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APPLICATION OF OPERANT CONDITIONING IN A COLLEGE READING CENTER.

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THE USES OF OPERANT CONDITIONING TECHNIQUES IN A COLLEGE READING AND STUDY SKILLS CENTER ARE DISCUSSED IN RELATION TO RESEARCH FINDINGS. OPERANT TECHNIQUES WERE USEFUL IN GATHERING DATA ON STUDENT BEHAVIOR AS WELL AS IN INCREASING THE PRECISION OF THE DATA GATHERED. THE EFFECT OF THESE TECHNIQUES ON READING AND HANDWRITING RATE ARE DISCUSSED AND CASE STUDIES ARE PRESENTED. REFERENCES AND SELECTED FIGURES ARE INCLUDED. THIS PAPER WAS PRESENTED AT THE NATIONAL READING CONFERENCE (ST. PETERSBURG, DECEMBER 1, 1966). (EK)

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R eading and Study Skills Center

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The technique of operant conditioning has been applied creatively to significant problems of elementary education. Roger Addison and Lloyd Homme worked with educationally limited children on an Indian reservation. (1966) They used a technique of reinforcement smorgasbord to teach basic skills. The child entered a behavioral contract with one of the investigators. To wit: if Johnny did 5 problems in his arithmetic program, he could spin Lloyd around in a swivel chair for 1 minute. There were, of course, more standard reinforcers available, and the children could take their choice. Gradually the cost in frames of math for one minute of spinning was increased. This behavioral inflation worked admirably. Eventually, the students were even willing to do X frames of reading for a chance to work Y minutes on arithmetic.

The basic notion of operant conditioning is deceptively simple. (Honig, 1966) If a certain well specified piece of behavior (called an operant) is followed by a certain stimulus (loosely called a reward or more technically a reinforcer) that same piece of behavior tends to reoccur in the future. The operant is said to have been reinforced. The problem for the teacher is to specify the behavior to be monitored and the stimulus to reinforce its future occurrence. Basically, the reinforcer can increase the occurrence of the behavior over time, or

