

TEACHING COIN SUMMATION AND PURCHASING POWER TO RETARDED ADULTS USING A SLIDE RULE PROCEDURE

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Concomitant with the movement toward normalisation and de-institutionalisation, there has been a growing interest in developing procedures for training mentally retarded persons' independent living skills such as occupationally oriented behaviours (Bateman, 1975; Gold, 1972, 1973), general self care behaviours (Lent, LeBlanc and Spradlin, 1970), telephone usage (Leff, 1974, 1975), pedestrian skills (Page, Iwata and Neef, 1976) and recall of current events (Keilitz, Tucker and Horner, 1973). Another essential skill for participation in the community is money usage.

Available programmes for teaching monetary skills include coin identification (Vogelsberg, 1975), coin summation (Bellamy and Buttars, 1975; Borakove and Cuvo, 1976; Wunderlich, 1972), coin equivalence (Trace, Cuvo and Criswell, 1977) and making change (Spellman, 1971). Most programmes designed to teach complex skills also require fairly complex entry behaviours; the studies cited above are no exception to this rule. In both studies on coin summation, subjects were either trained (Bellamy and Buttars, 1975) or selected on their demonstrated ability of rote counting and recalling the names and values of coins (Borakove and Cuvo, 1976; Lowe and Cuvo, 1976), whereas in the study on coin equivalence (Trace *et al*, 1977) subjects were also required to sum a sample of 10 combinations of coins. But, even among those individuals for whom a decision has been made transferring them to community residences, there are few who meet any or all of these programme requirements. Many of them, especially those who have been institutionalised for many years, cannot count by ones and fives to 100, do not recall the names of coins or their values, cannot name or identify numbers and do not understand concepts such as 'too much,' 'enough,' 'not enough,' 'more than' and 'less than.' The absence of these and other related requirements makes it impossible to use any of the existing programmes functionally unless each of these prerequisite skills were trained.

The present study is a first part of a programme project designed to teach severely and moderately retarded subjects all functional component skills of coin usage without using complex numerical skills other than those listed below. The purpose of the study was to evaluate the use of a slide rule procedure to teach coin summation and purchasing power of Dutch coin combinations.

METHOD

Subjects

Three subjects, Jan, Wim and Agnes, participated. Subjects were selected from the highest functioning population of an institution for the retarded. They functioned within the severe to moderate retardation range (I.Q.'s: 39-48; Mean = 43.7), were between 24 and 27 years of age (Mean = 26.3 yrs) and had been institutionalised from 8 to 11 years (Mean = 9.2 yrs).

Subjects were selected on their demonstrated ability (1) to speak, (2) to name one-, two-, and three digit numbers ranging from 0 to 100 following demonstration

of these numbers on price tags, and/or trained (3) to point to 'centen' (pennies), 'stuivers' (nickels), 'dubbeltjes' (dimes) and 'kwartjes' (quarters) under verbal request, (4) to name each of four coins following demonstration of the coin, (5) to point to the numbers on the slide rule (price slot) as demonstrated (price tag) and named by the trainer, (6) to select several same coins out of four piles of 12 same coins upon verbal request and (7) to name ten or less same coins. All three subjects needed pre-programme training (Wim: 28 min; Jan: 44min; Agnes: 202 min) on one or more items.

Screening Test

This test was designed to assess if a subject could determine the correct value of one or more or different coins, determine if he had enough money to purchase an item, pay with the appropriate combinations of coins, know when to expect getting change and to determine if the change received was correct or incorrect.

The screening test consisted of two blocks of eight trials. During each trial the trainer would first put one or more same or different coins on the table. The coins were presented in a natural, unorganised way. The trainer would then show a purchase item with a price tag attached while naming the price (e.g., 'This cost 73 cents'). Presentation of the item was followed by a fixed series of questions of which the two relevant for this study were: 'How much is this?' (referring to the coins) and 'Can you buy this?' (referring to the purchase item). Correct responses to each question were followed by verbal feedback (e.g., 'Right,' 'Yes' and 'O.K. '), or praise ('Good,' 'Excellent') and social approval (e.g., smile, nodding the head affirmatively). No consequences were programmed for incorrect responses or the absence of a response.

