

Altruistic behavior in the albino rat

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This experiment was designed to establish more conclusively the presence or absence of operationally defined altruistic behavior in the white rat. One animal could significantly reduce or completely alleviate another animal's distress state (created by foot shock) by appropriate manipulation of two operant levers. "Altruistic" behavior was shown to a significant degree only by animals that had themselves experienced the same distress state. An explanation of the results, based on factors other than "instinctive" ones, is offered.

Altruistic behavior in lower animals has been investigated by controlled experiment (Lavery & Foley, 1963; Masserman, Wechkin, & Terris, 1964; Rice & Gainer, 1962), but there are mixed conclusions about the existence of such behavior and about its determinants. The research described here was designed to establish more conclusively the presence or absence of altruistic behavior in the white rat. Rice & Gainer's (1962) operational definition of altruism was used, i.e., "behavior of one animal that relieves another animal's distress." A distress state (manifested by squealing, urination, defecation, and a "mincing dance") was induced in a rat (Victim or V) by administration of electric foot shock. Another rat (Operator or O) could introduce or terminate this distress state by appropriate manipulation of two levers.

SUBJECTS

The Ss were 70 male albino rats (56 Os and 14 Vs) of a commercial Sprague-Dawley strain, 90 to 150 days of age.

APPARATUS

Apparatus was an enclosed box divided into two adjacent compartments by a glass wall; spaces around the edges of the glass wall allowed passage of visual, auditory, and olfactory stimuli. The compartment for the V had three bare walls, and a grid floor through which electric shock could be delivered to the feet of the V. Constant shock delivery of .05 mA to the grid was assured by use of a commercial electro-mechanical scrambling device which changed the polarity of each grid-bar four times/sec. In the compartment for the O were two combination operant lever-food tray devices, each mounted on a wall adjacent to the glass separating wall. Each lever-tray device had a food-pellet dispenser which was set to deliver one pellet of food per lever press throughout the experiment. Circuitry was such that either lever could be set to actuate or terminate the grid shock in addition to and concurrent with the delivery of a food pellet. Thus, it could be arranged that a press of lever X by the O would deliver one pellet of food to the O and either introduce or terminate shock to the V, while a press of lever Y would yield only food reward, or vice versa. An automatic timer and reset system was used so that, for each lever press, shock was either introduced or terminated for 3 sec. During all experimental trials the entire apparatus was operated automatically.

PROCEDURE

Each O underwent 12 to 16 30-min trials (training and experimental), conducted on consecutive days. Os were deprived of food for 23 h prior to each trial.

Each O was first trained to feed itself by operating either lever, and then was allowed to develop a preference for one lever. A lever preference was considered to exist when the O procured more than 90% of his food pellets by use of the same lever for two consecutive 30-min trials. To speed up the development of a preference, one lever was adjusted so that it

required twice as much force to activate as did the other. By the end of 8 to 10 training trials over 80% of the Os showed a preference for the "easier" lever; remaining Os preferred the "harder" one.

When a preference for one lever had been established for the O, the V was introduced into its compartment and experimental trials were begun. It was during these trials that the V was subjected to a distress state and the O could manifest altruistic behavior. In all experimental groups, regardless of the factor being investigated, each O could significantly reduce or completely alleviate a V's distress state by changing preference of the lever by which it fed itself. Each O was allowed a maximum of eight experimental trials to manifest a preference change (defined as procurement of more than 90% of food pellets by use of the initially nonpreferred lever). If a preference change remained stable for three consecutive experimental trials, operationally defined altruism was considered to have occurred. If no stable preference change occurred during the eight experimental trials, altruistic behavior was considered absent.

Os were randomly assigned to two major experimental groups (each composed of two subgroups) and two equivalent control groups.

