METHODS AND TECHNIQUES

Use of Terrestrial Hermit Crabs in the Study of Habituation

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For small colleges, the use of invertebrates in undergraduate learning laboratory experiments may be a valuable alternative to the use of vertebrate species. This article describes a habituation experiment using terrestrial hermit crabs. All of the materials required are inexpensive and readily available. What makes this experiment unique is that although the instructor sets basic parameters, students have a crucial role in the experiment's design and the analysis of collected data. Assessment of learning outcomes and student evaluations indicate that conducting this experiment aided in students' learning of behavioral techniques, habituation phenomena and theory, and the role of habituation in the lives of organisms.

Hands-on experiments are valuable learning experiences for undergraduates in psychology (Elmes, 2002). In learning courses, rats or other vertebrates are the traditional subjects in experimentation. However, for small colleges with limited resources, work with vertebrate subjects is prohibitively expensive. Furthermore, students and faculty often experience discomfort with the use of these animals for demonstration purposes or for what are relatively simple experiments. The conditioning of human participants can also elicit discomfort. Computerized simulations are useful, but students perceive them as having their outcomes predetermined, and students rate simulations as less useful than real preparations in helping them to understand conditioning (Abramson, Onstott, Edwards, & Bowe, 1996). Thus, the use of invertebrate animals in real learning experiments can be a viable alternative (Abramson, 1990).

Studies of habituation and conditioning have been successfully conducted with crustaceans (Abramson, 1994). For this course-based laboratory study of habituation, terrestrial hermit crabs were research subjects. These animals do not need to be maintained in an aquatic environment, are available from a number of commercial sources, and are easily handled by most students. Hermit crabs inhabit abandoned snail shells into which they rapidly withdraw in the presence of a variety of visual, tactile, and vibratory stimuli. This behavior is easy to observe and subject to habituation (Abramson, 1994). In addition, the crabs are large and more physically robust than planaria (Owren & Scheuneman, 1993), which I have found not to survive repeated stimulation by students.

This project does more than simply give students an opportunity to observe habituation. It provides an opportunity for students to design and conduct a behavioral learning experiment and to analyze and report its results early in the term prior to the conducting of more complicated experiments. I have described the classroom laboratory protocol in detail for the purposes of replication, followed by the method employed to determine the effectiveness of the laboratory exercise.

The Habituation Experiment

Subjects

Terrestrial hermit crabs (*Coenobita clypeatus*) acquired from Carolina Biological Supply (Wilmington, NC) or Connecticut Valley Biological (Southampton, MA) were the subjects for habituation. The instructor should purchase enough animals so that one pair of students trains one animal and that there are extras in the event of death. The animals are housed in groups of six in 10-gallon aquaria filled to 2.5 cm with fine gravel and given ad libitum access to food and water.

Materials

The training of each crab occurs in a glass culture bowl (6 cm deep and 19 cm in diameter); the crabs are restrained with nontoxic modeling clay formed into a cylinder approximately 5 cm in height and 2 cm in diameter and pressed into the center of the bowl (Figure 1). The tactile stimulus was a small paintbrush (brush is 0.5 cm wide and 1 cm long with a 15-cm handle). A stopwatch is used for a variety of measures. Initial purchase of materials averages $7.00 per student and drops to less than $5.00 per student in subsequent terms.

Procedure

Students design as much of the experiment as possible. However, I provide guidelines. To adapt the crabs to being handled, students placed them (unrestrained) in the bowl during regular class periods held in the laboratory prior to the experiment. After a few sessions, the animals may remain active in the bowl for up to 1 hr. Students can observe the un-

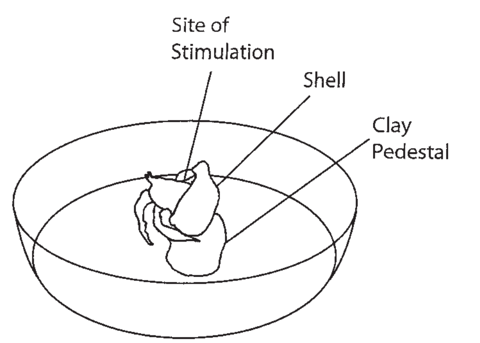

Figure 1. Depiction of hermit crab positioned in training apparatus.

conditioned behavior of the crabs and study the extent of their defensive behaviors. Students propose and discuss methods to measure the withdrawal behavior.

