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COGNITIVE FLEXIBILITY TRAINING WITH EDUCABLE RETARDED AND BRIGHT NORMAL CHILDREN OF THE SAME MENTAL AGE.

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THE MAJOR PURPOSE OF THIS STUDY WAS TO DEVELOP A COGNITIVE TRAINING PROGRAM DESIGNED TO INCREASE MENTALLY RETARDED AND NORMAL SUBJECTS' PERFORMANCES ON FLEXIBILITY-TYPE TASKS AND GENERAL INTELLIGENCE TESTS. A TEST BATTERY OF FIVE TESTS (STENCIL DESIGN, EMBEDDED FIGURES, PICTURE ANOMALIES, OBJECT SORTING, AND TELL ABOUT THIS), DESIGNED TO MEASURE COGNITIVE FLEXIBILITY (CF), AND THE STANFORD-BINET INTELLIGENCE SCALE (SB), FORM L-M, WERE ADMINISTERED TO 32 EDUCABLE RETARDED AND 32 NORMAL CHILDREN IN SPECIAL EDUCATION CLASSES AND KINDERGARTEN. TWO CLASSES OF EACH GROUP OF CHILDREN WERE USED AND WERE MATCHED ON MENTAL AGE AND SEX. THE EXPERIMENTAL GROUPS RECEIVED CF TRAINING IN 30 TO 45 MINUTE SESSIONS FOR 20 DAYS. EXERCISES PROVIDED PRACTICE IN SHIFTING FOR THREE GENERAL AREAS OF TRAINING--PERCEPTUAL, CONCEPTUAL, AND SPONTANEOUS FLEXIBILITY. AT THE END OF THIS TIME ALL SUBJECTS WERE RETESTED. RESULTS INDICATED THAT THE MEAN DIFFERENCE IN THE PRETEST CF TOTAL SCORES BETWEEN THE RETARDED AND NORMAL GROUPS WAS SIGNIFICANT AT THE .05 LEVEL, SHOWING A DIFFERENCE IN INITIAL FLEXIBILITY FAVORING THE NORMAL GROUP. THE MEAN CHANGE IN CF TOTAL SCORE FOR BOTH EXPERIMENTAL RETARDED AND NORMAL GROUPS WAS HIGHLY SIGNIFICANT (P IS LESS THAN .001). THE MEAN CHANGE IN CF TOTAL SCORE WAS NOT SIGNIFICANT FOR THE RETARDED CONTROL GROUP BUT WAS SIGNIFICANT FOR THE NORMAL CONTROL GROUP AT THE .001 LEVEL. AN ANALYSIS OF VARIANCE OF IMPROVEMENT IN CF TOTAL SCORES SHOWS THE F-RATIO FOR TREATMENT EFFECTS HIGHLY SIGNIFICANT (P IS LESS THAN .0005). THE MEAN INCREASE IN IQ FOR THE RETARDED EXPERIMENTAL GROUP WAS SIGNIFICANTLY DIFFERENT FROM ZERO AT THE .001 LEVEL, WHILE THAT FOR THE NORMAL EXPERIMENTAL GROUP WAS SIGNIFICANT AT THE .01 LEVEL. NEITHER MEAN DIFFERENCE FOR THE CONTROL GROUPS APPROACHED SIGNIFICANCE AT THE .05 LEVEL. THE ANALYSIS OF VARIANCE FOR CHANGE IN IQ SHOWS THE TREATMENT EFFECTS WERE SIGNIFICANT AT .01 LEVEL. IT WAS CONCLUDED THAT THE TRAINING PROGRAM WAS EFFECTIVE IN PRODUCING SIGNIFICANT INCREASES IN COGNITIVE FLEXIBILITY AND IN IQ. SEVERAL LIMITATIONS OF THE STUDY ARE NOTED. FIVE TABLES AND A REFERENCE LIST OF 23 ITEMS ARE INCLUDED. (RS)

Cognitive Flexibility Training with Educable Retarded and Bright Normal Children of the Same Mental Age

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Cognitive Flexibility Training with Educable Retarded and Bright Normal Children of the Same Mental Age [1]