The test was discontinued after the subject failed to respond correctly on three consecutive trials. The results indicated that all three subjects never gave a correct response to the first question and responded to the second question at chance level (50% correct). Jan's and Agnes' answers to the second question appeared to be random while Wim's answer was always affirmative.

Trainers, Setting and Materials

Test and training procedures were carried out by two university students. The author and a third student served as reliability observers.

The study took place in a separate room. Furniture included a large table, several chairs and a rack containing back-up reinforcers. Trainer, subject and reliability observer were sitting next to one another on the same side of the table.

Materials used for this study included:

1. Ninety nine different purchase items (e.g. candy, pen, marble, pencil sharpener, matches, etc.) each with a price tag varying from 1 to 100 cents. The prices of the items were in accordance with those in most stores.
2. Twelve pennies, twelve nickels, twelve dimes and twelve quarters.
3. Pen and record form for the trainer.
4. Pen and record form for the trainee. These record forms consisted of 20 rows and 25 columns and were used during training sessions only. The trainees were instructed to write a zero in a cell when erring on one or more questions on a given trial and a dash when all responses on a trial were correct.
5. Back-up reinforcers such as cigarettes, cigars or plastic money which could be exchanged for other items.

6. A (43cm x 9cm) wooden slide rule (Figure 1) consisting of five slats, i.e., a price slat and four coin slats. Two slats, i.e., the price slat (extreme left) and the quarter slat (extreme right) were fixed. The other three coin slats (for pennies, nickels and dimes) were longer (50cm) and could be moved back and forth.

The price slat showed the numbers 0 (bottom) to 100 (top), each number separated from the next by 4mm. All numbers were printed black, except for the fives which were printed red and the tens (including zero) both digits of which were printed red.

The penny, nickel and dime slats showed two columns of numbers, one on the left and one on the right side of each slat. All slats started with zero on the bottom of the column, going up to the maximum number of coins equivalent to 100 cents or one guilder (100 on the penny, 20 on the nickel, 10 on the dime and 4 on the quarter slat). The numbers of the right column of each slat were in the reversed order. Since the right sided columns were not used during the present study, they were covered with coloured transparent plastic (yellow for the penny, green for the nickel and red for the dime slat). The quarter slat showed only one column.

The numbers of each column were spaced such that when the zeros of each slat formed a horizontal line, the value of one or more same coins could, by going from right to left, be observed on the price slat. The horizontal lines connecting the very top and bottom numbers were printed red. The bottom of each coin slat carried a different symbol, i.e., a C for the 'centen' or penny slat, an S for the 'stuivers' or nickel slat, a D on the 'dubbeltjes' or dime slat and a K on the 'kwartjes' or quarter slat.

Attached to the slide rule was a transparent plastic strip (2.5cm x 9cm) with a black horizontal line in the middle. The strip could be moved back and forth along the total length of the slide rule.

PROCEDURE

General

Training sessions were conducted once a day, four to five days a week. Each session was of approximately 30 min. duration.

The programme consisted of eight sequential training steps. Starting each new step, the trainer would first make an introductory statement concerning its objective. Then he would start with one to six examples or introduction trials. During each of these trials, the trainee would receive as much assistance (verbal instruction, demonstration and physical guidance) as needed to perform the complete sequence of required responses. Correct responses and approximations were followed by verbal praise and approval. The trainee's record form was not used during these trials.

Following termination of the introduction trial(s), the trainer presented the first of a series of training and review trials. The review trials consisted of items learned during previous steps. The ratio of training and review was about three to one. Training and review trials were presented in random order.

