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PSYCHOLOGICAL AND EDUCATIONAL FACTORS IN TRANSFER OF TRAINING, PHASE II. HOW CONSCIOUS IS TRANSFER OF A SPECIFIC RULE. TECHNICAL REPORT 6.

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DESCRIPTORS- *TRANSFER OF TRAINING, *LEARNING PROCESSES, *COGNITIVE PROCESSES, RETENTION STUDIES, *LEARNING ACTIVITIES, *PSYCHOEDUCATIONAL PROCESSES, MODELS,

TO DETERMINE THE SPECIFIC MECHANISMS THROUGH WHICH TRANSFER OCCURS, THIS STUDY INVESTIGATED TRANSFER RESULTING FROM THE LEARNING OF A SPECIFIC RULE OR PROCESSING FORMULA. PREVIOUS RESEARCH WAS COMBINED INTO A TENTATIVE THEORY OF TRANSFER WHICH WAS TESTED AND ASSESSED BY FOCUSING ON BOTH TRIALS-TO-CRITERION AND VERBAL REPORTS AS MEASURES OF TRANSFER. THE THEORY INVESTIGATED WAS--WHEN A RULE HAS BEEN LEARNED, IT EXISTS IN SOME FORM IN THE LEARNER'S MEMORY. THIS LEARNING WILL HAVE INFLUENCE ON LEARNING IN A NEW SITUATION ONLY IF A TRANSFER HYPOTHESIS AND A TRANSFER INTENTION ARE FORMED. TWO TASKS WERE PRESENTED. IN THE FIRST TASK, A RULE WAS LEARNED AS APPLIED TO ONE SET OF STIMULI. IN THE SECOND TASK, THE SAME RULE WAS PRESENTED ALONG WITH ALTERNATIVE RULES AS POTENTIAL SOLUTIONS TO THE TASK. FINDINGS BASED ON THE STATISTICAL ANALYSIS OF ERRORS MADE BY THE GROUP TAUGHT RULE 1 AND THE GROUP TAUGHT RULE 2 INDICATED THAT THE SECOND RULE WAS MORE DIFFICULT TO LEARN AND USE. IN ADDITION, ANALYSIS OF VARIANCE OF TWO TIME-MEASURES FOR THE TRAINING TASK SUPPORT THE CONCLUSION THAT RULE 2 WAS THE MORE DIFFICULT. WHEN TRIALS-TO-CRITERION ALONE WAS USED AS THE CRITERION OF TRANSFER, IT APPEARED THAT THERE WERE NO TRANSFER-WITHOUT-AWARENESS EFFECTS AND THAT TRANSFER OF A SPECIFIC RULE COULD BE EXPLAINED SOLELY IN TERMS OF POSITIVE TRANSFER HYPOTHESES AND TRANSFER INTENTIONS. USING TYPE-OF-SOLUTION AS A FURTHER CRITERION OF TRANSFER DID NOT CHANGE THIS GENERAL CONCLUSION. IT WAS CONCLUDED THAT MEASURES OF THE LEARNING PROCESS SEEMED TO BE THE MOST POWERFUL CRITERIA FOR DETECTING TRANSFER EFFECTS. (GD)

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Psychological and Educational Factors in
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[1]Submitted in partial fulfillment of the requirements for the degree of Doctor of Philosophy in Psychology in the Graduate College of the University of Illinois, 1965.

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How conscious is transfer of a specific rule?

Transfer can be defined as "the effect of a preceding activity upon the learning of a given task" (Osgood, 1953), or as a "change in ability to deal with situations not encountered during training" (Cronbach, 1963). According to the latter author, transferable outcomes include specific actions, specific facts, broad concepts and generalizations, techniques of analyzing situations, attitudes toward the subject or situation, and even attitudes towards oneself. Though Osgood's definition of transfer emphasizes learning whereas Cronbach's emphasizes ability, the difference between the two need not be more than this matter of emphasis. Learning and changes in ability can be viewed as two sides of the same coin. Anything learned, if it is transferable, is a change in ability, and most changes in ability are the result of some new transferable learning.

Problem

The present study is concerned with transfer resulting from the learning of a specific rule or processing formula. In the first task, the rule was learned as applied to one set of stimuli; in the second task, the same rule and other alternative rules are potential solutions. The question was: What are the specific mechanisms through which transfer occurs?

Transfer Mechanisms

Why transfer occurs when it does is an interesting problem. The idea that the transfer of specific rules is not automatic is certainly not a new one. Judd (1927) stated it long ago. In fact, the problem of how to teach for transfer is one which has constantly plagued educational psychologists.

Two contemporary psychologists have been offered suggestions:

> Transfer of a behavior pattern to a new situation is likely to occur whenever the person recognizes the new situation as similar to other situations for which the behavior has been appropriate. (Cronbach, 1963).
>
> Perhaps the most important single determinant of the amount of transfer that is possible, and that we usually can do something about, is the knowledge, on the part of the learner, that what he is learning can be transferred. (Deese, 1958).

Both suggest that the learner must know that what he is learning, or has learned, is applicable to new situations, and he must be able to recognize these new situations when they occur. The term "recognition" seems to imply some type of conscious process. However, no experiment seems to have deliberately investigated whether the mechanisms of transfer are conscious processes.

Awareness in learning. The role of awareness in human learning has recently been rekindled into an issue in learning theory. One group of studies has reported learning without awareness in verbal operant conditioning. These studies have been reviewed by Adams (1957), Krasner (1958), Salzinger (1959), and Eriksen (1960). As some of the reviewers have pointed out, the questions asked often seem inadequate and the criteria of awareness are sometimes vague and arbitrary. Critical studies of learning without awareness have appeared in the areas of verbal operant conditioning (Dulany, 1961, 1962; Spielberger, 1962), and motor operant conditioning (Paul, Eriksen & Humphreys, 1962). With more adequate questioning, better criteria of awareness, and recognition of correlated hypotheses, negative results have been reported.

The major theory resulting from the recent controversy about learning without awareness was proposed by Dulany (1962). This theory is one of propositional verbal control of behavior under selective reinforcement.

The name of the theory could be misleading. It does not state that words or covert speech control behavior. It states that intra-organismic processes or conscious states, called "hypotheses" and "intentions" control overt behavior. Though these conscious processes are assessed by verbalizations, in the learner's awareness they may be completely verbalized, only partially verbalized, or merely cognitive-neural. The criterion of awareness is the learner's ability to verbalize specific hypotheses or intentions when questioned. The theory is neutral with respect to idiosyncratic differences in conscious states.

Awareness in transfer. Three earlier studies suggest not only that there are conscious processes involved in some types of transfer, but that these processes are somewhat analogous to those proposed by Dulany in his theory. Ruger (1910) distinquished automatic from non-automatic transfer by asserting that the latter is dependent on an act of analysis or conscious control. While investigating the solution of a set of mechanical puzzles, he observed that "it is not the mere occurrence of a variation but its conscious continuance" which leads to quick solutions. In other words, a possible behavioral hypothesis (something that the learner considers testing or trying) does not become actually useful unless it is consciously pursued. Barker (1932) found that a hint to relate a second finger maze to an already learned maze produced faster solutions of the second maze. He explained the difference in terms of "factory," which he called "knowledge of a pattern relationship" or "a general idea which would serve as a control."

Partial transfer. Stolurow & McHale (1965b) found that transfer of rules is a highly complex phenomenon. Their results suggest that transfer is not automatic, that it can occur at various times, and that there are individual differences in the manner in which it occurs. For example, if the rule learned in training is a complex one, it need not be transferred in toto. That is, a S might transfer the cues alone, the principle alone, or anything else which is dissociable from the total rule. However two things in their study make the results difficult to interpret. Negative transfer occurred, which was difficult to handle within the context of the task. Since information about conscious transfer was obtained in post-experimental interviews, it is posssible that these after-the-fact reports might not accurately reflect the transfer process as it actually occurred. It would be better if they could be obtained simultaneously with the process itself.

Theory

Suggestions from three preceding experiments were combined into the tentative theory outlined in Figure 1 which was tested in the present experiment. This theory is analogous to that of Dulany (1962), and was stimulated by his thinking. When a rule has been learned, it exists in some form in the learner's memory. But this prior learning will have influence on learning in a new situation only if a two-stage process occurs. This two-stage process includes both a transfer hypothesis (TH) and a transfer intention (TI). A "transfer hypothesis" can be described as the learner saying something like the following to himself: "I wonder if situation B is somehow or other related to situation A." But a transfer hypothesis alone is not sufficient for prior learning to have influence in a new situation. The learner might well decide against attempting to relate the new situation to an old one. Prior learning has an effect on the new situation only if a transfer intention accompanies the transfer hypothesis.

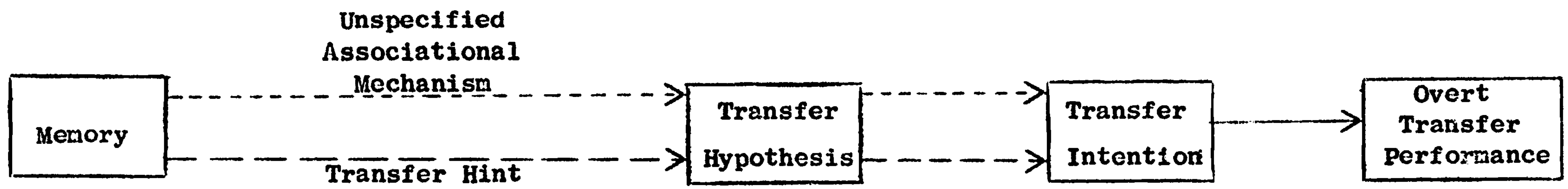

Fig. 1. Flow diagram of the tentative theory tested in this experiment.

A "transfer intention" is the actual conscious attempt to use old knowledge in a new situation. This "actual attempt to relate" may itself be temporary if the learner is not successful in finding a relationship. That is, the learner might decide to stop trying to relate the situations.

Ordinarily transfer hypotheses would seem to arise through some unspecified associative mechanism. If they are conscious processes; however, they also should be produced by instructions. That is, a transfer hint, similar to that given by Barker (1932), should produce both a transfer hypothesis (TH) and a transfer intention (TI). A higher proportion of Ss given such a hint should report transfer hypotheses and transfer intentions, and consequently groups given such a hint should solve the transfer task faster. Furthermore, within groups given a transfer hint, fewer Ss should report a transfer hypothesis without an accompanying transfer intention since the whole idea of transferring was given by E and not self-generated.