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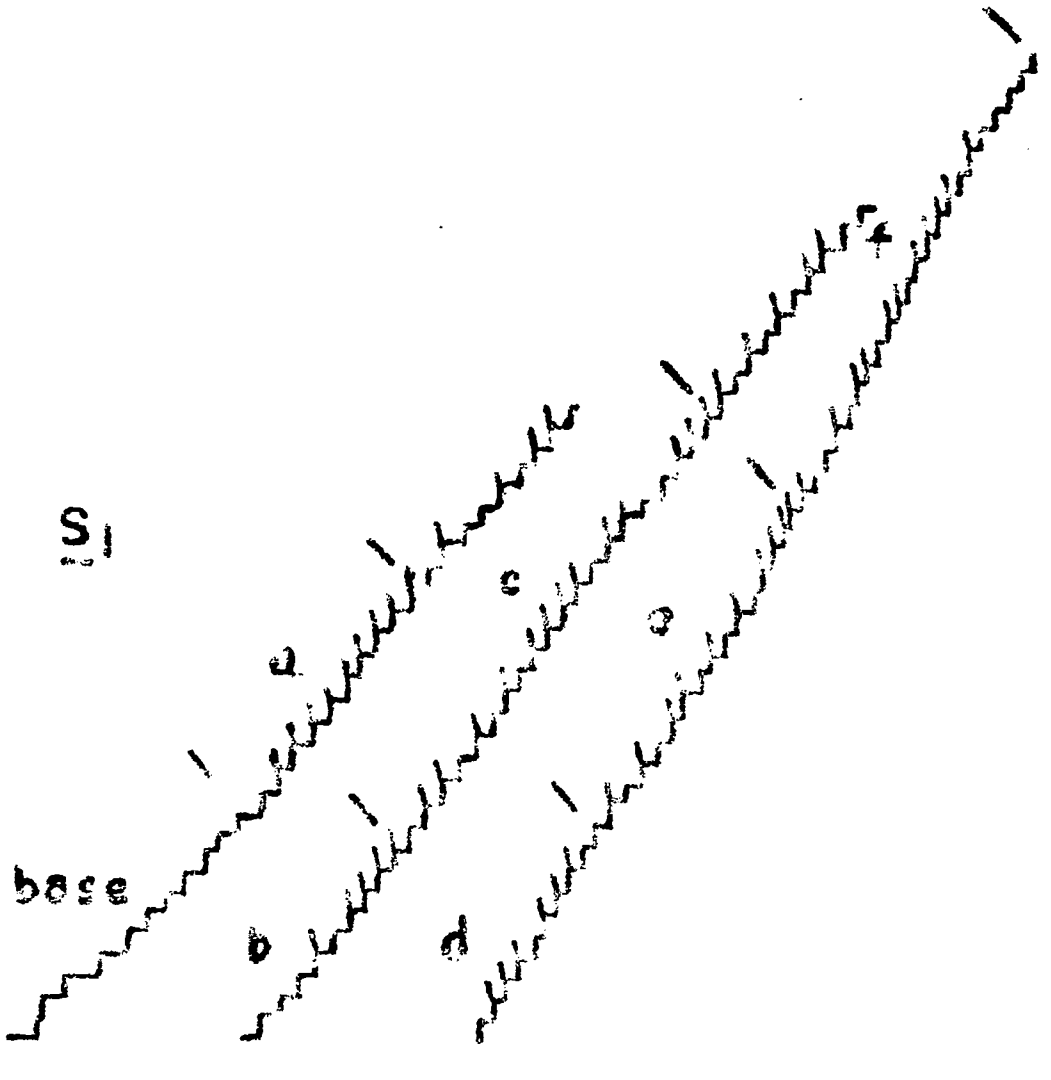
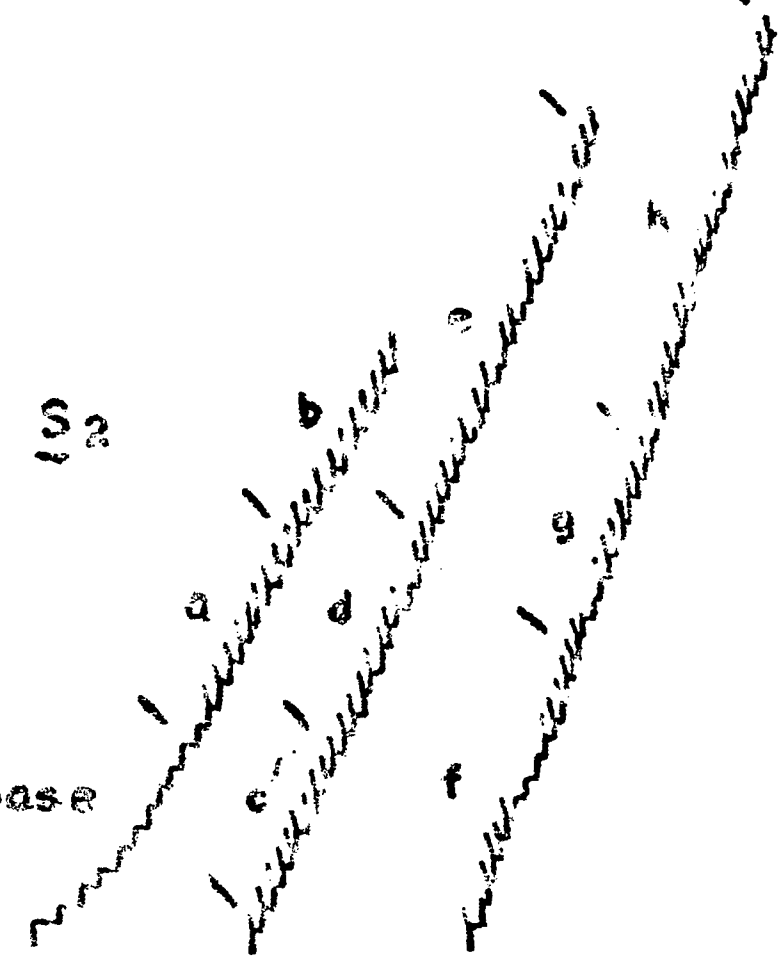
more specifically, its rate. This paper describes several instances of the use of operant conditioning techniques when working with adults in the college reading and study skills center at the University of Minnesota.

