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The Retention of a Discrimination

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One of the earliest and most persistent problems in the functional analysis of the behavior of living organisms has been that of the retention or loss ("forgetting") of a learned performance over a period of time. There are, of course, a number of experimental operations that may be used to reduce the probability of a given action: these include, e.g., withholding the reinforcement for the act, changing the stimulus conditions, reducing the drive, or reinforcing competing behavior (including that which prevents aversive stimulation following upon the original act). But a special problem is posed by the observation that a deterioration occurs in the subject's performance with the passage of time even when no experimental operation is performed. This has led to the concept that time itself may be the pertinent variable at a psychological level of analysis. However, since the very existence of the organism during the interval between the successive tests implies the operation of certain relevant variables, it seems unlikely that the independent effect of the passage of time, if any, can be isolated and measured. The most that can be said is that when appropriate techniques are employed a substantial retention of simple motor acts over long periods of time may be demonstrated (*1–7*). Such findings, however, have not yet been extended in any clear fashion to the retention of a discrimination (i.e., an appropriate relationship between the probability of the act and the stimuli which have marked the occasions when it will be reinforced). This is the purpose of the present study.

Six white rats were put on a daily feeding rhythm which maintained them at approximately 85% of their body weight under *ad lib* feeding. A bar or lever was inserted into the experimental cage (*8*), and each depression of this bar was followed by the delivery of a 1/15-g pellet composed mainly of Purina laboratory chow. When the animals were conditioned, the discrimination training was begun by making the further receipt of food contingent upon the presence or absence of cage illumination from above (4.5 ft-c). Light and darkness were alternated in 5-min phases throughout daily sessions of 100 min each. Certain of the pressings in the light (S^D) were reinforced with food at irregular intervals (mean of 2 min); none of the pressings in the darkness (S^Δ) was reinforced. By the end of 16 such training sessions, 85–90% of all responses occurred during the light phase of the cycle. Seven further test sessions were then conducted that were identical in procedure save for a systematic manipulation of the hunger drive. The results of these tests, plus further details of apparatus and procedure, may be found in a separate paper (*9*).

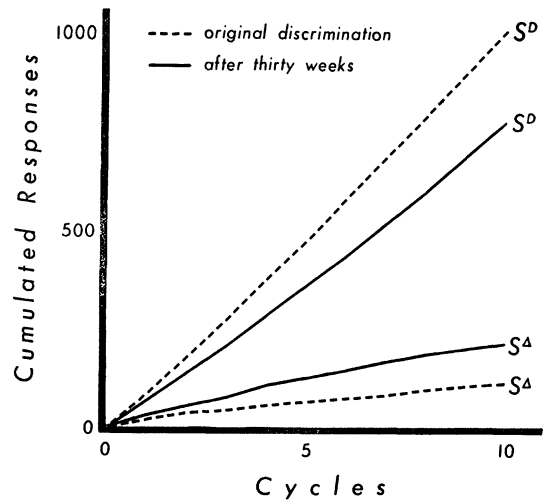

FIG. 1. The mean number of bar-pressings by 5 rats cumulated at the end of each 10-min cycle during a 100-min test session at the end of training and again 30 weeks later. The response was intermittently reinforced with food in the S^D (light phase of the cycle) but never in S^Δ (darkness).

In order to measure the retention of the discrimination over a period of time, all animals were brought back to 85% of normal body weight for an initial test session. One subject died during the ensuing period, but 30 weeks later the remaining 5 animals were tested a second time. To determine whether the rate of responding from cycle to cycle within either test period remained proportional to the total responding for the session, group means were calculated for each cycle. In both cases the rate of responding in S^D shows a slight increase (slope = 2.6 and 2.5 responses/cycle, respectively, by the method of least squares) and the rate in S^Δ a slight decline (−1.0 and −1.7) throughout the session. As may be seen in Fig. 1, however, where these means are cumulated for successive cycles, the shapes of the corresponding curves within either test session are approximately the same. It seems legitimate, therefore, to employ the totals for either session as measures of the animals' functioning before and after the retention interval.

