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THE TRAINING OF ORIGINAL PROBLEM SOLVING BEHAVIOR

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The experimental approach employed on this project presupposes that originality is a form of operant behavior and therefore follows the usual principles of behavior applicable to verbal response classes. Viewed from this approach the basic problem in training originality is the development of procedures which will increase the frequency of occurrence of originality so that it may be reinforced and as a consequence transfer to new situations. Simple experimental situations have been emplcyed for this purpose, simple in the sense that only a small number of the relevant variables are simultaneously influencing the behavior under investigation. Such situations offer some promise of eventually isolating the variables influencing originality and permitting their manipulation in the training of originality. Choice of these experimental procedures is a decision which is a consequence in part of our particular interpretation of problem solving and thinking generally.

As is the case with most investigators currently concerned with the study of originality we do not believe that it is a kind of behavior which is in a class by itself qualitatively different from all other kinds of problem solving behaviors. Originality is taken to be behavior which is relatively uncommon under specified stimulus conditions. To say that it is uncommon implies that there is some norm available for assessing the relative frequency of the behavior. But uncommonness may be relative either to a given individual's past behavior or to the behavior of a population at large. Inventions and works of genius are evaluated relative to the population at large, and the experimental research that we have conducted has also been of the sort where the uncommonness of a subject's response has been evaluated relative to group norms. Evaluation of uncommonness and training to increase uncommonness relative to the individual's own past behavior may well be the more desirable approach in the classroom. But this alternative approach does not entail any basic change in training procedure from the first.

In the research to be described here "originality" refers to behavior which occurs relatively infrequently, is uncommon, under given conditions, and in some sense is relevant to those conditions. It is therefore necessary if we are to evaluate the originality of a bit of behavior, to establish criteria of uncommonness and of relevance. Norms for behavior under these conditions may be constructed from the behavior of a comparable sample of different individuals. Relevance may be established by judgements of the behavior or may be defined as the behavior which solves a particular problem. Usage of the term "originality" is further restricted here in that we would distinguish it from creativity which is a function of considerably more behavioral and cultural variables. According to the present usage "creative" refers to the consequences of originality and other behavioral variables and to the judgements of these consequences made by members of some society. Considerably more variables determine a creative product than originality alone. The convention of distinguishing between originality and creativity was adopted so that uncommonness of behavior, one of the necessary conditions of creativity could be made more amenable to laboratory investigation. Certainly, a complete account of creativity must eventually consider these additional variables that enter into creativity, a task which would be shared with sociology, cultural anthropology, and history.

The Program of Research on Originality

A modified word association procedure was used in many of our studies in order to provide a situation amenable to experimental analysis, and which permits a measure of uncommonness of behavior. Another reason for the selection of these particular tasks is that there is some evidence that they are significantly correlated with other tests of originality and judgements of creativity outside the laboratory.

Our experimental studies of originality fall into five broad classes:
1. attempts to isolate the variables that would permit the facilitation or training of originality (Maltzman, et. al., 1959a, b, c, d).
2. attempts to determine the extent to which originality conforms at least in a gross manner with principles of learning (Maltzman, et. al., 1959 c, d).
3. studies of the effects of training with different stimulus materials (Maltzman, et. al., 1959d).
4. studies of the effects of originality training with different subject populations (Maltzman, et. al., 1963b; Simon, 1961).
5. investigations of the generality of originality training with different problem solving situations as dependent variables (Maltzman, et. al., 1963a; Maltzman, et. al., 1963).

1. Variables Facilitating Originality

Since we assume that originality and problem solving generally involves the occurrence of relatively uncommon responses, the problem of training originality involves devising techniques for increasing the probability of occurrence of uncommon responses. The problem is to induce the more frequent occurrence of original responses thereby permitting the operation of reinforcement. Whether the training procedure is efficacious or not is manifested by the originality of the behavior under different stimulus conditions. Some degree of apparently nonspecific transfer must occur if the training procedure is to be of any theoretical or practical consequence.

The principal procedure that we have employed is the simple one of repeatedly presenting the same stimulus words in a word association test with instructions to give a different response each time (Maltzman, 1959a). Under these conditions the responses to successive presentations of a list of stimulus words become progressively more uncommon. After six presentations of the same list of 25 stimulus words approximately 70% of the responses are unique, are given only by the respondent and do not appear at all in the norms for 300 subjects or even in the revised Kent-Rosanoff norms. Of greater significance is the occurrence of transfer to different stimulus words and a different task. Subjects receiving this training give significantly more uncommon associations to new stimulus words than subjects without this prior training. In addition, they typically give significantly more unique uses on Guilford's Unusual Uses Test of originality. Subjects are asked here to give as many unusual uses as they can think of for such common objects as a key, automobile tire, eyeglasses, and so on.

