Teaching Change Computation to the Developmentally Disabled

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TEACHING CHANGE COMPUTATION
TO THE DEVELOPMENTALLY DISABLED

by

Nancy Daeschlein

A Thesis
Submitted to the
Faculty of The Graduate College
in partial fulfillment of the
requirements for the
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This study evaluated a procedure for teaching three developmentally disabled adults to compute monetary change combinations. Also, the procedure assessed generalization to the skills of computing change with bills, verifying the correctness of change received, and computing change with both coins and bills. Subjects were first trained to make change using pennies and then were trained to use each successive denomination in combination with those previously trained. A multiple-probe design was used, including generalization probes of the above-cited skills. Results indicated that each subject acquired the behavior of change computation with coins as a function of the training procedure. Also, the change computation skills generalized to computing change with bills, excluding $20 bills which required additional training. Additional data suggested generalization to verifying change received and computing change using both coins and bills. Weekly follow-up data suggested maintenance of these skills following the termination of the training.
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Nancy Daeschlein
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CHAPTER I

INTRODUCTION

The current direction of services to the developmentally disabled population is currently defined by the principles of deinstitutionalization, normalization, and treatment in the least restrictive environment (Kindred, Cohen, Penrod and Shafer, 1976). For many, the consequences of this emphasis involve placement in community group homes, obtaining competitive employment, and/or participation in day programming in sheltered workshops. For some, long term goals would include fully independent living. Along with this emphasis and the resultant placements in new settings, come opportunities to participate in all aspects of community life.

Such changes often require the developmentally disabled person to interact effectively with the community. One critical factor for successful interaction with one's environment is having effective money exchange skills. These skills, while varying in complexity, are required when consuming goods and services, and are involved in many social events that include the exchange of money. Also, an individual may become eligible for certain employment opportunities as he/she develops higher level money management skills, such as making change. Daily

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living activities that involve money management skills include putting the right combination of coins in a vending machine at work, deciding which sandwich to order at a restaurant based on how much money one has, paying one's rent on time, and keeping a monthly budget.

Recent research suggests that the developmentally disabled individual often has skill deficits in the area of money management. Edgerton (1976) reported follow-up data that showed retarded persons discharged from an institution were typically economically marginal and deeply in debt. The author attributed part of the problem to a lack of training in change computation and budgeting skills. Aanes and Moen (1976) rated 46 residents of group homes on the Adaptive Behavior Scale before and after living one year in the community. Of the 27 skill areas rated, the scores obtained on money and budgeting were lowest on both the pretest and posttest. Also, there was no significant difference between the pretest and posttest scores, suggesting that skill acquisition is unlikely to occur as a function of opportunities to perform that skill. Bell (1976) surveyed retarded individuals discharged from ten state schools and found that problems were most frequently reported in money usage. McCarver and Craig (1974) cited research that indicated that financial responsibility was a critical factor for successful community placement. Therefore, it appears that the
area of money management includes skills sufficiently complex to preclude incidental acquisition in the natural environment. Also, the consequences for someone having such skill deficits are often punishing. There is clearly a need for the development of efficient methods for teaching money skills.

In the broad area of money skills, coin usage represents a group of specific skills that are frequently used and important to someone actively involved in the community. Coin usage can be divided into four distinct areas of ascending complexity: producing the name and value of the coin, summing coins (computing the total sum of a set of coins), forming equivalent combinations (producing a target value from a pool of coins using different combinations), and change computation skills.

Most of the research in this area has been done on the first three of the skills mentioned above. Producing the name and value of a coin has been taught to mentally retarded adolescents by Bellamy and Buttars (1975). Subjects were first taught a sequence of rote counting skills which was then applied to identifying and counting coins. Modeling was the principal training technique. The program required approximately 100 hours of instruction. A study done by Miller, Cuvo and Borakove (1977) using mentally retarded subjects, attempted to determine whether (a) it would require fewer trials to teach verbal production
of coin values or to teach auditory comprehension first, (b) comprehension training would generalize to production, and (c) production would generalize to comprehension. They found that it was more efficient in terms of number of training trials required to teach verbal reproduction directly, rather than teach participants to comprehend values prior to producing them. Generalization was obtained from production to comprehension, but the converse did not occur.

