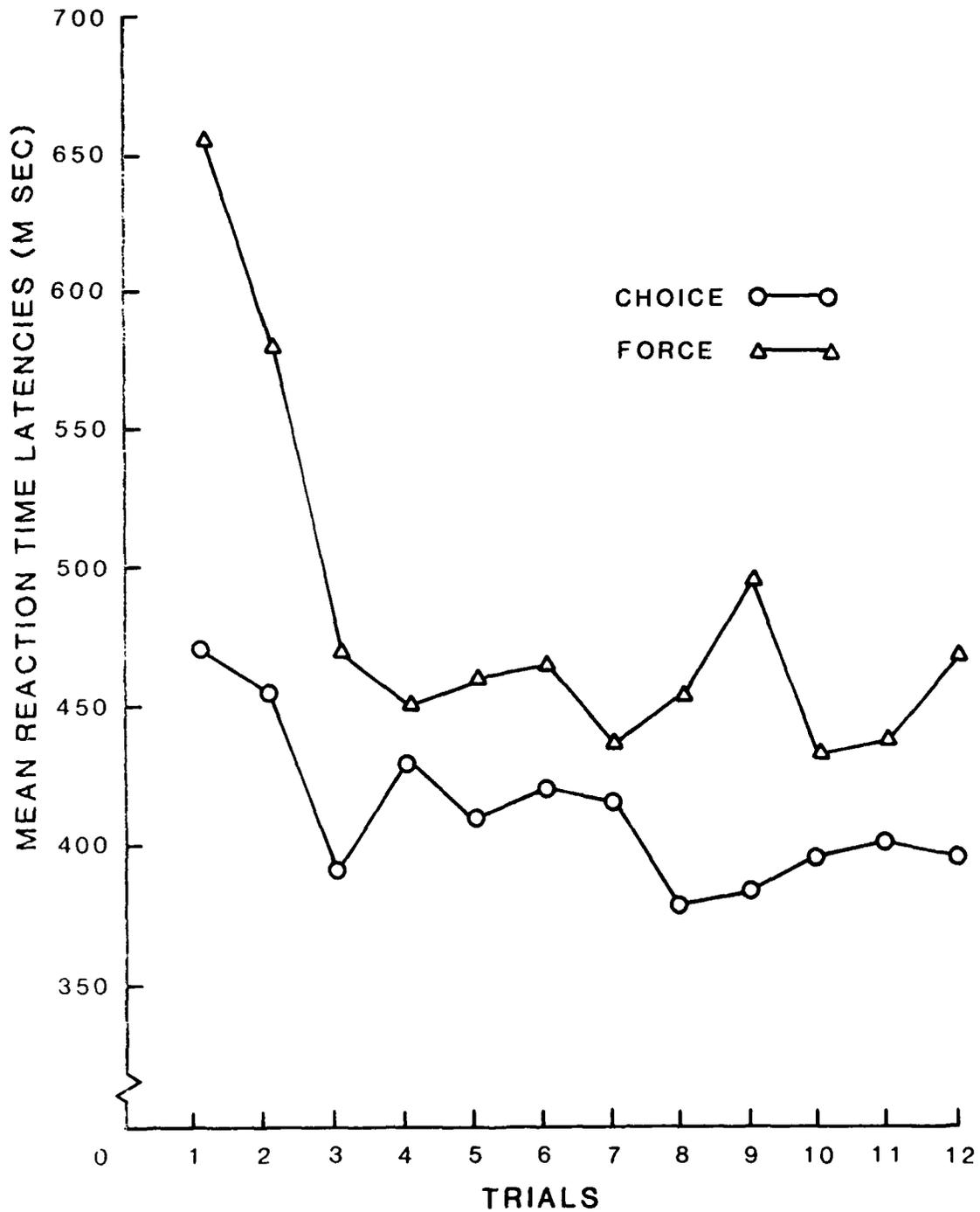


Figure 2. Mean reaction time latencies for the choice and force groups (Experiment 2).

