

“The Jumpers”

Elizabeth Heppenheimer

“I never knew that fish killed themselves,” I half jokingly said to my lab partner, Abi. We were cleaning up the remains of our shark minnows, which had apparently jumped out of their tanks overnight. Abi sighed as she wrapped a dead fish in a paper towel and tossed it into the garbage. “I just don’t understand how this happened,” she replied.

Abi and I had spent most of the previous night setting up six fish tanks for our final behavioral ecology class project. It was not supposed to be complicated. We prepared six fish tanks, each containing three species of fish. Three of the tanks were “high density” and had a total of twelve fish, while the three “low density” tanks had a total of six fish. We had planned to observe the behavioral interactions within and among species. After letting the fish acclimate overnight, Abi and I went back to check on them around ten in the morning.

That was when I found the first dead fish. The black countertop was in poor contrast with the graphite-colored bodies of the shark minnows, but sure enough, lying on the counter next to one of the depleted tanks was a fish that could not be resuscitated. The minnow had clearly been out of the water for several hours. Its body was so dry that it more closely resembled a raisin with fins than a fish. I was surrounded by fish carcasses, and there was only one explanation for how they got there. The fish had leapt out of their tanks.

For several weeks following the incident, I went around telling my friends the story of how my fish had committed suicide. But it soon occurred to me that by labeling what my fish had done “suicide” I was implying that the fish made a conscious decision to jump. I had no idea if what my fish had done was cognizant or if fish could even think. When I began to consider my word choice, my first instinct was that rainbow shark minnows were not capable of feeling the same kind of misery as humans and that they probably could not decide to kill themselves in the same way humans do.

Although they are named after a major marine predator, rainbow shark minnows are actually a puny species of ray-finned fish. They are only about three inches long, and I suspected that their brains are no larger than a pebble. Consequently, their capacity for emotion and conscious decision is likely rather limited. However, at this point it was unscientific to rule out that my fish could feel emotions and make the decision to end their life. To attempt to understand what happened to my fish, I paid a visit to the professor who had advised me on the ill-fated project, Dr. Dan Ardia.

Dr. Ardia was not what one might call a typical professor, the kind that wears a bow tie and a blazer with suede elbow patches. Instead, he opted for cargo pants and a t-shirt. He allowed his students to call him by his first name, or omit the prefix that acknowledged his hard earned PhD. Despite the casual garb and attitude, Dr. Ardia made sure that his students knew he was the one in charge, and I hated being on his bad side. He certainly had a few choice words for us when we told him that the fish had escaped.

I sat down and explained that I wanted to know why he thought the fish had jumped. He began with a few possible evolutionary explanations for the behavior that had nothing to do with emotions. “Jumping behavior in fish is something we observe with dispersal. It’s purposeful and adaptive,” he explained. Dispersal, or the tendency to leave one’s natal site, is a relatively common adaptive behavior. That is, a behavior that increases survival and reproduction. Initially, it may seem counterintuitive that jumping out of the water to disperse might actually *enhance* survival. However, dispersal is important in environments where resources are limited and competition for those resources is high, as individuals will have a greater chance of accessing resources that are important for survival if they can disperse from their native environment.

“It’s also possible that, in this case, the fish were engaging in some other kind of behavior, like fighting, and sort of accidently jumped out,” Dr. Ardia continued. When I

specifically asked if he thought the fish were committing suicide, he responded that suicide, in the human sense of the word, probably was not the proper term.

“Fish are thought to have a relatively low level of consciousness. They have not responded significantly to tests that are designed to measure self-awareness. I think it is unlikely that they evaluated their prospects and committed suicide because it looked grim.”

“Do you think fish are at all capable of experiencing emotions that are typically associated with suicide, such as hopelessness, despair, pain, or fear?” I asked.

“If you define hopelessness or fear as extremely elevated stress levels, then yes.”

Then Dr. Ardia said something that surprised me.

“We probably put them in too small of a space, which triggered their urge to explore. Think about it. If we were caged, we would want to explore and would actively seek to see the world.”

“But I thought you just said fish don’t have a high level of consciousness compared to humans,” I pointed out, confused.

“That’s right, they likely don’t. In this case, the urge to jump is probably pretty hard-wired. They don’t think about it. It’s an innate urge that is activated under certain conditions. In this case, that urge became fatal.”

“The six-gallon tank was the trigger because it was a small space?” I clarified.

“It might have been, but I don’t know for sure. It’s certainly testable: we could put rainbow shark minnows in a bigger tank and see if they jump.”

So maybe my fish did not *actually* commit suicide. But Dr. Ardia’s comment about the urge to explore stuck with me, and after my visit with him I did some follow-up research of my own. I started in the same place he had, with an evolutionary reason that fish might exhibit jumping behavior: dispersal.

To my dismay, there did not seem to be any scholarly research related to rainbow shark minnows and dispersal. However, dispersal-related jumping behavior has been documented in

at least one species of fish. Gobies, tiny fish that live in tide pools in the West Indies, have been observed to jump between pools at low tide (Aronson 1951). The existence of this jumping behavior in gobies implies that jumping from habitat to habitat must be beneficial in terms of survival and reproduction, because if it were not, the fish with a genetic predisposition to perform this behavior would not survive long enough to reproduce and pass their genes to future generations.