To test this theory, it is necessary to use some new dependent variables as measures of transfer. The customary measure, trails to criterion, is not the whole story. It is possible that a learner can attempt to relate prior learning to a new situation without being very successful. Yet his approach to the new situation would still show the influence of prior learning. If transfer is defined as any influence of specific prior learning on behavior in a new situation, trials to criterion is not a completely satisfactory measure. It must be supplemented with other measures of the learning process in the transfer situation such as verbal reports. Both trials to criterion and verbal reports were analyzed in this study.

The effect of verbalizations on performance can vary. Gagne & Smith (1962) found that performance was improved, while Stevenson & Weir (1963) and Toda (1962) found no difference in performance. Improvement was found with the "tower of Hanoi" problem, not with probability learning tasks. It is difficult to think of any *a priori* reason why thinking aloud should have any biasing effect on transfer in the present experiment in which all *Ss* including those in the control group were encouraged to think aloud and were required to give trial-by-trial hypotheses.

Method

Design. Forty-eight *Ss* were trained to criterion with each of the two training rules for a total of 96 experimental *Ss*. Twenty *Ss* in each training-rule group were given a transfer hint; the other 28 *Ss* in each group were not given this hint. Each subgroup had an equal number of males and females. Therefore this was a 2 x 2 x 2 (pretraining rule x sex x knowledge of the relatedness of the two tasks) design with 10 *Ss* in each transfer-hint cell, and 14 *Ss* in each no-transfer-hint cell. Besides the 96 experimental *Ss*, there were 32 control *Ss* with no relevant pretraining.

Subjects. About half of the *Ss* in the experiment participated as part of a course requirement for Introductory Psychology. The other half were fairly evenly divided between volunteers from other undergraduate psychology courses and paid volunteers. Three female *Ss* could not understand the rule for the training task, and refused to continue in the experiment on the grounds that numerical problems were too difficult for them. These three *Ss* were replaced. It is assumed that dropping these three *Ss* contributed to reducing group differences between males and females.

Task Model

The training and transfer tasks were generated from the same task model. The training task, originally developed by Azuma (1960), was used in a modified form (Stolurow & McHale, 1964a). The transfer task, developed by Mattson (1963), was also modified to suit the purpose of the present study.

Training task. An example of a stimulus from the training task is given in Figure 2. The concept to be learned is the k-ness of each stimulus. The k value of a stimulus can be any whole number from 3 to 12, and so there are 10 possible answers. The circle and square can appear in any row and any column. The rows and columns are numbered from 1 to 4 from bottom to top and left to right respectively. Hash marks on the frame are included to eliminate S's need to estimate the row and column values. In E's task model, the column values of both the circle and square are relevant, whereas their row values are irrelevant.

Instructions - learning task. In the present experiment, Ss were instructed to solve the training task in either one of two ways. Both of these solutions had been used by various Ss in a previous experiment (Stolurow & McHale, 1965a). Subjects were given written instructions explaining the task model together with the particular rule they were to use; some examples showing the correct application of the rule were also included. The two rules were:

1) k = 2(column number of the circle) + 1 (column number of the square)

2) k = 3(column number of the circle) ± the number of columns from the circle to the square

+, if the circle is to the left of the square

-, if the circle is to the right of the square

These two rules are perfectly correlated. That is, they both generate the same numerical answer for any stimulus.

Transfer task. An example of a stimulus from the transfer task is given in Figure 3. Again the concept to be learned is the k-ness of each stimulus; k can be any whole number from 3 to 12. A circle, square, triangle, and

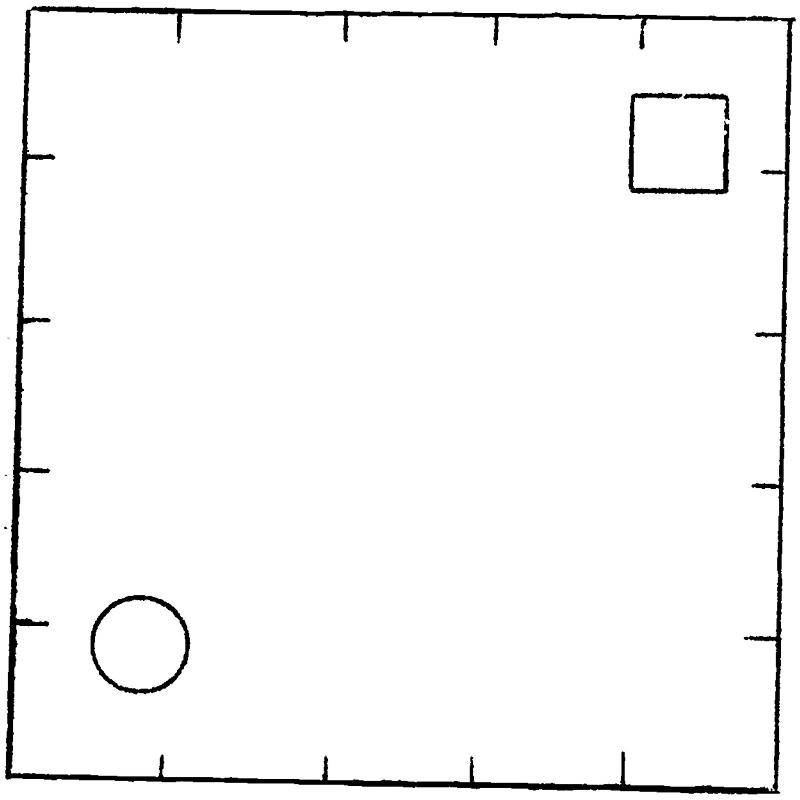

Fig. 2. A typical stimulus display of the training task.

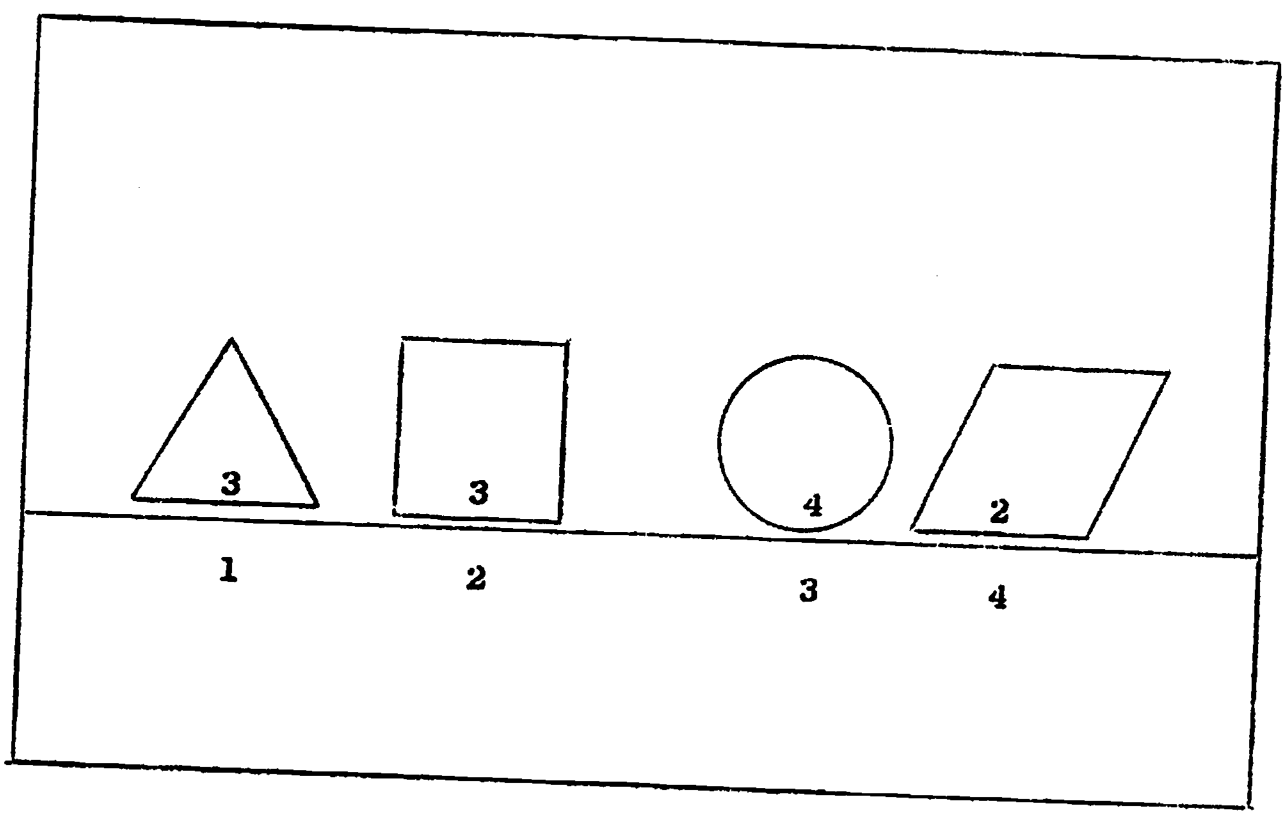

Fig. 3. A typical stimulus display of the transfer task.

rhombus appear on each stimulus card. Either a 1, 2, 3, or 4 appear in each figure; any number can appear in any figure. Each figure can appear in any of the four positions, counting from left to right. Either the <u>numbers</u> within the figures or the <u>position</u> of the figures can replace the row and column values of the training task. The figures are relevant in pairs. The position of the circle and square are relevant; the numbers within the triangle and rhombus are relevant. That is, the displaces were so designed that any of three rules would generate the same numerical answer for any one of them. Two of these rules are related to the position of the circle and square and are direct counterparts of the two training rules. The third is related to the numbers within the triangle and rhombus. The three rules are:

1) 2(position of the circle)+ 1(position of the square)

2) 3(position of the circle) ± the number of positions from the circle to the square

   +, if the circle is to the left of the square

   -, if the circle is to the right of the square

3) 2(number in the triangle) + 1(number in the rhombus)

These rules will be called 2CS, 3CS, and 2TR. It was impossible to design a counterpart using the numbers in the triangle and rhombus for 3CS. To do so would have eliminated all but a few of the possible cards.

Procedure

<u>Training.</u> Each <u>S</u> was run individually. After <u>E</u> explained that the experiment involved the investigation of <u>S</u>'s manner of problem solving and that it would be explained afterwards, <u>S</u> was given a set of written instructions for either training Rule 1 or training Rule 2. When <u>S</u> finished read-

the instructions, he answered a set of questions about the relevant points in them. (The written instructions for both Rules 1 and 2 plus the set of questions for each can be found in Appendices A and B). If S answered any of the questions incorrectly, the correct answer was explained to him. The following instructions were then read by E:

> Here is a card with all of the possible values of k. I would like you to think aloud during this problem as you figure the answer for each card. This should not be too difficult since it's just a matter of applying the rule that was explained in the instructions. We'll continue until you give me 12 consecutive correct answers. So take your time and try to be as accurate as possible. I'll give you one card at a time, and I'll tell you the correct answer after you have given me yours. Here is some scrap paper if you think it is necessary. You may use it only for calculating purposes. That is, you may not keep a record of past figures or past correct answers. Are there any questions?
> You may refer to the instruction booklet at any time. Perhaps you would like to open it to the page on which the correct formula is given. Remember to think aloud as you work.

