of positive results with wart extracts from cattle in three geographical areas.

Studies of wart viruses have been hampered by lack of convenient assay systems; none has been propagated in tissue culture, and no hæmagglutination has been detected. The bovine wart virus produces lesions in cows, horses[4], and hamsters[3]; but these systems are either cumbersome or insensitive. Since transformation was induced by virus dilutions as high as 10^{-3}, the highest dilution tested, it is possible that the system described here may provide a relatively sensitive assay for virus. However, its sensitivity relative to inoculation of cows or horses remains to be determined. The *DBC* cells do not appear to provide a method for propagating the virus, and in this respect the cell-virus relationship resembles some of the transformation systems with other papovaviruses[1].

The high percentage of *DBC* cells that are transformed by the bovine wart viruses suggests that this may be a particularly useful model system for studies of cellular transformation by viruses.

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PSYCHOLOGY

Use of 3-Dimensional Shapes for Investigation of Learning Sets in the Rat

IN a series of experiments, Harlow[1] and other investigators have studied learning-sets in a number of species. Their evidence demonstrates that the ability to form learning sets is related both to the phylogenetic 'level' of a species and to the individual animal's ontogenetic development. When trying to establish learning sets in such an animal as the rat, the difficulty has been that the learning of individual problems has taken so long that it was not possible to present sufficient problems to examine this phenomenon of learning to learn.

In an effort to achieve faster learning, the following apparatus was constructed using 3-dimensional shapes as discrimination stimuli. In this situation a rat not only sees an object but also touches and moves it. The procedure is sufficiently close to that of Harlow's work with primates to allow a comparison of learning-set formation with other species.

The animal was placed in a wooden box 12 in. × 10 in. At one end were two apertures 6 in. across and 4 in. high. The floor of each aperture was wooden and raised towards the back wall at an angle of 10°. In the centre of the floor of each aperture was a food-well ½ in. × ½ in. over which a wooden 3-dimensional shape was placed. There were two screens dividing the box from the apertures. A transparent inspection screen allowed the animals to see both shapes but prevented any approach to them until it was raised; a second opaque screen prevented animals from observing the change-over of shapes and from correcting their responses. The inside of the apparatus, with the exception of the white wooden shapes, was painted black.

Twelve male black hooded Norway rats were used; seven were 4 months and five were 11 months old at the beginning of the experiment. An animal was first trained to eat pieces of spaghetti from the food-wells and then learned to 'nose' off the shapes to find food beneath. In the experiment itself a rat, after being deprived of food for 20 h, was placed in the box with both screens 'down'. The stimulus shapes were placed in position, the 'correct' one was baited and the opaque screen was then raised for an inspection period of 5 sec, after which the inspection screen was raised so that the animal could respond. If the animal made a correct response, time was allowed for it to take the food and eat; if incorrect, then the screens were immediately lowered. An error was recorded when the animal entered the wrong aperture, and a correct response when the shape over the baited well was pushed away. The inter-trial interval was approximately 10 sec.

Each animal was given 210 trials on problem 1 (Fig. 1), and each achieved more than 75 per cent correct responses on the trials for the last day. Problems 2–5 were then presented for 100 trials at 25 a day. Once again all animals reached the criterion of 75 per cent correct responses. At this point it seemed that animals might reach this criterion in fewer than 100 trials, so problems 6–18 were run at 25 trials a day and changed immediately after passing the criterion. Most animals did in fact reach criterion on all problems in 50 trials. In order to present more problems to each animal, problems 19–58 were given at 2 a day and 10 trials per problem.

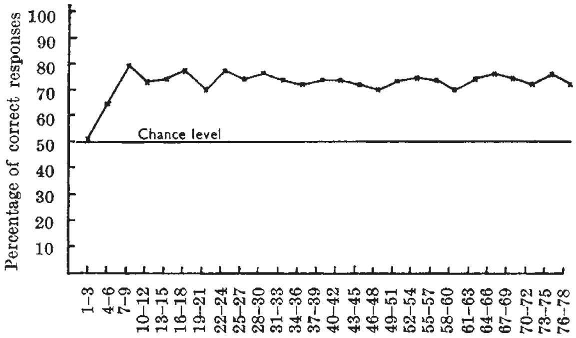

Fig. 1. No. of correct responses for first ten trials on problems 1–78

The animals again scored above chance; but towards the end of the problems scores were fluctuating and the latency of responses was increasing. Since further improvements with this rapid changing of problems seemed unlikely, the final problems, 59–78, were presented for 25 trials each at 1 problem a day. There was no marked change in performance for these last 20 problems though the scoring was again well above chance.

The scores for the first 10 trials for all problems are presented in Fig. 1. These animals had clearly learned how to react to this rapid change of pairs of stimuli and achieved scores which indicate some mastery of the task. By using three-dimensional shapes it was possible for these rats to learn 78 discrimination problems in a period of less than 3 months. This was considerably faster than with experiments using two-dimensional shapes, and gives some hopes that with this type of apparatus it should be possible to present a sufficient number of problems to these animals to make phylogenetic comparisons. So far, on the evidence of the present results, the rat learned quicker than with two-dimensional shapes, but, as a species, it was not so rapid as other animals higher in the phylogenetic scale.

This work was supported by a grant from the Medical Research Council.

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