For training trials including multiple component behaviours, the trainer presented a standard instruction (question) for each component. Correct responding to each component was followed by praise and the instruction for the next component of the instructional sequence. Incorrect responding was followed by the trainer using assistance procedures, his instruction to write a zero on the record form and immediate repetition of the trial. Correct responding to the second presentation of that trial was followed by praise only, while incorrect responding resulted in the trainer again using assistance procedures. The same trials were never presented

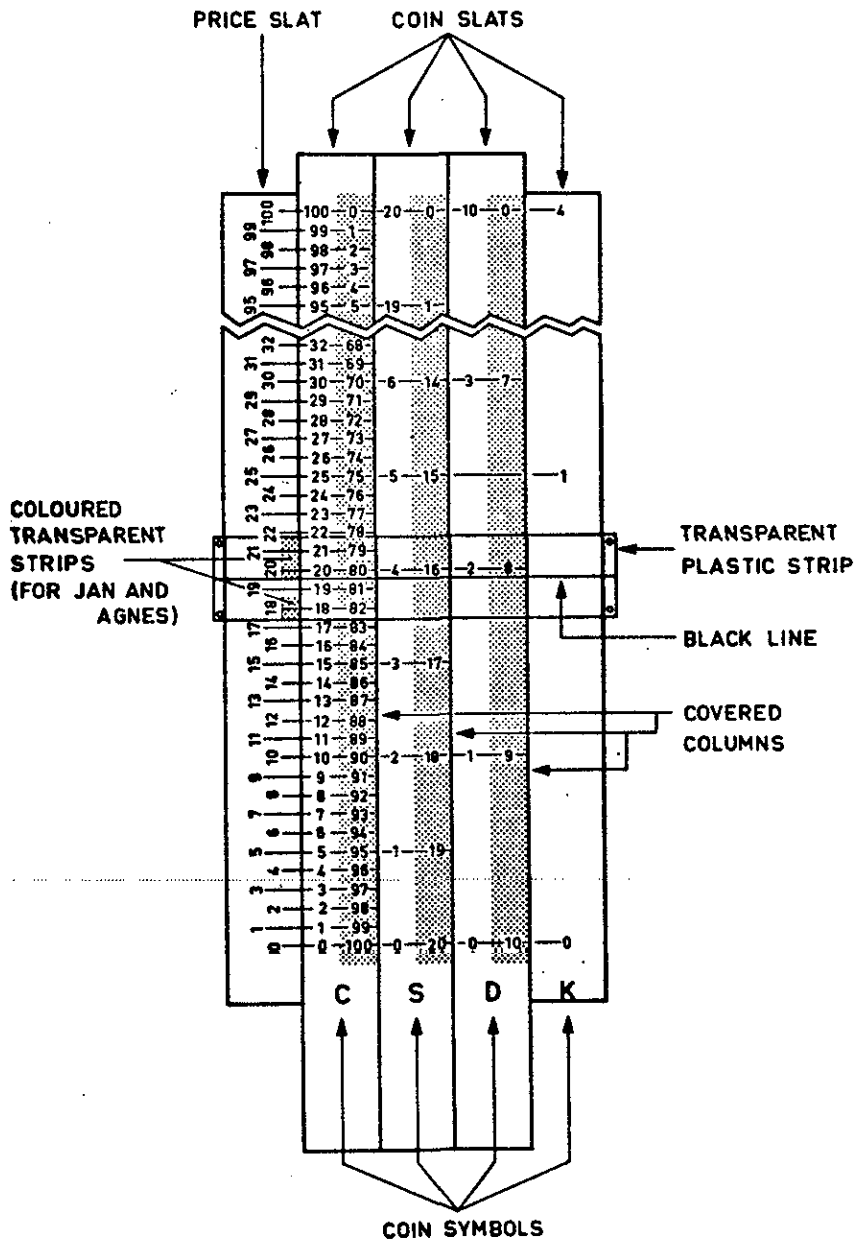


FIGURE 1.

Experimental slide rule in its standard position i.e. at the beginning of each new trial. Coin slats carrying the letters C, S and D can be moved back and forth.

more than twice in a row. A trial was considered correct when the trainee demonstrated all component behaviours on that trial without assistance. Correct reponding on training and review trials was followed by praise, the instruction to write a dash on the record form and the presentation of the next trial. A response on a trial was considered incorrect if the trainee failed to respond correctly on one or more component instructions of that trial.

