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An Analysis of the Recovery of Responsiveness Subsequent to Habituation

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AN ANALYSIS OF THE
RECOVERY OF RESPONSIVENESS
SUBSEQUENT TO HABITUATION

by

Lowell G. Smith

A Thesis
Submitted to the
Faculty of The Graduate College
in partial fulfillment
of the
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Lowell G. Smith

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INTRODUCTION

Biologists and ethologists have traditionally studied behavior within the natural environment. Only recently have scientists begun focusing attention on behavioral processes in a laboratory setting. The primary focus in these latter experiments has been on molar behavior, but attempts have also been made to ascertain specific learning processes that differentially influence behavior changes.

Ivan Pavlov developed the learning paradigm now known as Classical Conditioning. This model portrays behavior as being elicited by unconditioned events situated in the organism's environment. Pavlov demonstrated that a specific behavior can be elicited, not only by a specific stimulus, but by a neutral stimulus as well, given time and an appropriate number of pairings with the unconditioned stimulus.

Since Pavlov, many scientists have demonstrated that stimulus-reinforcer relationships account for a wide range of behavior increments and decrements. These same behaviors were formerly considered direct results of the organisms themselves without significant resultant interactions with their environment. This paradigm helped scientists understand the reflexive behavior of

organisms and it stressed the importance of the organism's environment.

Since B. F. Skinner first described voluntary behavior in an operant learning model, scores of scientists have demonstrated that behavior, occasioned by stimulus conditions in the environment, is affected by subsequent consequences in that environment. Their data clearly show that behaviors can be established, maintained, and eliminated by differential consequential actions of subsequent stimuli.

Again, the environmental influences on an organism's ongoing behavior was demonstrated to be an essential determinant of subsequent behavior. Adding the response-reinforcer relationships of the operant paradigm to the stimulus-reinforcer relationships of the respondent paradigm, behavior and learning processes seemed to be adequately accounted for.

There is, however, a third behavior change phenomenon which is as universal a phenomenon as these other forms of behavior change processes. This process produces a response decrement by repeatedly presenting stimuli which are not followed by any reinforcement. This process, habituation, uses stimulus-response relationships that do not fit into either operant or respondent paradigms. Habituation must be handled by some other learning model.

Thorpe (1963) defined habituation as a permanent waning of a response as a result of repeated stimulation which is not followed by any form of reinforcement. This absence of apparent consequential action raises questions, by definition, about the functional and categorical classification of habituation.

Habituation of an unconditioned response has not been traditionally recognized as a learning process. File (1973) suggested that a long-term response decrement, or long-term behavior change, would indicate habituation is a learning process. In an effort to support this theory, File (1973), working with the orienting response of a rat, observed complete retention of habituation following a 72 hour recovery period, and a 70% retention after 288 hours. This long-term retention suggested that habituation was distinguished from fatigue or some other type of temporary process.

In conjunction with the long-term phenomenon observed by File (1973), greater amounts of habituation produced by shorter inter-trial intervals, as reported by Askew (1970) are also essential decremental trends to acknowledge when investigating habituation. Askew (1970) found shorter inter-trial intervals produced a lower mean number of responses per trial. These results were due to less response recovery between stimulus trials. Thus, shorter

inter-trial intervals appeared to have a significant effect on the mean number of responses during the habituation procedure.

In summary, there are two response decrement measurements; long-term, in which little recovery of the habituated unconditioned response occurs subsequent to the terminal habituation criterion, and short term, the latter being the response decrement carried over between stimulus presentation intervals.

Habituation has been found to be affected by two sets of experimental variables; temporal and stimulus. Temporal variables involved with habituation include inter-trial interval, recovery interval, and type of schedule used for stimulus presentation. Stimulus variables refers to the intensity of the stimulus. The form of the stimulus (i.e., mirror, live conspecific male, and model of a conspecific male) has been shown to be a determinant of stimulus intensity.

The inter-trial interval is the length of time between discrete presentations of the unconditioned stimulus. Askew (1969) studied the head shake response of a rat using an inter-trial interval of 1 second and found that it produced more absolute habituation than an inter-trial interval of 10 or 100 seconds; however, the number of trials needed for each inter-trial interval value to

reach its specific asymptotic level was approximately the same for each value.

Figler (1972) studied habituation of 5 components in the threat display of a male Betta splendens. He measured the number of components displayed per observation period and found the greater the strength of the initial eliciting stimulus the greater the absolute amount of habituation, which is expressed by subtracting the terminal response level from the initial response level. Figler (1972) demonstrated an unhabituated conspecific male was the strongest eliciting stimulus. The strength of the remaining stimuli in descending order were mirror, habituated conspecific male, and a two-dimensional cutout of a conspecific male.

The recovery interval, or length of the time in which the organism is not presented with the unconditioned stimulus, is timed from the end of one experimental session to the beginning of the next experimental session. Clayton and Hinde (1968) found gradual recovery of the habituated gill-cover component in Betta splendens' display behavior over the first 1 to 2 days subsequent to the removal of the unconditioned stimulus; no subject showed a full return to the initial response strength displayed prior to the habituation procedure.