Both numerical answers and the formulas were recorded. The criterion of 12 consecutive correct answers (correct rule plus correct numerical answer) supplied evidence that S understood the rule. If S made a mistake related to a misunderstanding of the rule, E tried to correct his erroneous thinking since the purpose of the training task was to teach the rule and not to test how well the task instructions communicated. If S made a calculating mistake while using the correct rule, he was encouraged to strive for accuracy. The purpose of thinking aloud was twofold: 1) to detect any insights into other ways of solving the task, and 2) to get S accustomed to thinking aloud since this was a necessary part of the transfer task. No S discovered an alternate solution to the training task. When S attained criterion, all materials from the training task were removed and E immediately read the instructions for the transfer task.

Transfer task. E read the following instructions aloud while S read a second copy silently:

Here is a new problem. These are samples of the cards. Notice that there are four geometrical figures on each card: a rhombus, a circle, a square and a triangle. (Point to each figure on one card.) The geometrical figures can appear in any order on the cards. That is, each figure can be in either the first, second, third or fourth position, counting from left to right. (Describe the positions of one card). There is a number inside of each geometrical figure; the numbers range from 1 to 4. Any number can appear in any geometrical figure. Both the position and the number of a particular figure will vary from card to card.

Again you have to decide how much k-ness each card has. K can again be any whole number from 3 to 12. It can't be less than 3 or greater than 12, and it can't be a fraction or decimal, only a whole number. K is our arbitrary name for some numerical concept. There is a correct formula by which k is computed. The same identical formula applies to every card. It is your task to find this formula and use it correctly. You'll find it by giving me an answer (you'll have to guess on the first one), and then I'll tell you the correct answer and let you study the card to see how I might have obtained that particular answer. Are there any questions about the cards or the problem?

During this problem I'd like you to think aloud as much as possible. I'm interested in what goes on in your mind as you attempt to solve it, and I won't find out much about this unless you tell me. So try to tell me what you're considering, any conclusions you might come to, and any hunches or good guesses you might have. Since I'm not much of a mind-reader, don't think anything is too obvious to say aloud.

When I give you a card, you can answer as soon as you want, but if you don't answer within 30 seconds, I'll tell you to give an answer even if you have to guess. Think aloud during this time and tell me how you're getting the numerical answer you're testing. You may guess if you want, but please don't tell me you're guessing unless your answer has nothing to do with the position or numbers of the figure on the card. Then I'll tell you the correct answer, and you'll have 1 and 1/2 minutes to study the card. I'll warn you when there are 15 seconds left. If it takes you less than 1 and 1/2 minutes to decide on the formula you want to test next, just ask for the next card.

You may not use scrap paper at all during this problem. You'll have to do it all in your head. I know this is difficult, but some people would make better use of the scrap paper than others, and this would make the problem easier for them. Are there any questions about the procedure?

Remember that the position of each figure and the number within it changes from card to card. Not all of this information is necessarily used. Try to think aloud as much as possible. The experiment will not be a success unless you do this.

If any S asked about information contained in the instructions, that information was re-explained. But if a S asked about information not given in the instructions, he was told: that is a good question to ask yourself. For control Ss all mention of a first problem was omitted. If S was in a transfer-hint group, the following instruction was read just before the task began:

> There's one hint I would like to give you. This problem with the second deck of cards is related to the first problem with the first deck of cards (show one). If you keep that first problem in mind, you should be able to solve this problem much more quickly.

This hint was typed on a card which was placed directly in front of S on the table.

Task hints. Task hints were given to all Ss in all groups three times during the problem, unless the problem had been solved by these times. The task hints were given so that all Ss would solve the problem in a reasonable amount of time. The three hints were given at trials 10, 20 and 30. They were:

> At trial 10--Since this is a difficult problem, I will give you hints periodically. The first hint is this: there are only two figures which are relevant on each card. Two figures are relevant and you use them; two are irrelevant and you don't use them at all. The same two figures are relevant on each card.
>
> At trial 20--I want to give you a final hint at this time. The correct formula for k is:
>
> $$2a + b$$
>
> That is, you multiply one relevant figure by two, and then add the second relevant figure. You'll have to discover what a and b are.
>
> At trial 30--Position is entirely irrelevant in this problem. First, second, third and fourth positions don't count. It's the particular figures with particular shapes that count. With the approach you've been using you'll never solve the problem.

Since the task hints were given as soon as S gave his answer for cards 10, 20 and 30, he was able to study those cards in the light of them. These hints were also typed on cards and given to S to keep. The Ss were forced to use the hints in the sense that E reminded them of the hint if they failed to use it on subsequent cards. The hint at trial 30 was included because of two Ss who persisted in using formulas such as: 2(number in the first figure) + 1(number in the third figure). No task hint was given until trial 10 so that it was possible to investigate Ss' spontaneous approaches to the problem when they knew nothing about the task model. The criterion for the transfer task was four consecutive correct responses (correct formula plus correct numerical answer).

If an S made a calculating mistake while thinking aloud in the 1 and 1/2 minutes he had to study the card after feedback had been given, E asked him to check that formula again. Because of this technique, there might have been a small facilitating effect which was indirectly an effect related to verbalization. This type of monitoring is impossible if Ss do not think aloud.

The following questions were asked after S had attained criterion:

1) Did you notice any other formula that would have worked besides the one you have been using?

2) Did you think of the first problem with the first deck of cards while you were attempting to solve this second one? If so, what did you think of, and approximately when? (E made it clear to S that the question referred to the time before solution--not when the correct solution was discovered or when this question was asked.)

The purpose of the first question was to detect any other correct formula that S might have noticed but not mentioned in thinking aloud or responding to each card. The purpose of the second question was to determine how well the experimental technique of thinking aloud detected transfer when it occurred. The information was used to supplement that obtained by S's spontaneous verbalizations during the task itself.

Transfer elements and the task model. The experiment was so designed that any transfer which occurred was positive. Both pretraining rules can be broken down into transfer elements. This logical analysis into transfer elements is in no way meant to suggest that the pretraining formula cannot be transferred as a unit. But these elements are logically dissociable from the complete rule, and on the basis of pilot work, Ss do dissociate parts of the complete formula when they transfer. The transfer elements from each pretraining rule are presented in Table 1.

Horizontal position means using the position of a figure (rather than the number inside it) to determine its value. Relative horizontal position means using the position of one figure in relation to another in order to determine whether to add or subtract a constant and how large the constant should be. A third use of position is possible in the transfer task. This third use is exemplified by the formula: add the numbers in the first three figures. The numbers within the figures are added, but no consideration is given to the particular figures which appear in these positions. This use of position is unrelated to the task model, and so it is called irrelevant position. The third task hint was given to eliminate the use of irrelevant position.

Control task. For a warm-up task and to introduce them to thinking aloud, the Control Ss solved items from Raven's Progressive Matrices Test (1938) for 10 minutes before the transfer task was begun. Ten minutes was the best estimate of the amount of time required for the whole pretraining of experimental Ss. Since pretraining Rule 2 seems to be more difficult to grasp and use than pretraining Rule 1, half of the control Ss were given "easy" items; half were given "difficult" items. The easy items were subtests A, B and C. The difficult items were subtests D and E. The control group was split this way to see whether an "easy" or "difficult" set for the second problem would develop. Control Ss were encouraged to think aloud

Table 1

Transfer Elements from Each
Pretraining Rule

Rule 1	Rule 2
1) Circle and square	1) Circle and square
2) 2 to 1 weighting	2) 3 to ± 1, ± 2, ± 3 weighting
3) Use of only two figures	3) Use of only two figures
4) Horizontal position	4) Horizontal position
	5) Relative horizontal position

during the warm-up task. With prompts if necessary, they were successful with each item, but E would occasionally mention how "easy" or "difficult" the items were. Since there were no time limits on particular items and E allowed S to proceed more or less at his own pace, the data for this warm-up task were not analyzed. The procedure with control Ss was identical to that of experimental Ss for the transfer task.

Experimental Hypotheses

Based on the tentative theory being tested in this study, the following predictions about the results were made. Predictions were made in terms of three dependent variables: trials to criterion, type of solution, and various verbal process measures.

Trials to criterion. 1) The effect of the pretraining rule plus its interaction with the transfer hint will be slight, if there is any. 2) The transfer-hint groups will solve faster than the no-transfer-hint groups. 3) There will be no difference between Ss without a transfer intention (those who do not consciously transfer) and control Ss.

Types of solution rules. 1) There should be a significant difference between groups trained with Rule 1 and Rule 2, with 3CS solutions appearing only among the latter group. 2) Analyzing the two training-rule groups separately, there should be no difference between Ss given a transfer hint and Ss who were not, but who report a transfer intention. 3) There should be no difference between Ss not reporting a transfer intention and control Ss.

Process measures. The process measures of most interest are those related to the task model such as the number of figures used, the particular figures used, types of weighting used, and whether horizontal position and relative horizontal position are used. 1) Among Ss reporting a transfer intention, there should be no difference between those given a transfer hint and those not given this hint if they were trained with the same rule.

2) There should be no difference between *S*s not reporting a transfer intention and control *S*s, and the learning processes of neither group should be highly related to *E*'s task model.

Results

Training Task

Because of *E*'s experimental procedure of trying to clarify difficulties whenever they occured, the trials-to-criterion measure for the training task was not analyzed.

Rule difficulty. Of the 48 *S*s taught Rule 1, only 7 made a total of 8 errors; of the 48 *S*s taught Rule 2, only 17 made a total of 24 errors. The difference in number of *S*s making errors with the two rules was signigicant ($X^2 = 4.50$, $p < .05$). Apparently the second rule was more difficult to learn and use.

