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action. At the same time the reality of the serious nature of these genetic defects and the potential for severe illness or sudden death should be understood. The student can then appreciate that the best we hope for is to make what life these animals have as happy and meaningful as possible, while we learn from studying the natural course of their disease.

The above discussion illustrates one of many specific examples where animals with inherited diseases analogous to those of man can provide a challenging educational experience for the student.

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Reverence for Life: An Ethic for High School Biology Curricula

George K. Russell

Abstract

Ethical and pedagogical arguments are presented against the use of animals by high school students in experiments causing pain/suffering/death of the animal. No justification is seen for such experimentation when perfectly valid alternatives, using noninvasive techniques, exist or could be developed. An important concern is the emotional and psychological growth of young people. An overall objective of high school biology curricula must be to assist students in making viable connections with living biological processes and the natural world.

Introduction

In recent years, it has become increasingly common for high school biology students to make use of experimental procedures causing pain, suffering, and, in many cases, the death of vertebrate animals. Test reactions to toxic chemicals, deprivation diets, frog pithing and the removal of internal organs for physiological study, and other procedures have led to a growing concern among educators about the ethical and pedagogical value of these methods. To be sure, a commitment to "hands-on" learning and "inquiry-oriented" laboratory work is to be supported and encouraged, but at the same time one must seriously consider what is actually being done in the classroom and how it is done. The provision of living animals in high school classes for purposes of vivisection, for example, cannot be justified simply on the basis of an experiential learning approach; other more important aspects, including the humane treatment of sentient creatures and the emotional and psychological growth of young people, should be of much greater concern.

Reverence for Life: An Ethic for High School Biology

Thorough analysis of the relevant philosophical issues lies beyond the intended scope of this paper, but I should like to offer a fundamental ethical precept, which, I believe, could form the basis of a truly humane concern for vertebrate organisms in high school biology curricula. It is Albert Schweitzer's ethic of "reverence for life."

If (a human being) has been touched by the ethic of Reverence for Life, he injures and destroys life only under a necessity which he cannot avoid, and never from thoughtlessness. So far as he is a free man, he uses every oppor-

tunity of tasting the blessedness of being able to assist life and avert it from suffering and destruction (Schweitzer, 1949).

The central notion here is the phrase, "only under a necessity." Whatever views one has on the use of animals in advanced biomedical and scientific research, it is clear that no demonstrable necessity exists to justify infliction of pain or the killing of vertebrate animals in high schools, especially when humane alternatives exist or could be worked out. Indeed, in every instance where animals are "sacrificed" for some particular purpose, the burden of proof lies with those who advocate the taking of animal life to prove necessity. It is the principal contention of this paper that the cognitive education of young people in the high school biology curriculum can be fully satisfied without the need for destructive animal experiments, and that the emotional and aesthetic growth of high school students, so little considered in education today, can be deeply enriched and nurtured by a commitment to the preservation of animal life.

Pedagogical Considerations

Several arguments are advanced to justify the use of animal experimentation in high schools. Many teachers favoring the development of experiential learning hold the view that teaching is enhanced by providing "living material" for students' use. As a general proposition this may well be true, but in actual practice it depends entirely on how the organisms are used and the attitude the instructor adopts toward them. An experiment in which the brain of a frog is destroyed in order to study spinal reflexes or the beating of the animal's heart demonstrates very little that could not be found in any elementary textbook and is a troubling experience for a student of even modest sensibilities. On the other hand, one can learn a surprisingly large amount about a frog by quietly observing its rate of respiration, feeding habits, and the structure of its tympanic membrane. In addition, an imaginative teacher could make good use of transparent organisms (various species of fish and invertebrate organisms) to demonstrate living processes in living animals. It seems to me that one must always keep firmly in mind what the exercise is supposed to be demonstrating. Does the result in any way justify killing or the suffering inflicted on a living creature? (Russell, 1972).