In comparison, Figler (1972) demonstrated complete recovery of the gill-erection component between habitua-

tion sessions. The discrepancy between Clayton and Hinde's (1968) and Figler's (1972) recovery data was probably the result of Figler's (1972) experimental design. Figler (1972) ran only two forty-minute habituation sessions per subject. Clayton and Hinde (1968), on the other hand, exposed their subjects to the unconditioned stimulus for 10 days. Their experimental design would be expected to produce long term habitual effects because of the longer stimulation time.

The analysis of recovery following habituation remains a vital experimental question at this time. If long term behavior changes produced by habituation could be demonstrated, strong arguments for habituation as a learning process could be advanced (File, 1973).

An analysis of response recovery was attempted in the present study. Subsequent to subjects meeting habituation criterion utilizing two schedules of stimulus presentation, the amount of recovery after one day, two days, three days, and four days was systematically investigated. If retention of habituation was consistently observed across recovery tests it would support the theory that habituation involves long term behavior changes for a significant length of time. This long term behavior change could be considered direct evidence for habituation as a learning process that paradigmatically is neither operant nor respondent.

Peeke and Peeke (1970) studied two schedules of stimulus presentations and their effects on habituation. Subjects in one group were exposed to a live conspecific male for 15 minutes a day for 20 consecutive days, subjects in the second group were exposed to a conspecific male for 1 hour a day for 5 consecutive days. The total time of stimulus presentation was 5 hours for each group. The results indicated subjects exposed to a live conspecific male for 15 minutes a day for 20 consecutive days habituated more rapidly.

Peeke et. al. (1971) also studied two schedules of stimulus presentation and the effects of each on habituation. Subjects in the first group were exposed to a rival continuously for 24 to 28 consecutive hours. Subjects in the second group were exposed for 20 minutes a day for 38 to 44 days. They found waning of the responses to be more rapid for the subjects who had a continuous stimulus presentation.

Since there are conflicting data from previous investigations of the recovery of responsiveness following habituation, further research needs to be done addressing itself specifically to this issue. Conflicting data regarding recovery preclude any definite statements about response recovery following habituation; however, the relationship that seems to be emerging is that the recovery of the unconditioned response is abrupt and more complete

when the original habituation is accomplished by a single session, short term, constant stimulation (Figler, 1970), or by massed, short, inter-trial interval presentations of repeated stimulations (Russell, 1967a). It has been suggested that a more complete habituation brought about by multi-exposure, longer session methods, is more resistant to recovery (Clayton and Hinde, 1968; Peeke and Peeke, 1970; Peeke et. al., 1971).

The purpose of this experiment was to determine which schedule of stimulus presentation leads to the most rapid habituation; 1) 15 minute constant stimulation; 2) 15 minutes total stimulation with an inter-trial interval of 5 seconds and a stimulus duration of 30 seconds. Subsequent to habituation, the recovery of responsiveness was studied to determine how much, if any, recovery occurred. If the 5 second inter-trial interval group took more sessions to habituate it would lend support to the theory that recovery from habituation took place between trials. Also, if there was no recovery of responsiveness following habituation, the theory that habituation is a unique stimulus-response learning process would be supported.

METHOD

Subjects

Twelve adult male Betta splendens, purchased from a local tropical fish proprietor, were used in the present study. Six fish were used with each stimulus schedule. There was variability among subjects with regard to color and size, but all subjects were mature males. All fish were maintained in a home tank at least 24 hours prior to experimentation. The fish were individually housed in 4 separate compartments in a 10-gallon tank. The compartments were divided so no visual contact between subjects could occur.

All waste products and uneaten food were removed from the home tank and experimental tank every two weeks or each time new experimental fish were purchased, whichever occurred first. The fish were fed freeze-dried brine shrimp every day subsequent to the second experimental session for that day.

The fish were supplied with 24 hours of illumination produced by one 100 watt light bulb placed adjacent to the home tank.

Apparatus

This experimentation took place in a 2.5 gallon tank with a 13.5 cm. x 10 cm. x 10 cm. compartment sectioned

off on two sides by translucent plastic dividers and the two ends were sectioned off by glass. The glass ends allowed for visual observation by an experimenter and also provided a place where the unconditioned stimulus could be presented.

The unconditioned stimulus was presented by using a two-way mirror 23 cm. x 50.5 cm. in size. The mirror was held permanently in place by a wooden box 38 cm. x 23.5 cm. x 23.5 cm. which contained two 25 watt light bulbs. When the lights were illuminated in the box, the mirror was transparent; when the lights were turned off, the mirror was capable of reflecting an image.