Analysis of variance of two time measures for the training task support the conclusion that Rule 2 was the more difficult. The two time measures were: (1) time required to read the instructions and fill out the set of questions for them; and (2) time required to attain criterion--12 consecutive correct answers using the correct formula. Both were analyzed in a 2 x 2 (training rule x sex) analysis of variance. Means and standard deviations for each analysis are presented in Tables 2 and 4, respectively. The analysis are summarized in Tables 3 and 5, respectively. Type of rule was significant in both analyses; it took longer both to read the instructions and answer questions, and to attain criterion for Rule 2. The fact that Rule 2 seemed more difficult than Rule 1 supports the idea

Table 2

Means and Standard Deviations of Time Required to Read Instructions and Answer Questions for the Training Task

Groups	Mean	n	Standard Deviation
Rule 1			
Males	5.6[a]	24	1.06
Females	6.6	24	1.69
Rule 2			
Males	7.3	24	1.83
Females	8.4	24	1.33

[a]Means are correct to the nearest tenth of a minute

Table 3

Analysis of Variance of Time Required to Read Instructions and Answer Questions for the Training Task

Source	df	MS	F
Rule	1	71.24	31.4***
Sex	1	27.62	12.2***
Rule x sex	1	0.02	00.0
Within	92	2.27	
Total	95		

***Significant at .001 level

Table 4

Means and Standard Deviations of Time Required to Attain Criterion in the Training Task

Groups	Mean	n	S.D.
Rule 1			
Males	1.9[a]	24	0.75
Females	2.3	24	1.05
Rule 2			
Males	2.9	24	1.36
Females	3.3	24	1.41

[a]Means are correct to the nearest tenth of a minute

Table 5

Analysis of Variance of Time Required
to Attain Criterion in the Training Task

Source	df	MS	F
Rule	1	24.91	17.8***
Sex	1	3.88	2.8
Rule x sex	1	0.03	0.0
Within	92	1.40	
Total	95		

***Significant at the .001 level

of dividing control Ss into "easy" and "difficult" warm-up groups, since it is possible that a set for difficulty level did develop.

Transfer Task

Sex differences. Of the 24 Ss who did make mistakes 15 were males. The difference in the number of each sex making mistakes was not significant ($X^2 = 1.39$, $p > .20$). It took the females significantly longer to read the instructions, but not to attain criterion with Rule 2.

The results of the transfer task were analyzed in terms of three dependent variables: trials to criterion, type of solution, and various measures of the learning process. To test the experimental hypotheses, Ss were categorized into those who reported transfer hypotheses and transfer intentions and those who did not. These categorizations were based both on the spontaneous verbalizations during the task and the post-experimental interviews. For example, if an S did not spontaneously verbalize a transfer hypothesis (TH) or a transfer intention (TI) during the task but did so during the interview afterwards, he was still categorized as positive in that particular category. This supplementary use of the interviews seemed justified for two reasons: (1) the Ss were not trained to verbalize and they could not be instructed to verbalize transfer information; and (2) the proportion of Ss classified as positive TH or TI solely on the basis of the post-experimental interview was not different for the transfer-hint and no-transfer-hint groups. Given the assumption that Ss in the transfer-hint group did consciously transfer since they had the transfer hint on a card in front of them, then the proportion of Ss in that group who spontaneously verbalized transfer information during the task can be used as a base rate to justify the use of such information in categorizing no-transfer-hint Ss.

In the transfer-hint group, 33 Ss reported a TH during the task, 7 Ss afterwards; in the no-transfer-hint group, 20 Ss during the task, and 7 Ss afterwards. This difference was not significant ($X^2 = 0.30$). In the transfer-hint group, 33 Ss reported a TI during the task, 7 Ss afterwards; in the no-transfer-hint group, 18 Ss during the task, and 6 Ss afterwards. This difference was not significant ($X^2 = 0.15$).

No matter whether they were given a transfer hint or not, Ss were classified as positive TH or positive TI if their reports fit the stated descriptions. In positive TH, at some time or other during the transfer task, the S wondered whether the second task might not be related to the first task. In positive TI, the S consciously attempted to use what was learned in the first task while solving the second task. The positive TI category is a gross classification since it ignores finer discriminations such as how and when and how long an S attempted to relate the two tasks. Two Ss who were classified as positive TI reported a temporary TI which was abandoned when unsuccessful. Among the other positive TI Ss, there were obvious differences in the time and manner in which they related the two tasks, but no meaningful categories could be found which would take this information into account.

The number of Ss in each experimental group classified as positive or negative for both TH and TI is given in Table 6. Of the transfer-hint Ss, all 40 reported both a positive TH and a positive TI. Of the 56 no-transfer-hint Ss, 27 reported a positive TH, 24 a positive TI. There was a significant difference between these two groups in the number reporting a positive TH ($X^2 = 27.3$, $p < .001$) and a positive TI ($X^2 = 31.8$, $p < .001$). This difference was predicted. Furthermore, no-transfer-hint S reported a positive TH without a corresponding positive TI, whereas there were three no-transfer-hint Ss who did. This higher degree of correspondence for transfer-hint Ss was also predicted.

Table 6

Number of Ss Classified as Positive and Negative TH and TI in Each Experimental Group

Group	TH Pos.	TH Neg.	TI Pos.	TI Neg.
Rule 1				
Transfer hint				
Males	10	0	10	0
Females	10	0	10	0
No transfer hint				
Males	6	8	6	8
Females	6	8	5	9
Rule 2				
Transfer hint				
Males	10	0	10	0
Females	10	0	10	0
No transfer hint				
Males	9	5	8	6
Females	6	8	5	9

<u>Trials to criterion.</u> The dependent variable for these analyses was the number of trials up to, but not including, the four criterion trials (trials on which correct answers and correct formulas were given). An analysis of variance was performed on trials to criterion for the basic experimental groups. Means, standard deviations, ranges and cell frequencies for this analysis are given in Table 7. A summary of the analysis is given in Table 8. The only significant main effect was transfer hint. No other main effect and no interaction was significant.

Pooling positive TH across training rule and sex, the mean and standard deviation for transfer-hint <u>S</u>s were 5.85 and 6.1; for no-transfer-hint <u>S</u>s, they were 8.41 and 7.7. For positive TI, the mean and standard deviation for transfer-hint <u>S</u>s were 5.85 and 6.1; for no-transfer-hint <u>S</u>s, they were 6.92 and 6.8. There was no significant difference between these transfer-hint and no-transfer-hint <u>S</u>s for either TH (t = 1.55) or TI (t = 0.63). This lack of difference was predicted. Means, standard deviations, ranges and cell frequencies for these pooled TH and TI classifications are given in Tables 9 and 10.

Granted that the transfer hint did have a significant effect, the question still remains whether it had this effect through the mediation of conscious cognitive processes. To answer this question, it is necessary to examine the relationships of sex, training rule, transfer hint, TH, TI, and trials to criterion. The matrix of intercorrelations of these variables is given in Table 11. Since there was so significant difference between transfer-hint and no-transfer-hint <u>S</u>s categorized as positive TH and TI, these <u>S</u>s were pooled for all correlations. All correlations in this matrix are phi-coefficients except for correlations with trials to criterion, which are point biserials. Only the correlations between the transfer hint, TH,

Table 7

Means, Standard Deviations, Ranges, and Cell Frequencies of Trials to Criterion for the Basic Experimental Groups

Group	Means	n	S.D.	Range
Rule 1				
Transfer hint				
Male	2.6	10	3.3	0 - 10
Female	7.2	10	7.7	0 - 20
No transfer hint				
Male	12.4	14	8.2	0 - 26
Female	12.8	14	6.4	5 - 24
Rule 2				
Transfer hint				
Male	7.1	10	5.8	2 - 21
Female	6.1	10	6.6	0 - 20
No transfer hint				
Male	11.4	14	9.7	0 - 24
Female	15.6	14	8.3	0 - 30

Table 8

Analysis of Variance of Trials to Criterion for the Basic Experimental Groups

Source	df	MS	F
Training Rule	1	37.5	0.68
Sex	1	104.2	1.89
Transfer Hint	1	1,238.6	22.44***
Rule x Sex	1	0.1	0.00
Rule x Hint	1	3.4	0.06
Sex x Hint	1	1.3	0.02
Rule x Sex x Hint	1	126.7	2.30
Within	88	55.2	
Total	95		

***Significant at the .001 level

Table 9

Means, Standard Deviations, Ranges and Cell Frequencies of Trials to Criterion for Positive and Negative Transfer Hypothesis Groups

Group	Means	n	S.D.	Range
<u>Rule 1</u>				
<u>Positive TH</u>				
Male	4.3	16	4.8	0 - 13
Female	8.3	16	6.9	0 - 20
<u>Negative TH</u>				
Male	16.2	8	7.9	1 - 26
Female	14.8	8	6.6	8 - 24
<u>Rule 2</u>				
<u>Positive TH</u>				
Male	7.0	19	7.3	0 - 21
Female	8.1	16	7.5	0 - 21
<u>Negative TH</u>				
Male	19.4	5	4.5	12 - 24
Female	18.8	8	7.1	8 - 30

Table 10

Means, Standard Deviations, Ranges, and Cell Frequencies of Trials to Criterion for Positive and Negative Transfer Intention Groups

Group	Means	n	S.D.	Range
Rule 1				
Positive TI				
Male	4.3	16	4.8	0 - 13
Female	7.6	15	6.5	0 - 20
Negative TI				
Male	16.2	8	7.9	1 - 26
Female	15.2	9	6.3	8 - 24
Rule 2				
Positive TI				
Male	6.3	18	6.6	0 - 21
Female	7.2	15	6.9	0 - 21
Negative TI				
Male	19.7	6	4.1	12 - 24
Female	19.5	9	6.7	8 - 30

Table 11

Intercorrelation Matrix of All Variables
with Each Other and with Trials to Criterion

	Sex	Rule	Hint	TH	TI	Trials to Criterion
Sex		.00	.00	.07	.09	.13
Rule			.00	-.07	-.04	.08
Hint				.56*	.60*	.44*
TH					.93*	.57*
TI						.64*

*Significant at the .01 level

TI and trials to criterion were significant. Notice the following points:

1) The order of magnitude of the significant correlations with the criterion is as predicted: TI (.64) is higher than TH (.57) which is higher than the transfer hint (.44).

2) Since of the 67 Ss who reported a positive TH only three did not report a positive TI, the correlation between TH and TI is very high (.93).

3) Since the three Ss who reported a positive TH without a corresponding positive TI were all in the no-transfer-hint group, the correlation between transfer hint and TI (.60) is higher than between transfer hint and TH (.56).

Since the multiple correlation of all variables with the criterion is .66, in a purely predictive sense the use of TI alone is almost as good as using all possible variables.