Note. From "Perceived Control: A Generalized State of Motivation" by L. C. Perlmutter, K. Scharff, R. Karsh, and R. A. Monty, 1980, Motivation and Emotion, 4, p. 43.

PERSISTENCE OF THE EFFECTS OF CHOICE

The temporal durability of the effects of choice was examined in a series of studies. In one experiment (Monty & Perlmutter, 1975), subjects chose one of five potential stimulus words in the presence of the response words while the force group was assigned stimulus words in the presence of response words. Subjects returned on the following day and were presented with PA learning trials comprised of the respective S-R pairs. A second experiment required subjects to either choose response words or have them assigned in the presence of stimuli. When the choice/force task was completed, the subjects were dismissed until the following day. When the subjects returned the next day the experimenters presented them with the stimulus words and they were then required to recall the appropriate response words. The identical test procedure was used whether stimulus words or response words had been chosen or assigned. Not only did choice subjects perform better than force subjects, but more importantly, such effects were evident on the initial test trial. This latter outcome is important because it provides evidence for long-term retention effects of choice. The data from Trial 1 show that the association between stimuli and responses withstood the 24-hour delay period more strongly following choice.

In two additional experiments, subjects selected response words in the absence of the stimuli or selected stimuli in the absence of the respective response words. Once again, performance was significantly better after a 24-hour delay for choice than for force subjects (Monty & Perlmutter, 1975). In yet another experiment, a 1-week duration was used to examine the effectiveness of choice in enhancing discrimination performance. A page containing lines of words was presented. After exposure to the entire page, subjects in the choice condition selected one target word to be learned on each line. In the force condition, the target word was assigned. Subjects were instructed to study the target words and were then dismissed for 1 week. While subjects had not been specifically briefed about the nature of the test to be administered nor that they would be tested after 1 week, they had been informed about the requirement to return after 1 week.

When they returned, an "old" word that had been presented previously was displayed in a pair with a "new" word that had not been presented previously. Subjects indicated which word in the pair was old. The experimenters found that choice subjects identified target words significantly better than force subjects.

The importance of this study is in showing that the ability to discriminate the chosen target word even after 1 week was enhanced significantly by the opportunity to choose. Moreover, this study reveals that with respect to memory, the effectiveness of choice is not restricted to a cued recall of paired associates.

Implication

- Choice may be exercised up to 1 week and perhaps longer in advance of actual task performance without sacrificing its potential benefits.

DISRUPTION OF CHOICE

The benefits of choice generally appear to outweigh its several costs such as the additional expenditure of time necessary to implement the procedure. Another potential limitation associated with offering choice is the need to ensure that the anticipation of engaging in the chosen task is not disrupted by extraneous intervening events. For example, in a study by Perlmutter, Monty, and Cross (1974), subjects initially chose their own response words. However, after choosing was completed, a competing task was introduced peremptorily. The subjects were required to learn a substitute PA list comprised of the original stimulus words along with new response words that had not been contained in the sets of alternatives from which choices had been made. Force subjects had been initially assigned the response words originally selected by the choice subjects, and this group was also required to learn the alternate materials. Results showed that force subjects, not given the opportunity to choose on either list, learned the imposed S-R pairs (second list) significantly better than choice subjects. In other words, relative to force subjects, performance on the imposed task was degraded for choice subjects.

To account for the greater difficulty that choice subjects experienced in the learning of the nonchosen list, one additional assumption has to be added to the hypothesized relationship between choice and motivation. Namely, choice renders the chooser vulnerable to frustration (Perlmutter et al., 1974).

Finally, when the choice subjects were subsequently allowed to learn their chosen materials, choice was no longer effective in enhancing performance. The failure of choice to benefit PA performance on the chosen list is also consistent with the findings from another study (Perlmutter et al., 1980). In this study a reaction-time task, imposed between the choice/force procedure and the PA learning trials, eliminated the typical benefits of choice. Apparently, the imposition of a nonchosen task reduces motivation.

