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TEACHING COIN EQUIVALENCE TO THE MENTALLY RETARDED[1]

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A program was designed to teach coin equivalence to mentally retarded adolescents. Coin equivalence was defined as choosing several different combinations of coins to equal specified target values. A pretest-posttest matched-groups design was employed with an experimental group receiving the monetary training, and a no-training control group. A multiple baseline across coin-counting responses was also incorporated in the experimental group. Training was divided into six stages, each teaching one specific method of combining coins to equal 10 target values from 5¢ through 50¢. A three-component response chain was used, requiring (a) naming, (b) selecting and counting, and (c) depositing target monetary values into a coin machine. Experimental subjects improved significantly in coin equivalence performance and maintained their skill on follow up tests; control subjects did not.

DESCRIPTORS: coin-equivalence training, monetary skills, pretest-posttest design, multiple baseline, response chain, retardates

The principle of normalization (Wolfensberger, 1972) advocates that mentally retarded persons attain as normal an existence as possible, as is evident in the community placement of many institutionalized retardates. Concomitant with community placement is the need to train the retarded in daily living skills, of which one of the most important is the use of money. Pictorial representations of coins and bills are commonly used educational materials (LeBlanc, Vogeli, Barnhart, Grimsley, and Scott, 1973; O'Neil, Keiter, and Benson, 1971). Despite their widespread use, such materials have rarely been validated as effective teaching devices.

Research on teaching monetary skills is meager. Wunderlich (1972) used a matching-to-sample procedure to teach retarded children to discriminate between (a) the five American coins, and (b) combinations of coins that did, and did not, equal individual sample stimuli consisting of a nickel, dime, quarter, and half-dollar. Bellamy and Buttars (1975) employed a modelling procedure to teach monetary counting to mentally retarded adolescents. A sequence of rote counting was taught first and then this skill was applied to identifying and counting coins.

Although there are few tested procedures for teaching monetary skills, general training principles have been explicated (Denny, 1966). Modelling by an experimenter (*e.g.,* Ross, 1969) and the subject imitating concurrently with the experimenter modelling (*e.g.,* Ross, Ross, and Evans, 1971) have been found effective.

The present study extended previous work by focusing on another important monetary subskill. Procedures were tested to teach coin equivalence, defined as choosing several different combinations of coins to equal target amounts, to mentally retarded adolescents. Knowledge of coin equivalence is a functional skill. A store clerk or vending machine, for example, will

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typically accept any one of several correct combinations of the target price.

METHOD

Subjects

Seven male and seven female adolescent institutional residents ranged in age from 14 to 18 yr ($\bar{X} = 17.1$), and their WAIS IQs were between 46 and 70 ($\bar{X} = 57.93$). Their mental ages varied from 6 yr, four months to 10 yr, 10 months ($\bar{X} = 8$ yr, seven months). The average length of institutionalization was 7 yr, nine months.

Subjects were selected only if they could state the value of visually presented digits used in the training program, count by ones and fives to 100, recall the name and value of the penny, nickel, dime, quarter, and half-dollar when these coins were presented, and sum a sample of 10 combinations of coins, but could not select combinations of coins that equalled specified target values. The 14 subjects were then matched according to their coin-equivalence pretest scores, MAs, CAs, and IQs, as well as the types of equivalencies they composed on the pretest for each target amount. Subjects were then selected randomly within the matched pairs for experimental and no-treatment control groups.

Experimental Design

A combined pretest-posttest matched groups and multiple-baseline design was used. Six instructional stages were employed for experimental subjects, and a coin-equivalence test served as a comprehensive measure of performance for these stages. The test was repeatedly administered as a pretest, at the end of each training session, as a posttest, and followup tests to provide multiple-baseline data.

Apparatus and Materials

A coin machine was constructed by rewiring the coin mechanism from a vending machine and placing it in a wooden housing. The 10 values from 5¢ through 50¢ in 5¢ increments could be illuminated on the front of the coin machine. The mechanism accepted nickels, dimes, and quarters. If subjects deposited in the coin machine an amount to equal an illuminated value, a "happy face" on the apparatus brightened, and a connected Davis Scientific Instruments No. 310 Universal Reinforcement Dispenser delivered M&M candy. If subjects deposited an incorrect amount, the money was returned to a small platform in front of the machine. Thus, the apparatus provided a highly objective and unambiguous measure of response accuracy. Coins were retained by the machine when the response was correct and rejected when incorrect. The coin machine was employed only during the training phase and not during administration of the coin-equivalence test. Twenty-five nickels, 15 dimes, and 10 quarters were used for the coin-equivalence test and training.