In order to test for intrinsic relationships with the criterion, each variable was correlated with the criterion with all other variables partialled out. These partial correlations were: sex (.10), training rule (.13), transfer hint (.10), TH (-.08), and TI (.32). Since only the last correaltion is significant, only TI is intrinsically related to the criterion. This correlation is greatly reduced because of the high degree of correspondence between TH and TI. The correlation of TI and the criterion with all variables except TH partialled out is .52. It seems improbable that "deciding not to pursue a transfer hypothesis" would ever be a common phenomenon given this experimental situation. Introduced to a novel situation, Ss are attempting to solve a complex problem with no leads to follow except what they have learned in the first task.

An analysis of variance (difficulty level of warmup task x sex) of trials to criterion for the control group was also performed. The means, standard deviations and ranges for subgroups are given in Table 12; the summary of the analysis is given in Table 13. Since there were no significant

Table 12

Means, Standard Deviations, Ranges, and Cell Frequencies of Trials to Criterion for Subgroups of the Control _S_s

Group	Mean	n	S.D.	Range
"Easy" warmup task				
Male	17.4	8	4.6	12 - 24
Female	17.4	8	4.0	10 - 30
"Difficult" warmup task				
Male	19.8	8	4.0	13 - 23
Female	19.5	8	4.9	12 - 25

Table 13

Analysis of Variance of Trials to Criterion
for Subgroups of the Control Ss

Source	df	MS	F
Sex	1	0.3	0.01
Difficulty level (warmup task)	1	42.8	1.54
Difficulty level x Sex	1	0.3	0.01
Within	28	27.8	
Total	31		

differences, the data for the four groups were pooled in order to test controls against experimental Ss classified as not having consciously transferred. The latter Ss were those categorized as negative TI. Since there was not a significant difference between negative TI Ss trained with Rule 1 as opposed to Rule 2 (t = 1.59), all negative TI Ss were also pooled for the test against control Ss. There was no significant difference between control Ss and negative TI Ss (t = 0.79), and so no transfer without awareness appeared in the analysis of mean differences. However, four negative TI Ss solved the transfer task before the first task hint (given at trial 10) whereas none of the control Ss did so. Three of these negative TI Ss were trained with Rule 1, the other with Rule 2. All solved in 8 trials, except one who solved in 1 trial. He was trained with Rule 1. Thero was at least this one difference between the two groups.

Though there was no significant mean difference between control Ss given "easy" or "difficult" warmup items, there was a trend in the predicted direction with a mean of 17.4 for the "easy" group and 19.7 for the "difficult" group. Furthermore, 10 of the 16 Ss in the "easy" group solved the problem before the second task hint (given at trial 20), whereas only 4 of 16 Ss in the "difficult" group did so. Though this difference was not significant (x^2 = 3.18 .10 > p > .05), there is a suggestion of different difficulty sets, but it would have to be investigated further. This same trend appeared among negative TI Ss with a mean of 15.7 for those trained with Rule 1 and a mean of 19.3 for those trained with Rule 2. However, there might be another explanation for this difference. This explanation will be given later.

Type of solution. In E's task model, three rules solved the transfer task. All but two Ss in the experiment solved the task with one of these three rules. The two Ss who did not, however, used a variation of the 2TR rule. One used 2(T + R) - R; the other used T + R + T. Both were classified as solving with 2TR. Only three Ss found more than one solution; they found both of the 2 to 1 weighting solutions (2TR and 2CS). Their solutions were categorized according to the rule actually offered when forced to give one or the other.

Table 14 summarizes the frequency with which each type of solution was used by Ss in each of the experimental groups and in the control group. To test for differences in frequencies among experimental groups, the males and females in each group were pooled resulting in a highly significant difference (X^2 = 55.72, with 6 df, $p < .001$). Groups trained with Rule 1 and those trained with Rule 2 used different solutions; those trained with Rule 2 were the only Ss solving with 2CS.

The experimental groups were reclassified for further analysis. The no-transfer-hint groups were split into Ss with positive and negative TI. In Table 15, positive TI Ss from transfer-hint and no-transfer-hint groups are compared and negative TI Ss are compared with control Ss. Subjects trained with Rule 1 or Rule 2 were not pooled in these tables. The difference between positive TI Ss and either negative TI Ss or controls is obvious. Notice that the similarity of frequency split between positive TI Ss with or without a transfer hint and the same similarity between negative TI Ss and controls is always better for Ss trained with Rule 2. This difference between the two training rule groups will be discussed later.

Various Measures of the Learning Process

Various questions can be asked about each S's trial-by-trial hypotheses. This analysis looked for subtle differences in the learning process which analyses of trials to criterion and type of solution did not detect. For example, among Ss who spontaneously verbalized transfer information, the mean trial on which

Table 14

Frequency of Type of Solution in Each Experimental Group and Each Subgroup of Control Ss

Group	2TR	2CS	3CS
Rule 1			
Transfer hint			
Males	3	7	
Females	3	7	
Total	6	14	
No transfer hint			
Males	7	7	
Females	5	9	
Total	12	16	
Rule 2			
Transfer hint			
Males	3		7
Females	2	1	7
Total	5	1	14
No transfer hint			
Males	6	1	7
Females	10	1	3
Total	16	2	10
Control group			
"Easy" warmup			
Males	6	2	
Females	8		
Total	14	2	
"Difficult" warmup			
Males	6	2	
Females	8		
Total	14	2	

Table 15

Frequency of Type of Solution
for Positive TI (Transfer Hint vs. No Transfer Hint)
and Negative TI vs. Controls

Groups	Rules 2TR	2CS	3CS
Rule 1 - Positive TI			
Transfer hint	6	14	
No transfer hint	5	6	
Total	11	20	
Rule 2 - Positive TI			
Transfer hint	6		14
No transfer hint	3		10
Total	9		24
Negative TI			
Rule 1	11	6	
Rule 2	13	2	
Controls	28	4	

these verbalizations first occurred was 1.88 for the 33 Ss given the transfer hint, 3.83 for the 18 Ss not given the transfer hint. This mean difference suggested possible process differences, at least on the early trials. Furthermore, it was possible that the pretraining had effects among negative TI Ss, even though these effects were not sufficiently facilitating to produce a significant difference from the controls in the earlier analyses.

Information contained in the trial-by-trial hypotheses was divided into the following four categories:

1) The relationship of verbalized formulas to numerical answers. That is, was the agreement between the verbalized formulas and the numerical answers close enough so that the verbalized formulas could be analyzed as a reliable measure of the learning process?

2) Task model. How justified would E be in using his own task model to analyze performance? Are there detectable differences in the task model used by Ss in the various groups at different times in the learning process?

3) Known response scale. How much use did Ss make of the instruction about the response scale--that k could only be one of the whole numbers between 3 and 12?

4) Use of prior information. How much use of prior information, available through feedback, did Ss incorporate into their responses on a given trial?

Relationship of verbalized formulas to numerical answers. Including all experimental and control Ss, there were only 10 trials on which the verbalized formulas did not generate the numerical answer given. Considering that there was a total (across Ss) of 1537 trials before the criterion trials with formulas offered on 1278 of them, there was disagreement on only 00.8% of the trials. This was a remarkably high degree of agreement (99.2% of the trials), particularly since Ss were not allowed to use paper and pencil to calculate their responses and E did not point out miscalculations until after the response was given.

Task model. Analysis of the task model was subdivided into analyses of 1) percent guessing (no formula given), 2) number of cues used, 3) type of cues used, 4) use of relative position, and 5) use of weighting.

Task model: percent guessing. The percent of Ss in each group who offered no formula was computed for each of the first two blocks of five trials. Percentages were based only on pre-criterion trials. For block 1 (trials 1 to 5) the percentages were 11% for positive TI (hint), 12% for positive TI (no hint), 11% for negative TI, and 24% for controls. For block 2 (trials 6 to 10) the percentages were 8% for positive TI (hint), 9% for positive TI (no hint), 15% for negative TI and 20% for controls. Since some of the control Ss had expressed confusion about what a "formula" might be, control and negative TI Ss in blocks 1 and 2 were compared. In block 1, the mean number of guesses for controls was 1.22, the mean for negative TI was 0.56 ($t = 2.18$, $p < .05$). In block 2, the mean for controls was 1.00, the mean for negative TI was 0.72 ($t = 0.90$). Control Ss guessed significantly more than negative TI Ss only in the first block of trials.

Task model: number of cues used. Number of cues refers to the number of figures (numerical value or position value) used in a formula. In the task model only two cues are relevant. Because the first task hint (at trial 10) specifically stated that only two cues are relevant, only the first 10 trials were analyzed. These 10 trials were divided into two blocks of 5 trials each. The dependent variable was the number of times only 2 cues were used. Means for each group in each block of 5 trials are given in Table 16. The analysis of variance (groups x blocks) is reported in Table 17. Group differences were significant beyond the .001 level ($F = 48.5$); there was no significant interaction. All groups were significantly different beyond the .01 level

Table 16

Mean Number of Uses of Only Two Cues for Each Group in Each Block of Trials

Group	Block I (Trials 1 - 5)	Block II (Trials 6 - 10)	Total
Positive TI (hint)	3.75	4.32	8.07
Positive TI (no hint)	2.33	3.25	5.58
Negative TI	1.03	1.72	2.75
Controls	0.62	0.97	1.59

Table 17

Analysis of Variance of Number of Uses of Only Two Cues

Source	df	SS	MS	F
Between SS	127	837.44		
Groups	3	452.27	150.76	48.5***
SS w. Groups	124	385.17	3.11	
Within SS	128	185.00		
Blocks	1	23.77	23.77	18.6***
Groups x Blocks	3	2.38	0.79	0.6
Blocks x SS w. Groups	124	158.85	1.28	
Total	255	1022.44		

***Significant beyond the .001 level

(Newman-Keuls procedure), with positive TI (hint) > positive TI (no hint) > negative TI > controls.

Task model: type of cues used. Fourteen different types of cues were used by Ss. These were:

1. Numbers in particular figures
2. Position values of particular figures
3. Numbers in figures at particular positions--regardless of the particular figure which appeared there
4. Figures with the same numbers inside them
5. Figures with different numbers inside them
6. The overall pattern of numbers
7. Arbitrary numbers assigned to figures
8. Highest or lowest numbers
9. Odd or even numbers
10. Number of sides of a particular figure
11. Number of corners of a particular figure
12. Figures whose inside number differed from its position value
13. Figures whose inside number was less than its position value
14. The card number (it was written on the back of the card)

These types of cues were used singly or in various combinations. Only the first two types belonged to the E's task model. When Ss used other than task model cues they used type-3 cues 86% of the time. The first 20 trials were divided into four blocks of five trials each. Means for the use of type-1, type-2 and other-than-task-model cues for all groups are presented in Table 18. Type-1 and type-2 cues were analyzed. In order to compensate for the fact that Ss who solved before trial 20 were assigned the type of cue in their solution rule for all subsequent trials, simple analyses of variance were performed for each block of trials. Therefore these were conservative analyses. The four analyses for type-1 cues are presented in Table 19. Groups were significantly different only in block 3 ($F = 6.24$, $p < .001$) and block 4 ($F = 6.21$, $p < .001$). The two positive TI groups were significantly different from the negative TI and control groups in both blocks 3 and 4 (Newman-Keuls procedure). There were no other significant differences.

