

1-2013

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Recommended Citation

Elcoro, Mirari and Trundle, Melissa (2013) "Student Preferences for Live Versus Virtual Rats in a Learning Course," *International Journal for the Scholarship of Teaching and Learning*: Vol. 7: No. 1, Article 16.

Available at: <https://doi.org/10.20429/ijstl.2013.070116>

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Keywords

Learning, Operant conditioning, Rat, Sniffy, Student preferences; Undergraduate education

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Student Preferences for Live Versus Virtual Rats in a Learning Course

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Abstract

We examined the preference of undergraduate students for a live or a virtual rat when learning about concepts of operant conditioning. Students were provided with the opportunity to directly compare a virtual and a live rat in a supplemental exercise for Learning courses. We argue that the design of teaching exercises should involve a systematic examination of student preferences between different available techniques. In general, students preferred a live rat over a virtual rat when learning concepts in operant conditioning, specifically a fixed-ratio schedule of reinforcement. Students also listed advantages and disadvantages of using a virtual rat versus a live rat. These aspects evaluated by students are compared and contrasted with those provided by experts who have reviewed these learning exercises.

Keywords: learning; operant conditioning; rat; Sniffy; student preferences; undergraduate education

Introduction

Scientific thinking is a highly complex human behavior and, as such, it presents challenges when teaching it (Skinner, 1956). Hands-on experiences via courses with laboratory components to apply research methods offer an opportunity to explicitly train students in scientific thinking. This point is in line with Goal 2 of the American Psychological Association's (APA) guidelines for psychology majors, which states that students should value, understand, and be able to apply the basic research methods of psychology (Halonen et al., 2007). More specifically, students should be provided with more opportunities to learn through contingency-shaped behavior, which relies on direct contact with the subject matter, than with rule-governed behavior, which is mainly the verbal description of the behavior in question (Graf, 1995; Heward & Malott, 1995).

Several undergraduate psychology courses expand on principles of operant conditioning. Sometimes these Learning courses are accompanied with laboratory work, but not all colleges have a non-human animal (hereafter, animal) laboratory (Cunningham, 2003). Although animal laboratories have played a major role in psychology, maintenance costs,

federal regulations, and other factors have led to a decline in the use of animals for research and teaching (Plous, 1996). The growing availability and demand for online education (Villanueva, 2011) may further decrease the presence of this type of experience, as an animal laboratory component cannot be included in a fully online course.

In an attempt to find a suitable alternative to maintaining an animal laboratory, several computer simulations of animal laboratories have been developed. One of these programs, Sniffy the Virtual Rat (Alloway, Wilson, & Graham, 2005; hereafter referred to as Sniffy) was initially created in 1991 and has been revised three times. It is marketed as a more affordable way for students to have hands-on access to exercises with classical and operant conditioning. Alloway et al. (2005) stated that cost of equipment and ethical concerns about using animals humanely have led to Learning courses being taught primarily in a lecture format with no laboratory. Venneman and Knowles (2005) assessed learning outcomes with Sniffy used as a supplement to a Principles of Learning course and found that students who did homework using Sniffy scored significantly higher on exams, than students who spent two extra hours (beyond the time normally dedicated to exam preparation) studying schedules of reinforcement. Several researchers have reviewed versions of this program and agree that several modifications could improve it (Graf, 1995; Jakubow, 2007; Tomanari & Eckerman, 2003; Venneman & Knowles, 2005). Jakubow (2007) stated that Sniffy, although user friendly and adequate, presents some disadvantages relative to a live rat; for example, the animation of Sniffy can be somewhat choppy and it represents a limited model of a real animal which possesses a much more complex behavioral repertoire.

Carefully examining learning preferences helps in designing more engaging and effective learning experiences (Zhang & Bonk, 2009). Also, knowing student preferences stimulates important reflections on teaching that can help tailor learning experiences to maximize student engagement (Zhang & Bonk, 2009). Engagement here is broadly defined as students' attention, participation, and performance that lead to understanding and success in an academic environment (Skinner & Belmont, 1993). Enhancing engagement through active learning (Guenther & Miller, 2011) sets the occasion to teach scientific thinking in the laboratory. Discovery-oriented and student-active teaching methods promote engagement, motivation, and responsibility centered in the student instead of the instructor (Cherney, 2011).

Whether students prefer a live or a virtual rat in their learning experience has yet to be examined carefully. We propose that student preferences on this matter should be valued when designing teaching exercises, and even when pondering the potential substitution of a computer simulation for an animal laboratory. This study examined the preferences of undergraduate students from two upper-division Learning courses on the use of Sniffy and a live rat when learning about some operant conditioning concepts.