Principal Dependent Variable

The major dependent measure was a coin-equivalence test that required subjects to select from a pile of 25 nickels, 15 dimes, and 10 quarters a total of 37 different combinations that equalled 10 target values. These values ranged from 5¢ through 50¢ in 5¢ increments, (*i.e.*, 5¢, 10¢, . . . 50¢) and could be illuminated on the front of the coin machine. The experimenter requested subjects to make one to six different coin combinations for each of the target values.

After each response, the coins were returned to the pile and subjects were asked to place a different equivalent combination on the platform. This procedure was repeated for the specified number of different combinations for each of the target values. A correct response was recorded when the coin combination was equivalent to the target monetary amount, and not a duplication of a previously correct response.

The score for the test was the number of correct equivalencies produced; 37, the total number of equivalent combinations tested and trained across the 10 values, was the maximum score. Test administration time was approxi-

mately 30 min. All data collection and training were performed by the first author.

Setting and Sessions

Training was conducted in a quiet, well-lit room containing a table and two chairs. A pile of nickels, dimes, and quarters, as described previously, was placed on the table in front of the coin machine. The reinforcer dispenser was positioned to the left of the machine and the control panel to the right. Subjects received approximately five training sessions per week, each averaging 30 min. No more than one training session per day was conducted. Participants were seated in front of the coin machine and pile of coins, and the experimenter was seated to the right of subjects. An initial session familiarized subjects with the coin machine and reinforcer dispenser.

Training Procedure

Stages of training. Training was divided into six stages (see Table 1). The response requirements show that subjects learned one specific method of combining coins to equal the target monetary amounts at each stage. At Stage One, for example, subjects were taught to select the appropriate number of nickels to equal each of the 10 target monetary values. Across the six stages, subjects learned from one to six ways of combining each target value. The specific coin combinations taught did not exhaust all the permutations for combining the coins to equal target values. The methods selected generally involved the more complex combinations, whose solutions suggested that subjects could combine coins in a more elementary fashion.

Within each stage there were one to 10 sets of training trials, as represented by the rows of target values under each Stage in Table 1. The last amount in each row was the new amount to be trained. The number of different coin equivalencies trained and tested for each target value can be determined by referring to the novel amounts at the end of each set in each stage. Five cents, for example, was presented only once, in Stage One; 50¢ was presented in all six stages. Each previously trained target value was reviewed before a new value was taught.

Instructional method. Training was initiated at each stage by the experimenter stating the response requirements. Subsequently, the experimenter randomly selected two target values to be trained, and modelled the appropriate responses. The training trials for the appropriate stage were presented next. At the beginning of subsequent sessions of the same training stage, subjects were reminded of the response requirements; appropriate responses were not modelled.

Each monetary amount was trained by a three-component response chain, which required (a) naming, (b) selecting and counting, and (c) depositing the target monetary values into the coin machine. One instruction was given by the experimenter for each component. Training began with the experimenter asking subjects to state the illuminated monetary value on the coin machine. If subjects responded correctly, they were praised and given the instruction for the second component of the instructional sequence. If subjects responded incorrectly, the experimenter stated the correct response and the instructional sequence for the first component was repeated until performed correctly.

An identical procedure was followed for training the other two components of the response chain. For component two, subjects were instructed to count and place on the platform a coin combination equivalent to the target value and conforming to the response requirement for that stage. If subjects responded correctly, they were praised. If they responded incorrectly, the experimenter modelled the correct response, pointing to each individual coin as it was counted. After modelling, the subject imitated concurrently with the experimenter modelling once again. The experimenter faded the verbal prompts by providing only initial sounds of words until subjects were able correctly to count the coins independently. The coins were then removed, and the instructional sequence was resumed at component one. When the first two