The experimental tank and mirror box were placed inside of a four-sided cardboard amphitheater; an open area of 10 cm. x 12.5 cm. on the front side allowed for direct observation by the experimenter and an independent observer. The inside of the amphitheater was continuously illuminated by one 25 watt light bulb.

The water for the home tank and the experimental tank was tap water maintained at an appropriate PH level--slightly basic. Throughout the experiment, the temperature of the water for both the home tank and the experimental was maintained at 74° F to 80° F.

Recording of the responses was done manually on a specially designed data sheet, with stimulus presentations and components of the display behavior specifically

separated. Inter-rater reliability was obtained during the habituation procedure and during tests for recovery.

Electromechanical equipment was used to time the stimulus duration and the inter-trial interval.

Procedure

Twelve experimental subjects were assigned to one of two independent groups. There were six subjects assigned to each group. The groups were:

A) Each subject in group A was continuously exposed to his own reflection for 15 minutes each session until zero responses were observed for two successive sessions. Two sessions were run each day with an inter-session interval of an average of 12 hours. Responses were recorded every other half minute. There were 15 observation trials per session.

B) Each subject in group B was exposed to his own reflection for a total of 15 minutes per session; the discrete stimulus presentations had an inter-trial interval of VT 5 seconds. The subjects were run under this schedule until zero responses for two successive sessions were observed. Two sessions were run each day with an inter-session interval of an average of 12 hours. Responses were recorded each stimulus presentation. There were 30 stimulus presentations per session each lasting 30 seconds.

The criterion for habituation was two successive sessions with zero aggressive components displayed. All fish in all groups met this criterion before recovery tests were initiated. The total time of stimulus presentation per session was held constant within and between groups of subjects so total length of stimulus presentation could be easily calculated.

Subsequent to the final stimulation session where the fish met the habituated response criterion, 24 hours was allowed to pass before a test for recovery of the habituated responses was made. This test consisted of placing the subject back in the experimental tank and recording his responses for 5 stimulus presentations each lasting 30 seconds and with an inter-trial interval of FT 5 seconds. The fish were allowed to readapt to the test chamber 5 minutes prior to each test. Twenty-four hours was used as a constant time interval between subsequent tests for recovery. Recovery of responsiveness was tested after 24 hours, 48 hours, 72 hours, and 96 hours.

The specific components of the display behavior studied were gill-cover erection and fin erection.

During the initial habituation procedure, component responses per session and per block of 5 trials were calculated in percent of components displayed per total number of opportunities to display. An overall responding

level was also measured in the same manner. During the test procedure, component responses per block of 5 trials were measured in percent of components displayed per total number of opportunities to display; again, an overall level was calculated in the same manner.

A t-test was conducted to determine if the average number of sessions needed for each group to reach habituation criterion was statistically significant. A t-test was also conducted to determine if the average amount of recovery demonstrated by subjects in each group was statistically significant.

RESULTS

Five out of the six subjects in group A met habituation criterion. Subject A6 was the only fish not to reach criterion; 22 sessions later he still was responding at the 37% level. Habituation sessions were terminated because of his persistent responding. For this reason he will be excluded from the habituation data.

Subject A3 responded the longest time before reaching criterion--12 sessions. The shortest time needed to reach criterion was 5 sessions by A5. The average number of sessions to reach criterion was 8.6 sessions or 129 minutes of stimulus presentation.

Subjects initially responded 75% of the time or better. All subjects showed a rapid decrease in responding by the fourth habituation session. Subjects A1, A2, A3, and A4 showed a slight response increment just prior to reaching criterion.

There was high variability among subjects as to the time needed for habituation criterion to be met per specific component. For subject A5 both gill-cover erection and fin erection dropped simultaneously across sessions. In the case of subjects A1, A3, and A4, gill-cover erection decreased more rapidly or habituated before the fin erection component. Only the gill-cover erection of subject A2 occurred at a higher level than the fin erection

and by session 9 it was lower than the fin erection level and subsequently both habituated. Even subject A6, who did not reach habituation criterion, displayed gill-cover erection consistently at a lower level than the fin erection. See pages 17 and 19.

The recovery data indicate that no subject recovered his responsiveness at or near his initial responding level during recovery tests at 24, 48, 72, and 96 hours. However, there was some variability between subjects as to the overall amount of recovery. In all cases the overall level of responding was 30% of the time or less. Two subjects, A2 and A4, did not respond during any of the recovery tests. Fin erection was the only component that demonstrated any signs of recovery, but again, responding during recovery never approached the initial response level. Gill-cover erection did not show any signs of recovery subsequent to habituation. See pages 17 and 19.

Figure 1

Habituation and recovery data for subjects A1, A2, and A3. The graph indicates the percentage of components displayed per total number of opportunities to display for each session. An overall measure of responding is graphed, as are gill-cover erection and fin erection components.