Table 18

Mean Number of Uses of Type-1, Type-2, and Type-"Other" Cues

for Each Group in Each Block of Trials

Groups	Block I Trials 1-5	Block II Trials 6-10	Block III Trials 11-15	Block IV Trials 16-20
Positive TI (hint)	1.34	1.20	1.24	1.29
Positive TI (no hint)	1.54	1.17	1.71	1.56
Negative TI	1.47	1.81	2.98	2.97
Controls	1.11	1.25	2.73	3.02

Type-2

Groups	Block I Trials 1-5	Block II Trials 6-10	Block III Trials 11-15	Block IV Trials 16-20
Positive TI (hint)	2.58	3.44	3.69	3.59
Positive TI (no hint)	1.77	2.52	3.08	3.35
Negative TI	0.73	0.53	1.08	1.09
Controls	0.20	0.34	0.38	0.31

Type-"other"

Groups	Block I Trials 1-5	Block II Trials 6-10	Block III Trials 11-15	Block IV Trials 16-20
Positive TI (hint)	0.76	0.24	0.02	0.10
Positive TI (no hint)	1.10	0.98	0.08	0.00
Negative TI	2.23	1.91	0.47	0.44
Controls	2.38	2.41	1.05	0.67

Table 19

Analyses of Variance of Type-1 Cues

in Each Block of Trials

Block 1

Source	df	SS	MS	F
Between	3	3.19	1.06	0.50
Within	124	260.49	2.10	
Total	127	263.68		

Block 2

Source	df	SS	MS	F
Between	3	8.86	2.95	1.08
Within	124	339.61	2.74	
Total	127	348.47		

Block 3

Source	df	SS	MS	F
Between	3	71.18	23.73	6.24***
Within	124	471.68	3.80	
Total	127	542.86		

Block 4

Source	df	SS	MS	F
Between	3	83.25	27.75	6.21***
Within	124	554.81	4.47	
Total	127	638.06		

***Significant beyond the .001 level

The four analyses for type-2 cues are presented in Table 20. Groups were significantly different in block 1 ($\underline{F}$ = 16.31, $\underline{p}$ < .001), block 2 ($\underline{F}$ = 31.36, $\underline{p}$ < .001), block 3 ($\underline{F}$ = 25.83, $\underline{p}$ < .001) and block 4 ($\underline{F}$ = 24.50, $\underline{p}$ < .001). Using the Newman-Keuls procedure, the two positive TI groups were significantly different from the negative TI and control groups in all four blocks of trials. Positive TI (hint) was significantly different from positive TI (no hint) beyond the .05 level in both blocks 1 and 2. There were no other significant differences.

The four analyses for type-"other" are presented in Table 21. Groups were significantly different in block 1 ($\underline{F}$ = 14.88, $\underline{p}$ < .001), block 2 ($\underline{F}$ = 19.3, $\underline{p}$ < .001), block 3 ($\underline{F}$ = 9.99, $\underline{p}$ < .001) and block 4 ($\underline{F}$ = 5.43, $\underline{p}$ < .01). Using the Newman-Keuls procedure, the positive TI groups were significantly lower than negative TI and controls in blocks 1 and 2. In block 2, positive TI (hint) was significantly lower than positive TI (no hint). In block 3, all groups were significantly lower than the controls. In block 4, positive TI (no hint) was significantly lower than both negative TI and the controls; positive TI (hint) was significantly lower than the controls.

Though the negative TI and control groups did not differ significantly in use of type-1 or type-2 cues in any block of trials, the negative TI had a higher mean in all blocks of trials for both types of cues except for type-1 in block 4. Therefore these two types of cues were combined for these two groups in all four blocks and one-tailed $\underline{t}$-tests were used to assess differences. The means for negative TI $\underline{S}$s in the four blocks were 2.20, 2.34, 4.06 and 4.06; the means for controls were 1.31, 1.59, 3.11 and 3.33. All means were significantly different. In block 1, $\underline{t}$ = 3.24 ($\underline{p}$ < .05), in block 2, $\underline{t}$ = 1.75 ($\underline{p}$ < .05), in block 3, $\underline{t}$ = 2.41 ($\underline{p}$ < .01), and in block 4, $\underline{t}$ = 1.81

Table 20

Analyses of Variance of Type-2 Cues

in Each Block of Trials

Source	df	SS	MS	F
Between	3	118.43	39.48	16.31***
Within	124	300.69	2.42	
Total	127	419.12		

<u>Block 2</u>

Source	df	SS	MS	F
Between	3	238.95	79.65	31.36***
Within	124	314.52	2.54	
Total	127	553.47		

Block 3

Source	df	SS	MS	F
Between	3	252.66	84.22	25.83***
Within	124	403.72	3.26	
Total	127	656.38		

<u>Block 4</u>

Source	df	SS	MS	F
Between	3	260.90	86.97	24.50***
Within	124	439.78	3.55	
Total	127	700.68		

***Significant beyond the .001 level

Table 21

Analyses of Variance of Type-"Other" Cues

in Each Block of Trials

Block 1

Source	df	SS	MS	F
Between	3	66.06	22.02	14.88***
Within	124	183.97	1.48	
Total	127	250.03		

Block 2

Source	df	SS	MS	F
Between	3	98.38	32.79	19.3***
Within	124	210.67	1.70	
Total	127	309.05		

Block 3

Source	df	SS	MS	F
Between	3	21.57	7.19	9.99***
Within	124	89.46	0.72	
Total	127	111.03		

Block 4

Source	df	SS	MS	F
Between	3	8.78	2.93	5.43**
Within	124	67.28	0.54	
Total	127	76.06		

**Significant beyond the .01 level

***Significant beyond the .001 level

($p < .05$). Negative TI Ss consistently used task-model cues more than the control Ss.

There was one further point of interest about the use of cues. Among negative TI Ss and controls, the use of non-task-model cues (type-"other") dropped considerably after trial 10. Since the first task hint was given at this time, presumably that hint gave more information to these Ss than the fact that only two cues are relevant. Apparently, at least to these Ss, the hint gave information about both the number and the type of cues.

Task model: use of relative position. Relative position is defined as the incorporation, in some way or other, of the position of one figure in respect to another (or others) into a formula. Though relative position in the task model is related to adding or subtracting a constant, some of the actual uses of relative position were related to different formulas, applied conditionally depending upon which of two figures was "to the left." Since relative position was used only four times by controls, once by negative TI Ss, and twice by positive TI Ss trained with Rule 1, only the positive TI Ss trained with Rule 2 in the hint and no-hint groups were compared. The first 20 trials were again divided into four blocks of five trials each. Means for each group in each block are given in Table 22. A groups x blocks analysis of variance is also reported in Table 22. Neither groups nor groups x blocks was significant.

Task model: use of weighting. Weighting was analyzed in terms of two categories: 1) any type of weighting, other than 1, 2) task-model weighting. Means for all groups for each category are presented in Table 23. There means represent the mean trial on which this type of weighting was first used. Analyses of variance are also presented in Table 23. The groups were significantly different both for any type of weighting ($F = 28.97$, $p < .001$) and for task-

Table 22

Means for the Use of Relative Position in Each Block of Trials

for Positive TI (Hint) and Positive TI (No Hint) Groups Trained with Rule 2

Groups	Block I Trials 1-5	Block II Trials 6-10	Block III Trials 11-15	Block IV Trials 16-20
Positive TI (hint)	2.70	3.65	3.90	3.70
Positive TI (no hint)	2.54	3.23	3.62	3.92

Analysis of Variance of the Use of Relative Position

by Positive TI (Hint) and Positive TI (No Hint) Groups Trained with Rule 2

Source	df	SS	MS	F
Between SS	32	414.74		
Groups	1	0.81	0.81	0.06
SS w. Groups	31	413.93	13.35	
Within SS	99	155.50		
Trials	3	29.33	9.78	7.30***
Groups x Trials	3	1.81	0.60	0.45
Trials x SS w. Groups	93	124.36	1.34	
Total	131			

***Significant beyond the .001 level

Table 23

Mean Trials on Which Any Type of Weighting and Task Model Weighting was Used by All Groups

Groups	Any type of weighting	Task-model weighting
Positive TI (hint)	2.69	3.60
Positive TI (no hint)	5.17	7.08
Negative TI	11.31	14.66
Controls	12.44	15.75

Analyses of Variance of Trials on Which

Any Type of Weighting and Task-Model Weighting

were First Used by All Groups

Any Type of Weighting

Source	df	SS	MS	F
Between	3	2299.63	766.54	28.97***
Within	124	3280.86	26.46	
Total	127	5580.49		

Task-Model Weighting

Source	df	SS	MS	F
Between	3	3593.97	1197.99	41.79***
Within	124	3554.65	28.67	
Total	127	7148.62		

***Significant beyond the .001 level

model weighting (F = 41.79, $p < .001$). Using the Newman-Keuls procedure, both positive TI groups used both types of weighting significantly sooner than the negative TI and control groups. Positive TI (hint) used task-model weighting significantly sooner than positive TI (no hint).

Known response scale. Since Ss were told the k-scale, that correct answers could only be some whole number between 3 and 12, they could use that information in two ways. First, they could eliminate any response of numbers less than 3 or greater than 12. Second, they could monitor any formula by checking to see whether it generated all and only whole numbers between 3 and 12.

Subjects gave responses that ranged from -1 to +40. The number of off-scale responses were: positive TI (hint) 6, positive TI (no hint) 8, negative TI 25, and controls 10. Thirty-two of these off-scale responses were numbers less than three; 17 were numbers greater than 12. Since E reminded S of the k-scale when an off-scale response was given, these frequencies were probably somewhat controlled.

When the possible answers a formula could generate were compared with the k-scale, the verbalized formulas could be categorized into five groups. Because there was little difference among the four basic groups of Ss, they were pooled. The five categories of formulas and the percents in each of them were:

1) Give off-scale answers less than 3 (26%)

2) Give off-scale answers greater than 12 (13%)

3) Give off-scale answers both less than 3 and greater than 12 (25%)

4) Give only on-scale answers, but not all of them (7%)

5) Give all and only on-scale answers (29%)

Since only 29% of the formulas used seemed to take the known k-scale into account, Ss apparently made little use of this possible information. Only a few Ss spontaneously verbalized the use of such information.