In the present study, each student was given the opportunity to directly compare the same exercise with Sniffy and with a live rat. These laboratory-based exercises were a supplement to the contents of each of the courses. The study was conducted primarily to closely examine what students think about the utility of these two options when learning schedules of reinforcement and, specifically, which one they prefer. A questionnaire about general preferences between the two types of exercises was created by the authors; it included items on enjoyment, interest, learning concepts, ethical issues about animal research, and generalizability. To further examine student perspectives on animal research

in psychology, a modified scale of attitudes towards animal research (Angelucci & Hernandez, 2002) based on Plous's (1996) scale was also used.

Method

Participants

Twenty-four undergraduate students enrolled in upper-division Learning courses participated in this study as part of the course activities. Both were upper-division undergraduate courses are required for Psychology majors at Armstrong Atlantic State University. There were two men and 22 women, whose ages ranged from 19 to 53 years old ($M = 25$).

Materials

The virtual rat portions of the study were conducted using an Inspiron E1505 Laptop with Sniffy the Virtual Rat Pro Version 2.0. The live rat portions of the study were conducted using a desktop IBM compatible computer interfaced to a standard operant chamber for rats (Coulbourn Inst., PA) with experimental events controlled by Graphic State software (Coulbourn Inst., PA). Sucrose pellets (45 mg) functioned as reinforcers and delivered via a handswitch. Six male, albino, Sprague Dawley rats (Charles River, NC) ranging in age from 14-20 months old served as subjects. All rats had been previously exposed to various schedules of positive reinforcement. Laboratory procedures conducted with animals were approved by the Animal Care and Use Committee at Armstrong Atlantic State University.

A 20-item questionnaire contained six open-ended questions and 14 questions in which students selected ratings. The open-ended questions were about potential concerns that students may have about working with either a live or a virtual rat. Also, these open-ended questions addressed advantages and disadvantages of working with either a live or a virtual rat. The remaining items addressed the following topics: students' enjoyment, whether an option (live or virtual) should be presented at the beginning of the course, if fear of working with live animals should exempt students from such work, how interesting each exercise was, whether Sniffy is an adequate representation of the behavior of a live rat, how helpful each type of exercise was in understanding the concept of a fixed-ratio (FR) schedule, how much patience it takes to work on each exercise, whether one type of exercise offers the opportunity to learn about ethics in animal research, and generalizability of results obtained from each type of exercise.

An English translation of a revised version of Plous's (1996) scale on attitude towards animal research in Psychology by Angelucci and Hernández (2002) was employed (also available upon request). The scale contained 26 statements that students could rate by selecting four possible options: totally disagree, disagree, agree, and totally agree. Institutional Review Board approval was obtained prior to students completing this survey.

Procedure

Participants were randomly assigned to start with either the live rat portion or the virtual rat portion of the study. Each lasted approximately 15 minutes and were conducted during the same session to ensure that participants could directly compare their experiences. After

completing both portions of the study, participants filled the questionnaire and scale described above.

In the live rat portion of the study, participants were provided spoken and written instructions (available upon request) for an exercise on learning a FR schedule (i.e., progressive increasing the response requirement to earn a pellet). This exercise involved using a rat that had been previously trained to press a lever and immediately after consuming a 45-mg sucrose pellet. The goal of the activity was to progressively increase the lever-press requirement. Specifically, the student began the session by delivering 20 pellets under an FR 1 schedule, and then increased the requirement to an FR 2, deliver five pellets, and then increase the requirement to an FR 3, and so on. In sum, after increasing the requirement the first time (i.e., to an FR 2) the student had to deliver, using a handswitch, five pellets to move on to the next step. Some students observed ratio strain, and they were also given instructions on this: specifically, if pauses in between lever presses were longer than 10 s, then the requirement had to be decreased to the previous one. Participants were then given the option of handling the rat or having the experimenter handle the rat (i.e., moving the rat from its home cage to the experimental chamber) for the session.

In the virtual rat portion, participants were given written instructions for the same exercise described above. Sniffy had been previously trained to press a lever, so the same exercise on learning an FR schedule was conducted. Upon completion of both portions, the participant completed the questionnaire and scale previously described.

Results

Overall, results from the questionnaire suggest that most students preferred the live rat over the virtual one. Table 1 shows the percentage of students' responses on the 14 items from the questionnaire that required rating answers. We summarize below the most relevant findings.

Table 1. Percentages of responses from the portion of the questionnaire that required students select an answer to rate statements.

