Performance of "maze-bright" and "maze-dull" rats on an automated visual discrimination task[1]

HAL MARKOWITZ[2] and JAMES M. SORRELLS, JR., University of California, Berkeley, Calif. 94720

Twenty-five descendants of the Berkeley S_1 and S_3 strains of animals were tested in an automated discrimination apparatus with shock as reinforcement. On the four successive light-correct and dark-correct problems presented, the S_3 ("maze-dull") animals were superior. Some tentative interpretations of the results are presented. It is suggested that the labels "maze-bright" and "maze-dull" are inexplicit and inappropriate for use with these strains.

For over 20 years the colony at Berkeley has maintained a stock of animals derived from the early work of Tryon (1940). Behavioral selection techniques were used to produce maze-bright and maze-dull strains of rats. The two descendant strains which have been most widely used in recent years are labeled S_1 (descendants of Tryon maze-bright) and S_3 (descendants of Tryon maze-dull). These strains of animals have been shown to differ in a variety of behavioral, anatomical, and biochemical attributes (cf. Rosenzweig, Krech, & Bennett, 1960; Rosenzweig, 1964). Recent evidence suggests to us that the strains do not differ in maze learning per se. First, there has been a limited amount of work suggesting that factors such as timidity or emotionality may play a significant role in what has been called "maze brightness" (Rowland & Woods, 1961). Additionally, with trials distributed over long periods of time the S_1s apparently do not exhibit superior performance (Fehmi & McGaugh, 1961; McGaugh, Jennings, & Thomson, 1962); and in a simultaneous visual discrimination problem with massed trials no significant differences were found (McGaugh & Thomson, 1962).

We would like to explore further the arguments against such vague nomenclature as "maze-bright" and to present the results of two recent studies run with the S_1 and S_3 rats at Berkeley.

PROCEDURE

The procedure and apparatus to be described apply to both studies reported here, the second study being a replication. Differences between the results of the two studies may reflect differences in age of the two groups: The first study employed rats approximately 200 days old, while the Ss in the replication began training at approximately 120 days.

Subjects were eight S_1 and six S_3 male rats in the first study and six S_1 and five S_3 rats in the second. Strains were housed separately, two or three to a cage, and maintained on ad lib food and water.

Subjects were trained and tested on the ATLAS, an automated learning apparatus for rats designed by Markowitz, Rosenzweig, and Krech (see Fig. 1). Essentially, the apparatus consists of two Y mazes joined at their stems. The two compartments of either end may be independently lighted or darkened. Motor-driven doors, hinged at the choice point, open automatically at the beginning of each trial and close behind the rat as he enters the correct compartment. Shock is delivered to the animal through the grid floor of the apparatus. A silent electronic shock scrambler (Markowitz & Saslow, 1964) is used to commutate the shock.

At the start of any given trial, the door to the compartment occupied by the rat was opened. Five seconds later a buzzer on the same end of the maze began to sound. After another 5 sec, shock (approximately .75 mA) was applied to the entire floor except in the compartment designated as correct. The S was required, then, to leave his compartment and choose between the lighted and dark compartments at the opposite end of the maze. If the rat chose the correct compartment within 10 sec after the door opened, shock was completely avoided. Shock and buzzer were immediately turned on (or maintained) if an incorrect choice was made. When the rat interrupted a photoelectric beam in the correct compartment, buzzer and shock terminated, the door closed behind the animal, and the door at the opposite end was centered. Thus, a correction procedure was used. Trials were separated by 15 sec after which the animal was required to run to the opposite end.

The Ss were divided randomly into two groups which were trained on alternate days. Forty trials were presented each day. The animals were trained on successive light-correct and dark-correct problems, and the spatial location of the correct stimulus (light or dark) was randomized. Ss were trained to a criterion of 10 consecutive correct choices on an initial light-correct discrimination task and three subsequent discrimination reversals. It was possible for a S to reach criterion over two successive days, with the stipulation that the S be required to make five correct choices on the second day, regardless of the number (in excess of five) of consecutive correct choices at the end of the previous day. Out of the 100 problems solved, this restriction resulted in one animal running one extra trial to reach criterion.

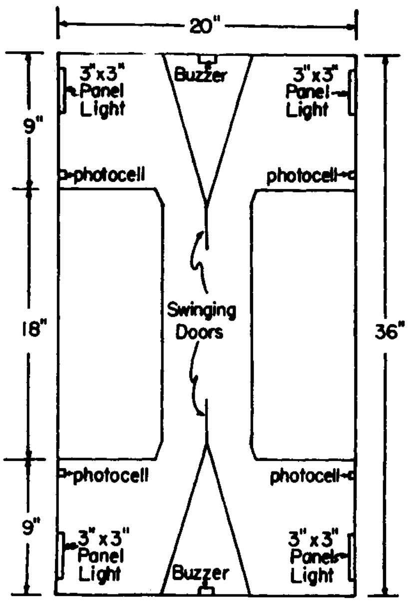

Fig. 1. Automated maze floor plan.