The first, and most obvious, application of operant techniques is to the control of reading rate. Raygor, Wark and Warren (1966) seem to be the first investigators to have applied this approach to increase reading rate by normal college students. They demonstrated that students could increase their rate by a factor of 2 to 2½ times in one 45-minute training session. The behavioral measure of reading was lever pulling, which exposed successive portions of an interesting, college difficulty adventure autobiography (Sanderson, 1937). Pulling a lever is exactly analogous to turning a page, a universally accepted measure of the multitudinous behaviors subsumed by the term "reading rate". The reinforcer, supplied by the investigators for higher and higher rates (shorter intervals between lever pull-page turning) was a pale green light shining up through the page. If the higher rate was not maintained, the student was not presented with the reinforcement stimulus.

The results of part of the study are present in Figure 1. The legend on the figure indicates that student 1 increased his rate from 222 words a minute to 400 words a minute. Student 2 increased his rate from 286 words a minute to 733 words a minute. This figure also contains a graphic display of reading rate data gathered by a cumulative event recorder. This machine may require some interpretation for those not familiar





	INTERVAL	base	a	b	c	d	e	f	g	h
S_1	TIME CRITERION	24"	25"	20"	18"	16"	14"	12"		
	READING RATE	222	250	250	286	303	334	400		
S_2	TIME CRITERION	23"	20"	18"	15"	13"	10"	9"	10"	7"
	READING RATE	286	400	400	500	500	571	600	667	733

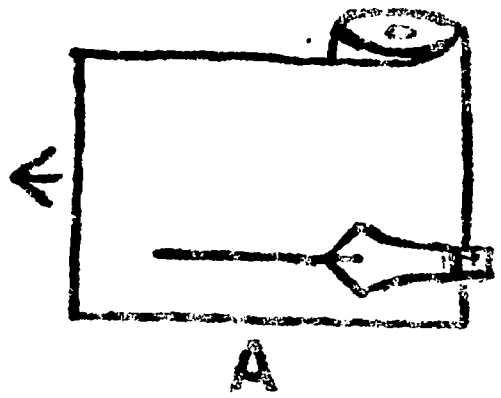
Figure 1 Increase in reading rate using a green light as positive reinforcement for reading above time criterion. (From Reygor, Work, and Warren, 1966.)

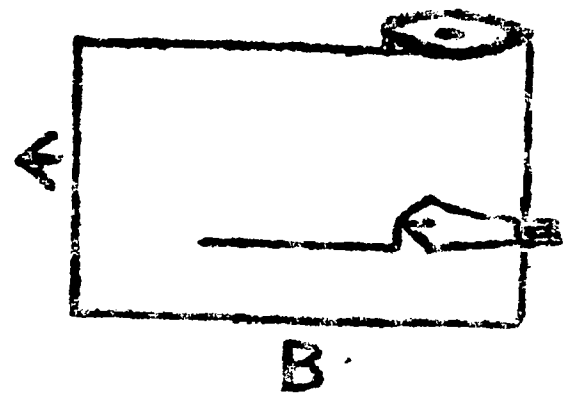
with cumulative response curves.

Figure 2 contains an idealized picture of a cumulative response recorder. A strip of paper is moved at a constant rate under a movable pen (A). Each time the student pulls the lever on the exposure machine, the pen is displaced one unit to the left (B). While the student is reading, the pen continues to mark parallel to the axis of the moving paper. The recorder produces a stair step curve of reading rate change (C). The faster the student reads, the shorted the interval between the displacement marks, and consequently, the steeper the slope of the lines (D). If the student slows down, the curve tends to flatten out (E). If two curves tend to converge at the top (F,G), the rates are not equal. The steeper curve indicates faster reading.

In Figure 1 we see that the curve for both students becomes progressively steeper. The curves are closer at the top than at the bottom, indicating that they are not parallel and that the students are indeed increasing their rates.

