The Use of Animals in National High School Student Science Fair Projects in the United States

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Summary — Science fair projects can provide a sound opportunity to teach students the value of scientific methodology without relying on the routine and unnecessary use of animals. Unfortunately, students are often encouraged to use animals in an expendable manner that both duplicates previous experiments and neglects the opportunity to "think outside the box" in order to generate new hypotheses/theories about human health, physiological processes or basic biological concepts. Although at least one national science fair sponsor has changed its policy regarding students' utilisation of vertebrate animals, others continue to encourage the more traditional *in vivo* experimental projects. This paper will review the guidelines of two major national science fairs in the USA; types of projects conducted that involve animals; numbers of animals involved; interview responses by some student finalists who used vertebrates in their projects; successful initiatives by animal advocates in the USA to eliminate the use of animals in science fairs; and potential areas of outreach to science educators, science fair sponsors, high schools and students.

Key words: *humane education, science fair, student.*

Introduction

Science fairs: the educational value

According to the American Association for the Advancement of Science, a science fair harmonises a student's entire educational experience and provides an opportunity to reflect upon lessons learned (1). Science fairs also allow students to partake in a process-driven, inquiry-based study of their interest, allowing them to become personally and directly involved in scientific investigation (2). The fairs emphasise communication, cognitive skills and intellectual development. Participation in a science fair may also shape a student's career and attitudes. For these reasons, the influence of the process of competing in a science fair should not be underestimated.

For those students who conduct science fair projects that involve experiments on animals, it may very well be their first experience of treating animals in this manner. Concern for the treatment of animals and the influence such participation has on students has led to laws prohibiting certain experimental procedures on animals by students in states such as California and Massachusetts (3, 4). Dr Barbara Orlans, a physiologist and Senior Research Fellow at Georgetown University's Kennedy Institute of Ethics, who has analysed science fairs over several decades, described the rationale behind the prohibition of animal use in the following way (4):

1. *Morally:* it is indefensible to hurt or kill animals unless original contributions that will advance human health and welfare can be expected. Elementary and secondary school studies do not meet this test.

2. *Psychologically:* it can be emotionally upsetting for youngsters to participate in harming or killing animals; even worse, it may be emotionally desensitising or hardening to immature minds.

3. *Socially:* in these days of widespread violence, fostering personal acquaintance with inflicting pain on (other) creatures should be avoided.

4. *Educationally:* teaching about abnormal states before the student has a sound grasp of normal physiology is against common sense and does not advance scientific education.

5. *Scientifically:* promoting teenage animal surgery or induction of painful pathological conditions fosters an improper regard for animal life and an unbalanced view of biology that will rebound adversely when the next generation of scientists comes of age.

History of science fairs in the USA

In the 1940s, the Science Service, an organisation in the USA that sought to bridge the gap between scientific achievements and the public's understanding of science, organised a network of science clubs in the USA and other countries, linking them to museums and other scientific institutions (5). In

1942, the Science Service and Westinghouse organised what is considered to be the oldest and most prestigious science competition in the USA, the Science Talent Search (STS), in order to promote careers in science and engineering. Meanwhile, various local science clubs established their own competitions, which led to the first National Science Fair, held in Philadelphia, Pennsylvania, in 1950, which later evolved into the Science Service's International Science and Engineering Fair (ISEF; 5).

In science fairs, students generally conduct projects independently or as a group, and display posters describing their methods and their findings with the hope of receiving monetary awards and recognition. Students from elementary, middle and high schools compete on local, regional, state and national levels. The major national and international science fairs in the USA are overseen by the Science Service, and approximately three to five million students complete science research projects annually (6).