Table 1

Stages of Training

Stage →	*One*	*Two*	*Three*
Response Requirements	To use only nickels to equal each of the 10 target monetary amounts. (*e.g.*, 50¢ = 10 nickels)	To use one dime and a sufficient number of nickels to equal each of 10 target monetary amounts. (*e.g.*, 50¢ = 1 dime, 8 nickels)	To use the maximum number of dimes and a nickel when necessary to equal each of seven target monetary amounts. (*e.g.*, 50¢ = 5 dimes)
Randomization of Monetary Amounts Trained at Each Stage	*5* 5, *10* 10, 5, *15* 5, 15, 10, *20* 10, 5, 20, 15, *25* 15, 10, 20, 25, 5, *30* 10, 20, 5, 30, 15, 25, *35* 25, 10, 5, 15, 35, 20, 30, *40* 10, 30, 20, 40, 5, 15, 25, 35, *45* 30, 40, 5, 25, 20, 35, 10, 45, 15, *50*	*10* 10, *15* 10, 15, *20* 15, 10, 20, *25* 15, 25, 20, 10, *30* 10, 30, 15, 20, 25, *35* 20, 35, 15, 30, 10, 25, *40* 15, 30, 20, 10, 25, 35, 40, *45* 45, 20, 15, 40, 25, 10, 30, 35, *50*	*20* 20, *25* 25, 20, *30* 30, 25, 20, *35* 25, 30, 20, 35, *40* 25, 40, 30, 20, 35, *45* 35, 45, 20, 40, 25, 30, *50*

Stage →	*Four*	*Five*	*Six*
Response Requirements	To use one quarter and a sufficient number of nickels to equal each of six target monetary amounts. (*e.g.*, 50¢ = 1 quarter, 5 nickels)	To use one quarter several dimes, and a nickel when necessary to equal each of four target monetary amounts. (*e.g.*, 50¢ = 1 quarter, 2 dimes, 1 nickel)	To use two quarters to equal the target monetary amount. (*e.g.*, 50¢ = 2 quarters)
Randomization of Monetary Amounts Trained at Each Stage	*25* 25, *30* 30, 25, *35* 30, 35, 25, *40* 35, 25, 30, 40, *45* 40, 30, 25, 45, 35, *50*	*35* 35, *40* 40, 35, *45* 35, 45, 40, *50*	*50*

components were completed correctly, subjects were instructed to deposit the money in the machine.

The procedures and instructions were followed for each of the monetary amounts trained in each set of values for each instructional stage. Discriminative stimuli included verbal instruction and visual presentation of target values. The instructional procedure incorporated modelling, shaping, chaining, and fading. Correct responding resulted in informational (knowledge of results), social (praise), consumable (M&M candy), and symbolic (happy face) consequences. Incorrect responding produced corrective feedback.

Stage-to-stage progression. To advance from one training stage to the next, subjects were required to (a) complete correctly all of the response requirements for that stage, and (b) demonstrate 100% mastery of the requirements for that stage on the coin-equivalence test. The only exception was that subjects were permitted to skip a stage if they demonstrated 100% mastery of that stage before training (*e.g.,* on a previous administration of the coin-equivalence test).

If, while being trained on a particular stage, subjects correctly composed fewer than 90% of the coin combinations required for a previously trained stage on the coin-equivalence test, a special review was given during the next session. This review provided rehearsal of all stages that had previously been mastered by requiring subjects to compose all the combinations they had learned. The coin machine was not used, and only the target values 35¢ through 50¢ were employed, since these provided adequate rehearsal for previously learned stages. The review was procedurally similar to original training. At the end of the review sessions, subjects were given the coin-equivalence test. If they then demonstrated 100% mastery of all previously learned stages, regular training was continued. If not, subjects were recycled through review sessions until they met the criterion. Training was then concluded after all stages had been completed and/or 100% mastery was demonstrated on all stages. The final administration of the coin-equivalence test served as a posttest. One week and one month after each individual's final training session, the coin-equivalence test was readministered as a maintenance check. The instructions were the same as those used during previous testing. Control subjects were administered the pretest, posttest, and two followup tests on the same day as their matched counterparts in the experimental group. They received no training.

RESULTS

All seven experimental subjects completed the training program, and six of the seven received one-week and one-month followup tests. The seventh experimental subject was discharged from the institution and was unavailable for either of the followup tests. Each of the seven control subjects was administered the pretests, posttests, and followup tests. Table 2 shows test scores for individual subjects and group means and standard deviations for these scores. The Wilcoxon signed-ranks test for matched pairs compared the experimental and control groups on the relevant variables on which they were matched and revealed no significant differences.

