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Effects of Prior and Interpolated Shock Exposures on Subsequent Escape/Avoidance Conditioning with Goldfish

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Effects of prior and interpolated shock exposures on subsequent escape/avoidance conditioning with goldfish.
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THESIS

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ABSTRACT

The relationship between inescapable shocks and subsequent escape/avoidance learning was first deomonstrated by Overmier and Seligman (1967). They found that dogs exposed to inescapable electric shock, while restrained in a harness, later failed to learn to escape shock in a two way shuttle box where escape was possible. Ninety goldfish were randomly assigned to one of five groups (N=18 per group). Ninety fish were tested in a Lafayette Aquatic Unit A-660 type shuttle tank. There are four independent variables in this study. The first independent variable is the presence of prior inescapable shock. The second independent variable is the level of shock intensity, 6V vs. 10V. The third independent variable is the amount of delay of subsequent conditioning, 1 hour vs. no delay. The fourth independent variable is the presence of interpolated shock. All subjects, except group 1 which did not receive prior inescapable electric shock, were treated with both prior and interpolated inescapable electric shock to assess the effects on subsequent escape/avoidance performance. Prior inescapable shock caused a significant reduction in all measures of performance. When inescapable shock immediately preceded conditioning, measures based on both escapes and avoidances were significant. The level of shock intensity interacted with the amount of delay of subsequent conditioning. The presence of interpolated shock produced a significant decrement in performance for the 53 fish in the last phase of the study.

Statement of the Problem

The relationship between inescapable electric shocks and subsequent escape/avoidance learning was first demonstrated by Overmier and Seligman (1967). They found that dogs exposed to inescapable electric shocks while restrained in a harness, later failed to learn to escape shock in a two way shuttle box where escape was possible. Seligman and Maier (1967) demonstrated that the uncontrollability of the original shocks caused this effect and theorized that the interference of subsequent escape/avoidance learning was due to the effects of "uncontrollability of aversive stimulus" and "independence of response outcome".

Review of the Literature

The learned helplessness effect has been demonstrated with dogs, with rats, with cats, with goldfish, and with humans (Seligman and Maier, 1967). The aversive stimuli used in these experiments include cold water, loud noise, and electric shock. There are only two studies of learned helplessness with goldfish. Padilla, Padilla, Ketterer, and Giocolone (1970) found the effect of inescapable shock disappeared in 72hr. in their second experiment using 28V shock intensity. Padilla (1973) found that a level of shock intensity of 15V could be safely employed while producing a learned helplessness effect.

The role of shock intensity in the learned helplessness paradigm using male Holtzman rats has been studied by Rosellini and Seligman (1978). They used three levels of shock no-shock=0mA, low=0.4mA, medium=1.0mA, and high=2.0mA. They found that the interference on subsequent escape/avoidance learning did not occur when inescapable shock intensity and intensity of escape/avoidance conditioning were highly discrepant such as high inescapable shock with low intensity of escape/avoidance conditioning or low inescapable shock with high intensity of escape/avoidance conditioning; however the interference on subsequent escape/avoidance learning occurred when inescapable shock intensity and intensity of escape/avoidance conditioning were similar. They could not explain why the results were this way, but they gave the reasons why this could not happen assuming hypotheses other than the learned helplessness hypothesis. Padilla's (1973) study indicated that inescapable shock interfered with the escape/avoidance performance during the subsequent escape/avoidance conditioning whether it was presented prior to the conditioning or interpolated between blocks of conditioning. Padilla's levels of shock intensity were very high, 28V and 45V. There is a reason to suspect that these levels of shock may cause some fish to die or be permanently injured. Bintz (1971) indicated on his escape/avoidance conditioning of goldfish that some fish died at 18V.

There are three conflicting explanations regarding the role of shock intensity used in escape/avoidance conditioning with goldfish. The first explanation established by Behrend Bitterman

(1963), Gallon (1972), and Scobie and Herman (1972) proposed that a level of shock between 6V to 7V is the optional level of shock intensity in Sidman's avoidance conditioning with goldfish. The second explanation established by Bintz (1971) and by Zerbolio and Wickstra (1975) proposed that a medium level of shock intensity between 9V to 15V is the optimal level for performance in escape/avoidance conditioning. Bintz (1971) obtained the optimal avoidance in the intermediate level of shock intensity groups (9, 12, and 15V), particularly in the 9V group, and found that the 6V and 18V groups did not do very well on avoidance. Zerbolio and Wickstra (1975) found an inverted U function of power, defined in terms of shock intensities (7.5, 10, 15, and 20V) times durations (100, 200, or 400 msec), with goldfish avoidance performance. Behrend and Bitterman (1963), Gallon (1972), Scobie and Herman (1972), Bintz (1971), and Zerbolio and Wickstra (1975) dealt with escape/avoidance conditioning only, not the learned helplessness effect. The third explanation dealt with the learned helplessness effect on the subsequent escape/avoidance conditioning. The third explanation proposed by Padilla et al (1970) and by Padilla (1973) believed that the high level of shock, between 28 and 45V, is the optimal level, provided it does not cause fish to lose equilibrium. Considering the previous experiments on escape/avoidance conditioning and the inescapable shock with subsequent escape/avoidance conditioning, five hypotheses were established.