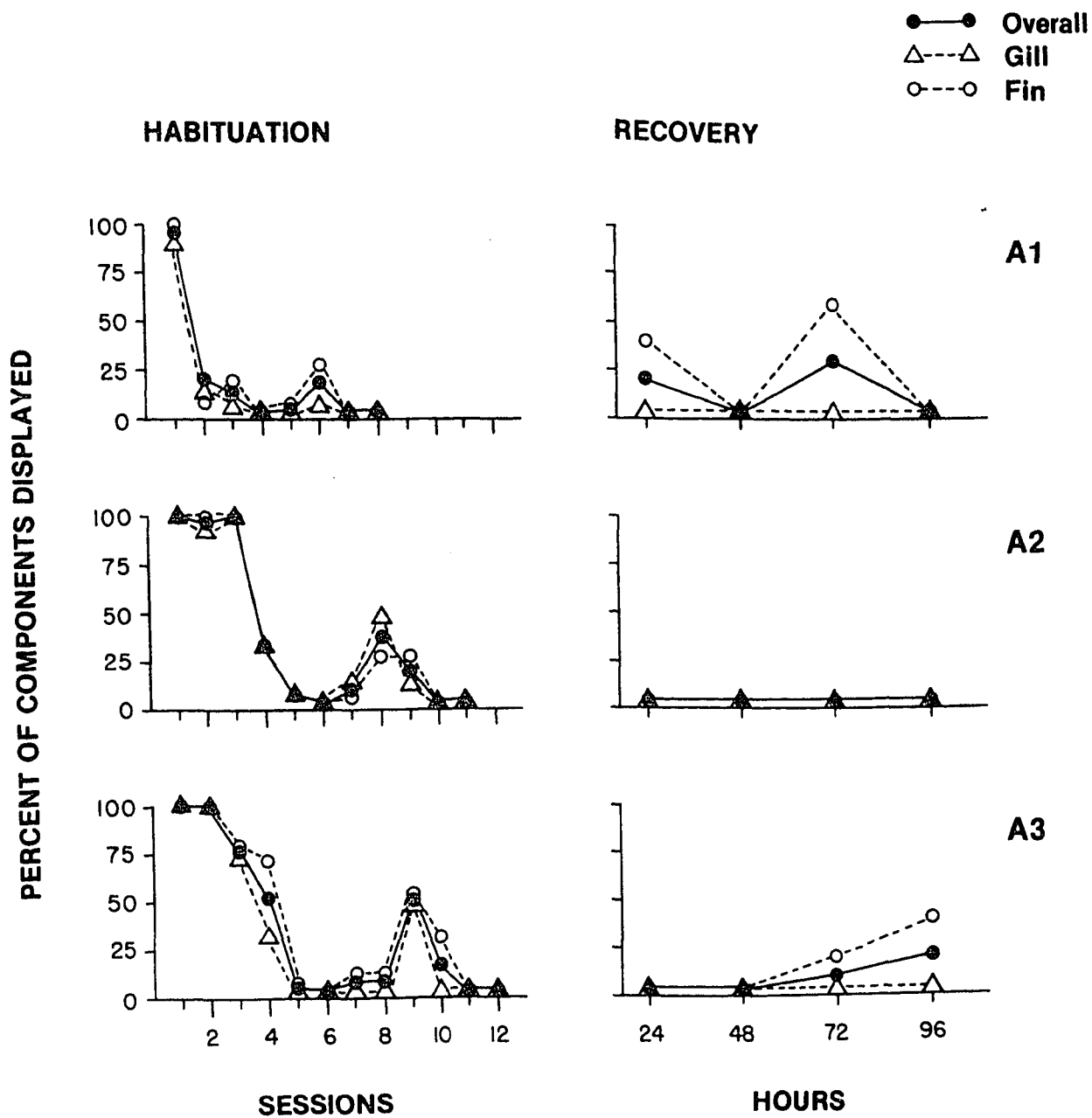
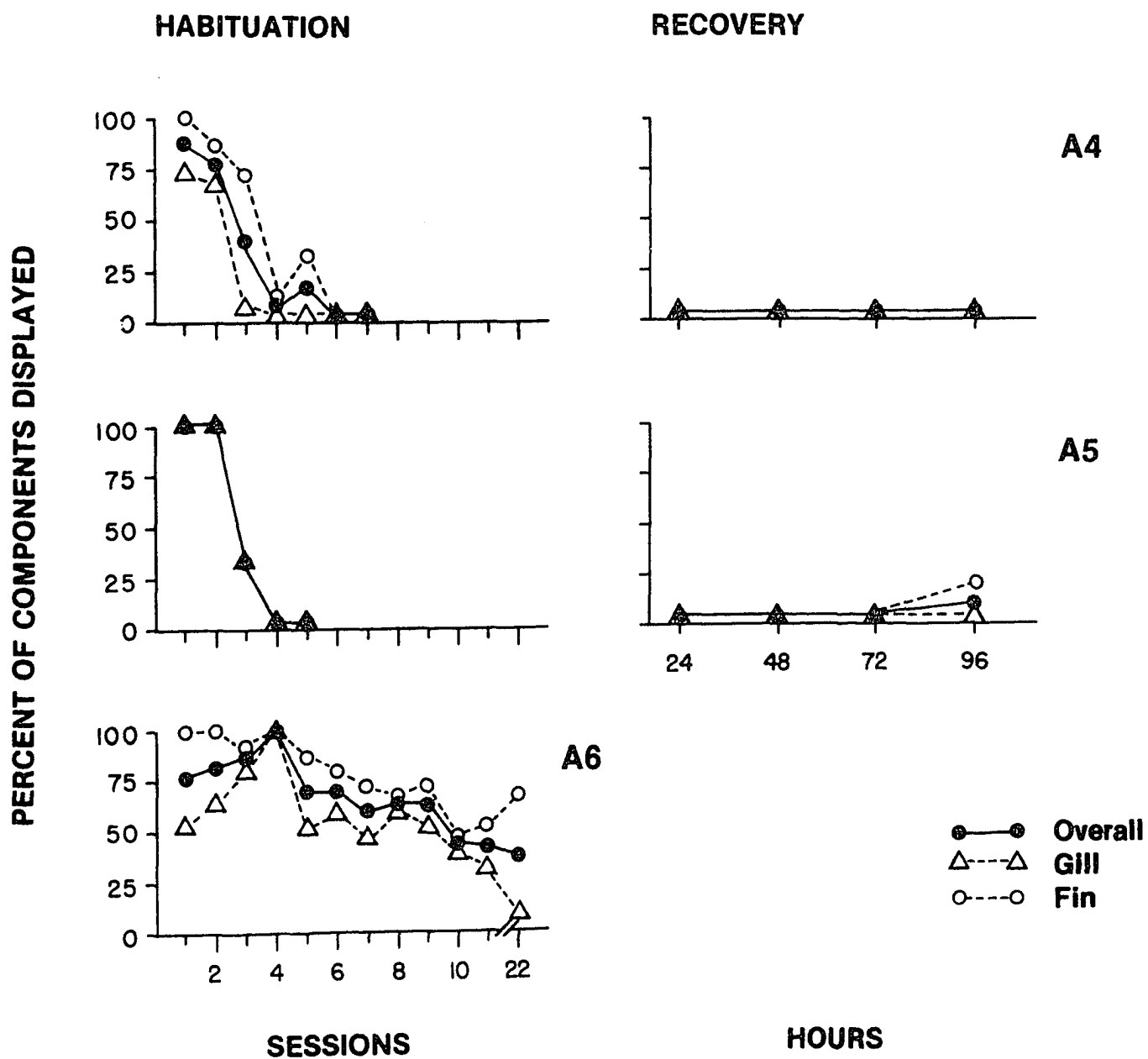