Data of this kind suggest that our training procedure of successive presentations of the same word association list has the desired effect of inducing progressively more uncommon responses to these words. There is evidence of nonspecific transfer of this disposition as indicated by the increased

uncommonness of the word associations to a new list of words and the uses offered for certain common objects.

The problem remains, however, as to what the relevant features of the procedure are that produce the apparent facilitation of associative originality. It is possible that the critical variable is simply the evocation of many different responses, or even the evocation of responses per se. Another study was therefore conducted employing what we shall call the standard experimental and the standard control conditions (Maltzman, et. al., 1958). The former receives repeated presentations of an initial list followed by a new test list. Only a single presentation of the initial list followed by the test list is administered the standard control group. Additional groups received lists of 125 different stimulus words so that these groups are equivalent to the standard experimental condition in terms of the total number of different responses evoked and the total number of stimulus presentations, although the latter groups may have an advantage in receiving different stimulus words on each presentation. In order to investigate the consequences of response evocation per se, another group received five repetitions of the initial list with instructions to give the same association upon each presentation of a given stimulus word.

Results from the word association originality test showed that the experimental groups giving different responses to the same stimulus words or those receiving different stimulus words did not differ significantly from each other. But each of these groups gave significantly more uncommon associations than the standard control group and the group that gave the same associations to successive presentations of the same stimulus words. Rather different results were obtained from the Unusual Uses Test. The standard experimental group gave significantly more unique uses than all of the other groups, and the group giving the same responses to repeated presentation of the same stimulus words gave significantly fewer unique uses than any of the other groups.

The significant loss of originality in the latter condition suggests, as many have contended, that a training technique can significantly decrease originality, a result which is of theoretical as well as practical interest. However, our interest is primarily in the facilitation of originality, an effect reliably obtained on the Unusual Uses Test as the result of the standard experimental technique.

Considering the results from both kinds of transfer tests, word association and unusual uses, it appears that under the given experimental conditions, the evocation of a relatively large number of different associative responses to different stimuli may increase originality in addition to the repeated evocation of different responses to the same stimuli. However, the latter procedure induced more extensive nonspecific transfer as evidenced by the results of the Unusual Uses Test.

These experimental findings suggest that two factors may be responsible for the originality training effect. One of these is the prompting or facilitation of uncommon intraverbal associations. It is quite likely that almost every verbal response is associated to some degree with every other. There is also some evidence which suggests that the associative strengths among common verbal responses are greater than between common and uncommon responses. Likewise, the associative strengths among uncommon responses are stronger than

among uncommon and common responses. Thus, stimulus words with low Thorndike-Lorge frequency counts evoke responses with significantly lower word counts than the associated responses of high frequency stimulus words. Forcing the subject by means of our training procedure to emit uncommon responses increases the disposition of other uncommon responses. Presumably, if we had adequate knowledge of the relevant preestablished network of intraverbal associations, it would be possible to predict which specific uncommon responses would subsequently occur.

Further research (Maltzman & Simon, 1959b) has indicated that associations to a long list of stimulus words become progressively more uncommon as the subject proceeds through the list. The occurrence of many different associative responses prompts or increases the probability of occurrence of a still larger number of associations thereby increasing the number of uncommon responses that may appear.

Additional evidence suggesting that the evocation of uncommon responses facilitates the occurrence of other uncommon responses comes from a correlational analysis. Word association originality on the first presentation of the training list, indicative of initial ability, has been found to correlate significantly with originality on the new word association test list and the number of unique uses and the last presentation of the training list. However, originality on the last training trial also correlates significantly with originality on these two tests after the performance on the pretest is partialled out. This indicates that originality on the new word association test and unusual uses is correlated with the uncommoning of the responses induced by the training procedure independent of the pretraining level of originality (Simon, 1961).

A second factor which may contribute to the originality training effect is that the standard experimental procedure provides for the extinction of common responses as well as the facilitation of uncommon responses. Through complex forms of conditioned generalization the effects of extinction will produce a decrement in the excitatory potential of other common responses. It is this characteristic which may be responsible for the more general transfer effects obtained with the standard experimental procedure than with other training methods that we have employed such as evoking uncommon textual responses or employing uncommon stimulus situations for evoking, in turn, uncommon responses. None of these other procedures would involve the inhibition or extinction of common responses. It must be admitted, however, that at the present time this hypothesis is entirely speculative. We do not as yet have any independent evidence that common responses are extinguished in the training procedure described.