Use of prior information. Three different questions can be asked about each formula verbalized by an S. Has this formula already been disproved, either explicitly or implicitly? Would this formula have given the correct answer on the preceding trial? What was S's subjective estimate of whether his formula would have worked on the preceding trial? In interpreting this data, it should be remembered that the task was complex and S's memory load was at a maximum since he saw only one card at a time and could not record prior information on scrap paper.

Use of prior information: status of the formula. Incorrect formulas were divided into the following three categories:

1) Insufficient information to reject it--though false, it would have given the correct answer on all previous cards.

2) Sufficient information but implicit--the formula would not have given the correct answer on one or more previous cards, but S had not explicitly used it.

3) Sufficient information and explicit--the formula was previously used by the same S and had not given the correct answer.

Since the differences between groups were slight, overall percentages for the three categories were computed. There were 16% of the formulas in category 1, 79% in category 2, and 5% in category 3. For category 2, the mean number-of-trials-back that the formula was implicitly disconfirmed was 1.84. This means that, on the average, the Ss were taking account of approximately the last two cards. For category 3, the mean number-of-trials-back that the formula was explicitly disconfirmed was 4.6. The fact that category 2 formulas were disconfirmed by a card which appeared less than 2 cards earlier on the average and the fact that 79% of the incorrect formulas were in this category suggests a severe memory problem.

Use of prior information: formula on trial n in respect to the formula on trial n-1. How much did Ss use the information from the immediately preceding trial? The percentages of formulas that would have worked or would not have worked on the previous card are given in Table 24. Pooling all groups, Ss did not make use of the information on the previous trial on 29% of the trials. The largest difference was between positive TI (hint) with 35% and positive TI (no hint) with 24%. It is possible that the high percentage for positive TI (hint) was related to the transfer hint. Possibly these Ss were paying some attention to using a formula related to the training task, and therefore payed less attention to the feedback for the preceding trial. There seems to be no obvious reason why the percentage of positive TI (no hint) should be the lowest.

Use of prior information: S's subjective estimate of whether the formula on trial n worked on trial n-1. For most trials information was available as to whether S thought he was using a formula which would have worked on the preceding trial. These subjective estimates can be categorized into six rough categories, no matter whether the formula actually did work on the preceding card or not. The six categories are:

a) S was sure it worked.
b) S "thought" it worked.
c) S was not sure or didn't remember.
d) S was sure it did not work.
e) No information given.
f) S claimed to have guessed, though he offered a formula.

The information about these categories is also given in Table 24. Subjects seemed to be more sure of themselves if the formula had worked on the previous card than if it had not worked. And though no S ever said a formula had not worked on the previous card when it actually had, Ss in all groups occasionally thought the formula they were using had worked on the previous card when it actually had not.

Table 24

Percent of Subjective Estimates in Six Categories

for Formulas which Would or Would Not have Worked on the Preceding Trial

for Each of the Four Basic Groups

Groups	Formulas which would have worked						Formulas which would not have worked					
	a	b	c	d	e	f	a	b	c	d	e	f
Positive TI (hint)	64	1	0	0	0	0	5	1	15	6	7	1
Total percent				65%						35%		
Positive TI (no hint)	72	0	0	0	2	2	8	0	5	5	3	3
Total percent				76%						24%		
Negative TI	69	1	1	0	0	0	5	2	8	6	2	5
Total percent				72%						28%		
Controls	68	1	1	0	0	0	5	1	7	9	4	3
Total percent				71%						29%		
Overall percent				71%						29%		

Effects of "easy" and "difficult" pretraining. Controls *Ss* were trained with "easy" or "difficult" items of Raven's Progressive Matrices Test since there was some reason to believe that a differential set for difficulty level might have been developed in negative TI *Ss* trained with Rule 1 ("easy" set) or with Rule 2 ("difficult" set). These subgroups were compared on various measures of the learning process. Since controlling for different difficulty-level sets was only a hypothesis, fairly conservative tests for differences were used.

Amount of guessing. The mean number of guesses for each group in each of the first two blocks of trials is given in Table 25. A simple analysis of variance for each block of trials showed no significant differences. For block 1, $F = 2.49$, $p < .05$; for block 2, $F = 0.33$.

Number of cues used. The mean number of use of two-cues for each group in each of the first two blocks of trials is given in Table 26. There was no significant difference between groups in block 1 ($F = 0.96$). There was a significant difference between groups in block 2 ($F = 3.41$, $p < .01$). Negative TI *Ss* trained with the "easy" rule (Rule 1) used two cues in block 2 significantly more than both the negative TI *Ss* trained with the "difficult" rule (Rule 2) and the control *Ss* with "difficult" pretraining (Newman-Keuls procedure).

Type of cues used. The mean number of times type-1, type-2, and type-other-than-task-model cues was used by each group in each block of trials is given in Table 27. There was no difference in the use of type-1 cues in any block of trials. The *F*'s for the four blocks were 2.09, 0.93, 1.27 and 0.11 respectively ($p > .05$ for all).

The *Fs* for the use of type-2 cues in each block of trials was 3.67, 1.76, 3.74 and 3.02. The *Fs* for blocks 1, 3 and 4 were significant beyond the .05

Table 25

Mean Number of Guesses in Each Block of Trials for the "Easy" and "Difficult" Pretraining Subgroups of Negative TI and Control Ss

Groups	Block 1	Block 2
Easy (controls)	1.56	0.94
Difficult (controls)	0.88	1.06
Easy (Rule 1)	0.65	0.65
Difficult (Rule 2)	0.47	0.80

Table 26

Mean Number of Uses of Two-Cues in Each Block of Trials for the "Easy" and "Difficult" Pretraining Subgroups of Negative TI and Control Ss

Groups	Block 1	Block 2
Easy (controls)	0.56	1.19
Difficult (controls)	0.69	0.75
Easy (Rule 1)	1.00	2.18
Difficult (Rule 2)	1.07	1.20

Table 27

Mean Number of Uses of Type-1, Type-2, and Type-"Other" Cues in Each Block of Trials by "Easy" and "Difficult" Control or Negative TI Groups

Type-1

Groups	Block I Trials 1-5	Block II Trials 6-10	Block III Trials 11-15	Block IV Trials 16-20
Easy (control)	0.91	1.16	3.00	3.22
Difficult (control)	1.31	1.34	2.47	2.81
Easy (Rule 1)	0.97	1.59	2.50	2.94
Difficult (Rule 2)	2.03	2.07	3.53	3.00

Type-2

Groups	Block I Trials 1-5	Block II Trials 6-10	Block III Trials 11-15	Block IV Trials 16-20
Easy (control)	0.25	0.47	0.28	0.25
Difficult (control)	0.16	0.22	0.47	0.38
Easy (Rule 1)	0.97	0.85	1.62	1.53
Difficult (Rule 2)	0.47	0.17	0.47	0.60

Type-"other"

Groups	Block I Trials 1-5	Block II Trials 6-10	Block III Trials 11-15	Block IV Trials 16-20
Easy (control)	2.22	2.44	0.59	0.41
Difficult (control)	2.53	2.38	1.50	0.94
Easy (Rule 1)	2.41	1.91	0.35	0.35
Difficult (Rule 2)	2.03	1.90	0.60	0.53

level. Negative TI Ss trained with the "easy" rule used type-2 cues significantly more than control Ss in the "easy" group in blocks 1, 3 and 4, than control Ss in the "difficult" group in blocks 1 and 3, than negative TI Ss trained with the "difficult" rule in block 3 (Newman-Keuls procedure). There were no other significant differences.

The Fs for the use of other-than-task-model cues in each block of trials were 0.48, 0.60, 3.21 and 1.23 respectively. Only the F for block 3 was significant beyond the .05 level. In that block, control Ss with "difficult" pretraining used this type of cue significantly more than the negative TI Ss trained with either the "easy" or "difficult" rule (Newman-Keuls procedure). There were no other significant differences.

Use of weighting. The mean trials on which each group first used any type of weighting (other than 1) and task-model weighting is given in Table 28. There was no significant difference between groups for "any" type of weighting ($F = 1.08$). There was also no significant difference between groups for the first use of task-model weighting ($F = 1.56$).

Discussion and Conclusions

The results of this experiment will be discussed in terms of the following categories: 1) the effect of transfer intentions (positive TI Ss compared with either negative TI Ss or controls), 2) the effect of a transfer hint (including a comparison of positive TI Ss either given this hint or not), 3) transfer-without-awareness effects (a comparison of negative TI Ss with controls), and 4) set-for-difficulty-level effects (a comparison of negative TI Ss and controls who had "easy" or "difficult" pretraining).

Table 28

Mean Trial on Which Any Type of Weighting (Other than 1) and Task-Model Weighting were First Used by "Easy" and "Difficult" Control Groups or Negative TI Group

Groups	Any type of weighting	Task-model of weighting
Easy (control)	12.06	15.50
Difficult (control)	12.81	16.00
Easy (Rule 1)	9.65	12.82
Difficult (Rule 2)	13.20	16.73

The Effect of Transfer Intentions

Trials to criterion. Mean trials to criterion for positive TI Ss, negative TI Ss and controls were 6.3, 17.4, and 18.5 respectively. The superiority of positive TI Ss is obvious. Furthermore, among experimental Ss, only transfer intention was intrinsically related to trials to criterion when all other variables were partialled out.

Type of solution. The percentage of solutions of the transfer task by means of rules identical to those given in the training task was much higher for positive TI Ss. The only Ss who solved the transfer task with the 3CS rule were positive TI Ss who had been trained with Rule 2.

Learning process. a) Positive TI Ss used two cues more than negative TI Ss and controls in the first two blocks of trials. b) Positive TI Ss used type-1 cues less in blocks 3 and 4, and type-2 cues more in all four blocks of trials. They used type-"other" cues less in blocks 1 and 2 than both negative TI Ss and controls. In block 3, both positive TI Ss given the transfer hint and those who were not used type-"other" cues less than controls. In block 4, positive TI (hint) used type-"other" less than controls whereas positive TI (no hint) used them less than both negative TI Ss and controls. Since type-2 cues were similar to those used in the pretraining task, their more frequent use by positive TI Ss is related to the fact that they were transferring. c) Only positive TI Ss trained with Rule 2 used "relative position" in any substantial amount. Only this group should have used "relative position" frequently since they were consciously transferring and had been trained with a rule which included the use of "relative position." d) Positive TI Ss used "any" type of weighting and task-model weighting sooner than negative TI Ss and controls. This earlier use of weighting, especially task-model weighting, reflects the fact that these Ss were transferring.