We have seen that the positive effects of choice endure for at least 24 hours. How long then does the vulnerability to frustration endure? To examine this question individuals selected stimulus words in the absence of response words and were then immediately assigned response words to be learned. We found that performance was poorer for choice than for force subjects. On the other hand, when choosing stimuli on one day and imposing response words on the next day, choice subjects nevertheless performed significantly better than force subjects on the PA task (Monty & Perlmutter, 1975, p. 185). These results confirm the durability of choice over a 24-hour period and also show that interfering with choice shortly after it has

been exercised results in a frustration-induced disruption of performance. Apparently, the potential for frustration follows a much briefer time course than does the beneficial effects of choice--a positive outcome that has been measured even after a 1-week period.

Implications

- Once choice has been offered, it leads to an expectation that must not be interrupted immediately or performance may be disrupted.
- If the effects of choice are frustrated after the passage of a longer period of time (i.e., 24 hours), the positive effects of choice will persist.

CHOICE AND ATTENTION

We have seen that choice enhances motivation and improves performance across a variety of tasks. In addition, choice can also be used to enhance performance by directing attention to materials to be learned.

Consider the following situation: When an individual is required to remember specific information such as a particular line of text on a printed page, in addition to learning the specific or "targeted" material, that individual simultaneously acquires and retains information about the context in which that target is embedded (e.g., see Zechmeister & McKillip, 1972). We refer to such contextual learning as "incidental" because it is not planned or purposeful. Furthermore, the learning of contextual "cues" influences recognition and recall of the intentionally learned target items. For example, recalling the location on a page of the material to be remembered has been shown to be positively related to recall of the target items (Schulman, 1973). Thus, Perlmutter and Monty (1982) manipulated the degree of involvement that the learner had with the contextual or background stimuli in order to determine how this might improve target discrimination and recognition. They presented the individuals with lines of words containing either two or four words per line. One word on each line, namely the target word, was explicitly required to be learned. The remaining words on each line were not explicitly assigned a function and thus served as background words.

In one group, individuals selected their own target words to be learned from among the alternatives. In another group, the target words were assigned. In the latter group, individuals could devote all of their effort to the learning of the target words since the background words, although present, played no explicit role. On the other hand, when individuals chose their own target words, they were obligated to some extent, to process target as well as background stimuli--a requirement that could interfere with target learning.

To examine the effects of choice on target discrimination and recognition, two tests were run successively. The discrimination test involved the presentation of the original materials, namely target and

background words, where individuals were required to correctly discriminate the target words. Results showed that discrimination scores were significantly higher in the choice group than in the force group.

On the recognition test, each word was presented individually. To control for guessing, test participants were presented with an equal number of new words. They indicated whether the word had appeared previously (i.e., was "old") or had not appeared previously (i.e., was "new"), and how confident they were in their judgments. Both the confidence and the old-new recognition data showed essentially similar effects, namely, that choice facilitated performance significantly.

In addition to the finding that choice significantly enhances target discrimination and recognition, the even more interesting observation is that choice enhances the recognition of background words. This finding is important for two reasons. First, since background words represent nonchosen or rejected alternatives, this result shows that the effects of choice are not limited to the chosen materials. Second, the enhanced recognition of target and background words indicates that the absolute amount of material learned in the choice group was greater than in the force group.

In a subsequent replication, two additional conditions were introduced (Monty, Perlmutter, Libon, & Bennet, 1982). One of these conditions required subjects to reject the nondesired (background) alternatives they did not want to learn on the assumption that in the process of rejecting, attention to the background items was likely to be greater than when selection was made through choice. Second, a choice-modified condition was added in which, following target selection, subjects crossed out the nonchosen word to ensure direct contact or greater commerce with the nonchosen background words than subjects in the choice condition might have experienced. Results showed, as in the earlier experiment, that directing attention to the background items by allowing subjects to choose target words enhanced the learning of background and target items relative to a force group to whom targets had been assigned. Also, when the subjects were permitted to select their targets by rejecting those they did not wish to learn, overall performance was even better than when choice was permitted. Thus, the earlier observations of the interrelationships of target and background learning were extended and showed that such learning can be greatly enhanced by giving the subjects the opportunity to choose or reject target words.