Experimental Group 1 (20 Ss)

The factor investigated in this group was onset of shock to the V. During experimental trials, continued use of the preferred lever by the O would result in 3 sec of foot shock to the V for each press, in addition to and concurrent with delivery of a food pellet to O. The nonpreferred lever would deliver the same amount of food, and would not result in shock to the V, but for most Os would require twice the minimum effort necessary to obtain food. This group was further subdivided: Os in Subgroup 1A (10 Ss) had never experienced foot shock; Os in Subgroup 1B (10 Ss) had experienced eight 3-sec foot shocks (in the V compartment) four days prior to training for lever pressing.

Experimental Group 2 (20 Ss)

The factor investigated in this group was offset of shock to the V. During experimental trials, the V experienced continuous foot shock. Continued use of the preferred lever by the O would deliver food reward to the O, but would not terminate shock to the V. Pressing of the nonpreferred lever would terminate shock to V, for 3 sec per press, as well as deliver food reward, but for most Os would require twice the minimum effort necessary to feed themselves. This group was subdivided in the same fashion as Group 1: Os in Subgroup 2A (10 Ss) had never experienced foot shock; Os in Subgroup 2B had experienced foot shock prior to the experiment.

Control Groups (16 Ss)

Os in Control Group 1 (8 Ss) had never experienced foot shock and served as controls for Os in Experimental Subgroups 1A and 2A. Os in Control Group 2 (8 Ss) had experienced foot shock in a manner identical to Os in Experimental Subgroups 1B and 2B, and served as their controls. All phases of the experiment for control and experimental Os were identical, except that the Vs used with control Os were never shocked.

RESULTS

In only one subgroup, Experimental Subgroup 1B, did a significant number of Os show operationally defined altruism. A stable preference change during three consecutive experimental trials was shown by 80% of the Os in this group ($p < .01$ by a Fisher t test). In each of the remaining three experimental subgroups, and in both control subgroups, less than 20% of the Os showed a preference change. Stated another way, only Os that had experienced foot shock changed their preferences of

levers to obtain food when continued use of the initially preferred lever resulted in shock to another rat. This occurred even though, for most Os, the nonpreferred lever required twice as much force to activate.

Correlations between Os that changed preference and possible intervening variables such as (a) number of depressions of each lever, (b) total number of trials, and (c) lever first learned, were all quite low or nonexistent by visual inspection of the data, and were not considered to be significant to the occurrence of preference change.

DISCUSSION

The phenomenon of discrimination might adequately explain the absence of altruistic behavior in Experimental Group 2, without recourse to any speculation regarding motivation. In Group 1 continued pressing of the preferred lever brought about an abrupt stimulus change (i.e., squealing and struggling of the V) in addition to food delivery. In Group 2, however, continued pressing of the preferred lever did not bring about any stimulus change in addition to food delivery, since V was in an ongoing distress state. Thus, in Group 2, there were no discriminable stimuli to be associated with Os' behavior.

The differential results are found in Experimental Group 1. In this group Os that had been shocked prior to the experiment showed altruistic behavior. Two existing hypotheses to account for altruistic behavior are: (a) that it is innate or "instinctive" (Masserman et al, 1964; Rice & Gainer, 1962); (b) that it serves merely to reduce the intensity of physical noxious stimuli (Lavery & Foley, 1963).

Neither of these hypotheses adequately explains the results of this experiment. According to each, nonshocked Os in Subgroup 1A should have shown behavior changes similar to those of shocked Os in Subgroup 1B. However, the hypothesis of Lavery and Foley becomes tenable if another concept is

considered—the concept of sensitization as espoused by Church (1959). As he sees it, "a group of animals that have been shocked may be more responsive to all stimuli, including the pain responses of others [1959, p. 133]. Thus, if Church's idea is valid, the "altruistic" Os in this experiment, having experienced shock themselves, could have been sensitized to the extent that they would perceive the abrupt increase in level of stimulation (i.e., squealing and squirming of V) as noxious, and thus would work to reduce it. This explanation seems more likely than one based on innate factors, since (a) shock-naive Os were not altruistic, and (b) it has been shown that both stimulus increase and/or decrease can serve a reinforcing function (Hunt & Quay, 1961; Roberts, Marx, & Collier, 1958).