Summing combinations of coins, the second skill in coin usage, also has been the focus of instructional research. Lowe and Cuvo (1976) validated a finger counting procedure to teach mentally retarded adolescents and adults to sum coins. Subjects were first taught to count a single target denomination and then to sum the coin of that denomination in combination with coins of previously trained denominations. A multiple-baseline design suggested that improvement in coin-counting performance only occurred after the coin was trained.

Research done by Wunderlich (1972) in the third skill area, forming coin equivalences, tested a matching-to-sample procedure to teach mentally retarded children to discriminate the penny, nickel, dime, quarter and half-dollar, as well as combinations of coins whose amount did and did not equal a single sample coin value. Programmed instruction presented by a teaching machine which required
a specific response pattern was used to successfully train the discriminatory responses.

Additionally, Trace, Cuvo and Crisswell (1977) trained mentally retarded adolescents to form equivalent combinations of coins (e.g., choosing different combinations of coins to equal specified target values). 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 naming, selecting and counting, and depositing target monetary values into a coin machine. Experimental subjects improved significantly in coin equivalence performance after training and maintained their skill in follow-up tests.

In another study done by Daeschlein, Braam and Samara (Note 1), mentally retarded adolescents and adults were trained to form coin equivalences. A multiple-probe design was used to assess the effects of training. The counting technique was trained using backward chaining; computing nickels and pennies was trained first with dimes, quarters, and half-dollars added in successive phases. Probes were conducted during each phase to assess generalization to other conditions. Also, coin summation skills were probed throughout training to determine generalization to related coin computation skills.

As mentioned previously, most of the research in this
area has been done on the first three skills. However, recent research has yielded relevant data on training the last skill, change computation. Pollio and Gray (1973) studied developmental differences in change computation skills among groups of 7, 9, 11 and 13 year olds, as well as college students. They found that efficiency of solution (i.e., using the least number of coins) was positively correlated with age. Cuvo, Veitch, Trace and Konke (1978) demonstrated the efficacy of instructional procedures for teaching change computation skills to three mentally retarded adolescents. While the results of this study indicate effectiveness of the training procedure (almost 100% performance on posttest and follow-up testing), the study is limited in several areas. The range of coin denominations taught (1-49¢) did not include all possible combinations of making change without using bills (1-99¢). Also, because of the limited number of certain coins available to the subjects (e.g., only four pennies), incorrect responses such as giving nine pennies for change instead of four pennies and a nickel were impossible. This also assumed that the subject would always have access to the same combination of coins that was used for training (which would be necessary for them to use that skill effectively in their environment). By not training change computation using bills, the trainees are severely limited in their ability to successfully interact with their...
environment due to the fact that most purchases involve the use of bills as well as coins. In addition, the study did not attempt to determine generalization effects by probing untrained amounts or untrained denominations (such as $1 bills).

The current study was similar to the research done by Cuvo et al. (1978) in that a general counting sequence was trained that would be applicable to any combination of coins. Both studies involved training subjects to make change as opposed to simply validating change. To expand on the research done by Cuvo et al. (1978), the current study trained a wider range of coin combinations (1-99¢) and the number of coins available to the subjects was greater and more varied, thereby more closely approximating the subject's actual environment. In addition to probing for generalization to untrained amounts of coins, the current study also included generalization probes to untrained denominations ($1, $5, $10 and $20 bills) that are different stimuli but largely similar to previously trained denominations (e.g., $1 is similar to 1¢, $5 is similar to 5¢, and $10 is similar to 10¢) to determine if money exchange skills would generalize to computing change with bills or if additional training would be required. Also, probes were conducted to determine if change verification skills, a less complex skill than change computation, were indirectly acquired by this procedure.
Making change from a pool of coins is a more complex, more useful skill in terms of increased successful interaction with one's environment, and a skill in which change verification is one aspect. Maintenance probes were conducted weekly following the completion of the training phases.
CHAPTER II

