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The effect of morning glory seeds upon extinction of a classically conditioned response in fish (*Tilapia mossambica*)

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Twenty-four fish were classically conditioned to a CS of 4-sec light-off paired with a UCS of 0.5-sec shock for 10 trials per day over 10 days. In a double-blind procedure, extinction trials of 10 trials per day for 4 days were given to fish receiving either their normal feeding or that of ground morning glory seeds. The effect of the morning glory seeds was to significantly increase resistance to extinction.

The effects of lysergic acid diethylamide (LSD) upon fish (Abramson & Evans, 1954; Abramson, Gettner, Hewitt, & Dean, 1961; Abramson, Sklarofsky, Baron, & Gettner, 1957; Abramson, Weiss, & Baron, 1958; Baron, Sklarofsky, Freemont-Smith, & Abramson, 1958; Chessick, Kronholm, Beck, & Maier, 1964; Chessick, Kronholm, & Maier, 1963; Cutting, Baslow, Read, & Furst, 1959; Evans, Abramson, & Freemont-Smith, 1958; Gettner, Rolo, & Abramson, 1964; Keller & Umbreit, 1956; Trout, 1957) are a quiescent state with changes in swimming and body movements, color changes, backward swimming, increased aggression, inferred "trance" states and perceptual changes, and a reduction of maze learning ability. Morning glory seeds contain several ergot alkaloids which resemble LSD: d-lysergic acid amide, d-isolysergic acid amide, chanolclavine, clymoclavine, lysergal, and ergometrine. Another principal ingredient is the glucoside turbicoryn, which is said to have antitension properties (Hoffer & Osmund, 1967). The principal hallucinogenic alkaloid in morning glory seeds is d-lysergic acid amide (LA), which is reported by Solms (1956) to be 1/10 as effective as LSD-25. Because of the chemical similarity of LSD-25 and LA, it has been assumed that they have similar pharmacological effects, although Solms reported that LA acting alone produces much less hallucinogenic and psychomotor activity and more sedative activity. Hoffer and Osmond (1967) have assumed that the overall effectiveness of morning glory seeds when ingested by man has been due to the combined effect of ergot alkaloids, principally LA, and the glucoside.

The effect of various ergot drugs resembling LSD upon Siamese fighting fish (Evans, Geronimus, Kornetsky, & Abramson, 1956) was postural and swimming changes, but each was much less effective than LSD. These investigators were interested in such nonlearning measures as quiescence, body position, aggressive display, and color change. The present study investigated the effect of ingesting ground morning glory seeds upon a learning variable, resistance to extinction of a classically conditioned response, with the fish *Tilapia mossambica*.

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METHOD

Subjects

Twenty-four experimentally naive mouthbreeders, *Tilapia mossambica*, of both sexes were used. The fish ranged from 5 to 7½ cm in length. The mouthbreeder was selected for the experiment because of its hardiness and its avid eating habits. The fish were individually housed in 15-gal aquariums.

Apparatus

Conditioning and extinction were carried out in an apparatus similar to that described by Bitterman (1966). The apparatus was a 15 x 10 x 12.5 cm Plexiglas box, divided in the center; one half housed the subject, and the other half a paddle immersed in the water to sense the movement of the fish. Fish movement acting on the paddle actuated a phonograph cartridge, the output of which was then amplified into an analog signal and recorded by an Esterline Angus recorder. Directly above the side of the chamber housing the fish was a 6-V dc lamp which, when turned off, served as a CS. The UCS was a shock applied to stainless steel plates at each side of the experimental chamber. The shock source was a Grass SD-5 stimulator set at 80 V dc, 10 pulses/sec of 50-msec duration and 50-msec delay. The effective shock level delivered to the fish was approximately 4 V, being variable due to changing properties of the water.

Procedure

During acquisition trials, the overhead lamp (CS) went off for 4 sec. During the final 0.5 sec of light-off, the shock (UCS) was presented. Each fish received 10 trials a day for 10 days. Beginning the following day, extinction trials (light termination only) were given, 10 trials a day for 4 days. Throughout the experiment, the intertrial interval was variable, in order to insure that the fish be relatively quiescent and swimming normally, but averaged approximately 60 sec. Similarly, each fish was allowed 5 or more minutes in the test chamber before initiating each of the daily acquisition or extinction trials.