REFERENCES

- CHURCH, R. M. Emotional reactions of rats to the pain of others. *Journal of Comparative & Physiological Psychology*, 1959, 52, 132-134.
- HUNT, J. McV., & QUAY, H. C. Early vibratory experience and the question of innate reinforcement value of vibration and other stimuli: A limitation on the discrepancy principle in motivation. *Psychological Review*, 1961, 68, 149-156.
- LAVERY, J. J., & FOLEY, P. J. Altruism or arousal in the rat? *Science*, 1963, 140, 172-173.
- MASSERMAN, J. H., WECHKIN, S., & TERRIS, W. "Altruistic" behavior in the rhesus monkey. *American Journal of Psychiatry*, 1964, 121, 584-585.
- RICE, G. E., & GAINER, P. Altruism in the albino rat. *Journal of Comparative & Physiological Psychology*, 1962, 55, 123-125.
- ROBERTS, C. L., MARX, M. H., & COLLIER, G. Light onset and light offset as reinforcers for the albino rat. *Journal of Comparative & Physiological Psychology*, 1958, 51, 575-579.

NOTE

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fractions than do other brain tissue in both shock-avoidance and water-maze experiments.

The AD and CB tissues consistently indicated differences between E and C in the shock-avoidance experiments as well as in the water-maze task. Such results probably reflect the running involved in avoiding and/or escaping the shock source in the former task and the swimming in the latter.

In some of the shock-avoidance experiments MD consistently provided significant differences between E and C, but this was not the case in the other experiments. It is probable that differences in MD in the shock-avoidance task reflected the pain and somesthetic stimulation resulting from the electrical shock. The medial dorsal cortex appears to be a somesthetic area (Zubek, 1951).

There was a strong tendency for $E < C$ in the specific activity of RNA, protein, and cell pool fractions and in ratios involving RNA and/or protein in some shock avoidance and water maze experiments. These results appear to be inconsistent with the expectations of individuals who believe that RNA performs a unique role in learning behavior (Gaito, 1966). One would expect that an increase in RNA and/or protein would be required for learning to occur. In these experiments the learning animals were indicating clearly that a learning process was under way during decreased RNA and protein synthesis, suggesting that an increase in neither RNA nor protein synthesis is necessary for the acquisition of a learned response. Other research with RNA and protein synthesis inhibitors (actinomycin-D and puromycin) indicated that learning can proceed even with greatly reduced levels of

RNA and/or protein being synthesized (see Gaito, 1966). However, only small amounts of unique RNA and/or protein species may be required to sustain learning events.

The consistent significance of MV (and possibly PV and AV) could indicate changes due to learning; such interpretation is consistent with results by other investigators (Gaito, 1966). However, the differences noted in these sites could be due to the stressing agents involved in each case. Lesion studies are now under way to determine whether the differences reflect neurochemical events unique to learning or to other processes such as stress.

REFERENCES

- ADEY, W. R., DUNLOP, C. W., & HENDRIX, C. E. Hippocampal slow waves. *American Medical Association Archives on Neurology*, 1960, 3, 74-90.
- GAITO, J. *Molecular Psychobiology*. Springfield, Ill.: C. C. Thomas, 1966.
- GAITO, J., MOTTIN, J., & DAVISON, J. H. Chemical variation in brain loci during shock avoidance. *Psychonomic Science*, in press. (a).
- GAITO, J., MOTTIN, J., & DAVISON, J. H. Chemical variation in the ventral hippocampus and other brain sites during conditioned avoidance. *Psychonomic Science*, in press. (b).
- ZUBEK, J. P. Studies in somesthesia. I. Role of the somesthetic cortex in roughness discrimination in the rat. *Journal of Comparative & Physiological Psychology*, 1951, 44, 339-353.

NOTES

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2. Complete data may be obtained by writing the first author.