METHOD

Subjects

The subjects were three developmentally disabled adults enrolled in a sheltered workshop in a rehabilitation center. Subject A was a 26 year old male with a WAIS Full Scale IQ of 68 and a WRAT math grade level of 3.0; Subject B was a 36 year old female with a WAIS Full Scale IQ of 76 and a WRAT math grade level of 4.0; and Subject C was a 23 year old female with a WAIS Full Scale IQ of 71 and a WRAT math grade level of 4.4.

The subjects were selected on the basis of their demonstrated ability to state the name and value of pennies, nickels, dimes, quarters, and half-dollars, sum various combinations of coins, form coin equivalences (producing a target amount from a pool of coins), and their inability to accurately compute monetary change computations.

Materials

The training materials included eight pennies, eight nickels, eight dimes, eight quarters, eight $1 bills, eight $5 bills, eight $10 bills, eight $20 bills, one $50 bill and one $100 bill. The coins were placed in
separate piles on a piece of 11" by 15" white posterboard. Four inch, white plastic numbers were used to display the "price charged" on a 11" by 13" piece of blue posterboard. This board had a 3" cent sign in the upper right corner and a 3" dollar sign in the bottom left corner.

Setting and Sessions

Sessions were approximately 20 to 30 minutes in length and were conducted daily. The setting for the sessions was a quiet, well lit education room containing two large tables and several chairs. The Experimenter sat across the table from the subject, with the materials directly in front of the subject. The tables and chairs were separated from the rest of the room by 5' partitions, which allowed the reliability observer to monitor the sessions unobtrusively.

Experimental Design

A multiple-probe design (Horner and Baer, 1978) across responses was employed to assess the effect of the training procedure on computing change using coins (pennies, nickels, dimes, and quarters) and to assess generalization to change verification (counting to determine the correctness of change received), computing change with bills only and computing change with coins and bills (complex combinations). The training procedure consisted of four phases: computing change using I. Pennies, II. Pennies and Nickels, III.
Pennies, Nickels and Dimes, and IV. Pennies, Nickels, Dimes and Quarters. During the training of computing change with bills (following generalization probes that indicated that additional training was required), probes were also conducted on complex combinations (computing change with coins and bills).

Response Measures

The principal dependent variable was the percentage of correct responses on change computation trials during training sessions. The Experimenter scored each response as either correct or incorrect. A response was considered correct only if the appropriate amount was obtained using the most efficient combination of coins (e.g., given 50¢ and a purchase price of 38¢, the only correct response would be two pennies and one dime). A response was considered incorrect if an inappropriate amount was obtained or if the appropriate amount was obtained using a combination of coins other than the most efficient available (e.g., given a $1 bill and a purchase price of 69¢, any combination other than one penny, one nickel, and one quarter would be scored as incorrect).

The percentage of correct responses was computed by dividing the number of correct responses by the total number of responses and multiplying by 100.
Interobserver Agreement

A practice session was held to demonstrate the procedure to the observer as well as to give the observer an opportunity to practice recording responses. The observer stood at the corner of the partition where he could observe the training area without distracting the subjects. Interobserver checks were evenly distributed evenly across all conditions. They occurred on 33%, 36%, and 35% of the sessions for Subject A, Subject B, and Subject C, respectively. Agreement percentages were calculated using the formula: agreements/agreements plus disagreements x 100. An agreement was scored when both the observer and the Experimenter scored the same response as either correct or incorrect. Agreement percentages averaged 98%, with a range of 96% to 100%.

