RATE BUILDING IN FLASHCARD-TO-WORKSHEET TRANSITION WITH BEHAVIORALLY RETARDED STUDENTS

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In teaching new skills to severely handicapped students, teachers use such techniques as modeling, prompting and fading of prompts; they carefully select the types of materials used; and they monitor the accuracy of students' responses to their cues. Most teachers aim for their students to perform accurately without assistance. But independent functioning also requires efficiency, which necessitates a modicum of speed.

Skills such as printing, doing simple computations, reading numerals and words or counting objects may be taught to a high degree of accuracy. However, for the student to perform independently, skills such as these are not functional unless they are performed fast enough. By including both accuracy and rate criteria in defining the objectives of instruction, the teacher ensures that students will be able to use their skills in a more efficient and, hence, more independent manner.

The majority of studies dealing with performance speed have been oriented toward workshop applications, where production rate is important to the economic survival of the enterprise (Evans & Spradlin, 1966; Huddle, 1967; Brown et al., 1972). While industry-competitive production rate criteria are likely easy to obtain, we have seen no studies comparing sheltered workshop production rates with rates on similar tasks in industrial settings. There are, however, rate norms on some of the basic and tool academic skills of nonretarded children in public schools (Kunzelmann, 1970; Starlin & Starlin, 1973), and standardized worksheets are available (Precision Teaching Project, Special Education Center, Great Falls, Montana).

To provide improved instruction for people with retarded behavior, it has been suggested that the performance speeds of "normal" children be used as "aims" or mastery criteria toward which to individualize the rate-building training of students with academic "problems" (Haughton, 1971). It has also been suggested that rate building in basic skills facilitates acquisition of more complex skills (Haughton, 1971). Students who learn to read faster comprehend more (Shelton & Warner, 1971). Speed training on paper-and-pencil tasks has shown positive transfer to performance of eleven other tasks (Hoyer, Labouvie & Baltes, 1973). And increasing the rate of printing letters (by scheduled access to a playroom) was accompanied by decreasing error rates, for which no contingency was programmed (Hopkins, Schutte & Garton, 1971). Thus, it would seem reasonable to expect that rate training could produce not only more normal and therefore more functional speed among those called "retarded" but might, as a byproduct, produce increased accuracy as well.

In determining rate criteria in academic performance one should be familiar with "precision teaching." In 1969 the idea of specifying individual aims evolved from a philosophy to a technology of teaching (Haughton, 1971). An "aim" specifies the number of responses per minute required and the number of errors (called "learning opportunities") allowed before a skill is considered to be mastered (e.g., reading a story at the rate of 80 words per minute with 0-2 errors per minute;

computing addition problems at 30 correct per minute with 0-2 errors per minute; copying randomly ordered upper-case letters at 90 correct per minute with 0-2 errors per minute). The rate of performance is observed and recorded. As a student learns to perform a basic skill at a high rate he can move to a more complex skill (e.g., from printing simple strokes to printing stroke combinations that form letters). There are minimum rates of performance at which basic skills must be performed in order to ensure success in acquiring the next composite skill. Performing at 30 digits (problems) per minute in math computation, for instance, allowed a student to move towards more complex tasks, while a student performing below 20 digits per minute decelerated as he moved to more complex problems (Haughton, 1971).

In precision teaching, accuracy and rate are used together in decision-making. Ranges of proficiency are being established in the areas of reading, printing and math (Starlin & Starlin, 1973). Within a task analytic hierarchy of subskills in these areas, rate building of component skills may facilitate acquisition of the composite skills. If so, at each step in composite skill training, rate building methods adapted for handicapped students might assist the teacher in producing the motor and verbal fluency that approaches the norms of nonretarded pupils. Thus, to adapt this approach to students with special needs, rate aims should be incorporated into each step of the task analysis of the composite skill. For example, as one trains accuracy in components such as the labeling of upper-case letters in random order, the labeling of lower-case letters in random order, the labeling of the two cases combined in random order and the labeling of the letters of words as a series of spelling skills, rate building should be incorporated at each step to ensure the fluent spelling and printing of the words by the student. We have incorporated rate building in the transfer of learning materials (for example, numerals, upper-case letters or words) from flashcards (where the student's rate of responding is dependent upon the teacher's rate of presentation) to worksheets (where rate is dependent solely upon the student's own pace) (Pease & George, 1975).