Another experiment was conducted in order to further specify the relevant variables in originality training (Maltzman, et. al., 1959d). The attempt here was to determine whether it is necessary for the subjects to actively emit the uncommon response and whether it must occur in the presence of an associated stimulus word. The standard experimental and control conditions were again employed. A second experimental group was presented with a booklet of 125 pairs of unique responses obtained from the results of the previous experiment. Subjects were instructed to underline which member of each pair goes more readily with the stimulus word orally presented to him. The stimulus words were the repeated presentations administered the standard

experimental condition. A third experimental group received the same pairs of responses as the previous group but without the preceding stimulus words. These subjects were asked to underline the member of each pair of words that they thought to be more familiar.

Neither of these experimental conditions produced results reliably different from the standard control condition on either the word association originality test or the Unusual Uses Test. The standard experimental condition was significantly more original than all other conditions on both tests.

These results in conjunction with the findings of the previous experiments suggest again that maximal transfer effects are produced by the standard experimental condition, and that the repeated evocation of different responses to the same stimulus words are relevant features of the training procedure responsible for extensive transfer. The uncommon responses must be evoked as intraverbal responses by the stimulus words, we would surmise, because this in itself is reinforcing.

The effects of instructions to be original have been studied to some extent, but not at all intensively. There appears to be a number of complex interactions between instructions and problem materials, and between instructions and kind or amount of originality training.

2. Learning Parameters and Originality

Our results in this area are relatively meager, but are in accord in a gross way with the assumption that originality may be learned in the same manner as other kinds of operant behavior.

As previously indicated, an initial reason for using the standard experimental condition was that the uncommonness of the responses to the training words would increase with successive repetitions. This effect has been consistently obtained during training. Employing a 25 word training list, the mean percentage of unique responses by the sixth presentation is 70%. By the third repetition over half the responses of the average subject are unique.

One common characteristic of operant behavior is that learning is a monotonic function of the number of training trials, in many cases negatively accelerated. Presumably increments in the amount of transfer of originality training effects could occur in a similar fashion. An experiment was therefore conducted (Maltzman, et. al., 1959d) in which the standard control condition was administered a single presentation of an initial word association list followed by a different test list. One standard experimental condition received two presentations of the same list; another group received five repetitions of the list and a final group received 10 repetitions of the list prior to the presentation of the word association and Unusual Uses Tests. The adjusted mean frequency word association test scores were a negatively accelerated function of the number of repetitions of the training list. All differences among the groups were highly reliable except for the five and 10 repetition groups which did not differ significantly. Results on the Unusual Uses Test showed that each of the experimental groups gave significantly more unique uses than the control group. However, a trend as a function of the number of repetitions was not apparent with this measure. The three experimental groups did not differ significantly from each other.

If, as we have assumed, originality is learned according to the principles of instrumental conditioning, then it should show some degree of persistence following training. Since retention is one of the characteristics of learned behavior, the disposition to emit uncommon responses to new stimuli induced by the standard experimental training procedure should show some degree of permanence. An experiment designed to study this characteristic of associative originality has been conducted with positive results (Maltzman, et. al., 1959c).

Standard control and experimental groups similar to previous experiments were employed. For two such groups a delay of approximately one hour intervened between the training and test lists. Different control and experimental groups experienced a delay of two days between the training and test situations. Both main effects, experimental training, and delay interval, were significant on the word association originality test, indicating that the effects of experimental training are significant despite the delay intervals, but that the longer delay is followed by a decrement in associative originality. Likewise, results from the Unusual Uses Test of originality indicated that the experimental training produced a reliable effect even after a lapse of two days.

3. Generality of Training Effects: Training Materials

We have conducted several experiments employing different stimulus materials in originality training while using word association originality and unusual uses as test situations. In contrast to the findings previously reported with word association training materials, the results have largely been negative. However, there is a difficulty of interpretation. We cannot conclude from these negative findings that it is due to the nature of the training materials, because the values of certain basic parameters have also differed from the previous experiments.

Repeated presentation of items from the Unusual Uses Test with instructions to give different uses failed to facilitate word association originality. In one study the six items from the above test were presented six times. Another study varied the six items 10 or 20 times while other conditions received 12 items naming common objects repeated 5 or 10 times. None of these variations produced a significant amount of facilitation on a word association test. Although the total number of responses for some of these conditions approximates the number employed in word association training conditions, no effect was obtained. Analyses of the changes during successive repetitions in training indicated that there was a small but significant increase in the number of unique uses during training. A markedly greater increase is obtained with word association originality. The implication therefore is that a larger number of training items evoking uses or a much larger number of repetitions may produce the desired effect. At most we can conclude at the present time that training with unusual uses is not as effective as training with word association lists (Maltzman, et. al., 1959d, e).