Students measure at least three dependent variables across learning trials: response magnitude, the number of stimulus presentations required to elicit the response, and the latency of the subsequent extension from the shell. To more easily observe the crab's behavior, encourage its extension from the shell, and apply the tactile stimulus consistently, the animals are restrained by pressing their shell into the clay pedestal so that the shell opening faces up (Figure 1). In this position, the crab can move freely within the shell and will fully extend its body, allowing for easy access to its dorsal abdomen from the rear. This area is not covered by the animal's tough exoskeleton and, thus, is very sensitive to tactile stimulation. Students then gently touch the crab with the paintbrush tip to elicit a withdrawal response. They touch the animal again within a second or two, if it does not withdraw. Too strong a stimulus or too frequent a presentation (e.g., more than 1 per sec) can produce sensitization. Discussion of how to avoid sensitization and recognize when it is happening (and to adjust presentations along the way) is an excellent opportunity for students to problem solve.

Each withdrawal marks the end of a trial. While one student applies the stimulus, the other student records the number of stimulus applications required to elicit withdrawal, the magnitude of that response, and how much time passes before the animal begins to extend its body from the shell. Interobserver reliability can be determined from the response magnitude reports from each student in the pair. As trials progress, changes in observed behaviors occur as evidence of habituation: The number of stimulus applications to produce a response increases, and the magnitude of withdrawal and the latency to extend decrease. A criterion for the appearance of habituation is established before training begins (e.g., 35 or more consecutive stimulus presentations required to elicit withdrawal). In past experiments, anywhere from 0% to 50% of crabs have not reached this criterion but demonstrated habituation by one of the other measures.

Students should devise a method to rule out motor fatigue as an explanation for the reduction in behavior (Domjan, 2000). The most common way is to dishabituate the animal by presenting a novel stimulus in another sensory modality (e.g., these crabs are very sensitive to visual movement); a normal withdrawal to this stimulus indicates a response inhibition specific to the tactile stimulus. Although students discuss the possibility that sensory adaptation might be occurring, a method for controlling it has not been developed for the course. It is possible for the animals to show signs of habituation in one training session (if the animal has adjusted well to handling). However, I have found that two or three training sessions of 1.5 hr each (including setup and cleanup time) may be necessary. These sessions should occur as close together in time as possible; for example, one morning session, one afternoon session on the same day, and a third session the next day. My course does not have a set weekly laboratory time (which may be too infrequent for most learning studies); students set time aside during specific weeks to work on experiments.

Prior to the experiment, students generate hypotheses concerning the crabs' behavior in response to the stimulus and develop a data analysis plan. Usually, the students average the measures for each trial across subjects and then calculate a correlation matrix for the variables including trial number. The students plot these mean values across trials. An example of data from a class where all of the crabs met the criteria for habituation appears in Figure 2. Finally, each student wrote an American Psychological Association-style research paper describing their study method and interpreting their results. In the instance that some of the crabs do not reach the criterion for habituation, students can compare their behavior to that of those crabs that did demonstrate habituation.

Assessment of Student Learning

Participants

Participants were 9 female psychology majors between the ages of 19 and 22 who were in enrolled in a course on the psychology of learning at Wagner College, a primarily undergraduate liberal arts college in New York City. All of the students enrolled in the course agreed to participate. Each student provided informed consent and was not compensated.

Dependent Measures

At four time points, the instructor administered questionnaires, which each contained two parts. The first part was a quiz composed of five multiple-choice questions about habituation. The quiz questions were the same at each test time. The second part was composed of a set of statements, some true and some false, about habituation where participants rated their level of agreement on a 5-point Likert scale, with higher scores representing greater agreement. The number of agree–disagree statements varied across testing periods with 5 statements at Time 1, 8 statements (5 original and 3 additional) at Times 2 and 3, and 15 (8 original plus 7 additional) at Time 4, including direct questioning on the value of the experience. The instructor did not inform the participants of their performance on the questionnaires.