Training Steps

The sequence and programmed activities for each of the eight training steps were as follows:

Step 1: Pointing to the correct coin slat upon verbal instruction. The trainer started this step informing the trainee of the one-to-one correspondence between the letter symbols on the coin slats and each of the four types of coins. The trainer then started with the first of twelve training trials, each time asking the trainee, 'show me the . . . slat.' Each slat was presented three times in random order. Step criterion: 12 consecutive trials correct.

Step 2: Pointing to the correct number of the left column on each coin slat. First the trainer would inform the trainee that, following the presentation of one or more same coins, he was to point to the equivalent number on the left (uncoloured) column of a coin slat. Then the trainer would start with the first of two introduction trials. During these trials the trainee was requested ('What do you have?') to identify the number of coins (e.g., 'Three nickels') and to point to the corresponding number (3) on the appropriate (nickel) slat. After finishing the introduction trials, the trainer started with the first of 24 training trials, each time asking the following questions, 'What do you have?' and 'Show me on the slat.' Step criterion: 12 consecutive trials correct.

Step 3: Establishing the value of one or more same coins. Before presenting the first of two introduction trials, the trainer instructed (and demonstrated) the trainee to check first if the bottom lines on all slats were connected with one another. During the introduction trials the trainer asked three questions of which the first two were identical to those used in step 2 ('What do you have?' and 'Show me on the slat'). Then he would say, 'Now I'll show you how much that is,' while moving the trainee's finger from that number on the coin slat (e.g., 1 on the quarter slat) in a horizontal direction to the price slat. When arriving at that number (25) the trainer would ask, 'How much is this?' If the trainee only mentioned the number, the trainer would prompt for the complete answer or model the response, e.g., 'Twenty five cents.' After completion of the two introduction trials, the trainer started with the first 24 training trials. Step criterion: 15 consecutive trials correct.

Special aid for Jan and Agnes. Since both trainees showed chronic problems making correct horizontal finger movements, it was considered necessary to allow them to use the black line of the plastic strip for that purpose. For example, when presented three dimes, they would point to number three on the dime slat, move the plastic strip so that the black line covered that number and follow that line to arrive at number 30 on the price slat. Both subjects were allowed to use this aid up to step 6.

Step 4: Establishing the value of quarter-dime combinations. Beginning with the first of two introduction trials, the trainer would hand the trainee a combination of quarters ($N = 1$) and dimes ($N = 2$). Then he requested the trainee to respond to the question, 'What do you have?,' followed by instructions to move the dime slat upwards so that the red bottom (zero) line matched the black line corresponding with number one on the quarter slat, point to number two on the dime slat and move his finger in a strict horizontal way to the left until he reached a number (35) on the price slat. At that point the trainer would ask, 'How much is that?' The trainees were informed that, when having different coins, they were to use the slats

going from right to left (first the quarter slat, then the dime slat, etc.). To facilitate this procedure, they were also instructed to group the coins in that order before responding to the first question. It also appeared necessary to provide a rule for when to move or not to move a slat. When presenting the first review trials (one or more dimes) the trainees were inclined to move the dime slat up to a number on the quarter slat (as if they had quarters). Therefore they were instructed to check first with all slats to the right of the one concerned. When they did not have such coins, the slat should not be moved.

Following the introduction trials, the trainer started with the first of 14 training and five review trials. A trial was scored correct if the trainee would identify the number of different coins, arrange the slats appropriately and identify the corresponding value on the price slat.

Step 5: Establishing the value of nickel-dime, nickel-quarter and nickel-dime-quarter combinations. Only one introduction trial was used. The procedures used during this trial were identical to those used for the introduction trials of step 4. Trainees were instructed not to move any slat (i.e., the dime slat when dealing with quarter-nickel combinations) of which they had no coins. Following the introduction trial, the trainer started with the first of 32 training trials randomly alternated with eight review trials (training items from steps 3 and 4). Criterion for scoring a trial correct was identical to that in step 4. Step criterion: 15 consecutive trials correct.