As part of a larger exploratory experiment we have investigated the effects of solving anagrams on subsequent word association originality and anagram solving. The test anagram in this case was the word "Generation." The problem for the subject is to make as many different words with the letters as possible. This problem was chosen because Barron has reported that performance on this problem correlates significantly with a variety of other

measures of originality. Prior to this test anagram the experimental condition received additional problems of this sort as compared to a control condition without prior training. Norms were established for the frequency of occurrence of the different solutions to the anagrams, and each subject's solutions were weighted in terms of the obtained frequencies. Under the instructions and training conditions employed, practice on previous anagrams facilitated the originality of the first solution to the test anagram as compared to the performance of a control group, but did not affect the overall mean scores of the solutions or the total number of solutions. Likewise, word association originality was not influenced by prior work on anagrams. Again, however, these conclusions must be restricted to the conditions of this experiment, including the amount of training and the instructions employed. We do not know at the present time what the effects are of extended anagram training.

4. Generality of Training Effects: Subjects

All of the research that we have so far reported has been conducted with college sophomores. We have, however, investigated the effects of originality training with several other kinds of subject populations.

The results of one such study has been most disappointing (Simon, 1961). Nearly 400 high school juniors and seniors were employed in what was to have been our major parametric study of the effects of varying the length and the number of repetitions of word association training lists on word association originality and unusual uses. In a factorial design different subgroups received 0, 2, 4, 6, or 8 repetitions of lists containing either 6, 12, 18, or 24 words. The rank order of originality effects on the word association test was in the expected direction; but only the 8 repetition group differed significantly from the control condition. Likewise, the order of the groups on the Unusual Uses Test was exactly as expected, but neither the trend or the differences among any of the conditions reached statistical significance. There was evidence that originality training produced some effect, however. Performance on the word association test and the Unusual Uses Test correlated significantly with performance at the conclusion of training after the correlation contributed by pretest performance was partialled out. These results as well as other considerations suggest that we need to investigate individual differences in originality training effects. Preliminary analyses have been made of some of our earlier data in terms of the effects of training at different initial levels of originality. They suggest that originality training has a greater effect on subjects who initially are relatively high in originality than individuals who are low. Training tends to increase individual differences.

One critical comment made of the conception of associative originality is that the measure of uncommonness is not sufficient to differentiate the truly original and uncommon association from the bizarre and psychotic. In part to examine the implications of this assertion, an experiment was conducted with normal and schizophrenic children (Maltzman, et. al., 1963b). Standard control and experimental associative training conditions were employed within each condition. Schizophrenic children gave what appeared to be reliably more uncommon associations than normal children when the associations were scored on the basis of norms derived from the responses of the normal children. However, if the associations were weighted in terms of norms derived from the

responses of the schizophrenic children, the normal children appeared to give reliably more uncommon responses. When the kind of associations offered by the two groups was examined, it was evident that the schizophrenics' associations did not meet the conditions of the experimental situation. The most frequently occurring response to each stimulus word for the schizophrenic children was the repetition of the stimulus word, despite repeated instructions to avoid such responses. Normal children almost never responded with the stimulus word. These results indicate that, at least for the sample of schizophrenic children observed, their associations are not more original than normal childrens', and that even in as apparently a simple situation as word association, there are conditions of relevance which differentiate normal uncommon, original, associations from uncommon inappropriate responses. The normal children in this experiment again failed to show transfer of originality to new materials. However, recent work by other investigators have indicated reliable transfer effects with children, but only after extensive training regimes.

5. Generality of Training Effects: Test Materials

As indicated earlier, the use of word association materials in the study of originality was selected because the availability and relative ease of developing norms depicting the intraverbal associations involved would permit analyses not readily conducted with other kinds of stimulus materials and the responses they evoke. In addition, there was some evidence that performance even in this simple situation correlates with other behavior commonly called original. Most of the experiments described employed a second originality test, unusual uses, which also correlates with other criteria of originality and would permit a gross assessment of the transfer of the training effect to a somewhat different situation.