The criteria for reinforcement are also indicated in the legend of Figure 1. The time criterion is the interval between lever pulls that the student had to beat in order to receive a green light reinforcer. Thus, for student 1, his base rate, without any reinforcement, was an average of 24 seconds for 100 words. In segment a, in order to receive a green light he had to read faster than 25 seconds. Each upright blip on the curve indicates that he did receive a green light. In section b of the chapter, his criterion was 20 seconds, and he averaged 250 words. By segment f he had been shaped to 12 seconds per 100 words





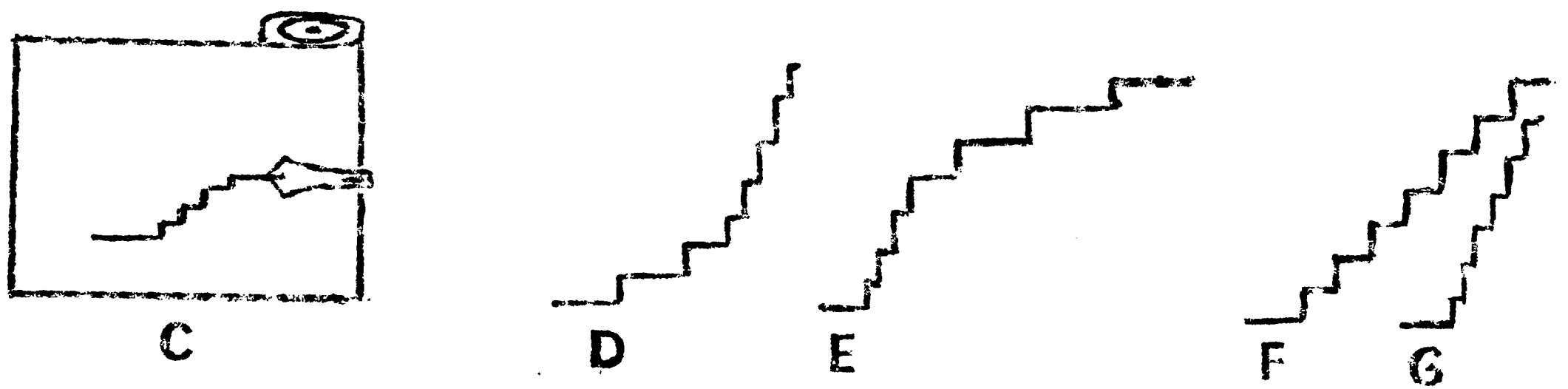


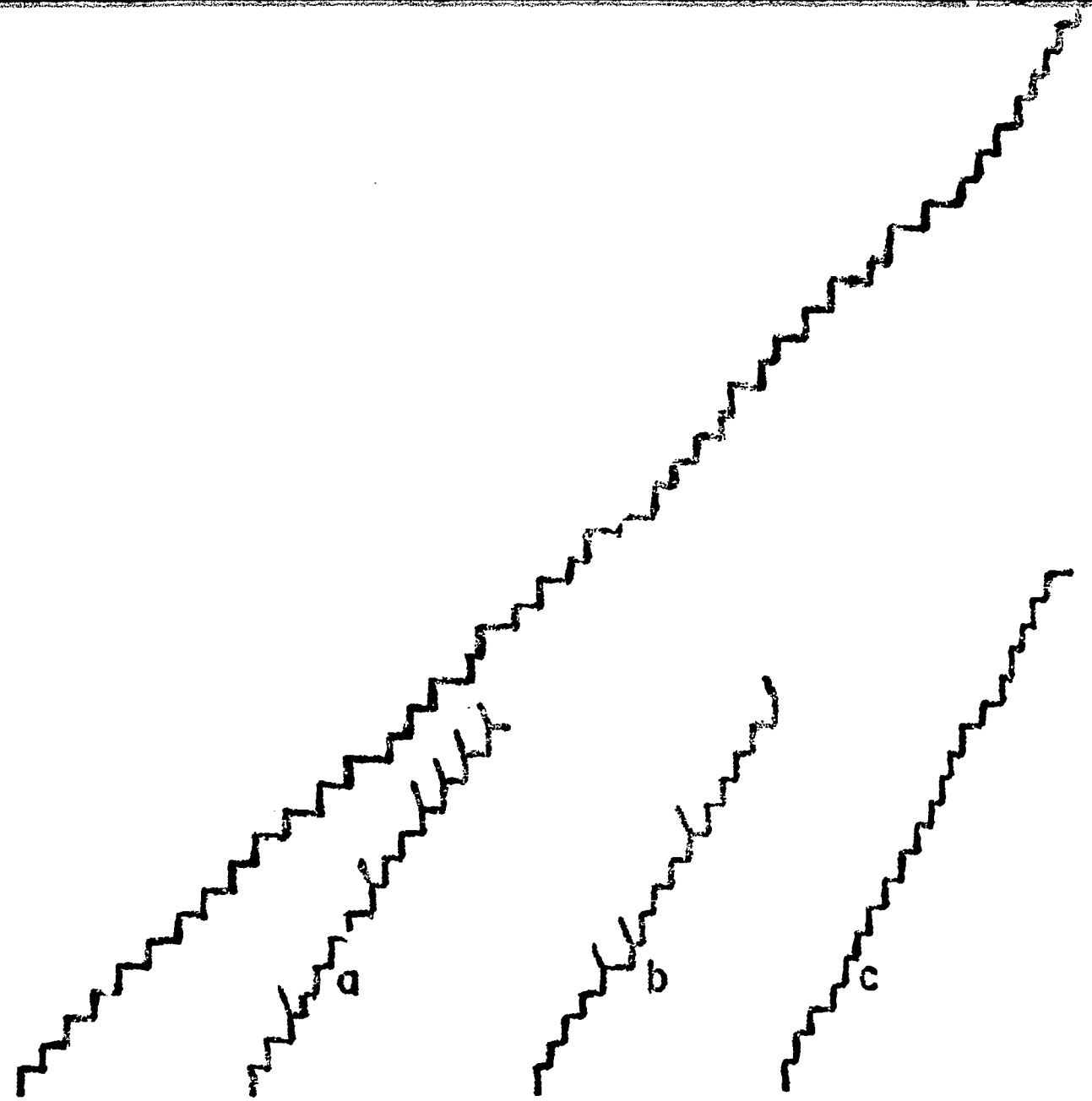
Figure 2 Idealized representation of a cumulative recorder mechanism and curves. (Adapted from Holland and Skinner, 1961.)

