FEATURE ARTICLE

The Study of Animal Behavior Provides Valuable Opportunities for Original Science Fair Projects: Recommendations from The Animal Behavior Society, Education Committee

RECOMMENDED FOR *AP Biology*

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Abstract

The study of Animal Behavior is critically important in understanding our living world and is a major program within the NSF. For students, animal behavior projects offer the opportunity to explore original questions in a scientifically rigorous manner. However, animal behavior projects are under-represented in science fairs and are often discouraged by teachers and judges. We give a sample of the types of questions that students could explore and we suggest appropriate judging criteria.

Key Words: *animal behavior; science fair.*

○ The Science of Studying Animal Behavior

The scientific study of animal behavior goes back to Aristotle, who was such a careful observer that he recognized that honeybee colonies have a queen and workers. The modern focus on the evolution of behavior was pioneered by Darwin (1859; 1872), who was as intrigued by behavior as he was by morphology. Perhaps the best known modern animal behaviorists are Konrad Lorenz, Niko Tinbergen, and Karl von Frisch, who shared the Nobel Prize in 1973 for their work on critical periods in development, social behavior, and communication (Lorenz, 1952, 1966; Tinbergen, 1963; von Frisch, 1967).

Today Behavioral Systems is a major program within the National Science Foundation. Thousands of scientists at hundreds of universities around the globe are involved in the study of animal behavior. They study topics as diverse as cooperation, social behavior, parent-offspring conflict, cognition, learning, predator and prey strategies, as well as parasite and host strategies (NSF, 2012). Their work is published in *Science*, *Nature*, *PNAS*, as well as journals that specialize in the topic, such as *Animal Behavior*, *Behaviour*, *Behavioral Ecology*, *Applied Animal Behavior Science*, *Ethology*, and *Advances in the Study of Animal Behavior*.

Although historically, much of this research effort has been basic science, animal behavior has also had dramatic application to human well being. For example, the work of Pates and Curtis (2005) on mosquito breeding has led to valuable new strategies for fighting mosquito borne diseases such as Zika. Work by Rothenbuhler (1964) and Gerula et al. (2015) on hygiene behavior in honeybees is being used to combat colony collapse. This has huge implications for food security since honeybees contribute an estimated 14.6 billion dollars to U.S. agriculture through pollination (Morse & Calderone, 2000). Work by Solomon (1993) on oxytocin and pair bond formation has led to the exploration of novel treatments for autism. Even very basic questions, aimed at more fully understanding specific aspects of animal behavior, can therefore lead to important scientific discoveries and contributions, and behavioral questions may be accessible to students at all levels.

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○ Resistance to Animal Behavior Projects at Science Fairs

Animal behavior is grossly under-represented in science fairs due largely to two misconceptions. First, many teachers, students, and judges assume, incorrectly, that permission is needed to observe vertebrate animals. Second, observational studies may not be viewed as

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experiments and consequently may not be considered appropriate science fair projects.

There is a common misconception that an observational study, which often lies at the heart of animal behavior research, is not science. This erroneous assumption stems from the fact that in such studies, the researcher is not controlling or manipulating variables, but rather is observing animals in a natural or captive situation (for example, in a park or zoo). Nonetheless, observational research in all settings adheres to standard scientific methodology: a hypothesis is proposed, data are collected, and the results will support or fail to support the hypothesis. For example, a student might hypothesize that in a zoo, female primates may be more likely than male primates to engage in grooming. By observing the primates and quantifying how much time males and females spend grooming others, this question can be addressed. Furthermore, although manipulative studies conducted with invertebrates may seem more rigorous and scientific, observational studies, conducted with a student's favorite vertebrates, are just as important and may be more exciting and motivating to the student. Independent and dependent variables exist, but in an observational study they are not controlled by the researcher. We have read judges' comments that suggested an observational study of gorilla behavior was not science because there was no experiment. Another science fair judge told a student that she should not be wasting her time on such things. Although we, science teachers, cannot be responsible for the various misconceptions that our volunteer judges hold, our written guidelines can help alleviate many misunderstandings and biases.