Figure 2

Habituation and recovery data for subjects A4, A5, and A6. The graph indicates the percentage of components displayed per total number of opportunities to display for each session. An overall measure of responding is graphed, as are gill-cover erection and fin erection components.



Looking now at the results from group B we see that subject B7 was added because subject B4 died prior to his final recovery tests. Data from B4 were not analyzed because it cannot be ascertained if the state of the organism and eventual death had any effects on the experimental results.

Four out of the six remaining subjects met habituation criterion. Two subjects, B2 and B3, did not meet criterion. Subject B2 responded at the 100% level after 22 habituation sessions, and subject B3 responded at the 100% level after 26 habituation sessions. Habituation sessions were terminated for these subjects because of their persistent responding and these data were not analyzed.

Subject B5 responded the longest time before reaching criterion--13 sessions. The shortest time needed to reach criterion was 4 sessions by B6. The average number of sessions to reach criterion was 8.75 sessions or 131.25 minutes of stimulation.

Subjects initially responded 95% of the time or better. Subjects B1 and B5, who took the longest time to habituate, also showed high response variability before reaching criterion. Subject A7 had a response increment immediately prior to reaching criterion.

The component analysis consistently demonstrated that gill-cover erection was displayed less often than

fin erection. This was evident in all fish including those that did not reach criterion (B2, B3) and the one who died before completing the recovery phase of the experiment (B4). See pages 23 and 25.

The recovery data from group B indicate that no subject recovered any responsiveness subsequent to meeting habituation criterion. See pages 23 and 25.

Inter-rater reliability for the habituation phase of the experiment for groups A and B was 93%, and for the recovery phase it was 97%. The overall inter-rater reliability was 93%.

Figure 3

Habituation and recovery data for subjects B1, B2, B3, and B4. The graph indicates the percentage of components displayed per total number of opportunities to display for each session. An overall measure of responding is graphed, as are gill-cover erection and fin erection.