Seven adults and five children received this form of instruction in our classroom. Transitional training begins when a student can respond 100% correctly to flashcards presented one at a time by the teacher with a verbal cue (i.e., the student can label or "read" the stimulus). The student then moves to flashcard presentation by the teacher without verbal cues, because eliminating a verbal cue (for example, "What is it?") brings the student closer to independent labeling of the stimuli. A "fading" procedure, using the same flash-cards gradually built into a worksheet-like array on a tabletop, facilitates transfer from teacher presentation to student self-presentation. As the student progresses, we introduce actual work-sheets and begin reducing the size of the stimuli (numerals, letters or words) from about 1¼ inches tall to as small as one-half inch, one-quarter or even elite type size. The decision to reduce stimuli is dependent upong the student's first reaching a predetermined rate

on the original set of materials. The teacher can then probe ahead to see if perhaps the student can perform as efficiently with the smaller size materials.

This report outlines the progress of three adult residents, whose acquisition of independent skills is representative of the performance of the 12 students who have had "worksheet-training" in our classroom.

STUDENT	AGE	ENTRY IQ	CONTENT OF FLASHCARD-TO-WORKSHEET INSTRUCTION
S1	58	unknown	numerals; clockfaces (3D to 2D)
S2	24	33-45	letters (upper-case)
S3	39	50	words; addition problems

Labeling numerals

S1 was first taught to touch numerals in a horizontal array of flashcards and then to label (i.e., say the word for) $1\frac{1}{4}$-inch numerals (0 to 10) on flashcards presented one at a time by the teacher, first with verbal cues and eventually without them. When the student could label flashcard numerals at a rate of 40 numerals correct per minute with 0 to 2 errors per minute, we reduced the numerals from $1\frac{1}{4}$ inches to $\frac{1}{2}$ inch in height. The reduction in size did not decrease the student's rate of labeling the numerals.

Next, by the same procedure, S1 was taught to label numerals on flashcards arranged in horizontal rows on a table. Transfer to a worksheet where S1 was required to label the numerals from left to right, top to bottom, resulted in five consecutive sessions in which the rate remained at 40 numerals correct per minute with 1 to 2 errors per minute. After the initial five sessions, S1 maintained a rate of 40 numerals per minute with no errors. He gradually accelerated to the criterion of 50 numerals per minute without error.

Now the numerals 11 to 15 were introduced on flashcards. The numerals were one-half inch high as S1 had the stimuli reduced to that size on the numerals 0 through 10. S1 was first required to touch the numerals on flashcards on a tabletop on teacher cue. On teacher-presented flashcards, the student got 58% correct, which converted to rate was 5.4 correct and 3.8 incorrect per minute. S1 was responding slowly as well as inaccurately. When receptive control was established (three consecutive sessions at 100% accuracy), S1 was required to label the numerals as the teacher presented the flashcards one at a time.

The next step was for him to label the numerals 11 through 15 on a self-pacing worksheet. Transitional instruction from flashcards to worksheet was not necessary as S1 generalized from one worksheet to

the next on labeling numerals from left to right on the row and from top row to bottom row on the page. Fifteen sessions later S1 was performing at a rate of 15 correct responses and 2 incorrect responses per minute on teacher-presented materials and at a rate of 17 responses correct and 2 responses incorrect per minute on self-presented materials. Four sessions later, his rate rose to 38 correct responses and one incorrect response per minute on self-presented worksheets and 26 responses correct and one incorrect response per minute on teacher-presented flashcards. The teacher-presented flashcards were terminated at session 22, when S1 reached five consecutive sessions with a rate of above 30 responses per minute without error. S1 was becoming more "fluent" and independent on the self-presenting worksheets. After 36 sessions, he could label the half-inch numerals at the rate of 40 per minute without error.

At that point the numerals 11 through 15 were combined with 0 through 10 in random order. At present S1 can label 0 through 15 in random order on a self-pacing worksheet at a rate of 45 correct responses and 0 to 2 errors per minute. When he attains a rate of 50 responses per minute with 0 to 2 errors, instruction of the numerals 16 through 20 will begin.

While this student is acquiring the ability to label numerals (obviously an important prerequisite for further instruction in elementary quantitative skills), he has also gained the advantage of learning left-to-right scanning and the return sweep to the next row of printed material, from the top of the page to the bottom of the worksheet -- a skill necessary for the more complex task of reading words, phrases and sentences.

With S1, as with all our students, rate data have been much more sensitive to progress than percent correct. Although S1 had maintained 100% accuracy over several sessions during initial instruction, his rate of labeling had yet to stabilize at the predetermined criterion. Until rate and accuracy both reached criterion S1 continued to label the numerals 0 through 15 as part of his daily math lesson.