and was reading at an average of 400 words a minute. The blip on the curve indicates that he was not getting constant reinforcement. That means that sometimes he was under the criterion, and sometimes he was over. But on the average his rate increased quite markedly.

The operant techniques for increasing rate need not be limited to recreational reading. A male junior college freshman came to the Reading and Study Skills Center asking for help in improving his textbook reading rate. He had a basic psychology text by Sanford (1961). The student was instructed to mark his text into 100 word units, using a felt tip Hi-lighter pen. This pen contains a transparent yellow ink that had the effect of indicating visually the limit of the passage, without interfering with reading. He was instructed to read his book at a comfortable rate and every time that he came to a yellow marker he was to push a hand switch which was connected to the cumulative recorder and indicated his reading rate. He reported no trouble reading with the yellow marks in the book.

The student was instructed to read for one hour and push the button when appropriate. The results of that 60-minute segment are recorded in Figure 3 as base. This is a non-reinforced base rate situation. His reading rate for that chapter was 173 words a minute.

The next day he returned to the laboratory and began reading the next chapter in the book. He was told that if he beat his previous rate a red light placed in the booth with him would flash. He was instructed to "get as many flashes of the red light as you can." The results of that contingency can be seen in segment a. His reading rate



SECTION	BASE	a	b	c	COMP 86%
PASSAGES	4500	1400	1400	1800	
CRITERION	—	240+	240-	—	
RATE	173	235	250	305	

Figure 3 Increase in rate of reading a textbook, using a red light as a positive reinforcer (a), a buzzer as an avoidance signal (b), and extinction (c) (From Verplanck and Skinner).

increased to 235 words a minute. He was then shifted to an avoidance situation. If he did not meet a criterion rate, he would hear a buzzer every time he pushed the button. Under that condition his rate increased (segment b) to 250 words per minute. The results of that simple little comparison suggested that for this student at least, avoidance was the more effective training situation. (The conclusion was only tentative, of course, since there was no control for sequence of training.) For the final section of the chapter, the student was told, "I'm going to turn off both the light and the buzzer. Go ahead and read at whatever rate is comfortable." His rate under extinction (segment c) was 305 words per minute, faster than either of the reinforced training conditions. This observed initial increase under extinction is typical of operant investigation.