National science fairs: Science Talent Search

As a result of pressure from animal advocates, in 1969, the Westinghouse STS changed its policy, prohibiting students from conducting projects involving direct contact with vertebrate animals (3, 4). This followed reports of an experiment that consisted of the blinding and starving of sparrows by a female high school student. Although three of the sparrows died as a result of her actions, the student was awarded a $250 prize. In 1998, the US microprocessor developer Intel took over sponsorship of the STS, which annually draws 2000 high school senior entrants and results in 40 finalists, who compete for the top prize of a $100,000 scholarship (7). The STS rules state, "No projects involving live vertebrate experimentation will be eligible. Live vertebrates are defined as any live, non-human vertebrate, mammalian embryo or fetus, bird eggs within three days (72 hours) of hatching and all other vertebrates at hatching or birth" (8). This rule excludes "non-invasive/intrusive" studies that are observational in nature and studies conducted at a registered research institution where the student is supplied with and only has contact with non-living material that was obtained for purposes other than the student's research (8).

National science fairs: the International Science and Engineering Fair

Touted by the Science Service as "the world's largest pre-college celebration of science" (5), finalists from approximately 500 affiliated fairs in the USA and 40 other nations compete each year at the ISEF for over 600 prizes and awards, including full-tuition scholarships to major universities, cash and international travel awards (6). Government agencies, non-governmental organisations and the ISEF sponsor these awards. As with the STS, the Intel Corporation became title sponsor of this competition to the year 2004.

The ISEF rules set the standards for other science fairs throughout the world. Unlike the STS, ISEF has a strong position in favour of animal use by students. Their website states (9):

We believe prohibition of animal based research projects at the Intel ISEF and affiliated fairs will eliminate these established guidelines governing animal use. If animal research projects at Intel ISEF are eliminated, unregulated and unsupervised animal research at the secondary and lower level will increase. Students will proceed with experimentation without rules or guidelines undoubtedly resulting in the proliferation of inhumane science projects and classroom activities. National and state mandated educational standards that require scientific inquiry will be seriously compromised. This action would be detrimental to science education and animals and would not serve the public interest.

A Scientific Review Committee must review all projects competing in the ISEF that involve non-human vertebrate animals before they begin and must be supervised by a Qualified Scientist or Designated Supervisor. ISEF rules also provide moderate guidance regarding the consideration of alternatives to live animal use, procurement, housing, care and euthanasia of animals and experimental conditions. ISEF rules specify that research on animals involving drugs, thermal procedures, physical stress, pathogenic organisms, tumours, surgical procedures, nutritional deficiency, ingestion, inoculation or exposure to hazardous or known toxic materials or drugs (until first signs of toxicity/lesions of the deficiency appear) are permitted, with a stipulation that food and water deprivation cannot exceed 24 hours (suitable to species, but not to age of animal[s]). Projects that involve the use of alcohol, acid rain, insecticide, herbicide and heavy metals in toxicity or behavioural studies are prohibited. In addition, studies designed specifically to kill vertebrate animal(s) and those that involve "unnecessary pain/discomfort" are not allowed, but experimental designs that include euthanasia are permitted (9). Students themselves may not perform euthanasia, except in an emergency situation.

Students must submit a Research Plan prior to the onset of their project. It must include:

1. justification for the use of animals/species/ number of animals;

2. experimental design/data analysis;

3. care/housing/medical care arrangements;

4. procedures to minimise discomfort, pain, distress and injury to animal(s);

5. description of drugs used and dosages/restraint devices; and

6. description of the fate of the animal(s) (if euthanasia, description of method and justification; 9).

Characteristics of ISEF finalists

In order to characterise projects conducted by ISEF finalists, data for all years available were obtained from the Science Service regarding the number of projects by category, number of finalists, and number of projects utilising vertebrates and other subjects. Table 1 illustrates a small decline in the number of projects using vertebrates from 65 (6.1% of total finalist projects) in 1996 to 49 (4.7% of total finalist projects) in 2002. Numbers of projects utilising humans, non-human vertebrates, human/animal tissue and DNA in the years 2001 and 2002 are shown in Figure 1. ISEF finalists were more likely to have used humans or human/animal tissue in their studies than non-human vertebrates or DNA. Figure 2 compares the number of non-human vertebrate studies to other combined non-human studies in the years 2001 and 2002. All 2002 finalist projects using non-human vertebrates are broken down by category in Figure 3. This illustrates that zoology projects far outnumber other categories in non-human vertebrate use.