The hypothesis that retardates are inherently more rigid in their cognitive functioning than are normals of the same MA was first advanced by Lewin (1936) and later subjected to experimental test by Kounin (1941). At present, considerable controversy exists concerning the nature of cognitive rigidity in mentally retarded children. Rigidity in the retarded has been attributed to the following: a lack of permeability of the boundaries within the elements of cognitive structure (Kounin, 1941); cortical and subcortical lesions (Goldstein, 1942); a lack of differentiation in cognitive development (Werner, 1948); the inability to satiate neural activity (Spitz and Blackman, 1959); the disruption of inhibitory processes (Siegel and Foshee, 1960); and the relative strength of various motivational variables such as reinforcement in the experimental situation (Zigler, 1962; Shallenberger and Zigler, 1961; Shepps and Zigler, 1962); the type of reward (Zigler and Unell, 1962); and social class (Zigler and de Labry, 1962).

Although it is of considerable educational importance, the authors were unable to find any attempts, by specific training procedures, to increase the cognitive flexibility of retarded children. Nevertheless, several experiments have been conducted which suggest that training in specific cognitive processes, e.g., fluency and concept formation, facilitates the performance of retarded children on various test variables

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(Rouse, 1962; McDonald, 1964). For example, McDonald has shown that training in similarities and differences is effective in improving concept formation in educable retarded children, and that this improvement is accompanied by a trend toward increased intelligence. Her results suggest that retarded children can be taught to reason and generalize by procedures that stress basic cognitive processes rather than the traditional content of subject matter (McDonald, 1964).

In like manner, it is tenable that retarded children can be taught to adopt more flexible approaches in problem solving by procedures which emphasize conceptual shifting rather than the acquisition of specific information. Therefore, the major purpose of this study was to develop a cognitive training program designed to provide retarded and normal subjects with reinforced practice in making various cognitive shifts and to test its effectiveness in increasing their performance on both flexibility-type tasks and general intelligence tests. Secondly, it was hoped that the comparison of retarded and nomal subjects on flexibility test variables and their differential response to training would provide additional information concerning the rigidity hypotheses for retarded children.

METHOD

The Test Battery

Since established instruments measuring cognitive flexibility in children were not available, it was necessary that special tests be developed for this purpose. A review of the factor analytic literature concerning flexibility in adults, as well as the experimental tasks employed with mentally retarded and normal children, suggested that the behaviors relevant to the construct could be divided into three general areas:

perceptual flexibility, defined as the ability to re-order a stimulus array in several ways; conceptual flexibility, defined as the ability to re-order or categorize concepts in several ways; and spontaneous flexibility, defined as the ability to shift between ideas or concepts in the rapid production of information (McKinney, 1966).

In a preliminary study, nine types of tests hypothesized to measure flexibility in each of these areas were constructed by the authors and were administered to 46 educable retarded and normal subjects with a mean MA of 82.11 months (McKinney, 1966). The test data were subjected to a factor analysis, and the hypothesis of a general factor was supported. In order to reduce the time for administration and to provide the most accurate measurement of the CF (Cognitive Flexibility) factor, the test battery was reduced to five tests, and optimal multiple-regression weights were computed. Cognitive flexibility was then operationally defined as the weighted sum of scores on the tests described below.

Test 1: Stencil Design. Flexibility as measured by this test was assumed to involve the ability to shift perceptually in terms of figure-ground relationships (Corter, 1952; Spitz and Blackman, 1959). Subjects were shown a test figure and were asked to reproduce the design by putting together several of the stencils before them. The stencils were circles with three-inch radii cut from colored cardboard sheets. The test was composed of 15 items which increased in difficulty according to the number of stencils required and the complexity of the figure-ground arrangement.

Test 2: Embedded Figures. Tests involving concealed figures have consistently loaded on flexibility factors (Frick et al., 1951; Dingman, 1958; Chown, 1959). Presumably, performance on this test is related to the ability to break a Gestalt down into its parts and to shift in the organization of part-whole relationships. The test was composed of ten items. Each item consisted of a complete design or object drawn on a 5x8 inch card with several parts of the figure represented on the same card. Subjects were asked to locate each part in the complex figure above it.

