EINSTELLUNG: KNOWLEDGE OF THE PHENOMENON FACILITATES PROBLEM SOLVING

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If subjects are given a series of problems that all have the same type of solution, they often have great difficulty with a subsequent problem that would ordinarily be solved very easily. This phenomenon is referred to as psychic blindness or Einstellung. This study explored whether knowledge of the Einstellung phenomenon facilitates problem solving. Eight subjects in each of three experimental conditions were given set-inducing problems followed by an otherwise easy "critical" problem that could not be solved by the strategy used on the set-inducing problems. Subjects in one condition worked on the easy problem without interruption. Subjects in a second condition were interrupted by an unexpected event. Subjects in a third condition were interrupted by a message explaining how the ability to solve an otherwise easy problem could be inhibited after solving a series of problems with more difficult solutions. Subjects given this hint were three times more likely to solve the easy problem than were subjects in the other experimental conditions. Four subjects in the No-Set Control condition all solved the easy problem by the third trial. The implications for training electronics technicians, computer programmers and other problem solvers are discussed.

Anecdotal evidence suggests that people often overlook obvious solutions to problems. A layman may think a piece of equipment is faulty because he or she has forgotten to turn on the power; an experienced electronics technician may overlook power supply anomalies while testing more complex hypotheses; a computer programmer may not notice that data are entered incorrectly and single step through a complex algorithm looking for a nonexistent logical error. Clearly, an enormous amount of time can be wasted if a simple solution is overlooked and complex hypotheses are tested.

The first systematic investigation of this phenomenon was conducted by Luchins (1942) in his investigation of set effects. Luchins presented subjects with a series of water-jar problems that could all be solved by the same complex sequence of "pouring" operations. He then presented subjects with a problem that could be solved directly by simply pouring the contents of one jar into another. Despite the simplicity of the solution, the vast majority of subjects persisted with the sequence they had used in the previous problems. Subjects who had not been given the original series of problems invariably used the direct solution. Luchins termed the overlooking of an obvious solution "Einstellung" or psychic blindness. More recently, McKelvie (1985) replicated Luchins's findings calling Einstellung a "rock-bottom" phenomenon.

An important question is whether Einstellung can be overcome or prevented. Luchins tried a variety of interventions designed to help subjects overcome Einstellung including (a) having subjects write "don't be blind" on a piece of paper, (b) introducing time delays of an hour, a week, or a month between the set-inducing trials and the critical trial, (c) the announcement of a new experiment, followed by a problem that could only be solved by the direct strategy, and (d) asking subjects to identify their present strategy and look for a new one. Although these interventions were effective to varying degrees in diminishing the number of subjects who chose the indirect solution, all of them failed for a substantial number of subjects. For example, even after a one-month interval, 27% of the subjects still showed Einstellung.

Levine and his colleagues (Fingerman & Levine, 1974; Levine, 1971; Ress & Levine, 1966) were able to induce Einstellung using discrimination-learning problems. In these problems, two stimuli differing on a single attribute such as whether the stimulus contains an "A" or a "B" were presented and the subject's task was to choose one of the stimuli. Subjects were told whether or not they were correct and were then given further trials until a criterion was met or a fixed number of trials had been presented. To induce set, Fingerman and Levine (1974) presented subjects with a series of discrimination problems with solutions consisting of the repetition of complex position sequences such as Right, Left, Right, Right, Left (RLRRL). Subsequently, subjects had great difficulty with a problem in which the solution was to choose the stimulus containing a single attribute (such as "A"). Subjects not receiving the problems with position-sequence solutions had no trouble with this type of problem, the vast majority finding the solution solve by the third trial.

Levine's (1974) theory of hypothesis testing provides an elegant explanation of Einstellung. The theory holds that hypotheses are grouped into sets of related hypotheses called "domains." Position-sequence hypotheses make up one domain; single attribute hypotheses make up another domain, etc. According to Levine's theory, hypothesis domains are sampled exhaustively so that all the hypotheses in one domain are tested before any hypotheses from another domain are tested. If the current domain is small (such as the domain of single-attribute hypotheses) then the domain is exhausted quickly and a new domain is sampled. If, on the other hand, the domain of hypotheses is infinitely large, as it is for the domain of position sequences, then one can never exhaust the hypotheses in the domain. This implies that if the solution is not in the domain, the solution will never be found. Fingerman and Levine's findings strongly support this notion: only four of 36 subjects solved a simple problem in 95 trials.

Since sampling the wrong domain can prevent a subject from finding the solution to a problem, the selection of a domain to sample is of critical importance. Levine (1974) explained the effect of experiencing a series of position-sequence problems on a subsequent simple problem with the transfer assumption: "When the subject receives a series of problems, he infers from the first n solutions the domain within the universe from which the $n + 1st$ solution will be taken." (p. 292).

Lane, McDaniel, Bleichfeld, and Rabinowitz (1976) extended hypothesis testing theory with the finding that subjects are more likely to change from a simple domain to a more complex domain than vice-versa. These findings indicate that the domain selection process tends to proceed in one direction, from simple to complex, and that sampling from a very complex domain appears to preclude resampling simpler domains. This implies that even without a series of set-inducing trials, subjects who start sampling a domain more complex than the solution domain will continue to sample domains of ever greater complexity.