During extinction trials, half the fish received the morning glory

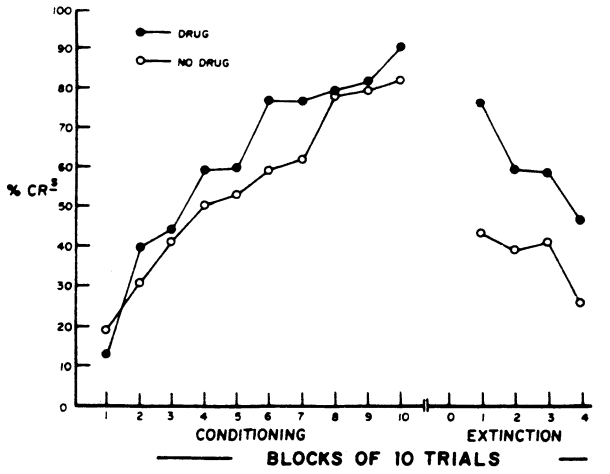

Figure 1. Performance of experimental and control groups during acquisition and extinction.

seeds and the other half their normal food. The dosage was either 35 mg of washed, ground Heavenly Blue morning glory seeds or 35 mg food, given in the home tank. (Heavenly Blue seeds have been reported by Taber, Vining, & Heacock, 1963, to have 0.02% to 0.039% concentration of ergot alkaloids.) Thirty minutes were allowed for feeding prior to the extinction trials, after which all remaining food or ground seed was removed from the home tank. The food and the ground seeds were given to the fish in a double-blind procedure.

The study was carried out in three parts because of space restrictions, since each fish was kept in a separate aquarium while being run in the experiment. Subjects were randomly assigned to experimental or control groups, and the data from the three parts were combined at the conclusion of the experiment.

RESULTS AND DISCUSSION

The results of the experiment are shown in Figure 1. The filled and open circles on the graph for acquisition identify the group which received morning glory seed ingestion (experimental) or noningestion (control), respectively, during the extinction trials. The initial levels of performance for acquisition, employing the first block of 10 trials, were not significantly different when evaluated with a Mann-Whitney U test. Similarly, the terminal levels of performance of the experimental and control groups (90% and 82% CRs, respectively) were not significantly different. An example of a typical conditioned response during acquisition is shown in Figure 2A, with the CS and UCS indicated on the lower and upper time lines, respectively. The effect of morning glory seed ingestion prior to each day's extinction trials was to significantly increase resistance to extinction (Figure 1) throughout the first 3 days of the extinction period. Differences between groups were nearly significant ($U = 40.5$, $p = 6.88$) on the fourth day. A typical conditioned response during the extinction period is shown in Figure 2B.

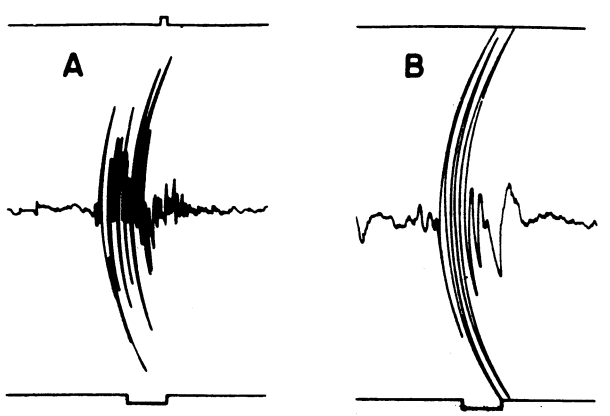

Figure 2. Representative data records for acquisition (A) and extinction (B).

It is tempting to interpret the results of the present experiment as being due to an activation effect attributable to the dosage level of morning glory seed ingestion. A recent study by Matheson and Thomas (1969) is consistent with this view, in that they reported an increased rate of motor activity in chicks observed in an open-field situation following morning glory seed ingestion. The effect of wild morning glory seed alkaloids upon humans has been reviewed and investigated by Isbell and Gorodetzky (1966), who reported a primarily sedative effect. This is consistent with the previously cited studies of the effect of LSD-25 and ergot alkaloids upon fish. Evans and his co-workers (1956), although not investigating the effect of LA in their study of ergot alkaloids in fish, emphasized a quiescent state in which there was arousal at the slightest stimulus, promptly followed by an immediate return to relative inactivity. The results of the present experiment seem to be best interpreted as an increased sensitivity to stimulus change, rather than to an overall activation or increase in motor activity.

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