Our decision to advance this student to new numerals or to combine a new set of numerals with a previously learned set was based on his attaining the criterion of 50 responses per minute with 0 to 2 errors for five consecutive sessions. The rate criterion is based on Starlin and Starlin's (1973) estimates of the lower limit for beginning reading. The need for five consecutive sessions of criterion performance is based on the amount of day-to-day variability shown by this student.

Another important factor in rate building is the schedule of reinforcement. Initially when S1 was learning to touch numerals in response to the teacher's cue, he was given a token for every correct response. When he began labeling the numerals on both flashcards and worksheets he was given a token for every fifth correct response.

By reviewing his progress and noting stabilization in the data, which were recorded on a Detailed Pupil Record form (George & Pease, 1975) and then transferred to six-cycle semilog graph paper, a decision to change the schedule of reinforcement could be made. Token delivery was eventually "thinned" to a requirement of 16 correct responses per token. As S1 adjusted to the schedule requirements, he learned that he had to talk faster if he was to earn as many tokens as he had in earlier sessions.

We chose a fixed ratio (FR) schedule because FR schedules of moderate value are characterized by a pause after reinforcement, followed by a quick change to a steady, increased rate of responding (Ferster & Skinner, 1957). In our students the pause has been minuscule, even with an FR50 schedule. With pauses so slight that there is no noticeable interruption in the rate of responding, the FR schedule is easily administered and has proved to be an effective tool. As the teacher says "Go," she starts the stopwatch and silently counts each response of the student. When the required number of responses is reached, the teacher places a token on the table. When the task is completed or when, at the end of a predetermined time period, the teacher says "Stop" and stops the stopwatch, she records the time and the number of responses, both correct and incorrect. Meanwhile, the student may collect his tokens and place them in a clear plastic tube (his "bank"). At a later time in the day, the teacher calculates the student's rate per minute, and at the end of the week, she plots each day's rate on semilog graph paper. From the graph we can readily make empirically based decisions to change the schedule, reduce or increase the size of the materials, eliminate verbal cues or make other modifications.

Labeling letters

S2 received instruction in labeling upper-case letters, a basic component of spelling. When S2 first came to our classroom she could say the letters of the alphabet by rote in serial order -- so well, in fact, that the "skill" interfered with acquisition of more functional skills. Even though letters were arranged on a worksheet in random order, S2 would say the letters in serial order. For example, if the first row of the self-presenting worksheet had the letters CFKLOR, she would say "C," then follow with "D" and "E". She might then label the fourth letter correctly but follow it with "M" rather than "O".

After 35 sessions of the teacher presenting one-inch tall upper-case letters one at a time on flashcards, S2 reached the predetermined criterion of 20 responses correct per minute and less than two responses incorrect per minute. Upon transferring to a self-pacing worksheet of half-inch letters (8 per row, 10 rows) S2 began labeling at the rate of 38 letters correct and 2 incorrect per minute. Fifteen sessions later she had not made significant improvement.

Her present rate is 44 responses correct and 6 responses incorrect per minute. The data show a pattern of consistent errors indicating need for a remedial program on the labeling of the letters G, E, M, N, O and Q. When the student demonstrates receptive control by touching the letter on the teacher's cue, the demand to label (say the name of) the letters will be re-introduced. This student's failure to accelerate to the minimum criterion of 50 letters correct with 0 to 2 errors per minute could be a function of our having reduced the size of the stimuli too soon or a function of the reinforcement schedule. At this time her schedule is FR15; a probe should show us if she responds faster on an FR10 or FR20 schedule.

Telling time

S1 is learning to tell the time. We began with a three-dimensional clockface, ten inches in diameter. The hands are changed manually for every trial. Although this is a time-consuming procedure (on top of being unnatural), S1 learned to label the numerals on the clockface and tell time on the half-hour and hour. Each session had 72 trials of "What time is it?" Each hour and half-hour was "presented" three times in random order. The sessions averaged seven minutes each. After 76 sessions of responding to a teacher-presented clockface, S1 reached the criterion of five consecutive sessions of responding at a rate of 10 per minute without error. He could now begin self-pacing on two-dimensional clockfaces.