Within-Groups Analyses

The experimental group mean increased significantly from 12.86 on the pretest to the maximum possible score of 37 on the posttest [$T(N = 7) = 0$, $p < 0.01$]; the control group, on the other hand, showed no significant gain [$T(N = 7) = 7$, $p > 0.05$] (see Table 2). Newly learned skills were also maintained by the experimental group. The mean one-week and one-month followup scores are 93% and 88% of the posttest score.

Between-Groups Analyses

A direct comparison was made between the coin-equivalence test scores for the two groups. Although groups did not differ on the number of coin combinations that they could form at pretest, the experimental group scores were signifi-

Table 2

Coin-Equivalence Test Scores for Experimental (*E*) and Control (*C*) Subjects

Subject Pair	*Pretest*		*Posttest*		*One-Week Followup*		*One-Month Followup*	
	E	*C*	*E*	*C*	*E*	*C*	*E*	*C*
1	22	21	37	20	36	20	34	21
2	19	18	37	17	35	18	35	17
3	5	9	37	8	32	8	30	10
4	8	6	37	5	34	5	30	5
5	10	9	37	10	34	10	31	10
6	13	11	37	9	36	8	35	9
7	13	12	37	13	—	11	—	13
X	12.86	12.29	37	11.71	34.50	11.43	32.50	12.14
SD	5.54	4.95	0.00	4.89	1.39	5.12	2.22	4.97

cantly higher than those of the control group on the posttest [$T(\mathrm{N} = 7) = 0$, $p < 0.01$], and the one-week [$T(\mathrm{N} = 6) = 0$], and one-month followup tests [$T(\mathrm{N} = 6) = 0$], $p < 0.025$ for the latter two comparisons.

Multiple-Baseline Analyses

Figure 1 shows multiple-baseline data obtained from the coin-equivalence test administered to the experimental group each session. The total number of items from each training stage represented on the coin-equivalence test is shown on the abscissa. Data points represent the mean number of equivalences formed for each of the six stages on the test. Figure 1 shows that performance on each stage increased only after training was initiated on that stage and that behaviors were maintained.

Error and Training-Time Analyses

As a measure of training-stage difficulty, analyses were made of the errors that occurred and the number of training sessions required for each stage. Overall, errors were made on 14% of the trials: 9% involved using the proper coins but counting them incorrectly, and 5% involved using the incorrect coins. Stage Five contained the largest percentage of errors. An average of 58% of the errors occurred in the first half of each stage and 42% in the second half. The average number of sessions required for the entire training program, excluding the followup tests, was 9.43. The mean total testing and training time was 4 hr and 43 min. By eliminating testing time in each session, actual training time averaged 3 hr and 8 min.

DISCUSSION

The training procedures were effective in teaching coin equivalence to mentally retarded adolescents. Experimental subjects improved significantly in coin-equivalence performance, and substantially maintained these increments on one-week and one-month followup tests; control subjects did not. Results indicated that skills were acquired relatively rapidly.

Multiple-baseline data showed that generalization across training stages did not occur for the group as a whole or, to any major degree, for individual subjects. In some cases, scores for untrained stages decreased when training was initiated for an earlier stage. This may be attributed, in part, to subjects' heightened attention to, and perseveration of, the method being trained.

Analysis of maintenance performance indicated that, except for Stage Six, performance on successive stages decreased somewhat in the percentage of maintained equivalencies. Later stages taught combinations composed of larger