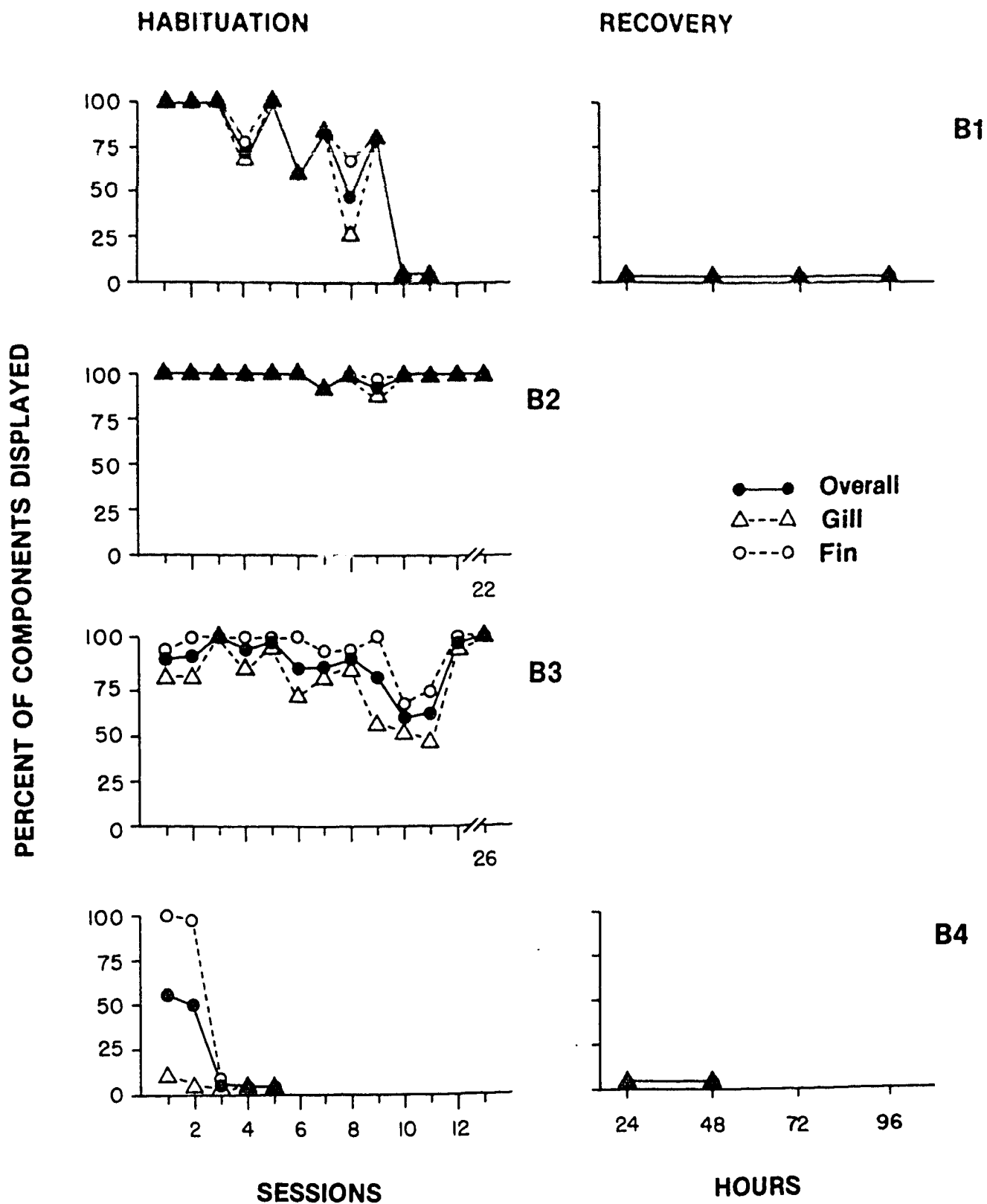
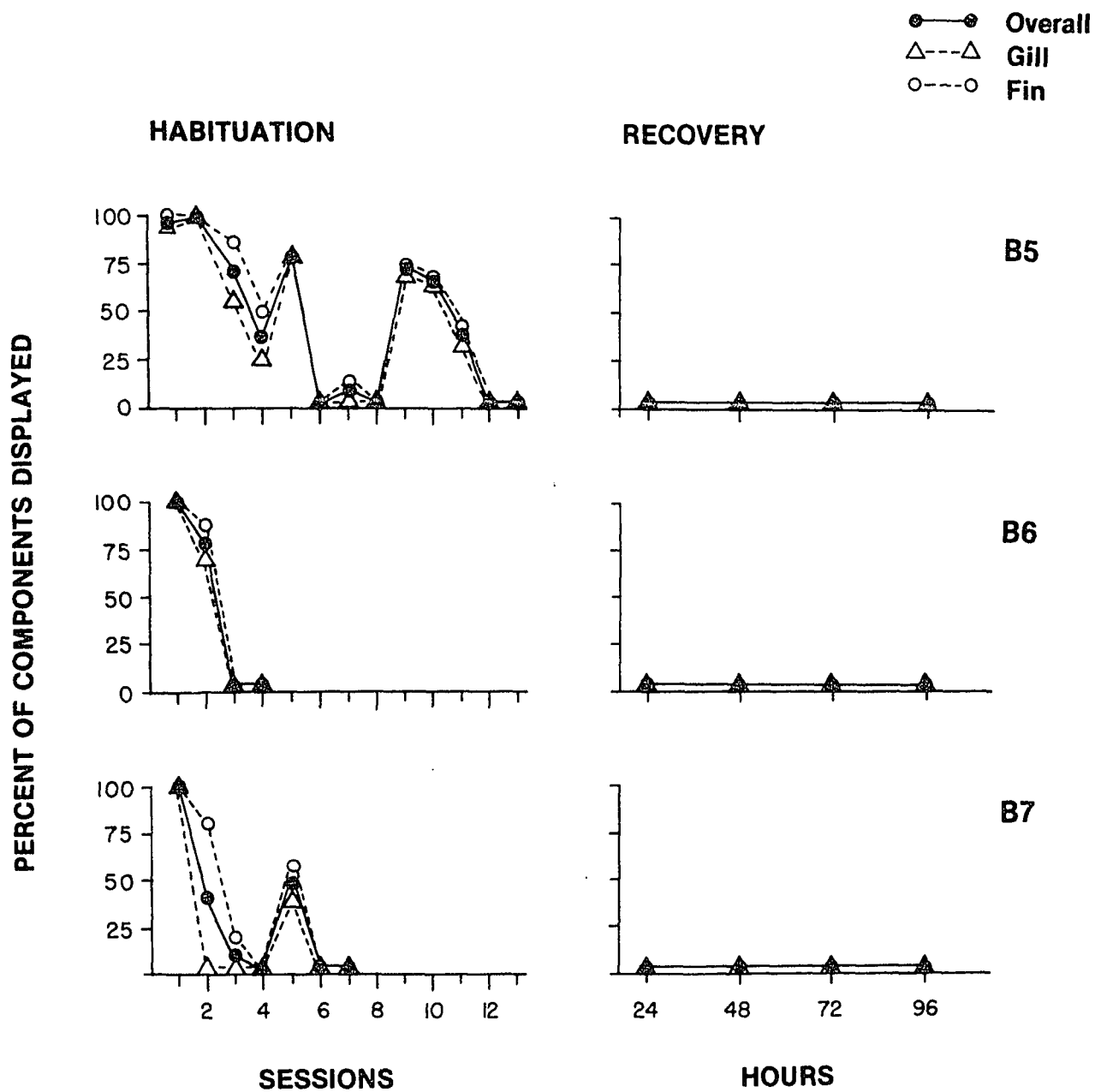