The first worksheets had clockfaces, three in a row, reduced from the 10-inch diameter to $3\frac{1}{4}$ inches. The clockfaces were permanently adhered to 8 x 11 inch paper and covered with transparent acetate, which allows the materials to be used over and over. (We use the protective covering on all worksheets that require an oral response.) The second set of worksheets had three clockfaces in a row, with a fourth clockface making the beginning of a second row. S1 generalized to the smaller clockfaces and the tabletop positions without error. The last step of transition from three-dimensional teacher-presented materials to self-presenting two-dimensional worksheets was to introduce two rows with three clockfaces per row. Four sets of hour and half-hour clockfaces were made to prevent the student from memorizing a particular order.

At this time rate building began. S1 was required to complete the entire worksheet (six clockfaces of randomly arranged hour and half-hour times) correctly in order to earn a single token. After 37 sessions (2,664 trials) S1 had doubled his rate to more than 20 responses per minute without error for more than five consecutive sessions. The amount of time per session (72 trials) varied from 2.5 to 3.0 minutes. The student's rate with self-paced worksheets was two to three times faster than his rate with teacher-presented clockfaces. The entire instructional sequence, from the labeling of numerals on the clockface to the telling of the time on the hour and half-hour on a self-pacing worksheet, took about 11 hours of

instruction spread over a year and three weeks (115 sessions and 8,386 trials). As a result of teacher and student time, energy and involvement, S1 is functioning independently of a teacher's prompts, presence or praise in a situation that approximates the requirements of time-telling in S1's environment outside the classroom.

Reading words

In another application of rate building, we taught a sight word vocabulary to S3. His first words were red, blue, green, white, orange, brown, purple, black. With flashcards, presented by the teacher one at a time, S3 was able to label the color words at a rate of 60 responses per minute without error. With self-pacing worksheets, his rate of labeling was 104 words per minute without error -- slightly above Starlin and Starlin's (1973) suggested aim of 50 to 100 words per minute correct and zero to two errors per minute for the beginning reader.

S3's next words were the seven days of the week. With teacher-presented flashcards, he reached a rate of 44 words per minute without error from a starting rate of 15 words correct and 23 words incorrect per minute.

Similarly, his rate increased and errors decreased on the self-pacing worksheets. S3 started at a rate of 46 correct words and 9 errors per minute. Six sessions later he was labeling words from left to right, top to bottom, at a rate of 62 responses per minute without error. The rate for days of the week is lower than that for colors, possibly because the color words except for purple are all one-syllable words while all the days of the week are two- or three-syllable words. S3 was required to maintain a rate above 50 words correct and 0 to 2 errors per minute on the worksheet for three consecutive sessions before moving on to a new set of words.

The next set of words was the months of the year. Again this student succeeded in reaching the minimum rate. In ten sessions he was labeling all the one-, two-, three- and four-syllable months at a rate greater than 50 words correct and 0 to 2 errors per minute.

Up to this time S3 had been labeling isolated words on flashcards presented by the teacher and then labeling the same words arranged randomly on a worksheet. S3 had not yet read a series of words in a sentence structure. The isolated words were arranged on a worksheet in a manner resembling a sentence: left to right in a row, with a series of rows on a page.

The words the, The, is, was, name and date were prerequisite to the oral reading of sentences. The flashcard presentation of these

words began immediately after initial instruction using a distance-fading procedure (Buchman, 1975).

The initial rate with flashcards was 31 words correct and four words incorrect per minute. Nine sessions later the rate of labeling flashcards had accelerated to 38 words correct per minute without error. The change in rate was considerably greater on the self-presented worksheets. S3 started at 52 words correct and 12 words incorrect per minute. Ten sessions later, he was labeling the words on the worksheet at a rate greater than 90 words per minute with zero to two errors per minute.

The words name and date were then used on the student's arithmetic computation sheets and on his library card application. The responses required of him were to print his name without assistance and to print the date with cues when necessary in the space provided next to the printed stimuli.

Now S3 was ready to learn the nouns hat, table, coat, window. Ten sessions after the initial instruction, which again used the distance-fading procedure, S3 went from 33 words correct and seven words incorrect per minute to 50 words correct per minute without error on the teacher-presented flashcards. On the self-presenting worksheet, S3 went from an initial rate of 44 words correct and 1 word incorrect per minute, to a rate above 80 words per minute. Then, to probe for generalization of the left-to-right labeling of words and the return sweep to the next line of print, we gave the student two-word and three-word phrases on worksheets (worksheets #1 and 2). He was able to label correctly and to point to a picture described by the phrase. For example, S3 would label (read) "red coat" from left to right and then color a line drawing of a coat or touch a drawing of a red coat, the one picture in an array of five that could be described by what he had just read aloud.