Question/Statement	Answers				
Did you enjoy working with?	Enjoyed very much	Enjoyed	Did not enjoy	Boring	Very Boring
	Live	58.33	41.67	0.00	0.00
	Virtual	12.50	54.17	33.33	0.00
How interesting was it to work with?	Very interesting	Interesting	Not interesting	Boring	Very Boring
	Live	66.67	33.33	0.00	0.00
	Virtual	20.83	45.83	29.17	4.17
How much patience	Too much	A lot	None	Very little	

do you feel it would take to work with?				
Live	0.00	75.00	0.00	25.00
Virtual	12.50	29.17	25.00	33.33
Helped me understand the concept of FR schedule.				
	Strongly agree	Agree	Disagree	Strongly disagree
Live	45.83	54.17	0.00	0.00
Virtual	20.83	62.50	16.67	0.00
Learn more about the humane care and use of animals.				
Live	45.83	54.17	0.00	0.00
Virtual	4.17	20.83	58.33	16.67
Results obtained are more generalizable				
Live	25.00	58.33	16.67	0.00
Virtual	4.17	41.67	50.00	4.17
Live or virtual should be optional				
	37.50	50.00	12.50	0.00
Fear Exemption				
	0.00	25.00	62.50	12.50
Virtual adequately represents real behavior				
	29.17	50.00	20.83	0.00

When examining the exercise conducted with the live rat, all indicated that they enjoyed it and found it interesting. As for the exercise with the virtual rat, 66.67% enjoyed it and 33.3% did not enjoy it. Also, 29.17% of students rated the virtual rat as "not interesting", and 4.17% considered it "boring". Potential order effects were examined to determine whether students who disliked Sniffy experienced the live rat first or second, but no reliable results supported such effects.

All students indicated that the exercise with the live rat adequately aided in understanding the concept of a FR schedule, whereas with the virtual rat, 16.67% of students disagreed. We also asked students whether someone who fears working with live animals should be exempted from this portion of the course; 62.50% disagreed and 12.50% strongly disagreed. It should be noted that in the present study, when given the choice to handle the live rat versus having the experimenter handle the rat for them, all students chose to handle the live rat, even those who expressed concern about working with a live rat in the first item of the questionnaire (two of 24).

All students indicated that the live rat helped them learn about ethical issues in animal research. Comparatively, when examining the virtual rat in this aspect of learning, 25 % of students agreed (combining strongly agreed and agreed), 58.33% disagreed, and 16.67% strongly disagreed. When asked if they thought the virtual rat adequately represented real behavior, 79.17 % agreed and 20.83% disagreed; however, 54.17 % disagreed with the fact that studies with a virtual rat would yield results generalizable to human behavior.

A summary of advantages and disadvantages of both live and virtual rats is presented on Table 2. Common answers were grouped by topic and the frequency of answers is shown in parentheses. The most frequently mentioned advantages of the live rat were experience with hands-on research which was listed 17 times. The most frequently mentioned disadvantage of the live rats was maintenance costs. The most frequently listed advantage of the virtual rat was that it may help people who are afraid of rats, and the most frequent disadvantage listed was that it does not adequately represents the behavior of the real animal.

Table 2. Summarized answers to open-ended answers to questionnaire. Frequencies are given in parentheses.

Live Rat		Virtual Rat	
Advantages	Disadvantages	Advantages	Disadvantages
Gaining experience in hands-on research (17)	Maintenance costs (11)	May help people who are afraid of animals (7)	Loss of actual (real) animal behavior through computer simulation (14)
No software	Fears, aversive to some students, including possible allergies (6)	Cheaper (3)	No hands-on experience, do not grasp the concepts as well (4)
Animals don't all behave the same way	Time consuming (2)	Seeing a graph as the experiment is conducted (2)	Very boring (3)
More rewarding	Animal rights	Helped see what the live rat was probably going to do in the chamber (2)	More far off from human application than an animal
Being able to see the variability in living things		Gives people the opportunity to experience animal research (at heart of conceptually) who don't have access to a lab (2)	It feels like playing a video game
Seeing the rat perform a task you shaped		Cleaner	It can only do what it was taught, worthless when studying new behavior
More interesting		It helps a person understand fixed ratio	No training on care or how to work with the animals
Bonding with the rat		Good perspective in how rats act/behavior	Not receiving full understanding of the study
Not sitting in front of a computer for long periods of time		Helps to understand about FR without having to deal with the animal	Less variability in behavior; less interaction--less emphasis animal treatment
Can change more conditions		You might be able to test things not advisable on live rats	Not getting to condition an animal
More errors to prepare better for future research		Good for learning, bad for research	
Accurate account of how the animal learns		Background/understanding in applications and various concepts	
Easier to manipulate and control			
Better experience			
Teaches responsibility			