Hypothesis 1 is: The learned helplessness effect occurs when group 1 (a control group which received no proir inescapable shock) is superior to other groups on Day 1. This hypothesis becomes "contrast 1" on the analysis of all data collected.

Hypothesis 2 is: The level of shock intensity makes a difference when group 2 (a group which received 6V level of inescapable shock immediately prior to the conditioning) and group 3 (a group which received 6V level inescapable shock one hour prior to the conditioning) are significantly different from group 4 (a group which received 10V level of inescapable shock immediately prior to the conditioning) and group 5 (a group which received 10V level of inescapable shock one hour prior to the conditioning). This hypothesis becomes "contrast 2" on the analysis of all data collected.

Hypothesis 3 is: There is a difference between the conditioning immediately after the inescapable shock and a delay of one hour when group 2 and group 4 are significantly different from group 3 and group 5. This hypothesis becomes "contrast 3" on the analysis of all data collected.

Hypothesis 4 is: There is a interaction between the shock intensity and a delay. This hypothesis becomes "contrast 4" on the analysis of all data collected.

Hypothesis 5 is: Interpolated inescapable shock produces a decrement in performance. This hypothesis can be proved by the performance difference between the day 4 and the day 5.

METHOD

Subjects: One hundred and thirty five experimentally naive goldfish (Carassius Auratus) were purchased from a local dealer on two occasions.

Apparatus: An attempt to use Testan Goldfish Shuttle box which used 20V as a high voltage and 10V as a low voltage for inescapable shock was aborted after the second conditioning days of set 1 due to apparatus failure. All subjects were tested in a Lafayette Aquatic Unit A-660 type shuttle tank. The shuttle tank was housed in a cardboard box with a small opening for observation. The apparatus was modified to pulse a .25 sec. shock with a 1.5 sec. inter-pulse interval. Shock intensity of 6 volts AC, used throughout conditioning, was selected on the basis of optimal goldfish performance found by Sobie and Herman (1972). The water in the apparatus (Ph=7.6) was aged for at least 24 hours and changed daily.

Procedure: Three sets of fish were trained for eight consecutive days. The fish in each set were randomly assigned to one of five groups. The first set consisted of 50 of the original purchase of 105 fish. Thirty seven of these fish survived. The second set consisted of the 25 fish that survived from the purchase. Twenty four of these fish completed the eight days of conditioning. The third set was from an additional purchase of 48 fish. Twenty nine of these fish completed the eight days of conditioning. Fish that died were replaced by naive fish so that 29 fish completed eight days of conditioning and there was an equal number of subjects in each group (N=18). The multi-level design for this study included a series of orthogonal contrasts involving the follwoing groups: Group 1 was a control group which received no inescapable shock prior to conditioning. Group 2 received 6V inescapable shock prior to conditioning and began conditioning trials immediately after the presentation of inescapable shock. Group 3 received 6V inescapable shock prior to conditioning and began conditioning trials one hour after the presentation of inescapable shock. Group 4 received 10V inescapable shock prior to conditioning and began conditioning trails immediately after the presentation of inescapable shock. Group 5 received 10V inescapable shock prior to conditioning and began conditioning trials one hour after the presentation of inescapable shock. Inescapable shock consisted of a series of 17 (.5 sec. duration) bursts. Each conditioning trial consisted of: (a) 15 sec. of light in the chamber without shock, (b) 20 sec. of light and pulsed shock, which pulsed .25 sec. shocks with a 1.5 sec. inter-pulse interval. Swimming to the other chamber after onset of light ended the trial and a new trial began after the timer was manually reset. All subjects were given 7 trials per day for 4 days. Latency of swimming to other side was recorded to the nearest second. If fish failed to escape the time of 35 sec. was recorded.

In the second phase of the study all subjects received inescapable 10V shock immediately prior to four additional days of conditioning using the same conditioning procedure as in the first 4 days. A fish which failed to escape shock for three consecutive trials was allowed short recovery period of approximately three minutes. A Hunter Timer failure required that the shock pulse be approximated using the timer of the Lafayette control panel during the last 2 days of the experiment for the third batch of subjects. The shock pulse varied as much as 1 full sec. from the .25 sec. used in the first 6 days.

RESULTS

The following measures were subjected to a series of 4 orthogonal contrasts related to the 4 hypothesis: 1) the number of avoidances per days, 2) number of escapes plus avoidances plus day, 3) a score which weighted an avoidance as double the value of an escape and 4) the total time spent in the presence of the light. The first analysis includes the 37 fish that received two days of escape/avoidance conditioning using a Testan Goldfish Shuttlebox. The second analysis excludes those fish.