Probes

Performance in each phase of change computation was assessed during probe sessions, conducted prior to beginning baseline sessions for each training phase. All sessions began with the Experimenter presenting the subject with a purchase price using the numbers and the poster-board and an amount to be given for the purchase (which varied from 10¢ to a $1 bill, in multiples of five) and asking him/her "If I buy something that costs ____ and I give you ______, how much change do I get back?". The
subjects did not receive feedback on the correctness of their performance during probe and baseline sessions. Each probe involved 10 trials at each response level. Prior to each training phase of change computation with coins, probes were conducted on all four phases of change computation with coins. If a subject scored less than 90% on a probe of a previously trained response, re-training was implemented. At the same time that probes were conducted on all four training phases, generalization probes were conducted for each of the four responses of change computation with bills.

Additional Generalization Probes

In addition to probes on the four training phases and generalization probes on change computation with bills, probes were conducted on two related skills: verifying change received using a limited range of coin values and computing change using coins and bills. Comprehensive probes (i.e., probes on each denomination for change verification and complex combinations) were not conducted so as to minimize the number of trials without consequences. Change verification probes were conducted following each training phase and employed those denominations previously trained. (In these probes, the Experimenter stated a purchase price, specified the amount to be presented by the subject, and gave the subject change for the purchase.)
The subject counted the change and said "Thank you" if the amount was correct or "I think I have the wrong change" if the amount was incorrect.) Complex combination probes were conducted following training completion on change computation with coins and following the additional training done on bills.

Baselines

Following each probe session, baseline data were collected only on the response in the sequence of change computation that was to be trained next. Twenty trials were conducted during each baseline session. The number of baseline sessions increased by one session for each successive training session (i.e., two sessions for Phase II, three sessions for Phase III, etc.). Therefore, while probe sessions measured each response in the entire change computation sequence, the baseline sessions only assessed the response about to be trained.

Training

Training sessions were divided into four phases. In Phase I, the purchase amount differed from the amount given by 1-4¢, thereby requiring the use of pennies only to make change. In Phase II, the purchase amount differed by 1-9¢, requiring the use of pennies and nickels. In
Phase III, the purchase amount differed by 1-24¢, requiring the use of pennies, nickels, and dimes. Finally, in Phase IV, the purchase amount differed by 1-99¢, requiring the use of pennies, nickels, dimes, and quarters.

At the beginning of each new phase, the Experimenter demonstrated three correct responses. All responses made by the subject following that demonstration were scored. Training trials were conducted using the procedure for probe and baseline trials with two exceptions. During training, the amount given for the purchase was either 25¢, 50¢, 75¢, or a $1 bill. Secondly, correct responses were followed by verbal praise by the Experimenter and incorrect responses were followed by the correction procedure. When a subject made an incorrect response, the Experimenter interrupted the response, demonstrated the correct response, the subject repeated the response with the Experimenter and then the subject was re-tested. Training sessions consisted of 20-25 trials. Criterion for advancing to the next training phase was 90% correct responding for two consecutive sessions.

Generalization

Generalization probes were conducted on computing change with bills and change verification following the completion of each training phase using coins. During the training of computing change with bills, generalization
probes were also conducted on change computation using coins and bills (complex combinations). Following the generalization probes, re-training was implemented on any previously trained response in which a subject achieved less than 90% accuracy. As during the training sessions, the dependent variable was the percentage of correct change computations. The subjects did not receive any feedback on the correctness of their performance during generalization probes.

Follow-Up

Weekly follow-up probes were conducted for each subject for two weeks following the completion of training. The probes were conducted in the same setting used for training. The procedure utilized for pre-training probes was also used for follow-up probes.

Social Validity

Social validity was assessed by having each subject make a purchase in the community and verify their change as being correct or incorrect. During the change verification probes, the subjects were instructed to say "I think I have the wrong change" in response to an incorrect amount and "Thank you" in response to a correct amount, as these would be appropriate responses when out in the
community. The subjects were escorted by the Experimenter on two excursions into the community. All three subjects correctly identified the change they received on both occasions.