The Effect of the Transfer Hint

There was a significant transfer-hint effect in trials to criterion in the analysis of the basic experimental groups. However transfer hint was not intrinsically related to trials to criterion when the cognitive transfer processes (TH and TI) were partialled out. The locus of effect of the transfer hint was in the occurrence of positive transfer hypotheses and transfer intentions in all members of the transfer-hint group. There were significantly more positive TH and positive TI Ss in this group than in the experimental group not given this transfer hint, and this difference accounted for the difference in trials to criterion for the two groups.

There were no significant differences between positive TI Ss given a transfer hint and those who were not in either trials to criterion or type of solution. The following differences were found in the learning process measures: a) Transfer-hint Ss used two cues more in the first two blocks of trials. b) Transfer-hint Ss used type-2 cues more in blocks 1 and 2, and type-"other" less in block 2. c) Transfer-hint Ss used task-model weighting sooner than positive TI Ss not given the transfer hint. These three differences suggest that the transfer hint caused positive transfer hypotheses and intentions to occur sooner. The fact that, among Ss who spontaneously verbalized transfer information, these verbalizations first occurred on a mean trial of 1.88 for transfer-hint Ss and a mean trial of 3.83 for no-transfer-hint Ss suggests this same conclusion. An earlier occurrence of transfer hypotheses and intentions for positive TI Ss given the transfer hint was not predicted. Its effect was not enough to show up in a significant difference in trials to criterion.

One further small difference was detected. The three Ss who reported positive TH but negative TI were all in the no-transfer-hint group. If this effect is reliable, it might suggest that transfer-hint Ss have more certainty while pursuing a transfer hypothesis than no-transfer-hint Ss.

Transfer-Without-Awareness Effects

There was not a significant difference between negative TI Ss and controls in either trials to criterion or type of solution. However, four negative TI Ss solved the transfer task before the first task-hint, whereas none of the control Ss did so. The following differences in measures of the learning process were found: a) The controls did more guessing than negative TI Ss in block 1. This difference seems related to the puzzlement of some control Ss about "what a formula might be." Controls had not had experience with the use of a formula in pretraining, whereas negative TI Ss had such experience. b) Negative TI Ss used two cues more in the first two blocks of trials. c) Negative TI Ss used type-"other" cues less than controls in block 3. And when type-1 and type-2 cues were pooled, negative TI Ss used them significantly more than controls in all blocks of trials.

The difference in (a) seems to be a non-specific type of transfer if specific is related to the use of some element of the pretraining rule. The differences in (b) and (c) suggest that negative TI Ss, at least in respect to the number and type of cues used, found E's task model sooner. These differences also seem to be a type of non-specific transfer which is not accounted for by conscious relating of the two tasks. The use of only two cues demonstrates a willingness to ignore information, and perhaps experience with the training task in which such ignoring was done facilitated this type of behavior in the transfer task. These differences between negative TI Ss and controls were not predicted.

Set for Difficulty Level

Control Ss were divided into "easy" or "difficult" pretraining by giving either the easy or difficult items of Raven's Progressive Matrices Test. Since experimental Ss trained with Rule 2 took longer to read the training instructions, took longer to attain criterion in the training task, and made more errors in the training task, Rule 2 was more difficult to learn and use. Therefore, it was possible that different sets for difficulty level developed in each subgroup of control and negative TI Ss.

There were no significant differences in mean trials to criterion between the four subgroups, nor was there any difference in type of solution. However, trials to criterion were in the predicted direction and when the number of Ss in each subgroup who solved before the second-task hint were compared, negative TI Ss trained with Rule 1 (easy) had significantly more, and the "easy" controls almost had significantly more, than the "difficult" controls. There were also no differences in guessing between the four subgroups, even though the pooled controls guessed more in block 1 than the pooled negative TI Ss.

The following differences between these subgroups in measures of the learning process were found: a) Negative TI Ss trained with Rule 1 (easy) used two cues in block 2 more than negative TI Ss trained with Rule 2 (difficult) and the "difficult" controls. b) Negative TI Ss trained with Rule 1 (easy) used type-2 cues more than either control subgroup in block 1, more than any other subgroup in block 3, and more than the "easy" controls in block 4. The "difficult" control group used type-"other" cues more in block 3 than either of the negative TI subgroups.

Therefore, there were some differences that could be attributable to difficulty level. Negative TI Ss trained with the "easy" role used two cues more than the other groups, significantly more than the "difficult" groups. This might be attributable to a set for an easier problem since they were willing to use less information. However, their greater use of type-2 cues might also suggest some type of transfer-without-awareness effect, which could explain that group's superiority. A higher percentage of Ss in this particular subgroup did solve the transfer task with the 2CS rule. The fact that the "difficult" control group performed worst in terms of solving before the second task hint and the measures of the learning process seems to have no other explanation that difficulty set.

When trials to criterion alone was used as the criterion of transfer, it appeared that there were no transfer-without-awareness effects and that transfer of a specific rule could be explained solely in terms of positive transfer hypotheses and transfer intentions. Using type of solution as a further criterion of transfer did not change this general conclusion. However, the various measures of the learning process suggested some differences between positive TI Ss who either were or were not given a transfer hint, some transfer-without-awareness effects, and some set-for-difficulty-level effects. Thus, measures of the learning process seem to be the most powerful criterion for detecting transfer effects. These differences detected by measures of the learning process in no way detract from the powerful effect of the cognitive transfer processes.

The hopes of obtaining specific data both on the exact time of transfer and the particular element or elements transferred did not materialize. Some Ss did not spontaneously verbalize such information, and among those who did, some admitted that they had been consciously transferring before verbalizing the fact. It is difficult to get an accurate time measure for Ss who do not spontaneously verbalize such information. After the experiment, some could only offer such vague information as "I was trying to do it before the first task-hint." And reports about the elements transferred were difficult to categorize because of their complexity. Though some Ss transferred only one element or combination of elements, others switched many times from one element or combination to another.

Nothing has been said about the unspecified associational mechanisms which cause uninstructed transfer hypotheses to occur. Though this question remains unanswered after this study the verbalizations of Ss suggest various possibilities. Many Ss without a transfer hint began to relate the tasks on the very first trial. Their transfer hypotheses might be related to a "suspicion" about the experiment or to something specific in the instructions for the transfer task. The second appearance of a circle and square or the second use of k and the same numbers for the k-scale might have been cues. If this is the case, calling the position values of figures in the second task "columns" should increase the amount of conscious transferring. Not using a circle and square and using a different response scale should decrease the amount of conscious transferring. Several Ss, including some given the transfer hint, abruptly began to transfer at some time during the transfer task. Those given the transfer hint apparently had forgotten it and then suddenly remembered it. Those not given the transfer hint frequently said that they had begun to wonder why they had been given the first task. One S, while studying a card after feedback, mentioned several hypotheses, one of which was 2CS. Having said it aloud, she said "That's just like the first one," and she continued to use it. However, she was the exception, for other Ss actually solved with 2CS and failed to realize that is was identical to Rule 1 in the training task. One S, after 14 trials, said "Well, I guess I'll have to try the old formula." When questioned about this, he said he had thought from the beginning that the two tasks might be related, but preferred to solve the second task "on his own." A further study should be done to pinpoint these cues for transfer.

Getting students to use principles or knowledge in new situations seems to be an accepted educational goal. A transfer hint is clearly useful for this purpose given a goal of efficient learning in an immediate task. Whether giving transfer hints is good training for teaching students to transfer on their own is a different question. Perhaps in the long run the self-discovery method is better training for a habit of transferring. Over and above the fact of transferring or relating, Ss seemed to have more or less skill in finding the relationship when they set out to do so. Some Ss were unsuccessful even though they tried to find it. There seems to be a skill in transferring that needs to be developed over and above the habit of attempting to do so.

The high percentage of agreement between verbalized formulas and numerical answers was used as justification for analyzing the former as behavior which actually reflects cognitive processes. The 99.2% agreement was also supportive evidence for the theory of verbal control of overt performance presented by Dulany & O'Connell (1963). The fact that Ss occasionally used formulas which they thought had worked on the previous card but actually had not is data unrelated to this theory of verbal control. This theory states that simultaneous conscious processes control overt performance. It does not state that these processes must be accurate representations of past events. Memory, as everyone agrees, can be erroneous.

Given a complex task such as the transfer task, analysis of it in terms of a task model would seem to be a precarious venture. All analyses of process measures related to the task model militate against the strong assumption that S's conception of the task is identical to E's conception of it. Perhaps this gross discrepancy would not be true of a simpler task, but the assumption of identity of task models for S and E is very strong. The data regarding use of the known response scale and the use of prior information can be added to the evidence against strong assumptions. Subjects did not use the information that k could only be whole numbers between 3 and 12 to any great extent. Only 29% of the verbalized formulas would have generated all and only the whole numbers on the k-scale. In fact, on 49 trials numerical answers that were off the k-scale were given. The Ss' use of prior feedback was also severely restricted. Of the verbalized formulas, 79% had been implicitly disconfirmed on the average of less than two trials (1.84 trials) prior. An additional 5% of the verbalized formulas had been explicitly disconfirmed by prior feedback. This lack of use of prior feedback suggest a severe memory problem and possibly the fact that Ss cannot encompass more than the information of a very few trials into their hypothesis-testing. Furthermore, it is possible and likely that some Ss do not even attempt to remember the whole preceding card or cards. The amount of selective memory of this type that occurred cannot be assessed from the present data.

Feedback seemed to have three roles in this particular task. It was used to eliminate false hypotheses. This function was suggested by Harlow (1959). However, this function must be qualified by the fact that it functions over a short sequence of trials since Ss do use formulas which have been either explicitly or implicitly disconfirmed. Secondly, it was used as a basis for the generation of new hypotheses. Thirdly, it has a relationship to S's certainty. Though no measure of this function was obtained in this study, many Ss recognized that a formula could be fortuitously correct for a short sequence of trials. Each correct answer increased their certainty of having the correct formula. Though this was not necessarily true of all Ss, many were not sure that they had actually solved the transfer task after the four criterion trials. Additional criterion trials would have been needed to make them absolutely certain.

If these two tasks are viewed as the first two problems in developing a learning set, some suggestions about learning sets are possible. Ordinarily learning sets are viewed as some unspecified process of "learning how to learn." However, they could just as well be viewed as learning some set of specific things about a family of problems. One of these things is probably learning to relate all the problems since they are in fact related. Though this study gives only some evidence on this point, it would be worth pursuing.

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