Generally, Dr. Ardia was correct in his assertion that fish can experience pain and fear. Ray-finned fish do have pain receptors that are similar to the human nervous system (Braithwaite & Huntingford 2004). Furthermore, experiments that exposed ray-finned fish to harmful stimulation, for example, acetic acid, the main ingredient in vinegar, were consistent with the hypothesis that fish can perceive these signals (Sneddon 2003). Interestingly, fish that have been exposed to these harmful chemicals display a distinct avoidance of unfamiliar objects that were added to their tanks, suggesting that the fish were afraid of the objects (Sneddon 2003). However, it is completely unclear as to whether these emotions are on par with what a human has the capacity to feel (Braithwaite & Huntingford 2004).

There is also evidence that red gurnards, another species of ray-finned fish, experience high levels of stress when confined to a small tank (Clearwater & Pankhurst 1997). Specifically, hormone levels in captured red gurnards suggest that they are persistently stressed during the first twenty-four hours of captivity (Clearwater & Pankhurst 1997). As the great rainbow shark minnow escape occurred somewhere between one and twelve hours after setting up the tanks, it seems possible that their behavior was associated with the stress of being confined to a small tank. However, I did not come across evidence that suggests fish exhibit jumping behavior when stressed.

Ultimately, I could not determine from the literature if my fish jumped out of their tanks because they were responding to an innate impulse to explore, because they were experiencing stress, or for another reason entirely. Although he could speculate, Dr. Ardia did not know the

answer either. We did know, however, that something we as researchers did to the fish led to their deaths. If human researchers are causing harm to their animal subjects, does that mean we have an ethical responsibility to modify our research practices to accommodate animal welfare? This question is commonly debated in science and the short answer is yes, but it isn't always clear when we are crossing a line. The few shark minnows that did survive their stint as research subjects were relocated to personal fish tanks. Our next step should be to design a set of experiments to determine if our research caused any irrevocable damage to their psyches.

Literature Cited

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- Braithwaite, V.A., Huntingford, F.A. 2004. Fish and welfare: do fish have the capacity for pain perception and suffering? *Animal Welfare*. 13: S87-92.
- Clearwater, S.J., Pankhurst, N.W. 1997. The response to capture and confinement stress of plasma cortisol, plasma sex steroids and vitellogenic oocytes in the marine teleost, red gurnard. *Journal of Fish Biology*. 50: 429-441.
- Sneddon, L.U., Braithwaite, V.A., Gentle, M.J. 2003. Novel objects test: examining nociception and fear in the rainbow trout. *Journal of Pain*. 4: 431-440.

This assignment was inspired by:

- Morell, V. 2013. *Animal Wise: The Thoughts and Emotions of Our Fellow Creatures*. New York: Crown.

Fellow Commentary

Kelly Rafey

When the editorial staff made the decision to place scientific writing beside humanities writing in this year’s edition of *Tortoise*, we did not anticipate that we would receive essays that were, to some degree, both.

A creative account of a scientific experience written in a style readily accessible to everyone, “The Jumpers” represents a genre of writing that we are unfamiliar with here at Princeton. It is an example of popular scientific writing: an engaging narrative designed to be accessible to the uninformed reader. Elizabeth wrote “The Jumpers” for an English course on Science Writing as an undergraduate student. Inspired by Virginia Morell’s 2013 book, *Animal Wise: The Thoughts and Emotions of Our Fellow Creatures*, the students were asked to describe and understand a notable encounter with an animal, with the primary goal of describing a scientific experience to an audience of nonscientists.

The immediate implications of this sort of assignment are clear: the writer must avoid overly technical jargon and strike a delicate balance between narrative and academic inquiry. Elizabeth tempers her informative sections (where she learns details about rainbow shark minnows and other fish that have been known to jump out of their tanks) with narrative details. She presents her section of “hypotheses” (that the rainbow shark minnows jumped either to disperse themselves or to escape their cramped living quarters) in the form of dialogue between herself and her professor. She quotes his speech just as a formal essay would quote a scholar’s published writing. By retelling the information as a section in a narrative, Elizabeth is able to slow down, clarify what her professor says, and, most importantly, present his speculations in an easily accessible manner. This style of dialogue, of presenting information as a story rather than an essay, is a feature of this particular genre. Yet the essay’s overall structure is not unfamiliar.

Elizabeth begins with all of the pieces of a classic introduction, refurbished to be more engaging and personalized. She poses her orienting question (Why did the rainbow shark minnows jump?) in the opening paragraph, signaling to the reader that this will be the topic of inquiry throughout the entire essay. Her question is strongly motivated by her personal anecdote of the mysterious minnow-deaths, a perplexing puzzle for her and a life-threatening situation for the fish. Only after she presents and motivates her research question does Elizabeth dip her toe in the waters of background information and hypotheses. She does research and presents her sources to the reader. She explains the evidence that they contain and analyzes their worth and their implications. At the end of her essay Elizabeth steps back and assesses her final position: what she has been able to answer and what is left unexplained? She closes with suggestions of further topics to research, a classic essay ending and often a staple of scientific writing.

On a fundamental level, “The Jumpers” is no different from any of the other essays we have published. It is not a scientific paper disguised as a humanities paper. It is simply an essay. It asks, motivates, and answers a specific question in a form best suited to its target audience. Just as an abstract for a biology conference is custom tailored for a panel of seasoned biologists, just as an English paper is written for an informed, well-read audience, this paper, too, is composed for a specific readership. And beneath the targeted composition of all of these papers is a single scaffolding: the basic structure of an academic essay.