However, our research has not been restricted to open-ended test situations such as word associations and unusual uses. As previously indicated, we have also used an anagram problem as a training and as a test device. In preliminary studies it has been found that practice in providing many different solutions for an anagram produces an increase in originality under certain instructions, but only for the first solution offered. The standard experimental word association originality training produced a similar reliable increase in originality of the initial solution as compared to a control condition. Anagram and word association training did not differ reliably under the conditions employed. Relevance is here built in by the conditions of the problem. However, the training effect was limited only to the first solution. It is quite likely that because of the large number of different solutions that are readily available for these anagrams, the introduction of the experimental training could have only a slight facilitative effect.

Another problem situation to be described is the most recent that we have employed. It combines advantages of word association materials in addition to establishing a specific criterion of relevance. There is a unique or only a small number of appropriate solutions to a given problem. The situation under consideration is the Remote Associates Test (RAT) developed by Mednick and King at the Institute for Personality and Assessment Research (IPAR).

An illustrative item perhaps will make the nature of the test apparent. Each test item consists of three words and the task of the subject is to find

a fourth word which is related to all three. For example, "cookies" "sixteen" "heart." A word related to all three is "sweet" - cookies are sweet, sweet sixteen, and sweet heart. The important aspect of the test for our experimental purposes was that the solution to each item, for example "sweet," is a stimulus word in the Kent-Rosanoff word association norms and the words comprising an item in most cases are uncommon associates to the answer. By using the word association norms we were able to obtain an independent assessment of some of the preestablished intraverbal associations entering into the solution of a problem item.

In our initial experiment employing the Remote Associates Test the subjects were run individually, and the test items were presented singly. Ten items were first presented in similar fashion to all subjects in order to obtain a measure of initial ability to be used in a covariance analysis. Ten different problems were used as the criterion measure. A control group received the 20 problems in succession. Following the operant level a standard experimental originality training condition was introduced. Prior to the presentation of each item of the Remote Associates Test under this condition a stimulus word was repeatedly presented with instructions to give a different association each time. In one group receiving this treatment the word association stimuli were in no way associated with the solutions to the problems as indicated by the revised Kent-Rosanoff norms. A second originality training group received stimulus words which were the dominant associations of the problem solutions. Another experimental group received these associates as the first word in each item. For these subjects each item was increased to four words with the first word the dominant associative response to the solution. A fourth experimental group was given 10 additional problem items prior to the test series in order to determine the effects of additional practice and to roughly equate for possible fatigue effects which would be greater in the originality training conditions than in the control condition. A correction procedure was used for all groups in which the experimenter gave the correct answer for each item to which the subject gave an incorrect solution or failed to respond within two minutes.

The added practice group did not differ significantly from the control group on the criterion measures, while the other three groups did. Differences between the control condition and the two groups receiving dominant associations were highly significant. These two groups did not differ from each other. The difference between the control group and the experimental group which responded to stimulus words not related to the solution approached significance. However, subsequent experiments failed to obtain a reliable difference. Originality training with associated words was significantly superior to practice with unrelated words. The latter results were repeatedly obtained in subsequent experiments with the RAT.

Since there are a large number of uncommon responses that may be prompted in any one associative response hierarchy, the probability of occurrence of a specific uncommon response appropriate to a problem would be increased only slightly if at all. Nonspecific originality training would therefore be unlikely to facilitate solutions of algorithms, except under certain special conditions. However, much problem solving, for example in science, consists of attacking problems which have no single correct solution. A host of different original solutions may be effective under these conditions, and originality training may facilitate their occurrence.

Conclusions

Thinking appears to be endlessly complex because we do not know all of the initial conditions present when an individual begins to think. The most important of these initial conditions is the probabilities of occurrence or response strengths of his available responses. Labels such as categories of thinking, strategies, reasoning, etc. do not represent principles of thinking. They represent the products of thinking and are therefore misleading in their emphasis. Fully adequate explanations of thinking under different stimulus conditions will never be possible until the history of learning of the individual is known, until reaction tendencies of the relevant responses in a situation can be assessed through a knowledge of the number of occasions that they have occurred in the past.

In the absence of such knowledge we do not know precisely what is happening when we administer so-called originality training. A technology that is not based upon a knowledge of the basic behavioral principles cannot hope to be widely generalizable or successful. Nevertheless, the experimental procedures that we have employed in experimental studies of originality, as well as the techniques of others, could be employed in simple minded ways in more complex situations and may well prove effective in the facilitation of originality. Many of the available methods have already been employed in classroom situations, especially by the brainstorming people. Although their results have been promoted in much the same way as a new toothpaste, it appears that reliable long term increases in originality may be obtained.

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