Test 3: Picture Anomalies. Flexibility as measured by this test has been attributed to the ability to shift one's set suddenly when confronted by the unexpected in the form of dissonant information (Corter, 1952). The test was composed of 20 anomalies which were represented in pictures drawn on 5x8 inch cards. Some items involved missing parts, e.g., a dog without an ear; others involved inappropriate relationships, e.g., a mouse chasing a cat. Subjects were asked to tell what was wrong in each picture.

Test 4: Object Sorting. Flexibility as measured by this test was assumed to involve the ability to shift concepts. Concept shifting tasks have been consistently applied as definitions of flexibility for both retarded and normal groups (Kounin, 1941; Zigler, 1962). Subjects were required to restructure the same group of stimuli according to several principles. The test was composed of eight items. Each item was constructed from several wooden blocks cut in different shapes and painted different colors. Subjects were asked to sort the blocks into several piles such that all of the blocks in each pile were alike in some way. After the initial sorting, the subjects were asked to sort them according to another principle. Difficulty level varied according to the types of concepts employed and the number of principles involved in sorting.

<u>Test 5: Tell About This</u>. Presumably, successful performance on this test requires a rapid shift in the production of ideas. In this sense, the Tell About This test seems to be related to several of Guilford's flexibility-fluency tests such as Brick Uses and Object Synthesis (Frick et al., 1959). Also, rigidity as displayed on this test seems to be related to the number of different characteristics one perceives for common objects and consequently to the concept of functional fixedness (Dunker, 1945). The test was composed of five common objects for which the subjects were asked to name as many characteristics as they could in one minute.

The means and standard deviations of the CF subtests and the CF total score are presented in Table 2. The test-retest reliabilities of the CF subtests ranged from .725 to .904, and the internal consistencies ranged from .727 to .932. The CF factor loadings for each subtest ranged from .588 to .812. For a complete description of test development, see McKinney (1966).

The Training Program

Since the general goal of training was to provide practice in shifting, it was considered necessary that a large number of diffeent exercises employing a variety of materials be used. It was believed that such a program would prevent the formation of simple response sets and would thus require the subject to shift across materials as well as within materials.

In order that such an arrangement might be achieved, the three general areas of training, i.e., perceptual, conceptual and spontaneous flexibility, were subdivided into two kinds of exercises for each area. The types of exercises included in the perceptual area were figure-ground reversal and embedded figures. The figure-ground reversal exercises included such tasks as coloring or pasting various figures and then reversing the configuration; verbal responses to reversible figures, e.g., the Rubin-Vase-Profile; and the selection of figure-ground opposites in multiple-choice problems. The embedded figures exercises consisted of finding common objects hidden in a more complex array, the hiding and finding of various abstract figures drawn on plastic overlays, and multiple-choice problems. The types of exercises included in the conceptual area were similarities-differences and concept shifting. The exercises in concept shifting consisted of sorting and classification tasks in which the subjects ordered both concrete and abstract materials according to some general principle and then were required to shift principles. Exercises in opposites and analogies were also included in the conceptual area. The exercises in spontaneous flexibility included tasks in both structured and unstructured fluency such as class naming, rhymes, and cancellation.

In conjunction with each type of exercise, an effort was made to teach the appropriate verbal concepts such as "figure," "ground," "part," "whole," "alike," "different". The instructions for each exercise emphasized change or shift, e.g., "Do it another way. Put them togethere a new way that is different from the way you have them here." To insure maximum variation, no specific type of exercise was repeated more than three times throughout training, and no specific type was given two days in succession. Positive reinforcement was given verbally and applied liberally. Whenever possible, corrective feedback was given immediately on both group and individual bases. Frequent prompting of responses was employed as a device to facilitate responding, to maintain rapport, and to encourage attempts with difficult items. Review of concepts and procedures, using materials from previous exercises, was held briefly before beginning each new exercise. Throughout the program, care was taken to insure that all training materials were independent of test materials.