There are four different contrasts. The "contrast 1" compares the control group with the rest of the groups. In the avoidances on day 1 of the first analysis, there was a significant difference (t=2.32, df=85, P<.023) comparing the nonshock groups (M=2.22) with the four shocked groups (M=1.28). In the escapes on day 1 of the first analysis, there was a significant difference (t=2.54, df=85, P<.013) comparing the nonshock group (M=5.61) with the four shocked groups (M=4.19). In the weighted score on day 1 of the first analysis, there was a significant difference (t=2.84, df=85, P<.006) comparing the nonshock group (M=7.83) with the four shocked groups (M=5.47). In the gross time to cross to the other chamber of the first analysis, there was a significant difference (t=-2.15, df=85, P<.035) comparing the nonshock group (M=1029.33) with the four shocked groups (M=1210.14). In the escapes on day 1 of the second analysis, there was a significant difference (t=2.02, df=49, P<.049) comparing the nonshock group

(M=5.73) with the four shocked groups (M=4.24).

The "contrast 2" compares the groups which received the low voltage prior inescapable shocks with the groups which received the high voltage prior inescapable shocks. None of the eight contrasts were significant.

The "contrast 3" compares the groups which began the conditioning immediately after the prior inescapable shocks with the groups which began the conditioning one hour after the prior inescapable shocks. In the escapes on day 1 of the fist analysis, there was a significant difference (t=-2.23, df=85, P<.029) comparing the no delay groups (M=3.64) with 1 hour delay groups (M=4.75). In the weighted score on day 1 of the first analysis, there was a significant difference (t=-2.39, df=85, P<.019) comparing the no delay groups (M=4.58) with 1 hour delay groups (M=6.36).

The "contrast 4" is the interaction between the delay of shock and the intensity of shock. In the avoidances on day 1 of the first analysis, there was a significant difference (t=2.75, df=85, P<.007) comparing the high intensity and no delay group (M=.33) with the rest of the groups (M=1.75). In the escapes on day 1 of the first analysis, there was a significant difference (t=2.56, df=85, P<.12) comparing the high intensity and no delay group (M=2.61) with the rest of the groups (M=4.94). In the weighted score on day 1 of the first analysis, there was a significant difference (t=3.06, df=85, P<.003) comparing the high intensity and no delay group (M=2.94) with the rest of the groups (M=6.69). In the avoidances on day 1 of the second analysis, there was a significant difference ($t=2.41$, $df=49$, $P<.020$) comparing the high intensity and no delay group ($M=.50$) with the rest of the groups ($M=1.73$). In the weighted score on day 1 of the second analysis, there was a significant difference ($t=2.04$, $df=49$, $P<.047$) comparing the high intensity and no delay group ($M=4.00$) with the rest of the groups ($M=6.52$).

In the difference between the fourth day avoidances and the fifth day avoidances of the second analysis, there was a significant difference ($t=2.30$, $df=49$, $P<.026$) comparing the nonshock group ($M=2.91$) with the four shocked groups ($M=0.97$). In the difference between the fourth day weighted score and the first day weighted score of the second analysis, there was a significant difference ($t=2.30$, $df=49$, P .026) comparing the nonshock group ($M=4.91$) with the four shocked groups ($M=1.65$).

DISCUSSION

Padilla (1973) demonstrated that inescapable shock interferes with avoidance performance of goldfish whether presented prior to escape/avoidance conditioning or interpolated between blocks of escape/avoidance conditioning. In this study the first analysis, which includes the fish that received two days of escape/avoidance conditioning using the Testan Goldfish Shuttlebox, confirmed that presentation of prior inescapable shock reduced the number of avoidances made during the escape/avoidance conditioning. However, the second analysis, which excludes those fish, did not confirm Padilla's (1973) finding. In the Testan Goldfish Shuttle box the high voltage groups received 20V inescapable shock which was reduced to 10V using the Lafayette apparatus while the low voltage groups which received 10V inescapable shock was reduced to 6V. Padilla (1970) used 28V and increased to 45V in his 1973 study. It is possible that a minimum of 20V is necessary to reduce escape/avoidance performance and therefore this study did not use a level of shock intensity which was high enough to produce a difference. Clearly additional research on shock intensity is needed.

Maier and Seligman (1976) clearly stated that the learned helplessness effect is a failure to escape from shock. They said that the avoidance reports may not be relevant to the learned helplessness effect. This study includes escape data and found both the first analysis and the second analysis showed significant differences in escapes and avoidances on day 1. This finding provides some support for Seligman's theory of learned helplessness. The difference in the delay of conditioning may not be very important since the weighted score and the number of escapes plus avoidances in the first analysis were the only significant differences.

The interaction between the amount of delay and the intensity of shock on day 1 showed a significant effect on: 1) the number of avoidances, 2) the number of escapes plus avoidances, and 3) the weighted score. These findings suggest that high voltage-immediate inescapable shocks reduces performance more than the other combinations of these variables.

Interpolated shock affected two of the behavioral measures on the second analysis which supports Paddilla's (1973) contention that interpolated shock as well as prior inescapable shock disrupt escape/avoidance performance.

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