Step 6: Establishing the value of penny-nickel, penny-dime, penny-quarter, penny-nickel-dime, penny-nickel-quarter, penny-dime-quarter and penny-nickel-dime-quarter combinations. One introduction trial was used. Except for the inclusion of pennies and the elimination of the question, 'What do you have?', the procedures used during this trial were identical to those used for the introduction trials in steps 4 and 5. Following this trial, the trainer started with the first of 28 training trials randomly alternated with eight review trials selected from steps 3, 4 and 5. A trial was scored correct if the trainee would handle the slat appropriately and determine the exact value of the coin combination in response to the question, 'How much is that?' Step criterion: 15 consecutive trials correct.

Jan and Agnes had been allowed to use the plastic strip during steps 3, 4, 5 and 6. Therefore it was necessary, after meeting criterion on step 6 to retrain them on that step without using the strip.

Step 7: Determining the price of a purchase item. The trainer initiated this step showing a purchase item while indicating its value in cents. Then he requested the trainee to place the black line of the plastic strip on that number of the price slat. The trainee was instructed to do this every time the trainer would say, 'This costs . . .'. After terminating the introduction trial, the trainer would start with the first of 25 training trials. A trial was scored correct if the trainee placed the black line on the same price slat number as shown on the price tag within a 10 sec. interval. Step criterion: 10 consecutive trials correct.

Step 8: Deciding when having enough money to purchase an item. Six introduction trials were used. During these trials the trainee was given coin combinations which values matched (two trials), exceeded (two trials) or were less than (two trials) those listed on the price tags of the purchase items. The trainee was informed and demonstrated that he could buy the purchase item when the value of the coin(s) as indicated by the number on the price slat was 'on' or 'above' the black line of the plastic strip (indicating the price of the purchase item), whereas he could not buy it when the number on the price slat was 'below' the black line of the strip.

After terminating the introduction trials, the trainer would start with the first of 32 training trials. Training trials included all types of coin combinations used

during previous steps. The number of trials in which the trainee did not have enough money ('L-trials') was equal ($N = 16$) to the combined number of trials in which he had the right amount of money ('E-trials'; $N = 8$) or more than enough money ('M-trials'; $N = 8$) to purchase items. L-, E- and M-trials were presented in random order.

A trial was scored correct when the trainer placed the black line of the plastic strip on the correct number of the price slat, handled the coin slats appropriately, established the exact value of the coin(s) and made the correct decision concerning their purchasing power when asked, 'Can you buy this?'

Special aid for Jan and Agnes. Since both subjects did not know the concepts 'on', 'above' and 'below', it was necessary to add green and red coloured transparencies on the strip (see Figure 1). These colours were associated with those of traffic lights. The trainees were informed that, 'When in or passing green, you may go on (meaning they could purchase the item), while when red is ahead you must stop (meaning they could not purchase the item).'

RESULTS

Agreement in scoring between trainers and reliability observers was assessed during five sessions for Jan, four sessions for Wim and nine sessions for Agnes. During each of these sessions reliability checks were based on all responses during the first presentation of each trial. Reliability was based on percentage agreement obtained from one-to-one component response comparisons. The percentage agreement was computed by dividing the number of agreements over the number of possible agreements multiplied by 100. The agreement percentages for Jan ranged from 96% to 100% (Mean = 99.2%), for Wim between 95% and 100% (Mean = 98.75%), while those for Agnes varied between 92% and 100% (Mean = 98.4%).

For purposes of data representation, the total number of trials required to meet criterion on a step was divided into blocks of 8 (screening test), 10 (step 7), 12 (step 1 and 2) or 15 (steps 3, 4, 5, 6 and 8) trials. The number of trials per block was identical to the criterion for each step. For the remaining (i.e., initial) step trials, blocks of less than the criterion number were used unless their number was less than half of the criterion number minus one. Thus, in case the number of remaining trials was equal or less than 4 (step 7), 5 (steps 1 and 2) or 6 (steps 3, 4, 5, 6 and 8), they were not considered a block and hence disregarded for calculation purposes.