Implications

- Choice significantly increases the recognition and the discrimination of correct information.
- Choice of target materials also enhances the recognition of background materials or items of secondary importance.

SOME HYPOTHETICAL EXAMPLES

We have seen that when individuals are offered a choice of one aspect of a given task, performance on that task as well as tasks performed in temporal proximity to it is also enhanced. We have also seen that if an individual is confronted with a display comprised of target and background items and is allowed to exercise a choice of target items, information about those target items will be retained better than if no choice was offered. But, interestingly, information about background items will also be elevated to a significantly greater degree than if no choice was offered.

Consider the implication of this for the Counter Air Display now being studied by the Army. The pilot is shown a display with a number of potential targets. At some point in time, one of these is designated as the target, and the others are relegated to the status of background (not to be completely ignored nonetheless). If the pilot was offered a role in the selection of the target, retention of critical information about both the target and the background should be enhanced. Further, should a new target then be defined, that is, one drawn from the background; the prior opportunity for choice would be expected to facilitate the learning of the "new" information.

Let's consider another example. The fire unit display (FUD) as now conceived presents four types of targets or symbols to the observer: namely a *C* for friendly, a *U* for unknown, a *V* for designated unknown (very possibly hostile), and an *H* for hostile. The data available underlying this categorical description actually encompass an entire continuum from friendly to hostile. In other words, certain information has been "masked" by making these categorical distinctions. But, consideration is currently being given to providing the full continuum of information to the observer, which could help or hinder performance. One thing is almost certain, the full continuum of information would increase the observer's workload at the time of high stress. Might this be detrimental to performance? The work of Lukas (1987) would suggest, in the case of some personality types (reducers), yes; and in other types (augmenters), no--it might even be beneficial. Might this concept be combined with the notion of offering choice? That is, what if the soldier could choose whether he wants a categorical or continuous display of information. Might the performance of both types of individuals be enhanced? This is clearly an important issue for further research with the potential for a high payoff.

SUMMARY AND RECOMMENDATIONS

This report has summarized several years of research on choice and perceived control and has deduced a number of potentially important display principles. In addition, the motivational mechanism elucidating how and why choice operates to improve performance has been examined.

Nevertheless, despite the successful applications of choice and control to problems of human performance, much additional basic and applied research needs to be conducted.

For example, virtually all of the work to date has been within the visual modality. Will parallel consequences be found if choices are offered in the auditory modality? Additionally, most of the research has focused on tasks with a major memory component. While most real-world tasks do involve memory, there are exceptions. We might, therefore ask if offering choice improves decision making or tracking performance. More work also needs to be done on the type of choice offered. For example, will offering choice over simple physical features of a display (such as symbols or background color) enhance performance? Another unexplored area is the role of individual differences. For example, do all individuals benefit equally from the opportunity to choose?

Finally, while displays present information that is identifiable as either target or background, such categorizations are often transient. That is, the dynamics of the information display are such that what is background one moment may become target the next. Therefore, any procedure that enhances the simultaneous learning of both target and background information holds promise for enhancing operator performance without information overload. Our work on choice satisfies this requirement. For example, when operators make choices, both target and background learning increases significantly. Future research should be designed to examine such questions as how many choices are required to enhance performance. If the individual knows in advance that the number of choices is limited, this stricture should intensify the individual's attention to the task thereby enhancing performance. Another question should focus on when is choice the most effective. That is, is choice more effective during times of high information load? How does choice reduce interference from background information?

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