An added complication comes from the perceived problem of studying vertebrates. Observational studies do not, and should not, require approval to utilize vertebrate animals. When the researcher is a passive observer, not manipulating or changing anything in an animal's environment, permission should not be required. Indeed, even among academic researchers, permission from Institutional Animal Care and Use Committees is often not required for observational studies. Middle and high school students should not be held to a higher set of standards than professional scientists.

○ Animal Behavior Studies Encourage Creativity

A 2008 study of four years of science fair programs (over 1300 projects) in a large metropolitan city science fair found a surprisingly limited variety of topics (Margulis & Margulis, 2008). Nearly 9 percent of projects addressed the same three questions: Is our water safe to drink? Which fertilizer works best? Which cleaner kills the most bacteria? When queried about where they got the idea for their project, answers such as "I found it in a book," "I googled it," or "my teacher told me to do it" were far too common. Animal behavior, on the other hand, lends itself to interesting and original student research that is more independent and student-guided.

It has been suggested that there is a genetic basis for our attraction to animals (Breed & Moore, 2012; Wilson, 1984), and anyone who has advised students has surely noted the overwhelming interest in animals, particularly vertebrate animals. We should encourage students to pursue diverse questions about animal behavior, recognizing that observational studies do not require equipment that may be cost prohibitive for many students. Additionally, since these studies do not require complicated equipment, students can work more independently and may be less reliant on mentors. This allows students themselves to answer the questions that they come up with, encouraging creativity, which is a cornerstone of good science. When students conduct observational research, they learn the scientific tools of careful observation, detailed description, quantification, and scientific reasoning. Students also accept and are held accountable for the ethical responsibility of working with animals, which is an important opportunity for growth. The early discussions that lay out the limitations of many projects are often framed by constraints of equipment and cost. But the discussions of animal studies allow us to explore the added question of whether we ought to conduct the proposed project. By encouraging students to pursue animal behavior questions, we are empowering students by giving them ownership and responsibility of their own research and learning, thus encouraging creativity.

Quantifying observations is an important challenge for all students, not just those who choose to develop a science fair project involving animal behavior. Even if students have not been introduced to the concepts of the ethogram, focal and scan sampling, there are excellent online introductory curricula that teach these tools (see, for example, Littman & Moore, 2016; Powell, 2008; http://www.weblessons.com/).

○ The Challenge of Judging

Science can be broadly defined as a process that allows us to collect evidence to discover knowledge. It values logic, precision, and skepticism, but it can be conducted in an infinite number of ways. This makes judging research incredibly challenging. Indeed, the idea of a single, standardized method by which all scientific inquiry is conducted is misleading and inaccurate (Cutraro, 2012; Harvey & Pagel, 1991; Pagel, 1992). A range of methodological approaches is available for diverse scientific inquiry. The method of choice will depend on the nature of the question. Like granting agencies for research institutions, science fairs subdivide entries into categories (22 for the Intel International Science and Engineering Fair). But with the exception of engineering projects, science fairs judge all poster entries using five general categories: research question, design and methodology, execution, creativity, and organization of presentation (ISEF, 2017; CSEF, 2015). Under design and methodology, judges are asked to note whether "variables and controls [are] defined, appropriate, and complete" (ISEF, 2017; CSEF, 2015). This may not be an appropriate standard for an excellent observational research project. Additionally, observational animal behavior research would likely fall into the category Animal Sciences, which could be quite broad. For example, a student who observed primate behavior may be compared to a student asking an ecological question about tritrophic interactions, or to a student doing genetics in flatworms, or even students studying animal husbandry, nutrition, or medicine. The onus is on judges to decide how vastly different projects compare to each other.