Many of the animal studies carried out by high school students are not experiments at all. As simple demonstrations they do not meet the educational objective for students to conduct inquiry-oriented laboratory study. The late Joseph Wood Krutch called attention to the cruel and pointless nature of many so-called investigations in which animals are starved, infected or manipulated so that students can witness at first hand the effects of experimental procedures, the results of which are already well-known to them in advance. With reference to deprivation diet studies Krutch (1956) wrote the following:

By now it is as well known that a rat will sicken and die without certain foods and vitamins as it is that he will die if given no food at all. Would any one learn anything by poking out the eyes in order to prove that without them animals can't see? . . . Taught by such methods, biology not only fails to promote reverence for life, but encourages the tendency to blaspheme it. Instead of increasing empathy it destroys it. Instead of enlarging our sympathy it hardens the heart.

In no way do these studies give the students a true experience of research or the joy of discovery, nor do they develop the scientific imaginations of young people. Krutch's argument applies, I believe, to a great deal of the animal work performed in high schools today.

Animal experiments in scientific and biomedical research have been justified by their contribution to the advancement of human knowledge. The advances in physiology and medicine and through the use of animal experimentation, for example, have been very substantial indeed, but the question here concerns pedagogy, not research. No single experiment in high school advances human knowledge in the slightest.

Special emphasis is often placed on the need for vivisection and other forms of invasive animal experimentation in high schools to interest young people in medical and scientific careers.* In my opinion, this notion has been greatly overstated, particularly in the premedical area. Has it been clearly demonstrated, for example, that career choices in human or animal medicine are specifically promoted in high school children by starvation of animals or the dissection of living tissues? The available evidence suggests that young people develop an interest in health related careers from personal experience with serious illness, part-time employment with a vet or in a health clinic, or from a deeper, idealistic commitment to a helping profession. Surely, one wishes to nurture the medical and scientific interests of young people, but not at the expense of their compassion and devotion to life itself. And what of the many young people of superior qualifications who, disheartened and disaffected, have turned to other professions because they could not reconcile the infliction of pain, suffering or death in high school experiments with their interest in healing and the preservation of life. I am personally acquainted with several. In my view, premedical education at the high school level would be performing a far greater service by fostering veneration and compassion for life. In an age of specialization, when many physicians are more interested in the disease than in the welfare of the patient, compassion and a personal commitment to human and animal well-being are just as important as diagnostic, therapeutic and technical skills. A prospective surgeon or veterinarian may have to perform animal experimentation during his medical training, but a compelling case has not been made for this to be an essential part of the high school biology curriculum.

The psychological effects of vivisection and invasive animal experimentation on the personality of a young person cannot be overemphasized. In no way does vivisection make a young person better, more capable or more humane. My opposition to so many of the student experiments is based on a concern for the humane treatment of animals and, equally, a concern for the emotional and mental health of the students (Russell, 1972). Commenting on this aspect of animal experimentation in schools, F. Barbara Orlans (1970) has written the following:

Recognizing that youngsters can be emotionally upset by seeing others injure animals, many school districts require that no animals be killed in the presence of pupils. When a student himself hurts or kills an animal, the experience may be either traumatic or emotionally desensitizing. Many high school students

*Of the approximately three million students who take high school biology each year in the United States, only a very small percentage goes on to professional careers in biology or the health sciences. I have often observed that discussions on animal experimentation in high school biology curricula focus too much on the pre-professional students and too little on the overall educational aims for ordinary students, half of whom will never take another science course in their educational careers.

cannot bring themselves to harm animals as it is against their natural feelings, and they are seriously troubled over the moral problems involved when others hurt or kill living beings. Surely it is of paramount importance that a child be protected from violent experiences that are psychologically disturbing.