An indirect measure of whether or not the subjects could perform this skill in other environments came from their verbal reports of purchases made during their daily routines. Often the subjects would report the purchase amount, amount given, and whether or not the amount received in change was correct or not.
CHAPTER III

RESULTS

Figures I, II, and III represent the training and probe data for Subjects A, B, and C, respectively. Percentage of correct responses is shown as a function of training sessions. The results were similar for each subject. As a function of the training procedure, each subject acquired the behavior of computing change with coins. Subject A required a total of 14 training sessions to master change computation with coins, Subject B required 10 and Subject C required 13. There did not appear to be generalization across phases.

However, generalization did occur to computing change using bills. For Subject B, generalization to bills closely paralleled the training on coins (i.e., percent correct on $1 and $5 increased following Phase II on coins); this did not occur for Subjects A and C. None of the subjects generalized to computing change with bills including $20 bills. However, each subject met criterion on this skill after three training sessions.
Figure 1. Percentage of correct responses during training sessions and generalization probes on each component of change computation (Subject A).

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Figure 2. Percentage of correct responses during training sessions and generalization probes on each component of change computation (Subject B).
Figure 3. Percentage of correct responses during training sessions and generalization probes on each component of change computation (Subject C).
Probes on change verification (see Figure 4) were all at 100% and support the assumption that the skills necessary for change verification are components of change computation and do not require separate training.

For each subject, the probes on change computation with complex combinations (see Figure 5) reached 100% only after training was conducted on computing change with bills, including $20 bills.

Follow-up probes indicate maintenance of both trained and untrained (i.e., acquired through generalization) change computation skills for all subjects for two weeks following training.
Figure 4. Percentage of correct responses on change verification probes.
Figure 5. Percentage of correct responses on change computation with complex combinations.
The results indicate that the training procedure employed was effective in training change computation skills to developmentally disabled adults having the necessary prerequisite skills. Following training, each subject acquired change computation skills relatively quickly; the longest training phase was four sessions and the largest number of sessions required for all training, including coins and bills, was 17.

Also, training change computation with coins appeared to have had the effect of generalization to change computation with bills. Importantly, this occurred only to the denominations of bills that correspond directly to denominations of coins (i.e., $1, $5, and $10 correspond to pennies, nickels, and dimes, respectively). Correct computation of change using bills including $20 bills occurred only after training that response. Therefore, while training change computation with coins may have a substantial effect on related skills, it may not, by itself, result in a comprehensive repertoire of change computation skills.

In addition, the limited probe data on change verification and complex combinations tentatively suggest
that these skills may not require separate training if the fundamental skills of change computation with coins and bills are successful.

Anecdotal data suggest an additional benefit from the training. At the beginning of the study, each subject demonstrated certain weaknesses in their coin-counting skills. To varying degrees, each subject used their fingers when counting (a less normalized technique than simply counting verbally) and occasionally displayed idiosyncratic counting techniques (e.g., beginning with the largest denomination or counting by groups of coins). Although these techniques were not directly addressed by the Experimenter, by the end of the training these behaviors were virtually eliminated; the subjects counted verbally and systematically from the smallest denomination, one coin or bill at a time.

Although the subjects responded well during follow-up probes, it is suggested that maintenance training be employed to insure maintenance of these skills. Conversations with the subjects about their use of money indicated that their opportunities to use the skills may not be sufficiently frequent to maintain their skills. (At the time of the study, each subject lived in a semi-independent residential situation and none had primary responsibility for all of their money). Maintenance training would avoid the need for re-training in the event
that a subject had an employment opportunity that required change computation skills or gained increased responsibility for managing their money.

In conclusion, the current study demonstrated the effectiveness of the training procedure for training some of the more complex skills involved in using money. The current procedure, when combined with previously documented procedures (Lowe and Cuvo, 1976; Trace et al., 1977; Daeschlein et al., 1979) for training more basic money-counting skills, should allow an instructor to teach comprehensive monetary skills to developmentally disabled adults.
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