The percentages of students' answers to the attitude scale revised by Angelucci and Hernández (2002) are presented in Table 3. In general, students' attitudes towards animal research were supportive; students value this type of research as long as proper ethical guidelines are followed. Most students indicated that animal research is important for better understanding human behavior and that it is an important component in their education. More specifically, 95.84% of the students considered that the use of animals in research is necessary for the progress of science, that financial resources to support such research should be increased (95.83%) and that animal laboratory work should be a requirement for undergraduate psychology training (91.67% agreed). All students disagreed with the statement that animals in psychological research are treated cruelly, and also with the statement that animals used in research experience pain and unnecessary ill treatment. At the same time, 95.33% of students totally agreed that ethical guidelines are required to conduct research with animals in psychology.

Table 3. Percentages derived from answers to the scale by Angelucci and Hernandez (2002).

Survey Statement	Responses			
	Totally disagree	Disagree	Agree	Totally agree
The use of animals in research is necessary for the progress of science	0.00	4.17	54.17	41.67
Financial resources for the study of animal behavior should be increased	0.00	4.17	70.83	25.00
Research on animal behavior increases our understanding of human phenomena	0.00	4.17	66.67	29.17
Animal laboratory work should be a requirement for undergraduate psychology training	0.00	8.33	50.00	41.67
Animals used in psychology research are treated cruelly	45.83	54.17	0.00	0.00
Animal research requires ethical guidelines to be carried out	0.00	4.17	33.33	62.50
Animal research allows for better control to study behavior	0.00	4.17	54.17	41.67
Animals have the same rights as humans	0.00	33.33	41.67	25.00
The use of animals is essential for applied research	0.00	4.17	70.83	25.00
During research, animals are subject to pain and unnecessary ill treatment	45.83	54.17	0.00	0.00
Results obtained in animal research correspond to reality	0.00	8.33	79.17	12.50
Animal research is necessary for improving human quality of life	0.00	12.50	62.50	25.00
Animals have the right to avoid pain and suffering	0.00	4.17	50.00	45.83
Research in animal behavior is as important as research in human behavior	0.00	16.67	66.67	16.67
Animal experiments are inadmissible	20.83	62.50	16.67	0.00
Animal research is important for understanding certain psychological phenomena	0.00	4.17	70.83	25.00
One can learn more doing research with a patient than doing research with animals	4.17	66.67	16.67	12.50
The difference between animals and humans is so great that animal research it renders very little information for understanding human behavior	12.50	79.17	8.33	0.00
Animal research is valid in biomedicine, not so in psychology	12.50	83.33	4.17	0.00
Psychologists working with laboratory animals follow strict rules that minimize any harm to the animals	0.00	0.00	50.00	50.00
General principles of behavior can be obtained without the use of animals	0.00	58.33	37.50	4.17
Laboratory animals are constantly being exploited	20.83	70.83	8.33	0.00
The use of animals is indispensable in teaching experimental psychology	0.00	33.33	58.33	8.33
Animal work is an important requirement in the training of a clinical psychologist	4.17	33.33	58.33	4.17
Sacrificing one species for the survival of the other is a mistake for coexistence	8.33	29.17	54.17	4.17
Attitudes that predispose towards war and suicide are those that have one species impose itself upon another	4.17	41.67	37.50	8.33

Discussion

In this study, each student had the opportunity to directly experience the same exercise using both live and virtual rats during a session. The majority of students preferred to work with a live over a virtual rat when learning about operant conditioning and indicated that it was superior in helping them understand an FR schedule of reinforcement. Also, responses to the attitude scale suggest that most of the students who participated in this study value

animal research in psychology and consider it necessary in undergraduate training in order to more fully understand human behavior.

These results, taken together, suggest more student engagement (Guenther & Miller, 2011) with the live rat than with virtual rat. The most frequently listed advantages for the real rat, compared to those of the virtual rat, indicate that students prefer an active method (working with a live rat in the laboratory), over a passive (working with a virtual rats with a computer simulation) one. Such preference is consistent the definition of active learning provided by Cherney (2011) and that this method will likely promote more engagement than an active one.

In reviewing the literature for this study, we notice a parallel in the use of the terms *active and passive learning* by Cherney (2011) and the terms *contingency-based and rule-governed behavior* by Heward and Malott (1995). Specifically, *active learning*, is very similar to *contingency-based learning*. As stated in the introduction, providing students opportunities to directly contact the subject matter in the laboratory is a form of active learning. The terms *contingency-based* come from the behavior analytic literature, while *active learning* seem to be more broadly used. Noticing and examining such parallels may help in future integration of literature across fields and in building a dialogue between disciplines to strengthen the scholarship of teaching and learning.

