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Title: The study that made rats jump for joy, and then killed them

Subtitle: The gap between knowledge and practice widens when scientists fail to engage with the ethical implications of their own work

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Updated scientific evidence for animal sentience should translate into political changes, but a persistent gap between knowledge and practice continues to limit this very translation [1]. This trend is exemplified in rodents, a taxon whose members experience pain, laugh when tickled, exhibit complex emotions like empathy and regret, and engage in costly helping behaviors towards conspecifics. Nonetheless, rodents remain excluded from legislative protections (e.g., the U.S. Animal Welfare Act), are victims of routine killing in the name of science, and are viewed as pests in the eyes of the public [2]. Here we suggest that an overlooked cause of the disconnect between harmful practices, research in animal welfare science, and debates in animal ethics is that scientists themselves fail to engage with the ethical implications of their own work [3]. This disconnect is clear, and most egregious, when the scientists who generate data on rodent sentience and subjectivity harm or kill them without acknowledging any ethical issues, or offering any justification for this harm. How can we expect society at large to translate updated evidence into ethical changes when science itself fails to openly recognize, let alone change, the contradictions involved in conducting invasive research on sentient animals? We reflect on a particularly illustrative case below, which shows that acknowledging such contradictions may be the first step towards resolving them in an ethically acceptable way.

A recent study published in *Science* titled ‘Behavioral and neuronal correlates of hide-and-seek in rats’ [4] illustrates the incongruence that arises when contemporary behavioral science stops short of considering the ethical implications of its own findings. While the pioneering study design, which relied on play bonds between rats and experimenters, sheds new light on rats' perspective-taking abilities, autonomy, and the potential for human-rodent relationships, the study subjects were ultimately killed in the service of the research. While the researchers themselves offer their results as evidence of sophisticated mental and emotional capacities in rodents, they nevertheless do not address any ethical issues raised by their methods and results.

In their innovative experimental setup, researchers trained rats to participate in an elaborate role-play game: to ‘hide’ (take cover in one of several locations and wait there until being found by the experimenter) and ‘seek’ (search for hidden experimenters until finding them). Not only did rats rapidly learn to play and switch between both roles, they appeared to find the game

intrinsically rewarding. The authors highlight how this ‘agency-affording’ methodological approach represents a welcome departure from traditional behavioral paradigms, which often rely on strict control and conditioning [4]. They directly emphasize the potential of this original and unrestricted experimental setup, wherein rats are allowed to just ‘be rats’ [5]. This study is exciting in that it showcases the potential of human-animal interactions (i.e., the social bonds cultivated between the researchers and the rats) to explore animal minds. It thereby breaks with historical paradigms that impose detachment between experimenters and study subjects in the interest of scientific objectivity, following recent studies on domestic dogs [6]. We also find these pioneering aspects of the study design worthy of recognition, not to mention the key findings and corresponding insights they generated, which together exemplify how a greater acknowledgment of animal subjectivity can lead to innovative empirical techniques and widen the scope of the hypotheses that scientists of animal behavior can test [3].

In order to test the novel hide-and-seek hypothesis, rats were remunerated with playful social interactions (rather than classic rewards like food, which are typical of associative learning paradigms) upon finding or being found by the experimenter. The authors contend that play itself was rewarding, as they describe the rats jumping for joy (*freudensprung*) upon reunion with experimenters, which is a behavior that many mammals exhibit when they are merely having fun. Rats emitted complex vocalizations both when seeking and finding, but were silent when hiding. Rats thus assumed different roles and strategized about where to hide, which the authors acknowledge as evidence that rats can consider the vantage point of the experimenter, thereby providing a unique window onto perspective-taking and theory-of-mind capabilities. Upon being found, rats prolonged the game by re-hiding and thereby delaying the social reward—a behavior indicative of self-control and autonomy. It is likely that the authors are aware that these very concepts are central to arguments for the ethical standing of animals, and have figured prominently in recent personhood cases advocating for legal protections for large mammals [7]. Indeed, the article seems to be aware that its results will be regarded as exciting and high impact due to background assumptions of readers, who will find the discovered traits remarkable precisely because of the ethical questions that they raise.

Although the novelty of the behavioral design and associated results appear powerful enough on their own to warrant publication in *Science*, and to solicit the broad media coverage that did indeed follow, the authors further endeavored to study the neural underpinnings of this striking hide-and-seek behavior by surgically implanting tetrodes in the rats’ brains. At the conclusion of the experiment, rats were anesthetized (so that tetrode positions could be demarcated) and eventually received an overdose of the anesthetic before being transcardially perfused [4]. Alongside evidence of sophisticated play behaviors indicative of capacities like agency and autonomy, these procedures generate the sense of a practical contradiction between the study’s results and its methods. As a result, the fact that the publication and associated press coverage made no mention of ethical questions raised by the neuroscientific protocol is a surprising and glaring omission.

Of course, this omission reflects a pervasive and institutionally set, yet false, divide between ‘objective’ scientific inquiry and the value laden-field of ethics more generally [3], as well as a scientific routine where killing rodents is such common practice that alternatives may sometimes fail to be considered. Most tellingly, press coverage of the study emphasizes that hesitation to

attribute human-like mental states to other species is receding [8], but this in turn should raise questions about killing animals for scientific research, echoing the ethical questions that recent discoveries about octopus minds raise for octopus farming practices [9]. To be clear, we are not referring to research ethics protocols (i.e., authors' statement of adherence to animal welfare guidelines and experimentation permits), nor do we intend to ignite a broader debate about the relative scientific value of neuroscientific (vs. non-invasive behavioral) evidence, which is an important discussion in its own right—but one that would require extensive reflection on a much wider array of sources and issues. Our aim is *neither* to reprimand the researchers and their moral character, *nor* to deem the study ethical or unethical. Rather, this study uniquely underscores the fact that behavioral science and scientists should no longer step over the ethical issues they directly bring to the fore.

Although identifying a contradiction between results and practice would not necessarily go far enough in our view toward correcting the problem, acknowledging this contradiction is a necessary first step. It is also a first step towards bridging problematic divides between research and practice, knowledge and policy, science and society. Studies like the one described above have clear and direct implications for pressing moral issues surrounding the welfare and treatment of animals. The scientific community studying animal behavior bears a social responsibility to engage with these implications [3], and researchers are at least expected to acknowledge such ethical issues, especially when their own questions and protocols require that animals are harmed and/or killed. Such acknowledgement is particularly expected when research aims to contribute to knowledge of animal mental and emotional states, which directly informs ethical guidelines. Other recent studies show that the study discussed here is by no means the exception in this regard. For example, research demonstrating empathy and prosocial helping behavior in rodents relies on experimental paradigms that also involve harmful and ultimately lethal procedures that aim to uncover biological mechanisms [10]. To be clear, in isolating one study, we do not wish to point fingers or ostracize its authors, but provide a higher resolution analysis of a recent, influential study that illustrates this more general, pervasive phenomenon. When scientists remain silent on the paradoxes generated by our increasing knowledge of animal agency and subjectivity, they do not adopt a 'neutral' stance, but rather widen the gap between the current state of knowledge and animal treatment. More specifically, by not openly acknowledging this dissonance, these scientists actually act in an antagonistic manner towards efforts to marry evidence with legislative or political changes for rodents. There is growing recognition that ethical and philosophical debates can have an important and productive impact on science [11] including those related to the moral standing of animals [3], but the absence of recognition of ethical issues in research articles like the one described here shows that engagement between these fields may be overdue.

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