The intent of this study was to explore whether knowledge of the Einstellung phenomenon can help prevent it. We used Fingerman and Levine's (1974) paradigm to induce Einstellung.

METHOD

Subjects and Design

Subjects were undergraduate students at Rice University. Eight subjects were randomly assigned to each of three experimental conditions (No Interruption, Interruption, and Hint). An additional four subjects were assigned to the No-Set Control.

Equipment

A Macintosh Plus computer was used to display the stimuli and record the responses.

Procedure

Subjects saw two letters on the screen: either an "A" on the left and a "B" on the right or a "B" on the left and an "A" on the right. They then selected a letter using the mouse and clicked the mouse button. If the response was incorrect, a "beep" was played. If the response was correct, no specific feedback was presented. The assignment of letters ("A" and "B") to positions (left and right) was determined randomly. The subjects were given no information about the criterion for a correct response, but were instructed that the beep meant the response was incorrect. For each problem, subjects responded until they had either completed 15 correct responses in a row or they had completed 100 trials.

The solutions to the first six problems were position sequence solutions in which the identity of the letters was irrelevant. The solution to the first problem was to select the positions LLRR (Left, Left, Right, Right) and repeated the pattern irrespective of the letters at those positions. The solutions to the second through sixth problems were repetitions of the following patterns: RLRL, RLRRL, LRLLLRL, RRRLRLLLL, and LLRLRRRLRR. If subjects made an error after the 85th trial then the solution was explained to them.

The solution to the seventh and critical problem was much simpler and sequence played no part. The solution was to choose the stimulus with the "A" (or for half the subjects "B") no matter which position it was in.

The treatment of the three experimental conditions differed on the critical problem that followed the six set-inducing problems. Subjects in the "No Interruption" condition worked uninterrupted on the critical problem. Subjects in the "Interruption" condition were interrupted by an unexpected event that occurred following the 40th trial. The interruption consisted of a system error message, a subsequent "wait one moment" message (that appeared with the system error message), and the blackening and clearing of the screen four times in an erratic manner. The purpose of this condition was to control for the delay and interruption that occurred in the "Hint" condition. The subjects in the "Hint" condition were shown the following message if they had not solved the problem by the 40th trial: "Hint for Solution. Under some circumstances, people who have developed a strategy to solve a series of problems are less likely to solve a subsequent problem. The subsequent problem, presented alone, is solved very easily." Finally, the No-Set Control was given the critical problem without any of the set-inducing problems.

RESULTS AND DISCUSSION

All of the subjects solved at least one of the non-critical problems indicating that they were sampling from the domain of sequence solutions. As can be seen in Table 1, all four of the subjects in the No-Set Control solved the critical problem very quickly whereas only 25% of the subjects in the "Interrupted" and "Uninterrupted" conditions solved the critical problem at all.

Table 1

Performance on the Critical Problem as a Function of Condition

Condition	Subject	Trial of Last Error
Control	1	0
	2	2
	3	3
	4	3
Hint	1	47
	2	37
	3	40
	4	Unsolved
	5	62
	6	40
	7	42
	8	Unsolved
Interruption	1	Unsolved
	2	55
	3	Unsolved
	4	Unsolved
	5	Unsolved
	6	Unsolved
	7	Unsolved
	8	7
No Interruption	1	Unsolved
	2	70
	3	Unsolved
	4	Unsolved
	5	Unsolved
	6	Unsolved
	7	Unsolved
	8	17

This replicates Fingerman and Levine's important finding that even problems with obvious solutions are difficult to solve if subjects are induced to sample from an incorrect and large hypothesis domain. Performance was considerably better in the "Hint" condition in which six of the eight subjects solved the critical problem. A Chi Square test revealed significant differences among the four conditions, $\chi^2(3, N = 28) = 10.00$, $p = .019$. A significantly higher proportion of subjects solved the problem in the "Hint" condition than in either the "Uninterrupted" condition, $\chi^2(1, N = 16) = 4.00$, $p = .046$ or the "Interrupted" condition, $\chi^2(1, N = 16) = 4.00$, $p = .046$. Therefore, the message about how using a strategy for difficult problems may make a subsequent easy problem difficult to solve appears to have facilitated solving the problem. There is, however, evidence that giving subjects knowledge about the phenomenon is not as helpful as not having induced the set in the first place $\chi^2(1, N = 6) = 6.00$, $p = .014$.

The results of this experiment suggest that information presented about the Einstellung phenomenon can facilitate movement from a complex domain to a simpler domain. Most of the subjects were able to recognize the difference between the hypothesis domains they were testing during the Einstellung and the hypothesis domains they had begun with on the first problem. The next question we are planning to investigate is whether training about the Einstellung phenomenon before the set-inducing problems helps to "inoculate" against Einstellung from occurring on the critical problem. If it does, we are interested in the temporal and contextual constraints involved. It may be that explicit training about Einstellung should be a regular part of the education of electronics technicians, computer programmers, and anyone involved in problem diagnosis. At a minimum, diagnosticians should be taught to look for simple solutions and to test hypotheses that are easy to test before testing complex and difficult to test hypotheses.

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