Since S3 had no problem labeling phrases and demonstrating comprehension, we taught him the verb go and Go. The first sentence structure was, "Go to the (noun)" (worksheet #3). Following S3's performance at greater than 50 words correct and 0 to 2 errors per minute, we began instruction of the words make and Make (worksheet #4). From the very beginning S3 was required to demonstrate comprehension of the written material. The teacher would randomly select a word, phrase or sentence from the worksheet, and S3 would again label the word(s) and then perform the action stated, touch the picture of a described object or make an object the correct color.

When the words book, Push, push, chair, open and close were introduced, in only five sessions S3 climbed from 16 words correct and 5 incorrect per minute to 31 words correct and 1 incorrect per minute in labeling teacher-presented flashcards. His rate on a self-presenting worksheet (worksheet #5) went from 58 correct and 6 incorrect responses per minute, to 113 responses correct per minute without error.

At this point we introduced a new worksheet (worksheet #6), with the same sentence structure but two sentences per line. S3 labeled the sentences at a rate above 90 words per minute with 0 to 2 errors per minute and, as with previous worksheets, S3 demonstrated comprehension by following the direction of the printed material.

Now S3 had to label two sentences from left to right; then the sentences were removed from his view and he had to perform the actions stated in the sentences in the order in which he had read them. (At the same time, the size of the lettering was gradually reduced until S3 was labeling typewritten copy.) This worksheet prepared S3 for compound sentences.

The word and was introduced first on flashcards and then on the worksheet. The first session in which and was included on the self-pacing worksheet resulted in a rate of 66 words correct and 4 words incorrect per minute (worksheet #7). In just five sessions more, S3 accelerated to 99 words correct and 1 word incorrect per minute. During the six sessions, S3 was labeling (reading) each compound sentence and following the directions (e.g., Push the red chair and close the door or Make the hat green and open the window).

We then introduced the words big and little, one at a time. In five sessions S3 went from selecting the word from an array of four words (with initial acquisition again facilitated by distance-fading cues), to pairing the words to the appropriate objects, to reading the words in compound sentences and following the directions. The words big and little were then incorporated into compound sentences typewritten on a worksheet. With his new worksheet (worksheet #8) S3 had no difficulty at all. The first session resulted in a rate of 110 words per minute without error.

With the ability to read typewritten sentences at a useful rate, with a sight word vocabulary of greater than 40 words and with demonstrated comprehension of the vocabulary, S3 is now ready for a commercial reading program.

As we noted earlier, we make decisions to change a student's reinforcement schedule on the basis of acceleration or deceleration curves plotted on semilog graph paper. For S3 we developed a general procedure of reinforcement, shown by his performance to be effective for him. When a new worksheet was presented, he received a token for each line of printed material read correctly. The next session he received a token for completing every two lines of print. Depending on his performance at that point, the teacher could decide to continue gradually "thinning" reinforcement by increasing the requirement to three lines per token, or to probe ahead to see if a "maintenance" schedule would suffice. (By increasing the number of tokens as the student's rate approaches criterion, but delivering the tokens only upon completion of the timed sample, the teacher moves the student that much closer to independent functioning.) S3 is now receiving tokens at the end of the reading task. He can label

more than 100 words per minute, and he is prepared to read a story in a primer and be reinforced at the end of the story rather than for each page.

For easy tabulation of the number of words labeled by the student, we noted the total number of words on the bottom of each worksheet and the words in each line were totaled at the far right. (The numbers did not interfere with the student's performance.) Errors were recorded on the Detailed Pupil Record in the column headed "Notes." We ignored errors during the timed sample but afterwards we pointed out consistent (or repetitive) errors and modeled the correct response. The student did not lose tokens for making an error because we found that, without special remediation, errors decreased in frequency as his rate of labeling went up. The following were counted as errors:

1) omission of a word on the worksheet
2) substitution for a word on the worksheet
3) inclusion of a word not on the worksheet
4) on making a return sweep to the next line of print, the omission of an entire line or the repetition of a line
5) repetition of a word

Simple addition

While acquiring basic reading skills, S3 has also been learning to add single-digit numerals. So far, he has learned to add the numerals 0 through 9 to the numerals 0, 1, 2, 3 and 4.