The percentages in Figure 2 represent the proportion of correct trials of each block (histograms) and the proportion of each block consisting of the longest series of consecutive correct trials (line graphs). Thus, if a trainee made on any block of 10 trials (step 7) seven trials correct, including a longest sequence of five consecutive correct trials, the corresponding points on the histogram and the line graph for that block of trials would be 70% and 50% respectively.

The obtained results indicate that all trainees eventually learned to identify the value of one or more same and different coins and to determine their purchasing power. The total training time required to finish the entire programme (steps 1 through 8) was 1054 min for Wim, 1443 min for Jan and 1500 min for Agnes.

Although the histograms and line graphs usually showed the same trend, the percentages corresponding with the histograms were, as might be expected, considerably higher than those of the line graphs. Inspection of the histograms further indicates that, with occasional exceptions, the average rate of correct trials exceeded the 25% level at the very first or first few trial blocks in steps 4, 5, 6 and 8 (during which steps the ratio of training and review trials was three to one).

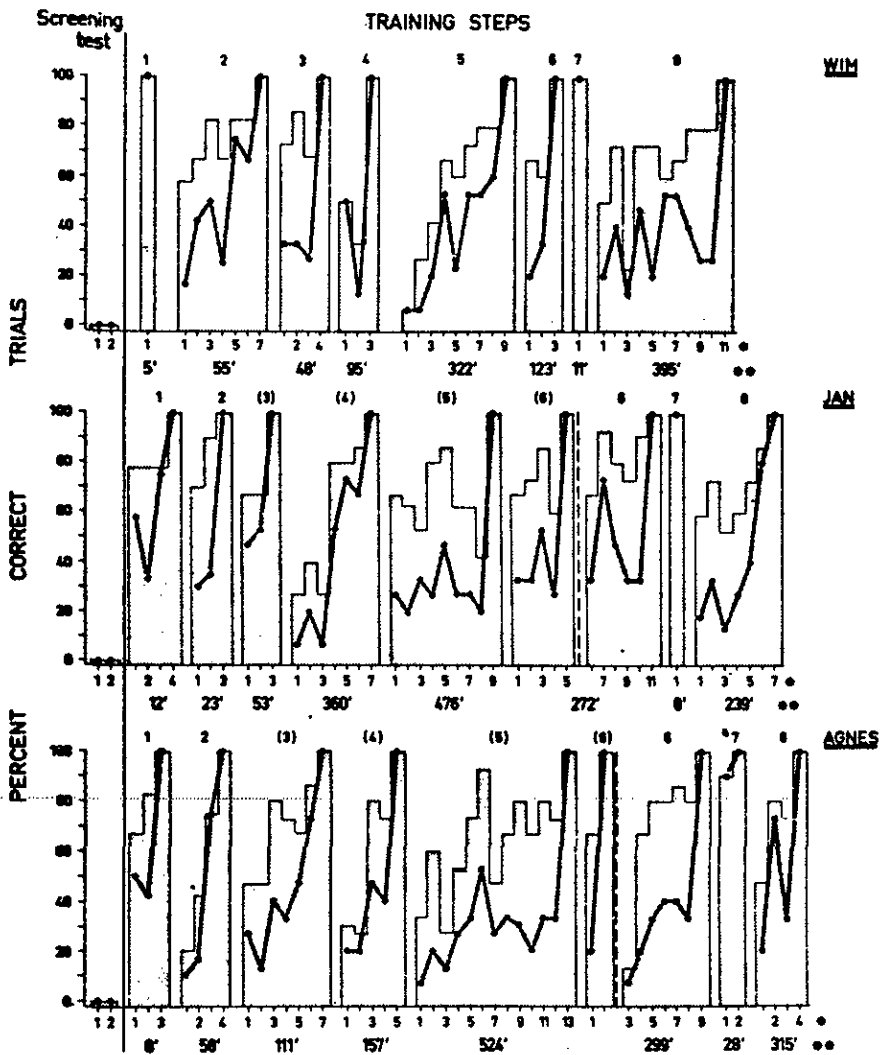


FIGURE 2.