2002 ISEF finalist survey: methods

The author attended the 2002 ISEF in Louisville, Kentucky, on 15 May 2002, to conduct a survey of finalists who used non-human vertebrates in potentially invasive studies or required the acquisition of animals (i.e. excluded non-invasive clinical studies or studies using companion animals). The Intel ISEF 2002 Finalist Directory (10) was analysed to determine which projects utilised animals in this manner, and hence, which students should be surveyed. Student finalists were asked general, open-ended questions about their projects and more specific open-ended questions regarding their use of animals, their intended careers, and consideration of alternatives. Thirteen audio-recorded interviews took place, but five were disqualified, because the projects described did not actually involve live animals; therefore, a total of eight audio-recorded interviews were analysed. If a student was not present, their abstracts, if available, and information regarding subjects and methods, if available, were collected from the project display.

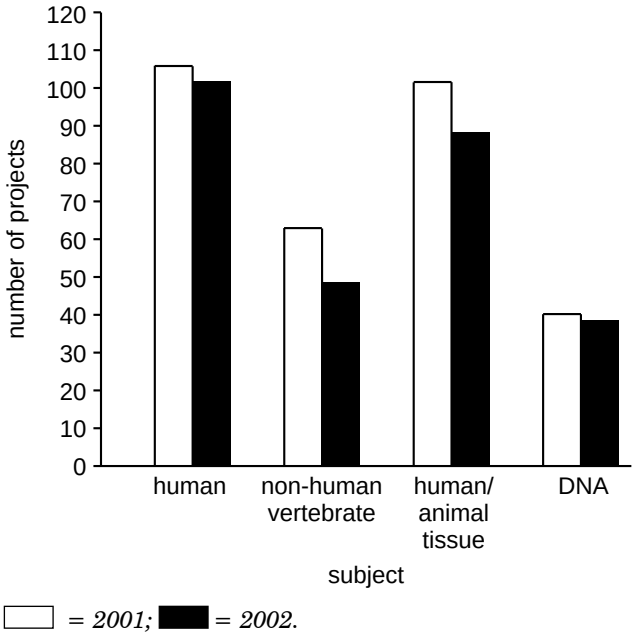
Table 1: The International Science and Engineering Fair finalists using vertebrates (1996–2002)

Year	Total finalists	Total vertebrate projects	Percentage
1996	1067	65	6.1
1997	1089	73	6.7
1998	1125	66	5.9
1999	1159	58	5.0
2000	1224	70	5.7
2001	1230	63	5.1
2002	1051	49	4.7

Results

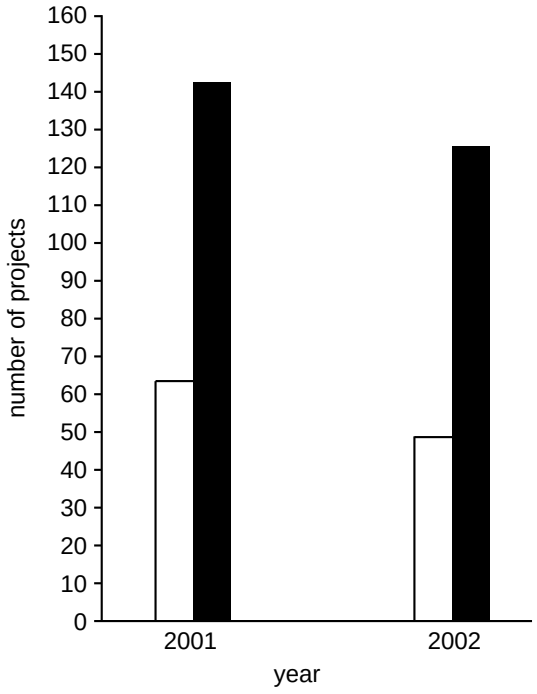
Not only was it difficult to ascertain which projects involved the use of live animals, based on project titles and available abstracts, but also it was difficult to locate students in one day's time. These factors presumably led to the small sample size. Interview responses were analysed qualitatively and quantitatively. The number of animals used by finalists interviewed (n = 8) totalled 82 mice, 36

Figure 1: International Science and Engineering Fair finalist projects by use (2001 and 2002)



Source for table and figures: Science Service, 2002.