Individual totals for each of the 5 animals are presented in Table 1. The typical effect of the passage of time is an increase in S^Δ responding (4 of 5 animals) and a decrease in S^D responding (all 5). The mean percentage of responding occurring in S^D drops from 89.9 on the first session to 80.3 on the second, a loss of 9.6 points. In view of the small number of subjects,

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TABLE 1

Rat No.	Original discrimination			After 30 weeks		
	Responses		Percentage	Responses		Percentage
	(In S^D)	(In S^Δ)	(In S^D)	(In S^D)	(In S^Δ)	(In S^D)
12	1,242	125	90.9	1,027	154	87.0
13	1,094	167	86.8	827	265	75.7
14	1,070	87	92.5	913	348	72.4
15	700	107	86.7	341	35	90.7
17	977	80	92.4	804	261	75.5
Sum	5,083	566	.....	3,912	1,063	.....

however, and the range of individual variation, this figure should be viewed as no more than a rough estimate of any population value. The important feature to note is that a substantial difference in rates is retained by all animals. Similarly, the total number of responses drops from a mean of 1,130 to one of 995, or about 11.3%.

Although some loss of discrimination and some decline in total responding is suggested by these figures, it is concluded that a well-established discrimination between two stimuli may largely be retained over a period of 30 weeks, under normal laboratory conditions; the breakdown of such a discrimination is not inevitable with the mere passage of time.

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Effects of Indolebutyric Acid and Other Compounds on Virus Concentration in Plant Tissue Cultures

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In a previous paper by Kutsky and Rawlins (*1*), culture methods and a new method of analysis for tobacco mosaic virus in tobacco stem tissue cultures were described. It was reported that naphthalenacetic acid at 1.0 mg/l was effective in reducing the concentration of tobacco mosaic virus in tobacco stem tissue cultures. Further tests of compounds for effect on virus content are reported here.

The tissue culture technique and method of analysis were essentially the same as previously described (*1*). The characteristic nucleic acid absorption maximum at 260 mμ was used as a measure of virus concentration in processed extracts. By calculating the absorption ratio, T/C, of treated to control culture extracts one obtains an index of the effect of the added compound. For cultures where coloration was evident in the final fluid an added step—namely, precipitation of the virus in half-saturated ammonium sulfate and resuspension in water or $M/15$ phosphate buffer, pH 7, was inserted before the ultraviolet spectrophotometric analysis. Coloration, which occurred sporadically and interfered with the ultraviolet analysis, remained largely in the supernatant when the virus was precipitated with ammonium sulfate.

TABLE 1

EFFECT OF INDOLEBUTYRIC ACID ON CONCENTRATION OF TOBACCO MOSAIC VIRUS IN TOBACCO TISSUE CULTURES

Compound used	Concn (mg/l)	Terminal fresh wt of culture (mg)	Optical density/mg of tissue	T/C*	Av T/C
IBA	100	565	0.117	0.38	
Control	None	245	.306		
IBA	100	835	.144	.39	0.40
Control	None	315	.370		
IBA	100	590	.135	0.44	
Control	None	280	0.303		

* $\frac{T}{C} = \frac{\text{Optical density/mg treated tissue}}{\text{Optical density/mg control tissue}}$.

Twenty compounds were tested. The maximum concentration in each case is expressed as mg/l of solution brought to the pH of the medium (6.0) with 0.1 N sodium hydroxide: hydroxylamine, 1.0; sodium fluoride, 10; cobalt chloride ($CoCl_2 \cdot 6H_20$), 10; zinc chloride, 100; uranyl acetate, 100; ascorbic acid, 100; desoxyribonucleic acid, 2,000; ribonucleic acid, 1,000; colchicine, 10; *p*-hydroxyphenylglycine, 10; D-usnic acid, 0.1; 2,6,diaminopurine, 0.01; terramycin, 100; streptomycin, 1.0; subtilin, 100; caprylic acid, 10; phenylacetic acid, 10; phenylpropionic acid, 100; phenylvaleric acid, 100; indolebutyric acid, 100.

The first 19 substances were found to have no effect on the virus content at the concentrations listed. In most cases the concentration given is close to the maximum that the tissues can tolerate and still exhibit normal growth. Lower concentrations of all compounds were tried, but it was found that the maximal effect, if any, was produced at the highest concentrations that the tissue cultures would tolerate.

Indolebutyric acid, like naphthalenacetic acid, is

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