RESULTS

A total of over 15,000 trials of light-dark reversal discrimination learning yielded the results summarized in Table 1. The S_3 ("maze-dull") animals were superior to the S_1s on every measure reported, beyond the .05 level of significance. The S_1s, in short, took more trials and made more errors in reaching criterion than the S_3s in both studies and for the two studies combined. Latency of choice was also recorded, and again, S_3s were superior. (Extreme variability among individual animals prevented statistical analysis of the group latency differences.) In Figs. 2 and 3 it may be seen that there is no overlap between the two strains on any of the discrimination problems. (In fact, it appears that strain differences increase on each successive problem, suggesting that even greater differences might have

Table 1
Mean Trials and Errors to Criterion over Four Discrimination Problems for S_1s and S_3s

	Mean Trials			Mean Errors		
Experiment	1	2	1 & 2	1	2	1 & 2
S_1	98.1	147.5	119.3	42.3	62.5	51.0
S_3	87.4	99.3	92.7	35.0	39.5	37.0
S_1 minus S_3	10.7	48.2	26.6	7.3	23.0	14.0

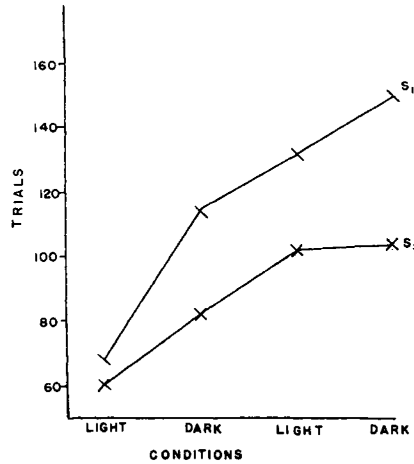

Fig. 2. Mean trials to criterion for combined groups.

been obtained had there been more reversals.)

DISCUSSION

It is apparent that the S_3 animals are superior in terms of the task run in the automated maze. In interpreting this result which is discordant with the majority of findings for these strains, we believe that there are two components of the task which must be analyzed separately.

First, the present study required the S to respond to a visual cue (light or dark) while most previous studies with S_1 and S_3 animals have used mazes in which the spatial component was the critical one. Petrinovich, in his dissertation (1960), ran a primarily visual mask task. An inspection of his data indicates that the S_3 animals took 5% fewer trials, thus supporting our notion that the S_3 rats may be better at solving visual problems. This line of argument is also consistent with the earliest observations of behavioral differences between these two strains in the "hypothesis apparatus" (Krechevsky, 1933). Krechevsky used an unsolvable problem (correction procedure) and found that ancestors of the present S_1 strain preferred spatial "hypotheses," while ancestors of the S_3 strain did not. The one study that we have seen showing superiority of the S_1s on a visual problem was that of Fehmi & McGaugh (1961) who reported that S_1 animals were superior on a horizontal-vertical stripe problem with massed training. We have run another brief experiment in the automated maze, in which we found that there was no significant difference between S_1 and S_3 animals on simple spatial discrimination reversal problems. (Light compartment location randomized; right correct to criterion of 10 consecutive right choices, then left correct to criterion of 10 left choices, etc.) The total trials required for an initial spatial problem plus three reversals were almost identical for the two strains as were the mean trials for each successive problem.

The second crucial aspect of our situation was the use of shock as the motivating factor. Robustelli, McGaugh, & Bovet (1963) have recently reported an experiment in which they found no significant correlation between avoidance conditioning (Warner Cage) and maze learning (Lashley III) in a sample of 52 male albino rats. This finding suggests that we must extend our research to assess the weights which should be given to the type of motivation and the type of problem, either visual or spatial. To this end we are at present working on a new automated maze which will allow for positive, as well as negative, reinforcement and either spatial or visual tasks.

In conclusion, we wish to point out that our data underline the fact that labels such as "maze-bright" and "maze-dull" have questionable validity and utility. We suggest alternatively that strain differences be expressed in terms of the specific type of problem employed.

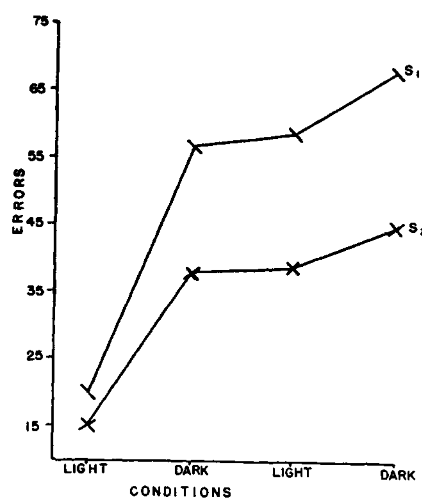

Fig. 3. Mean errors to criterion for combined groups.

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NOTES

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2. Now at Oregon State University, Department of Psychology, Corvallis, Oregon.