Percentages of correct trials across training steps for Wim, Jan and Agnes.
 Bar graphs depict the percentages of total trials correct for each block.
 Line graphs represent the percentages of each trial block consisting of the longest series of consecutive correct trials. Number of trial blocks (one asterisk) and training time (two asterisks) required to meet criterion on each step are indicated.
 Brackets refer to training steps in which Jan and Agnes were allowed to use the plastic strip for identifying the value of coins on the price slat.

None of the trainees had any difficulty learning to identify the coin slats (step 1), to point to the appropriate number on the left column of each slat (step 2) or to indicate the item prices on the price slat (step 7). The average time required for teaching these steps was 69.3 min. The trainees had also little difficulty learning to establish the value of one or more same coins (step 3); the average time for acquiring this skill was 70.6 min. Teaching the value of different coins (steps 4, 5 and 6) required most training time, i.e., 540 min for Wim, 1108 min for Jan and 980 min for Agnes (Mean - 876 min). The average training time was the highest for step 5 (440.7 min), followed by step 6 (231.3 min) and step 4 (200.7 min). The average time for training step 8 was 316.3 min.

DISCUSSION

The purpose of the present study was to evaluate the feasibility of training severely and moderately retarded adults to use a specially designed slide rule for establishing the value of one or more same and different coins and their purchasing power. The results indicated that the procedures were effective in teaching both skills to all three trainees.

Analyses of obtained data revealed that, particularly for steps 4, 5 and 6, generalisation of acquired skills across steps was left much to be desired. In addition, all trainees (especially Jan and Agnes) would make many incorrect responses on review trials when beginning a new step. These phenomena and the observed highly variable learning curves (usually associated with complaints from desperate trainers) suggest that several programme procedures may need to be revised. Whether such revisions should include other sequencing systems, reinforcement schedules, introductory statements, introduction trials, assistance procedures or step criteria (e.g., three consecutive sessions 90% correct), remains to be explored.

The slide rule was designed to transform and substitute numerical skills and concepts otherwise required for teaching both programme objectives. To test this prosthetic function, trainees were selected on their demonstrated ability to identify one-, two- and three digit numbers from 0 to 100 and to name and select 10 or less coins only. This, of course, does not provide any evidence that the success of the programme was based on the programmatic use of these skills alone. Since none of the trainees had been tested on other numerical skills before entering the programme, the prosthetic function of the slide rule can only be assumed. *Post hoc* evaluations, however, indicated that, even when using prompts, only one subject (Jan) was capable of counting by one to 100 whereas none of them could count by fives to that number. Only one subject (Wim) was able to indicate the highest and the lowest of one-digit or two-digit numbers reliably; Jan and Agnes always selected the first of the two numbers.

Although training procedures were planned to match everyday purchasing situations as closely as could be allowed for (use of real items, price tags and presentation of coins in a random fashion), the primary purpose of this study was to evaluate only the programmatic aspects of the acquisition process of both monetary skills. Therefore, no efforts had been made to check for any duration or generalisation effects. Considering the social and technical restrictions of the slide rule (e.g., format and coin combinations up to one guilder), the time required for training both skills (17.56 hrs - 25 hrs), the subjects' need to sort out coins on the table first, trial duration (during the final session of step 8, the average time per trial ranged from 43 sec to 67 sec) and the limited application value of both monetary skills concerned, the practical implications of training retardates the slide rule programme in its present form probably would be minimal.

The power of treatment and training programmes has been defined in terms of outcome criteria such as the speed of the effect, percentage of clients benefitted, degree of benefit, durability over time and social acceptability (Azrin, 1977). Another and often neglected criterion would be the complexity of prerequisite skills relative to those constituting the programme objective. Follow-up studies designed to evaluate the slide rule programme as a means to training more complex and hence more functional skills are currently in progress.

SUMMARY

The study was designed to teach severely and moderately retarded adults to use an experimental slide rule for identifying the value and purchasing power of Dutch coins up to one guilder. Since none of the subjects demonstrated any of the prerequisite numerical skills used in other available programmes, the function of the slide rule was a prosthetic one. A programme consisting of eight sequential training steps was used. All three subjects learned both monetary skills in 17 to 25 hours.

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