SUBJECTS AND PROCEDURE

The subjects were 32 educable retarded and 32 normal children who attended special education classes and kindergarten. Two classes of each group of children were used. Subjects were without previous institutional experience.

All subjects were individually pre-tested with the Stanford-Binet Intelligence Scale (SB), Form L-M, and the Cognitive Flexibility Test (CF). The four groups were then matched on MA and sex. In accordance with the matching procedure, 16 subjects were selected for each group half were boys and half were girls. The means and standard deviations of the CA's, MA's, IQ's, and CF total scores for each group are given in Table 1. To insure that the groups were adequately matched, an Analysis of Variance of the pre-test MA's for each group was carried out, and the resulting F-ratio ($F=0.389$) was nonsignificant.

The experimental groups received CF training in 30 to 45 minute sessions for 20 days. The control groups participated in their usual classroom activities but did not receive CF training. One of the authors conducted the exercises each day except for two days during which the teachers had charge of training.

At the end of training, all subjects were re-tested with the SB and the CF test in approximately the same order in which they were pre-tested.

RESULTS

The means and standard deviations of the pre-test CF subtests and

CF total scores for the retarded and normal groups are given in Table 2. The mean difference in CF total scores between the retarded and normal groups was 52.56. Since this difference was significant at the .05 level, it was necessary that the hypothesis of no difference in initial flexibility between the retarded and normal groups be rejected.

As shown in Table 2, the mean score for the normal group on each CF subtest was consistently higher than that for the retarded group. However, the only such difference that was significant was on the Object Sorting subtest, although the differences observed for the Stencil Design and Tell About This subtests approached significance.

The means and standard deviations of change scores in each test variable are presented in Table 3. The mean change in CF total score for the retarded experimental group was 137.80, and that for the normal experimental group was 152.94. Both of these means were highly significant ($P < .001$). The mean change in CF total score for the retarded control group was 31.87, and that for the normal control group was 52.69. The mean change in the retarded group was not significantly different from zero; however, the change in the normal control group was significant at the .001 level.

A summary of the Analysis of Variance of improvement in CF total scores is given in Table 4.[1] As Table 4 shows, the F-ratio for treatment effects was highly significant ($P < .0005$). However, the F-ratio for group effects as well as that for interaction failed to approach significance.

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[1]Since one S in the retarded experimental group moved during the post-test phase, his CF score was estimated by using the group mean for the post-test CF scores. Accordingly, one d.f. was subtracted from both the total and error d.f.'s.

Individual comparisons were made between the mean improvement for the retarded experimental group and the normal experimental group as well as between the retarded control group and the normal control group. The t-ratio for the experimental group comparison was 0.573, and that for the control group comparison was 1.474. Neither ratio was significant at the .05 level.

As Table 3 shows, the two experimental groups showed significant improvement in all CF subtest variables with one exception, that the retarded experimental group failed to show a significant increase on the Stencil Design subtest. The retarded control group failed to demonstrate significant changes on all test variables except Stencil Design. The mean change on this subtest was significant at the .05 level. Likewise, the normal control group failed to improve on all test variables except the Picture Anomalies subtest. The mean change on this subtest was significant at the .001 level.

The mean increase in IQ for the retarded experimental group was 6.25, and the corresponding increase for the normal experimental group was 10.19. The mean for the retarded experimental group was significantly different from zero at the .001 level, while that for the normal experimental group was significant at the .01 level. The mean change in IQ for the retarded control group was 2.12, and that for the normal control group was 2.44. Neither mean difference approached significance at the .05 level.

A summary of the Analysis of Variance of change in IQ is presented in Table 5. As Table 5 shows, the treatment effects were significant at the .01 level; however, the F-ratios for the group effects and interaction were not significant. In addition, individual comparisons between the mean change for the experimental groups as well as those for the control groups were not statistically significant. The t-ratio for the experimental group comparison was 1.671, and that for the control group comparison was 0.173.