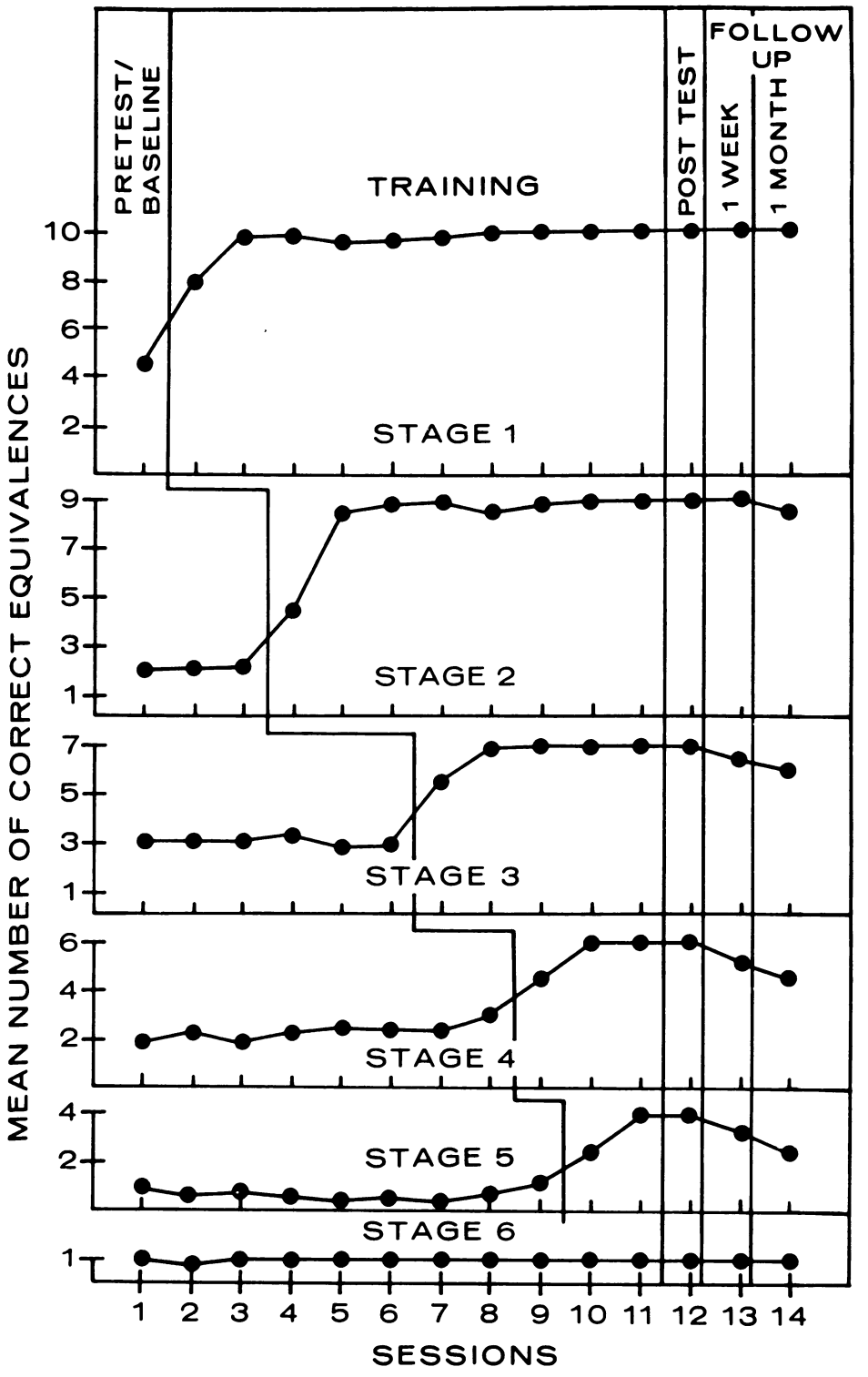

Fig. 1. Mean number correct on each of the six stages of the coin-equivalence test administered as a pretest, during each training session, as a posttest, and one-week and one-month followup tests.

coin values, thereby eliminating the smaller target amounts. This resulted in fewer training sets in the later stages; thus, there were fewer rehearsal trials, for each amount. Since each successive stage had fewer rehearsal trials, it is not surprising that fewer equivalencies were maintained. Additional rehearsal trials in the later training stages might ensure that they had been learned. Also, to facilitate maintenance of monetary skills, the opportunity should be provided for subjects to use these skills daily.

These results have added importance when considered in light of the Pollio and Gray (1973) study, which found that it is not until age 11 or 12 that nonretarded children choose a variety of monetary combinations or are able to incorporate the fewest number of coins to equal target amounts. The retarded subjects trained in the present study had an average MA from 2 to 3 yr younger than those in the Pollio and Gray (1973) study, and yet were able to acquire coin-equivalence skills.

Subjective observation indicated that the coin machine served a motivational and attention-maintaining function. Subjects seemed to pay particular attention to the flashing lights on the mechanism, and looked for them on each trial. A followup study could compare the relative effectiveness of the instructional program with and without the machine.

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