Frequently, the issue of cost was also noted frequently by students in this study as a disadvantage of the exercise with the live rat. Cost is an undeniable issue for many universities; however, the results of our study indicate that using a virtual rat may come with a different cost, in that students are less engaged in the learning process.

Another source of difficulty in maintaining an animal laboratory is public opinion on animal research. Such scrutiny has hindered the communication of contributions from laboratory research even in some Introductory Psychology textbooks (Domjan & Purdy, 1995). More specifically, these authors carefully examined eight of these textbooks and concluded: "In obscuring the contributions of animal research, major general psychology textbooks miss the opportunity to educate the general public about the importance of psychology experiments with animals" (p. 501). We believe that the laboratory experience for undergraduate students in psychology will also effectively train students to learn directly about how the origin of many research methods, applied techniques, and general knowledge about behavior lies in laboratory work. The laboratory experience also offers an ideal opportunity to train responsibility to students, and even help some students overcome fears.

Experts who have reviewed several versions of Sniffy conclude that while the virtual program can be useful as a supplement to teaching, using it as an alternative may be less than optimal (Graf, 1995; Jakubow, 2007; Tomanari & Eckerman, 2003). Our results show that Sniffy adequately represents behavior and helps students learn, but with less engagement than the live rat. Several students in our study pointed out similar disadvantages of using the virtual rat (see Table 2) as those noted by reviewers such as Jakubow (2007); for example, that the behavioral repertoire of the virtual rat is more limited than that of the live rat.

It should be noted that even though limited, Sniffy conveys necessary information to students. Our results showed that many students found this form of the exercise valuable in understanding FR schedules (83.33%, combined strongly agreed and agreed). The

distribution of responses on this aspect, when comparing live and virtual rat was not that different; however, more students strongly agreed with the statement that the live rat helped them understand FR schedules.

In an undergraduate operant conditioning laboratory, there is value in using a virtual rat, but perhaps not as much as using a live rat. This is not surprising given the various reviews of Sniffy (Graf, 1995; Jakubow, 2007; Tomanari & Eckerman, 2003) that point out its strengths and weaknesses. Likewise, the students who participated in the present study were able to discern both the advantages and disadvantages of using a virtual rat. It is certainly a good thing in the absence of a laboratory, Sniffy provides students with a model of the next best thing.

We contend that by working with a live rat students are not only learning about the rat as a model of human behavior, but also learning about animal behavior. Sniffy is one model with a limited behavioral repertoire (Graham, Alloway, & Krames, 1994) compared to a live rat. In the laboratory, students work with more than one rat so they also witness differences in training different animals (i.e., individual differences).

Limitations and Future Research

The present study examined a limited number of operant conditioning concepts in one exercise; future studies could examine more concepts, such as variable ratio schedules. Because the present study focused on the examination of student preferences and engagement, there was no analysis of actual learning outcomes. Other assessments including exams and assignments will be useful in further examining both student engagement and learning outcomes with each of these techniques.

Conclusions

The Learning-Centered Psychological Principles of the American Psychological Association's Board of Educational Affairs (1995, as cited by Cunningham, 2003) state that students need to make choices about learning consistent with their personal interests. Studies such as the present one, that systematically examine student preferences about learning exercises, are a suitable approach to design better teaching techniques and maximize student engagement.

Despite some limitations, Sniffy is convenient, inexpensive, and useful in teaching basic learning concepts, especially when there is no option for an animal laboratory. We contend though, that the animal laboratory, at an undergraduate institution is an important direct experience with basic research, which is the root of many applied techniques in psychology. Many undergraduate students in psychology pursue applied positions or applied graduate programs in psychology which offer little or no exposure to basic research. For these students the Learning laboratory may be one of the few experiences with basic research they will have (Sidman, 2011; Skinner, 1956). It is critical, therefore, that the instructor promotes and emphasizes how skills required to excel in the laboratory (e.g., discipline, organization, critical thinking, application of scientific methods, use of instrumentation, data analysis, graphing, writing, ethical considerations) are also necessary to perform tasks in various professional activities. In this way, with proper instructional guidance, we can teach the value of basic research in psychology (Halonen et al., 2007).

Acknowledgements

Special thanks to Dr. Nancy McCarley who aided in building the questionnaire used in the present study and helped in revising a previous version of this manuscript. Also thanks to Dr. James W. Diller for helpful comments on an earlier version of this manuscript. Portions of the results were presented in a poster at The Student Scholars Symposium at Armstrong Atlantic State University during Spring 2011.

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