Figure 2: International Science and Engineering Fair finalist non-human studies by category of experimental subject (2001 and 2002)



□ = *non-human vertebrates;* ■ = *other non-human projects.*

Source for table and figures: Science Service, 2002.

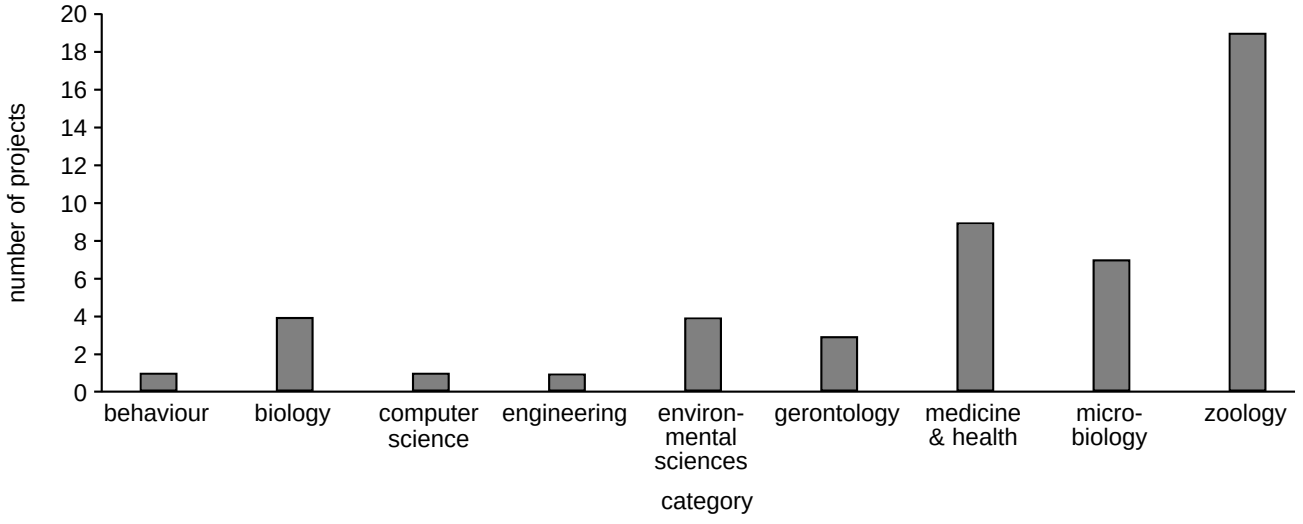
rats and three cats. The projects were each classified in one of four categories: Medicine (three), Biology (two), Zoology (two), and Behaviour (one).

Though many other projects at the ISEF sought ultimately to help animals by providing environmental enrichment to river otters, or studying, and hopefully remedying, stereotypical behaviour of captive pandas in China, many resulted in the harm and death of several animals.

In one project sponsored by the National Institutes of Health, a student analysed the locomotion of three cats who were obtained from a local shelter and whose spinal cords had previously been (intentionally) injured. Another student monitored 24 rats in an operant chamber after they were injected with cocaine, in order to understand the mechanisms of cocaine abuse. In a study to determine the effects of creatine (a supplement used by body builders) on muscle mass, a student used 16 six-week-old mice, who later were euthanised to remove their gastroc-plantaris muscles. In order to study types of serotonin in the brain that affect feeding behaviours, a student used 12 rats who were injected with two types of serotonin. Two of the 12 died due to an overdose of anaesthesia and, as with many of the other projects, the remaining animals were euthanised at the end of the study. Another student studied the effects of radiofrequency radiation (microwave radiation) on the ability of 12 mice who were exposed to 2500MHz and of 12 mice who were not exposed to radiation, to reach a submerged platform within an opaque water maze.