DISCUSSION

One objective of this study was to test the general hypothesis that normal children are more flexible than are retarded children of the same MA. Inspection of Table 2 indicates that the difference between the mean pre-test CF total scores for the normal and retarded groups was significant at the .05 level. However, when the performance of these two groups on the CF subtests was compared, significant differences were found only for the Object Sorting subtest. Therefore, the differences between the mean pre-test CF total scores for the normal and retarded groups may be attributed to differences between the two groups on the Object Sorting subtest, and to a lesser degree, to differences in the Stencil Design and Tell About This subtests.

These results suggest that differences in cognitive flexibility between normal and retarded children of the same MA are due primarily to differences in their ability to shift concepts. Thus, the results of this study support the conclusions of previous research finding greater difficulty in concept shifting among retardates as compared to normals (Kounin, 1941; Bolles, 1937; Kerstvedt et al., 1954; Haplin, 1958; Silverstein et al., 1963).

However, several limitations must be imposed on the generality of these findings. First, it may be argued that the normal group was not truly "normal" in the sense that the mean IQ's of the normal experimental and control groups were in the bright normal range (113.56 and 117.37, respectively). Secondly, the retarded and normal groups were not matched for social class. The normal group was composed primarily of middle class children, and the retarded group of lower middle and upper lower class children. Since some research shows social class to be an important variable contributing to differences between normal and retarded children on various cognitive tasks (Zigler and de Labry, 1962), the finding that the normal groups employed in this study were more flexible than the retarded groups when matched on MA must be considered equivocal.

The second objective of this experiment was to test the hypothesis that special training procedures designed to provide practice in shifting would increase the cognitive flexibility of retarded and normal groups. As Tables 3 and 4 show, this hypothesis was confirmed. Therefore, one can conclude that the training program was effective in producing significant increases in flexibility in the experimental groups, and that these increases were significantly greater than those observed in the control groups.

In addition to the hypothesis that the training program would produce significant increases in flexibility in both experimental groups, it was predicted that the retarded and normal groups would respond differently to training, i.e., the mean improvement in the retarded group would be different from that in the normal group. As Table 4 shows, the group effect for the Analysis of Variance of improvement in CF total score was not statistically significant. Therefore, it was concluded that there was no difference between the normal and retarded groups in improvement.

According to the Lewin-Kounin theory of retardation, the retarded child is assumed to be dynamically different from the normal child of the same MA in that the boundaries between his cognitive structures are less permeable, thus rendering his congitive system less fluid and more rigid (Kounin, 1941). It follows, therefore, that the retarded S's cognitive system would be more resistant to change than would the normal subjects, insomuch as change implies movement within the system. Thus, according to the Lewin-Kounin position, one would predict that the normal group would show greater improvement following training than would the retarded group. Since this prediction was not verified, some doubt must be cast on the validity of the Lewin-Kounin theory of rigidity. On the other hand, these results seem to imply that although retarded children demonstrate greater difficulty in performing cognitive shifts than do normals of the same MA, the retarded child is nevertheless capable of producing the same relative change in his cognitive structure as the normal child. In this sense, therefore, he is not inherently more rigid than the normal child of the same MA.

The third major objective of the study was to test the hypothesis that the effects of CF training would generalize to other areas of cognitive functioning and thus would facilitate improvement on cognitive tasks which were independent of training. As Tables 3 and 5 demonstrate, highly significant improvement scores in IQ were observed for the experimental groups. Similarly, the Analysis of Variance of improvement in IQ shows a highly significant treatment effect with nonsignificant group and interaction effects. Consequently, it was concluded that the training program was effective in producing significant increases in IQ for the experimental groups, and that the mean increase in IQ for the experimental groups was significantly greater than that for the control groups. Further, it was concluded that there were no significant differences in improvement in IQ between the normal and retarded groups.

Unfortunately, these conclusions must be interpreted in the light of several limitations. First, as discussed previously, the retarded and normal groups were not matched for social class nor for etiology. Also, since the physical requirements of the experimental situation permitted no contact with the control groups during the training period, the possibility exists that some of the improvement that was observed in the experimental groups might be due to the establishment of greater rapport with these groups during the training period.