Figure 4

Habituation and recovery data for subjects B5, B6, and B7. The graph indicates the percentage of components displayed per total number of opportunities to display for each session. An overall measure of responding is graphed as are gill-cover erection and fin erection components.



DISCUSSION

The stimulus schedules used in the present study were completely response-independent of subjects' behavior. These response-independent schedules did not allow the display behavior to be influenced by subsequent response consequences. Also, display behaviors were initially elicited by the unconditioned stimulus in groups A and B at the 93% level and 91% level respectively. These results indicate that the display behavior is a species specific behavior and confirms Figler's (1972) findings that a mirror is an effective elicitor of the display behavior in Betta splendens. These conditions, by removing response-reinforcer relationships and stimulus-reinforcer relationships, remove behavior decrements produced by habituation from either operant or respondent learning paradigms. The term habituation, as used in the present study, consequentially fits Thorpe's (1963) definition of habituation where the waning of a response is a result of repeated stimulation which is not followed by any reinforcement.

The difference between the mean number of sessions for group A and the mean number of sessions for group B to reach habituation criterion was not statistically significant at the .10 level. A t-test was conducted on the mean number of sessions for each group to reach criterion.

The mean number of sessions for group A and group B were 8.6 and 8.75 sessions respectively. The value of t , with 7 degrees of freedom, was .065, well below the 1.895 value needed for significance.

The large difference in total number of sessions needed by different subjects to reach response criterion, as observed in this study, is in accordance with Denny and Ratner's (1970) position where a characteristic of habituation is large individual differences in rate and amounts of habituation.

Askew's (1970) results supported much of the literature on inter-trial intervals. He found shorter inter-trial intervals were associated with a greater amount of habituation with no accompanying differences in the rate of habituation. The results of the present study are in line with these findings also. Short inter-trial intervals do not affect the number of sessions needed to reach habituation criterion. Group A, which had no inter-trial interval, and group B, which had an inter-trial interval of VT-5 seconds, did not significantly differ in the mean number of sessions needed to reach habituation criterion. The response criterion of zero responses in this study made it impossible to determine the effects of shorter inter-trial intervals on the asymptotic level of responding.