Some generalisations can be made on the data obtained from interviews and abstracts. All data collected were from the USA, and most projects were carried out through registered research institutions

Figure 3: International Science and Engineering Fair finalist projects using non-human vertebrates, by category (2002)



and commercial entities. Most of the students interviewed had joined on-going projects at these facilities and focused on a specific area; therefore, most animals were obtained and cared for through these facilities or businesses. Students were given animal handling lessons of varying degrees by their supervisor, but with one exception, did not administer injections, perform surgery and so forth. Two of the eight students interviewed were awarded a prize or prizes, and all but one of them stated that they are planning a career in medicine.

When asked if they had considered using unspecified methods that did not involve the use of live subjects, the students responded in various ways including: "In some cases, yes, but computer analysis, at this time, is not viable"; "No"; "I did, but because of the micro-radiation, there was really no other option in this case"; "Yes, but it wouldn't be possible for this experiment"; and "Yes, [but] it wouldn't relate as much to humans. It is practically impossible for our level [because there are too many confounding variables in human studies]".

Discussion

Based upon data from the Science Service, the number of ISEF finalists using non-human vertebrate animals is declining each year, but it is unknown whether this is a result of judging or types of projects entered. Though the STS is considered to be the most prestigious science competition in the USA, the ISEF rules are the standards for most science fairs. If the ISEF prohibited projects that utilise vertebrate animals in harmful or invasive experiments or procedures, it is likely that other science fairs would be influenced to abide by the new rule. This is contrary to the Science Service assumption that inhumane, unregulated projects using animals will increase if ISEF rules exclude invasive studies on vertebrates.

Information provided in entrants' abstracts and displays should be improved, as they often fail to extrapolate results to humans or otherwise indicate how findings would be useful to humans or other animals. They also lack clarity in the actual procedures performed by the students and the total numbers of animals used, despite the requirement that this information be included in the initial Research Plan.

Furthermore, if most students work with animals in a laboratory setting in conjunction with on-going research at an institution, then it is likely that the research question is not truly original. If the students work as volunteers in laboratories prior to their science fair project, as many of the respondents do, or if they seek projects with facilities outside of their schools, then students are likely to develop the attitude that it is justifiable to use animals in experiments prior to entering science fairs.

Given the potential negative impacts upon students exposed to the harmful use of animals, there are several actions that can be taken by animal advocates and humane educators to facilitate a decrease in the use of animals in science fair projects. Outreach to educators, students and teachers' associations of all school levels by distributing humane science materials is important in communicating ways in which science can be both fascinating and useful without relying on traditional animal experiments. Animal advocates and humane educators should also maintain pressure on science fair sponsors to adopt stricter standards regarding animal use. For example, the American Anti-Vivisection Society paid for an advertisement in April 2000, criticising the Intel ISEF for allowing the use of animals. Science fair award sponsors can also be educated about adopting humane standards for their award criteria, and indeed, the National Anti-Vivisection Society (US) awarded a Humane Science Award worth US$5000, at the 2002 ISEF, to a student who used human hepatic cells in her project, an innovative alternative to the use of animals (11). Just as students can be groomed for a future in biomedical research, they can also be guided toward a more humane approach.

Conclusions

Science fair projects using vertebrate animals are controversial because of the detriment to animals and the impact upon the students. Although most science fair projects at the ISEF do not utilise animals, many projects are conducted that result in harm to the animals and subsequent euthanasia. If the ISEF adopted the STS policy and vertebrate projects were eliminated from the ISEF, or if invasive or harmful experiments on vertebrates were prohibited, only a small percentage of students would be affected, and those wishing to compete would probably choose suitable projects in order to qualify for the ISEF. At the very least, ISEF abstract content and project details should be improved, so that it is clear how the animals were used and who was involved.

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