Procedure

After participants gave consent, the instructor administered questionnaires at the beginning of regularly scheduled

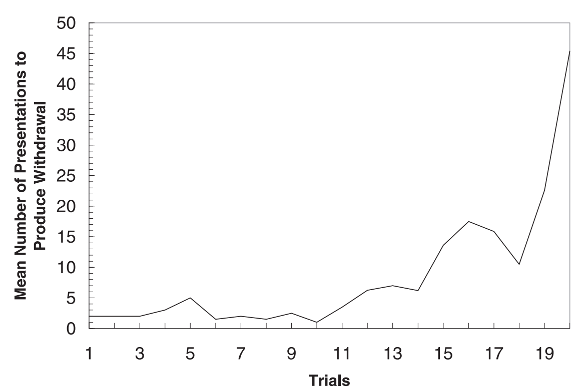

Figure 2. Example of data collected from the habituation experiment. The mean number of stimulus presentations to produce a withdrawal by the crabs (N = 8) is plotted across learning trials (each trial ends when the crab withdraws).

class time prior to that day's activities on 4 different days: after reading the assigned book chapter on habituation, after prelaboratory lecture and discussion on habituation, after conducting the habituation experiment, and after the submission of the research paper describing their results. A faculty member who was blind to the procedures being used collected and collated the questionnaires and removed all identifying information from the forms. Data analysis occurred at the end of the semester.

The questionnaires provided two scores for each student: one was the quiz grade (range = 0 to 5), and the second was the mean rating given to the five statements common to all four test periods administered. False statements were reverse-coded so higher scores indicate higher agreement with the statement in all instances. A repeated measures ANOVA and contrast tests were performed to determine how these scores changed over the four test periods. All statistical analyses used an alpha level of .05.

Results

One of the students did not complete all of the questionnaires (but did complete all stages of the habituation experiment), so only her evaluation responses are included here. The mean quiz scores for the four administrations were 2.25 (SD = 0.97), 2.50 (SD = 1.32), 3.50 (SD = 0.71), and 3.50 (SD = 0.71) and increased significantly over time, $F(3, 21) = 3.61$, $p = .03$. Difference contrasts revealed that the mean scores for quizzes at Time 3 and 4 were higher than for Time 1. No student answered all questions correctly. The mean ratings of the degree to which the participants agreed with the statements about habituation at the four administration points were 3.83 (SD = 0.42), 4.33 (SD = 0.57), 4.34 (SD = 0.50), and 4.43 (SD = 0.43). The repeated measures ANOVA revealed a significant change in this measure, $F(3, 21) = 7.71$, $p = .001$. Difference contrasts indicate that means at Times 2, 3, and 4 were all significantly higher than Time 1.

Table 1 contains the student evaluations of learning outcomes. The students' evaluation of their learning were generally very favorable. Students most strongly agreed with statements suggesting the experiment improved their understanding of how conditioning studies are conducted and of habituation. Students expressed less agreement about the value of the paper. Only one student indicated that she was not looking forward to conducting another study in the class.

Table 1. Mean Ratings for Each Student Evaluation Statement

Question	*M* Rating	*SD*
Experiment helped me understand how conditioning studies are conducted.	4.44	0.68
Experiment assisted me in my understanding of habituation.	4.89	0.31
I understand how habituation occurs in the real world.	4.78	0.63
Research paper helped me better understand the experiment.	4.22	0.92
Research paper helped improve my analytic skills.	3.67	0.82
Research paper improved my understanding of habituation.	4.11	1.20
I am looking forward to conducting another experiment in this class.	3.89	1.37

Note. $N = 9$. Based on a 5-point Likert scale ranging from 1 (*do not agree*) to 5 (*agree completely*). Higher scores represent greater agreement.

Discussion

The results of the assessment suggest that quiz grades in particular may be aided by the laboratory experience. Because a nonexperimental control was not possible here, a practice effect cannot be ruled out. However, the improvement in the score was not gradual; it was restricted to the postexperiment testing period. The experience of writing the paper did not appear to increase the quiz score further. The students' statement ratings became more accurate after the prelaboratory lecture and discussion meeting. They did not increase significantly after the habituation experiment, but remained high for the final two test periods.

By conducting this habituation experiment, students have an opportunity to design a behavioral study and to see habituation happen. Operationalizing and measuring behavioral variables, recording and analyzing the results, and discussing what it means that this animal's core defensive, reflexive behavior is modifiable brings the students to a level of understanding of behavior and experimental method that probably would not occur without the experience.

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Notes

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