The composite skill of addition includes the essential basic component skills of labeling numerals and printing numerals. At entry S3 was able to label the numerals 0 through 10 at a rate above 100 per minute both by rote (by repeating the serial order for one minute) and by labeling quarter-inch numerals randomly ordered on a worksheet with 15 numerals per row. He could also print the numerals 0 through 9 in serial order at a rate greater than 50 per minute in half-inch squares (the space allowed for answers on the addition worksheet). Thus, S3 had the prerequisite skills to begin elementary arithmetic instruction.

In teaching beginning addition skills to S3, we took the following steps:

1. Given a numeral orally, S3 counted out the correct number of objects (paper clips, blocks, tiles, etc.) from a set.

2. Given a written numeral, S3 counted out the correct number of objects.

3. Given an addition problem orally ("two and three"), S3 counted out each set using the objects, then recounted the two sets, giving the total sum.

4. Given a written horizontal addition problem (the plus sign is labeled "and") S3 counted out each set using objects as in step 3, then printed the correct answer in a space provided.

5. The horizontal addition problems were converted to conventional vertical addition problems.

6. The teacher presented the problems orally and the student learned them on a rote basis. In this step, objects were used only to correct errors. The teacher provided the correct answer if the student hesitated -- better to have him imitate the correct answer than to produce an incorrect one.

7. We introduced a worksheet with three rows, ten vertical addition problems per row (30 problems).

The aim is for S3 to do the addition problems at the rate of 30 correct per minute with 0 to 2 errors per minute (Haughton, 1971). This worksheet has three sliding tabs. Every problem has the correct answer directly below the space provided for the student to print his answer. Each tab covers the answers of an entire row of problems. When the student finishes computing the 30 problems, he removes the three strips and compares his answers to the ones provided by the teacher to see if they are the same. (Occasionally, the teacher even gets one wrong, much to the student's delight!) The student circles all problems that have answers that are different from the teacher's. The problems are then quickly repeated using objects. Objects are otherwise not available to the student.

We followed steps 1 through 7 for the addition of 0 to the numerals 0 through 9 until S3 could complete 30 problems per minute without error. Then steps 3, 6 and 7 were used to teach the other "families": +1, +2, +3, +4.

S3 reached the criterion rate for +0 in six sessions (40 per minute correct without error). He learned to add one (+1) to the numerals 0 through 9 in just three sessions. When +0 and +1 problems were arranged on the same worksheet, he performed computations at the rate of 46 correct per minute without error. However, proceeding to the +2 family resulted in a drop in rate. In the first +2 session, S3 performed at the rate of 7 problems correct and 5.5 problems incorrect per minute. Over 13 sessions he gradually built up his rate to the criterion. The conversion to vertical problems, made at +2, did not affect the acceleration.

The combination of +0, +1, +2 randomly arranged on a single worksheet yielded a rate of 23 correct per minute without error. Instead of building rate on this task, we introduced S3 to the +3 family, and he took 14 sessions to reach criterion.

Next, S3 was given random combinations of the +0, +1, +2, +3 families. After three sessions of 30 problems per minute correct without error

S3 suddenly decelerated and needed another 15 sessions to reach criterion again.

When S3's addition of +0 and +1 was reassessed, he performed at the criterion rate. But his +2 performance was at the rate of 23 problems per minute without error, and +3 at 27 problems per minute without error. These modest rates apparently resulted from our failure to build the combined +0, +1, +2 to criterion from 23 problems per minute before starting the instruction of +3. S3 was backed up to the +2 and +3 families. When criterion was attained, +0, +1, +2, +3 problems were combined. Recognizing that rote response to the orally presented problem plays an important role as a basic skill in the computing of the written problem, in the +4 family instruction, we did not introduce the vertical worksheet until S3 could answer randomly presented oral +4 problems at 100% accuracy. As a result of the change in procedure, S3 was able to approach the criterion in only six sessions. At that time he could compute 37 problems per minute without error on the self-pacing worksheet.

S3 earned one token for every ten problems completed correctly and an additional token for completing the 30 problems within a minute. With the change in procedure, S3 should be able to continue to the rest of the families in single digit addition with greater success in fewer sessions.

Comment

The progress of these three adult students illustrates how a teacher can arrange the learning environment to increase students' rates of responding. Rate is increased and accuracy maintained as the teacher transfers a student from materials that depend on teacher presentation to materials that depend only on the student's rate of responding. Through continuous monitoring of the rate (most easily seen as a curve on graph paper), the teacher can make decisions about changing the schedule of reinforcement, reducing stimuli size, increasing the number of stimuli presented or otherwise modifying the instructional program to help the student to become a more efficient, more independently productive person.

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Sample worksheets are not appended due to the poor quality of the archival documents.