Peeke and Peeke (1970) demonstrated mature male Betta splendens habituated rapidly when exposed to a conspecific male for 15 minutes a day for 20 consecutive days. They also found the gill-cover erection component habituated sooner than the fin erection component. The results of the present study using two stimulus presentation schedules (15 minute continuous presentation per session and 30 second stimulus duration with an inter-trial interval of VT-5 seconds for a total presentation time of 15 minutes per session) failed to find a significant difference between the number of sessions needed to reach habituation criterion. The previously mentioned t-test lends statistical significance to this finding. With regard to a component analysis, the present study supports Peeke and Peeke's (1970) results. Gill-cover erection consistently habituated first or was displayed at a lower level for both groups.

The decremental trends observed in the present study cannot be attributed to fatigue or sensory adaptation. Habituation sessions were separated by a mean of 12 hours so recovery from fatigue and sensory adaptation had sufficient time to occur since these are relatively transient phenomena. The absence of responding across sessions essentially eliminates the possibility of fatigue and sensory adaptation accounting for the behavior change observed.

The recovery data from this experiment failed to indicate any subject, in either group, recovered responsiveness near

or at it's initial responding rate. However, the difference in amount of recovery obtained between groups was an important result.

The difference between the mean amount of recovery for subjects in group A and group B was statistically significant at the .10 level. A t -test using the mean amount of recovery for each subject was conducted and a t value of 2.14 was obtained. For significance at the .10 level, with seven degrees of freedom, a value of 1.895 or greater was needed. This criterion was met.

The results of this study are in line with current data suggesting that habituation brought about by multi-exposure, longer session methods is more resistant to recovery.

A component analysis of the recovery data indicated the only component to recover was the fin erection component. According to Denny and Ratner (1970), components closest to the final consummatory component become refractory or habituate temporarily and then recover. If the fin erection component is considered in this context it would appear it lies closer than the gill-cover erection component to the final consummatory component of the aggressive display in Betta splendens. However, a systematic study charting the behavioral continuum of the aggressive display for Betta remains a research question at this time.

Traditionally, a long-term behavior change has been attributed to learning. Operant and respondent paradigms were established to aid analysis of specific learning processes. Each paradigm has, as the criterion for learning, a long-term behavior change. Extending long-term behavior change criterion to habituation, scientists could theoretically make strong arguments for classifying habituation as a unique learning process if long-term effects were observed, and such effects have been reported by several investigators.

File (1973) studied habituation of the orienting response in the rat. Interruption of licking when a tone stimulus was presented was taken as a measure of the orienting response. Subsequent to habituation of the orienting response, tests for recovery of the response were conducted. Her results indicated complete retention of habituation after 72 hours and 70% retention after 288 hours. Clayton and Hinde (1968), using display behavior of a Betta splendens, showed recovery of responsiveness after habituation to be gradual the first 1-2 days and further recovery was very slow or non-existent.

The results of the present study also demonstrated long-term behavior changes that persisted for four days after habituation criterion was met. All subjects in group B retained complete habituation during recovery tests, three subjects in group A showed some recovery of

responsiveness; however, the level of responding was substantially less than the initial responding level.

The results of File's (1973), Clayton and Hinde's (1968), and the present study all give evidence that habituation produces long-term behavior changes, thus meeting preliminary criterion for learning.

REFERENCES

- Askew, H. R., "Effects of Stimulus Intensity and Inter-trial Interval on Habituation of the Head-shake Response in the Rat." Journal of Comparative and Physiological Psychology, 3 (1970), 492-497.
- Clayton, F. L. and Hinde, R. A., "Habituation and Recovery of Aggressive Display in Betta Splendens." Behavior, 30 (1968), 96-106.
- Denny, M. R. and Ratner, S. C., Comparative Psychology (rev. ed.). Homewood, Ill.: Dorsey, 1970. Pp. 518-538.
- Figler, S. E., "The Relation Between Eliciting Stimulus Strength and Habituation of the Threat Display in Male Siamese Fighting Fish (Betta splendens)." Behavior, 42 (1972), 63-96.
- File, S. E., "Long-term Retention of Behavioral Habituation in the Rat." Animal Behavior, 21 (1973), 585-589.
- Peeke, H. V. S. and Herz, M. J., Habituation: Behavioral Studies. New York and London: Academic Press, 1973. Pp. 59-83.
- Peeke, H. V. S., Herz, M. J. and Gallager, J. E., "Changes in Aggressive Behavior in Adjacently Territorial Convict Cichlids: The Role of Habituation." Behavior, 40 (1971), 43-54.
- Peeke, H. V. S. and Peeke, S. C., "Habituation of Conspecific Aggressive Responses in the Siamese Fighting Fish (Betta splendens)." Behavior, 36 (1970), 232-245.
- Russell, E. M., "Changes in Behavior of Lebistes Reticulates Upon a Repeated Shadow Stimulus." Animal Behavior, 15 (1967a), 575-585.
- Thorpe, W. H., Learning and Instincts in Animals. Cambridge, Massachusetts: Harvard University Press, 1963. P. 61.