Sanford provides a set of multiple-choice comprehension checks on each chapter of his book. In the chapter under study the student earned an over-all 86% on the comprehension test. Clearly he had increased his rate while comprehending the material. On four subsequent chapters of the same book, the student earned an over-all average of 77 percent on the comprehension tests. This was under a wide variety of contingencies, from continuous reinforcement by red light to a periodically presented avoidance of the buzzer.

The work with this single student raised some interesting points about types of feedback for operant control of reading. Apparently either a light or a buzzer can be used for feedback. It can be used to indicate responses faster than criterion or responses slower than criterion. Will pure avoidance work to increase reading rate? Which

more effective, avoidance or positive reinforcement?

In a study to answer some of these questions two college freshmen men were trained on a pure avoidance schedule, using Sanderson's material.

e results are presented in Figure 4. Clearly, they increased their tes. An extinction, or non-reinforced section was inserted into the aining at various times. The effects were not consistent. Subject 1 creased her rate in the first extinction interval, but increased in e second. Subject 2 decreased in both of hers, and did not make as eat a gain overall. But clearly, avoidance does work.

A study with upward bound high school students in the summer of 966 suggests that avoidance may actually be more effective than positive einforcement (Wark, 1966). Volunteer students were run under a variety ' conditions, and for various lengths of time. But in all cases, the nditions of reinforcement with a light or avoidance signaling with a uzzer were alternated. Each student served as his own control, under o different conditions. The sequence of conditions were alternated r various students, i.e., some got a light first, some a buzzer.

Table 1

BJECT	1 L-B	2 L-B	3 L-B	4 L-B	5 L-B	6 L-B
1	163-174					
2	202-179	188-195				
3	500-526	482-500	513-606	588-645	727-909	800-950
4	317-447	533-556	588-556	625-606	625-645	769-745
5	229-244	260-253	282-284	241-280	274-268	219-275
6	211-198	217-235				
7	308-298	363-351	351-333	364-345		
$\bar{D}$	-19.4	-7.8	-11.2	+10.5	-65.33	-60.66
	51.76	14.50	56.26	43.89	101.87	87.09
t	2.62*	3.24*	.79	1.20	1.92	2.05

*P 05

MEAN AND STANDARD ERROR OF RATE DIFFERENCES USING LIGHT (L) AS POSITIVE REINFORCER AND BUZZER (B) AS AVOIDANCE SIGNAL, UPWARD BOUND STUDENTS

The results are presented in Table 1. Avoidance seems to be at least as effective, and in the early cycles significantly more effective, in producing rate gain. There is reason to expect that if there were sufficient students who had run through all six cycles the differences in favor of avoidance would have been even more pronounced.

Although operant conditioning techniques work on rate of behavior, there may be other aspects of the behavior, correlated with rate, that are of great interest in study skills centers. One young lady came to the Center asking for help with her handwriting. Her advisor had referred her because she was failing her written exams. She studied well, knew her material, and could discuss it satisfactorily. But no one could read her handwriting. This was a long standing problem that showed up in all her writing. It was not limited to exams, when she might have been under some unusual pressure. I decided to treat her problem as if she were writing too fast, and see what happened when she was reinforced for writing slower.

She was asked to copy 25 word passages (Simpson, 1950). I found that she was writing that much in an average of 60 seconds. She was placed on an operant slow down schedule, under which she avoided a buzzer only if she wrote slower than a certain rate. She used a special heavy and thick ball pen, with red ink. She was told to use that pen whenever she wanted to write something that another person was to read. For her own memos and class notes, which she alone would see, she could use anything except her special pen. She was asked to come back for two more slow down sessions one week apart. At the end of the 3rd session, she was writing 25 words in a mean of 72.9 seconds. Pre and post training

samples of her writing are presented in Figure 5.

A majority of judges have agreed that the bottom, post training sample is the more legible. The differences are not primarily due to letter form. In the second sample, the writing is more influenced by the lines on the page. In the first sample, this was not the case. The writing dips and swoops and departs from the horizontal.

One criticism of this illustration of operant techniques is, of course, that it misses the point. The student would have been better helped if told to write neatly and then given training and exhortation in better penmanship. Perhaps the Palmer method should have been applied to the seat of the problem. I think it is safe to assume that these methods had already been tried, by friends, parents and a succession of teachers. It was precisely because they didn't work that the young lady came to the Study Skills Center and was put through the type of regime that I have described. And in any case, such criticism misses the point of the report.