Nevertheless, these results may be interpreted as providing support for the assertion that retarded and normal children can be trained to adopt more flexible approaches in problem solving. In this respect, it can be argued that such training has a high degree of generality. This implies that such training is more "basic" in terms of cognitive functioning than procedures which stress the acquisition of specific skills. Thus, the individual seems to learn not only what responses are appropriate or inappropriate but, more importantly, how to modify his behavior.

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Table 1

The Mean and Standard Deviation of Each Pre-test Variable for the Retarded and Bright Normal Groups

Group	N		CA	MA	IQ	CF
RE	16	$\bar{X}$	124.19	81.25	65.75	467.25
		s	14.09	10.19	5.86	140.85
RC	16	$\bar{X}$	126.00	80.56	65.06	417.25
		s	11.43	9.89	8.28	114.90
NE	16	$\bar{X}$	69.69	78.00	113.56	488.06
		s	4.53	6.78	11.59	131.03
NC	16	$\bar{X}$	69.81	80.56	117.37	501.56
		s	4.17	9.44	15.86	115.69

Table 2

The Mean and Standard Deviation of Each CF Subtest and CF Total Score for the Retarded and Bright Normal Groups

Test	Retarded $\bar{X}$	Retarded s	Bright Normal $\bar{X}$	Bright Normal s	$\bar{X}_D$	t	
Stencil Design	8.50	5.29	10.37	5.72	1.87	1.357	n.s.
Embedded Figures	17.84	4.83	18.87	4.24	1.03	.906	n.s.
Picture Anomalies	23.44	6.98	24.12	4.22	.68	.471	n.s.
Object Sorting	17.28	6.55	22.03	8.49	4.75	2.504	**
Tell About This	18.62	5.00	20.78	6.06	2.16	1.555	n.s.
CF Total	442.25	129.07	494.81	121.78	52.56	1.675	*

n.s. = not significant - $P > .05$
* = significant - $P < .05$
** = significant - $P < .01$

Table 3

The Means and Standard Deviations of Change Scores for Each Test Variable for Each Group

Group	N		Total CF	IQ	Stencil Design	Embedded Figures	Picture Anomalies	Object Sorting	Tell About This
		$\bar{X}$	137.80	6.25	1.13	3.27	5.47	11.73	9.87
RE	15	s	58.9(	5.74	2.97	3.75	4.87	7.64	6.38
		t	9.05***	4.36***	1.48 ns	3.38**	4.44***	5.95	5.99***
		$\bar{X}$	31.88	2.13	1.25	- .69	1.63	.94	- .88
RC	16	s	64.18	4.86	2.05	3.18	3.95	5.13	3.14
		t	1.99 ns	1.75 ns	2.44*	- .87 ns	1.65 ns	.73 ns	-1.12 ns
		$\bar{X}$	152.94	10.19	3.25	3.19	5.75	10.56	6.94
NE	16	s	84.42	12.03	4.36	4.52	4.06	8.28	4.88
		t	7.25***	3.39**	2.98**	2.82**	5.67***	5.10***	5.69***
		$\bar{X}$	52.69	2.44	1.06	.56	3.13	2.06	-.06
NC	16	s	47.53	8.98	3.57	2.66	2.83	5.39	5.23
		t	4.43***	1.09 ns	1.19 ns	.85 ns	4.43***	1.53 ns	- .01 ns

ns = not significant - $P < .05$
* = significant - $P < .05$
** = significant - $P < .01$
*** = significant - $P < .001$

Table 4

The Analysis of Variance of Change in CF Factor Scores

Source	SS	df	MS	F
Treatments	170,053.14	1	170,053.14	43.209****
Groups	5,166.02	1	5,166.02	1.313 ns
Interaction	129.39	1	129.39	0.033 ns
Error	232,198.56	59	3,935.57	
Total	407,547.11	62		

ns = not significant - $P > .05$

**** = significant - $P < .0005$

Table 5

The Analysis of Variance of Change in IQ

Source	SS	df	MS	F
Treatments	564.06	1	564.06	8.033 **
Groups	72.25	1	72.25	1.029 ns
Interaction	52.60	1	52.60	0.749 ns
Error	4213.09	60	70.22	
Total	4902.00	63		

ns = not significant - P .05

** = significant - P .01