For many young people, harmful animal experimentation leads to insensitivity, callousness and a progressive crippling of the capacity for feeling. A student who is ready to inflict unnecessary suffering on defenseless animals will certainly be capable of doing the same to human beings. Even if the perception of others as belonging to his own kind restrains him from actual physical abuse, he is likely, I believe, to be insensitive, impersonal and selfish in his dealings with other people. Furthermore, destructive animal work in the classroom impairs a young person's emotional development by teaching him to "rationalize and condone the unjustified inflicting of pain" (Stevens, 1970). The ordinary student who is not continuing into a medical or biological career is hardened and made less humane if his high school studies harm animals; the prospective biologist or medical researcher is impoverished by his lack of sensitivity (Stevens, 1970). Surely, as educators, we have a major responsibility to help young people awaken respect for life and to develop love and admiration for all living things.

It may seem that I have unduly stressed the role of education in fostering the feeling life of students, for education is said to be concerned above all with intellectual growth. Many young people, however, are rather indifferent to academic subject matter and lack genuine enthusiasm for the serious study of natural phenomena. This lukewarm interest, I believe, is caused in part by an overemphasis on unnecessarily abstract mechanistic explanations and too little emphasis on careful observation and first-hand acquaintance with the actual subject matter under consideration. It is essential that students feel inwardly connected with the material they study. A student can begin to understand the "personality" of a species of bird or mammal from patient observation of its life-habits without even knowing the common name of the animal. Only when he has achieved a familiarity based on respect and a sense of kinship can he pursue a true course of intellectual study. Many high school students have little affective connection with the natural world and what concerns me greatly is that cruel or destructive animal experimentation severs the very tenuous connection that does exist, thus making real learning and a viable connection with nature impossible. A student will eagerly learn the names, parts, and processes of plants and animals for which he feels admiration and a sense of wonder (Russell, 1972).

Many young people actively seek ideals by which they can meaningfully conduct their lives in what they see as a troubled and uncertain world. Surely, deeply felt compassion for sentient life and a commitment to the protection of defenseless creatures can help young people to build stable and harmonious personalities, and bring a force of devotion and healing to a world greatly in need of it. A recent editorial (Christian Science Monitor, 1978) summarizes it so very well:

In the deepest sense, the issue (of animal experimentation) has a bearing on the kind of moral environment that is fostered. Surely humaneness toward animals as well as men, a reverence for the life of all creatures, is an essential ingredient of that high ethical tone that marks any civilized society. As scientists who have turned away from animal experimentation argue, the best way to use animals to help humans is to teach people to love.

Humane Alternatives: A Challenge

One must recognize the legitimate need to provide meaningful laboratory experiences for high school students in science fairs, after-school science clubs, and within the ordinary biology curriculum itself. True inquiry-oriented laboratory study gives all high school students a basic understanding of the scientific process, and allows those students, contemplating careers in the biological sciences, to deepen their interests and to investigate natural phenomena in a manner that is both intellectually rewarding and scientifically sound. I firmly believe that these aims can be fully satisfied with humane alternatives that involve no killing or animal suffering. To this end I offer the following list of studies and approaches. The list represents only a broad outline of possible student investigations, and it will serve, I hope, as a challenge for the development of many more. Indeed, if even a fraction of the effort expended so far in devising student experiments could be directed to the imaginative development of humane alternatives, we would soon possess a rich and varied selection of procedures, approaches and meaningful avenues of study.

(1) Use of plant pathogens to illustrate the principles and techniques needed to prove that microbes act as causative agents of disease (Koch's postulates)—The role of microbes in the causation of disease and the specific procedures by which one proves that a particular microbe causes a specific disease (Koch's postulates), can be thoroughly investigated with plant pathogens. As a simple example, soft rot disease of carrots caused by the bacterium, *Erwinia carotovora*, can be studied with very little laboratory apparatus, and the essential features of Koch's postulates thoroughly investigated (Hogue, 1971); procedures of this type provide first-hand knowledge of basic microbiological techniques and their role in studying infectious disease. Analogies can easily be drawn to animal and human disease, and videotapes and films may be used to provide clear demonstrations of clinical symptoms. In brief, one need not present high school children with morbid animals to teach them about disease.