We therefore suggest that science fairs add information to judging guides to explicitly define the criteria for a high-quality observational animal behavior research project. We propose expanding on the existing judges' criteria for design and methodology (ISEF, 2017; CSEF, 2015). Guidelines currently read, "Well-designed plan and data collection methods, variables and controls defined, appropriate, and complete." We suggest, "Well-designed plan and data collection methods. For experimental studies, variables and controls defined, appropriate, and complete. For observational studies, carefully describe (operational definitions) and quantify (e.g., number of each behavior performed or the proportion of time spent performing a given behavior) observations."

○ Regulations for Use of Animals in Science Fairs

Most animal behavior research is conducted on vertebrates (Rosenthal et al., 2016). Currently, any science fair project that uses vertebrate animals must adhere to strict guidelines. Student research must be approved by an Institutional Animal Care and Use Committee (IACUC) or by the Scientific Review Committee (SRC) including a veterinarian or animal care provider. IACUC protocols may be submitted only by principal investigators with a PhD, and SRC approval may be complicated and time-intensive to procure. The additional challenges associated with animal care approval may cause mentors to discourage students from pursuing animal behavior research. *It is important to recognize that observational animal behavior research is exempt from this review process as long as there is no direct interaction with animals, no manipulation of the environment, and the study meets all federal and state laws (ISEF, 2017)*. Nonetheless, it would be good practice to require students to inform or ask permission before conducting an observational project at a zoo or aquarium. Given the vast array of animal behavior research questions that can be asked, and for which quantitative information can be collected, guidelines should be made more explicit. Rather than discouraging students from conducting observational studies of vertebrates, we should be encouraging them to do so. This type of original, creative scientific research can support students' continued exploration of and interest in the sciences.

○ A Taste of the Diversity of Questions that Your Students Could Explore

We do not want to fall into the trap of offering an array of cookbook-type projects that substitute animal behavior for the safety of cleaning products. Instead, consider this list of questions that might be explored by collecting observational data on species found at the local zoo, at the backyard bird feeder, at a local park or dog park, or around the barnyard. Age and gender of wild vertebrates can often be determined by comparing plumage, or pelage, or size. In zoos and dog parks, these characteristics can be determined by reading the signs, asking keepers, or talking to dog owners. Many invertebrates display even more dramatic sexual dimorphism and age dimorphism. Learning the natural history of a study species (whether wild birds, baboons, or fruit flies) is a critical early step in planning a project.

- Are older animals more selective about what they eat?
- Are young animals more cautious than their parents?
- Do animals stay closer to their own species when they are in a mixed-species group?
- Do parents prefer to feed some offspring more than others?
- Do young animals beg more often than older animals?
- Do larger animals win more often when they compete with smaller animals?
- Are males or females more active?
- Do animals at the zoo behave differently on crowded days?
- What proportion of time do animals spend engaged in various behaviors? Does this depend on time of day or differ between related species, between sexes, or between wild and captive individuals?
- How common are stereotypical (redundant, often self-directed) behaviors in various captive species or across different types of zoo enclosures?

○ Conclusions

The science fair community has been invaluable at promoting science and encouraging students to consider a career in science from a young age, but science fairs also have the important responsibility of being the first independent science experience for many students. This puts science fairs in a unique position to shape current views on science. ISEF has already moved away from the term *scientific method* and uses the phrase *scientific methods*, which recognizes a more realistic representation of science as a process. It is critical that teachers and judges realize that a diversity of scientific approaches is used by scientists to answer scientific questions (Wilson, 1984). Science fairs have the opportunity to train judges in this task. We encourage science fairs to update judging guides to explicitly define criteria for different types of research projects. We at the Animal Behavior Society would especially like to draw attention to the power of observational research. Well-designed observational studies of animal behavior have made significant contributions to the field of biology historically, and this is an active and exciting area of current research. Zoos offer students the opportunity to explore the behavior of species that may be rare or endangered; the growing field of conservation behavior attests to the recognition that behavior has the potential to make substantial contributions to wildlife conservation (Greggor et al., 2016). Further, mentors should encourage more students to conduct observational research, recognizing that observational research is generally exempt from animal care guidelines.

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