This was not a test of the effectiveness of operant conditioning vs some other method. It is merely an illustration that the manipulation of rate of behavior may have consequences for other more important properties of that behavior, even if the attempt to manipulate rate was not markedly successful.

There is another and potentially much more useful application of the operant approach. Operant techniques are extremely useful in gathering fine grain data on student behavior (Raygor, 1963). The reading rate curves reported above, for example, give a precise moment

to moment picture of what the student is doing. The data are much more detailed than the usual over-all average rate of a single exercise. Students are typically instructed to keep records of each rate and comprehension exercise, on the assumption that watching a graph line go up increases the probability of future gains. The graph is based on relatively gross pieces of behavior. Consider how much more effective the presumed effect on behavior would be if the student could see the results of much smaller bits of behavior.

There is another advantage to using an operant as a unit for data gathering. A teacher or investigator can profit from the increased precision of data about his student or subject. For some time I have been interested in the relation of text book reading and study note taking. Gates (1917) suggests that the more times a student spends in recitation, the better he will retain what he has learned. In fact, these data are cited quite frequently in many How to Study manuals. As a first step in really utilizing these data, it might be interesting to find out how much time a student actually spends in reciting by taking notes.

In one brief methodological study, a student spent some time reading and taking study notes in the laboratory of the Study Skills Center. She had previously marked her book into 100 word passages using a yellow magic marker. Each time she came to the marker she pushed a button that was connected to a cumulative event recorder. Whenever she wished to stop and write a note she pushed another button that reset the recorder pen back to base line. Since the recorder paper was moving at a constant rate of speed, it was a simple matter to establish the amount of time spent in reading and notetaking, and to examine the

sequence of those two behaviors. The results of two sessions are reported in Figure 6.

For the two days, we note that the student spent a mean of 2.88 minutes reading and 3.24 minutes writing. We also note that there is a gradual decline in the time spent in each activity before changing to the other. This shift may be built into the material the student was reading. The data would be consistent with a book in which the author wrote successively shorter passages before changing topic or before presenting a note-worthy point. Looking through the book, I suspect that such is not the case, however. I think that these data reflect a fact of life for this particular student. She may shift from one activity to another in a more or less predictable way. We might suspect a decreasing "attention span", defined as increasingly frequent shifts of behavior, until she gets to the point where she just stops.

If we leave aside the possible diagnostic information that this type of data gathering provides about this particular student, we still have certain more general applications. This approach yields some interesting base rates of the amount of time a student spends in recitation. We might want to see what, if any, effect a lecture on the value of recitation has on this base. We might wonder what the relation is between speed of reading and amount of time spent in notetaking. Does faster reading, taught in the Center, transfer to faster work in other aspects of study? In fact, we might wonder if rate on practice material transfers at all. Another way to use this sort of data is to pinpoint exactly when in the reading act the student stops to take his