(2) Physiological studies of a wide variety using the students as experimental subjects—It is of particular interest that physiological studies with the students themselves are coming to play an increasingly important role in American medical school education.

There seems to be a trend toward utilizing experiments that can be done on humans and minimizing those done on animals. One reason given is that the student being introduced to bedside teaching early in medical school receives practical demonstration of physiology at the bedside and has much less interest in performing experiments. These labs have offerings of physical diagnosis, pulmonary function tests, electroencephalograms and ECG readings, exercise physiology, special senses and many others using the students themselves as subjects. (Poland et al., 1975)

The following list presents some of the physiological studies that can be carried out by high school students: measurement of blood pressure and cardiovascular status, simple electrocardiography, the galvanic skin response, respiratory processes, exercise physiology and the measurement of physiological parameters during physical training, circadian rhythms, sensory processes, urinalysis, human nutrition, studies on

the blood, and many others. As the author of a college-level laboratory manual in human physiology using noninvasive techniques (Russell, 1978), I can state without reservation that students are eager to participate in studies of this kind and, at the introductory level, learn just as much physiology as they would through destructive animal experiments. As newer forms of educational equipment become available, the range of these experiments should expand considerably, especially at the high school level.

(3) Use of mechanical models to investigate physical principles involved in biological processes—One could offer many suggestions here, but I shall mention only one, the use of mechanical models to investigate elementary physical principles of the heart and circulation. Two such models (composed of syringes, valves, tubing, etc.) have been described by Greenwald (1975) and Rodbard *et al.* (1976). With this apparatus, students can investigate principles such as cardiac output, stroke volume, valve action, peripheral resistance to blood flow, and many others, very few of which could be studied with the usual frog heart preparation. Taken together with the student's assessment of his/her EKG, blood pressure, sounds of the heart, and other cardiovascular processes, these studies give the student a thorough basic understanding of the heart's action. In addition, many schools offer excellent courses in basic cardio-pulmonary resuscitation (CPR) with a strong emphasis on practical aspects. This approach lays to rest, I believe, an objection which has frequently been raised to me, *i.e.*, "How can high school students possibly study the workings of the heart without killing animals?"

(4) Use of human cells (skin, peripheral lymphocytes, etc.) grown in tissue culture for the study of human chromosomes—Tissue culture methods and karyotyping, using human cells grown in suitable nutrient media (available in kit form), can be performed by exceptional high school students. In addition, these methods can be modified to study the effects of pharmacological agents, food additives, radiation, etc. on cell growth and chromosome structure. Most importantly, methods of this kind, which play a significant role in biomedical research, give the students a genuine experience of laboratory research.

(5) Biological studies on living animals in the classroom using methods of non-intervention—Numerous worthwhile suggestions have been offered by several authors and many more can be developed. The Animal Welfare Institute (1977) lists many projects, books and references in this area, and recent books by Crum (1974) and Orlans (1977) present hundreds of detailed suggestions for interesting and highly instructive student investigations. To quote from the introduction to *Animal Care From Protozoa to Small Mammals* by F. Barbara Orlans (1977),

Biology teaching should mesh together the teaching of humaneness, kindness and respect for life, with the spirit of objective inquiry. Students normally show a natural interest in and fondness for animals. It is the responsibility of biology teachers to foster that natural curiosity and affection and broaden it into serious study of the understanding of life processes.

Maintaining living organisms, from protozoa to small mammals, is an ideal way to achieve this end. Among the objectives of keeping classroom animals

are an appreciation of all forms of life, an opportunity to observe and perceive and the challenge to develop a spirit of inquiry and reasoning based on a sound sense of values. All of these pursuits are compatible with the thesis that scientific inquiry and respect for life go hand in hand.