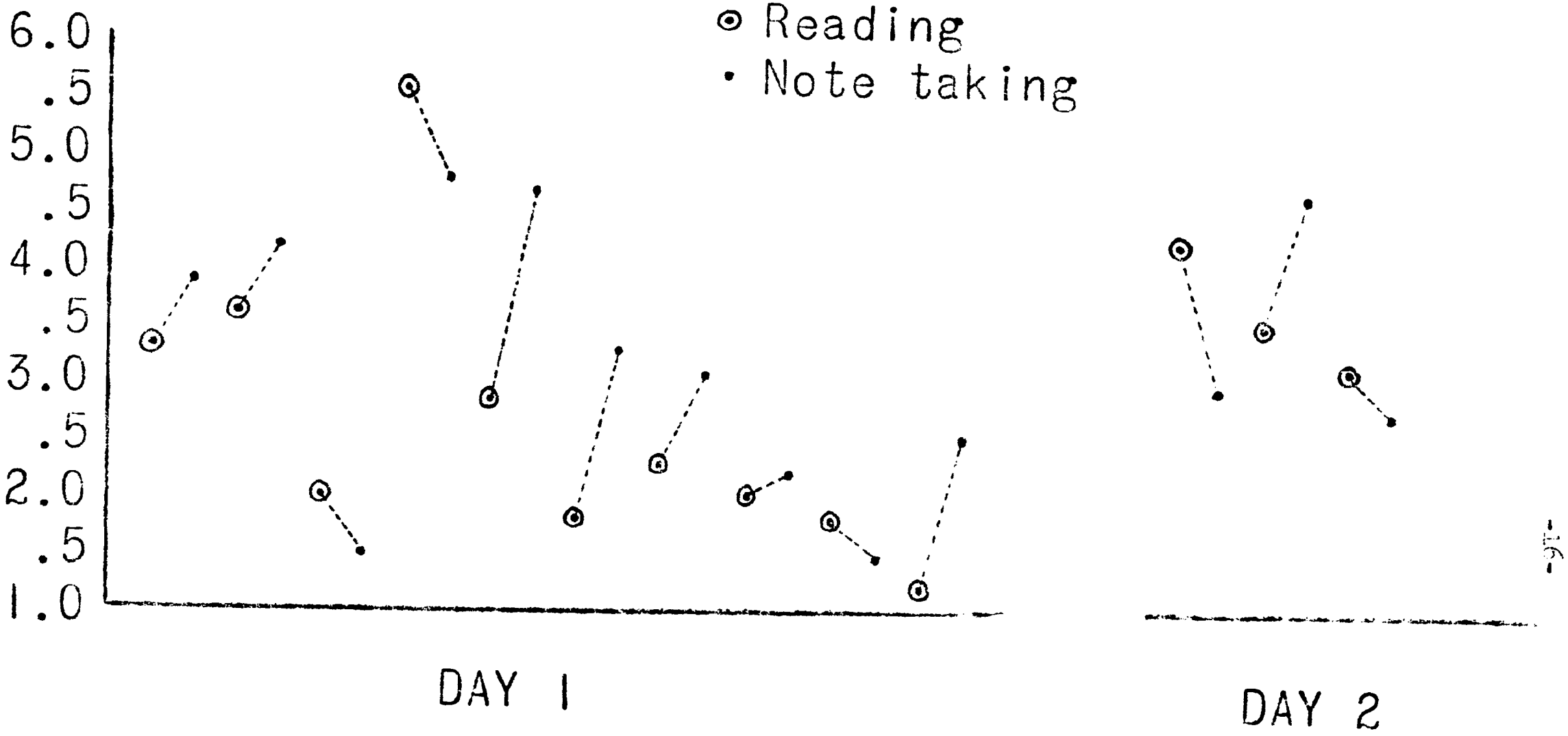


Figure 6 Time spent in alternating reading and note taking on two days by a single student.

notes. Does he read a whole section or chapter and then go back to the beginning, or does he read a little, look at an illustration, write a little, read a little, etc.? The technique of marking a text into short, equal units could be used to develop a very good behavioral measure of readability.

I would be the first to admit that the kinds of records that I have described could be gathered by anyone with a short pencil and long patience. But I want to make two points. First, operant data can be gathered more economically and more reliably with the kinds of recording equipment I described. Once the basic set up is established, and the behavior of interest is specified, it is easier, but by no means necessary, to let some piece of hardware do the data collecting. Second, and much more importantly, it is the acceptance of the "operant point of view" that leads an investigator, or a techer, to search for this kind of precise, moment to moment data on observable behavior. If one is going to attempt to manipulate the rate of certain actions by a student, the actions themselves must be stated as objectively and precisely as possible. Then, and only then, can we start the search for the appropriate reinforcers. And fortunately since we are dealing with humans and not rats, we have available a large collection of relatively effective and practically free reinforcing stimuli. After all, what does it cost to tell a student, "you didn't do that well, Sidney" or "now you're really moving, Melvin!"?

SUMMARY

Operant conditioning techniques can be used to produce some fairly rapid changes in some of the behaviors of interest to the staff of a

reading and study skills center. These behaviors include reading and handwriting rate. Of course, there may be instances when it is not the rate, but some other characteristic of that behavior which is of interest. In such a case, the direct manipulation of rate may be the most expedient way to get at the behavior in question. Whether or not the best approach is to reinforce faster behavior, or to warn students about slower behavior is at this point a question open to more research. Clearly though, the use of operant techniques, or at least a serious acceptance of the operant point of view, leads to a way of examining student behavior that can not help but be productive of new insights into the problems common to a reading and study skills center.

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