(6) Study of animals in their natural state using methods of nonintervention—A central aim of all high school teaching of science must be to provide young people with a meaningful experience of nature—minerals, plants, animals, clouds and the weather, geological processes, and the entire natural world—through patient and quiet observation. Many college freshmen of my acquaintance have been deeply moved by a study of Iain Douglas-Hamilton's (1975) work on the elephants of Lake Manyara, Tanzania, Durward Allen (1979) on the wolves and moose of Isle Royale, Lake Superior, Jane van Lawick-Goodall (1971) on the wild chimpanzees of Tanzania, and the more popular writings of Konrad Lorenz, Farley Mowat, John Muir, Robert Franklin Leslie and many others. For these young people, the study of biology has suddenly assumed a new and highly relevant dimension, and they have eagerly sought ways to observe wildlife in their own surroundings—squirrels, rabbits, woodpeckers, chickadees, orb spiders, earthworms and many other forms of life. The ethologists and behavioral ecologists can help us to develop many meaningful observational exercises along these lines. I sincerely believe that a proper study of natural history is a fundamental way to assist young people in developing genuine empathy and respect for the natural world and to aid them in building a devoted, lifelong interest in plants, insects, birds, mammals and all life.

As an educator, I am increasingly aware of the additional responsibilities that are coming to fall within the sphere of science education. As in the past, one must formulate educational objectives dealing with knowledge and skills, but also, more recently, with fundamental questions of value. Never before have young people questioned meanings and values so much as today. In spite of this, there is recent evidence that the actual state of high school biology education in this country is one of "a traditional discipline taught in a traditional way. Biology is primarily scientific content, not social concerns, and biology teaching is basically didactic" (Stake and Easley, 1978). Schweitzer's ethic of reverence for life, as well as a new emphasis in biology teaching based on this ethic, could help to give young people an important foundation for their lives. If biology were taught in a manner that developed a sense of wonder and a feeling of reverence for life, and if students felt inwardly enriched from their study of life, these individuals would formulate as a lifelong goal the steadfast determination to protect and preserve all life, and would, I believe, dedicate themselves to the creation of a better world.

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Pain-infliction in Animal Research*

Dorothy Tenrov

Abstract

A summary of research outlining the main sources of pain and stress to animals in laboratories provides the background for the results of a survey conducted by the author on how students feel about experimentation involving animals. The psychological aspects of student reaction to animal experimentation are examined. The conclusion outlines specific recommendations on ways to minimize pain and discomfort of laboratory animals.

Attitudes Toward Pain-infliction in Animal Research

It has been observed that willingness to cause injury or death to others varies with degree of dehumanization of the victim (Bernard et al., 1971), physical proximity (Milgram, 1965), and visibility (Johnson, 1972). Among situations in which pain is commonly inflicted is psychological research using animal subjects. The study reported in this article explores reactions to such research as a function of (1) the species of the animal subject, and (2) a verbal context which stresses either benefits to human beings or painful research procedures.

A brief questionnaire was designed to determine whether, when asked to participate in a pain-infliction animal research project, subjects would consent or refuse primarily (1) on the basis of the pain and discomfort to be experienced by the animal (assuming those phylogenetically closest to humans would be more likely to experience pain as we know it), or (2) on the basis of evaluation of the species in terms of its relationship and familiarity to human beings. It has been demonstrated that attitudes toward pain infliction vary among human categories (Berkowitz, 1964; Johnson, 1972). Species differentiation was conceived of as analogous to differentiation among human categories as well as of interest in itself.

Subjects were 688 undergraduates from introductory psychology classes. At the beginning of the class session, a one-page flyer was distributed. There were three basic forms: (a) **TORCH**, which began with "Although human beings have undoubtedly benefited in the process, research animals have been subjected to such extremely painful procedures as burning by blow torch, submersion in scalding water, and extreme unavoidable electric shock," (b) **BENEFIT**, which began with "We would still be in the

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