Red Fish,

Investigating

by Lisa M. Blank

Wolves flatten their ears, raise their tails, and deliver a menacing growl. Cats arch their backs and raise their hackles. Red deer roar. Iguanas nod their heads. Rattlesnakes shake their tails. And Siamese fighting fish flare their gill covers and splay their fins. All of these behaviors are examples of animal threat displays. What signals trigger such aggressive behavior? In this inquiry exploration for grades five through eight, students test their ideas about what triggers aggressive behavior in Siamese fighting fish.

Siamese fighting fish

Siamese fighting fish (*Betta splendens*) are native to Southeast Asia, where they inhabit shallow water channels and flooded rice fields. Bettas, like lungfish, can obtain oxygen from both water and air because of an extra respiratory organ located in the roof of their mouth. This is why Bettas can live in the small fish bowls you see in pet stores. You probably have also noticed that there is never more than one Betta per bowl. This is because male Bettas are extremely aggressive with one another and will engage in spectacular battles when kept in close quarters. When placed together, the males will face each other, flare their gill covers, and raise their fins to increase their apparent size—a threat display that usually succeeds in avoiding a physical confrontation, which would involve severe biting, side-to-side tail beating, and sometimes even death.[1]

What's the signal?

Because of these clearly observable threat displays, Bettas quickly generate student interest in animal behavior and, best of all, questions that students can answer through inquiry. So what is the signal that triggers the Betta's behavior?

Ethologists, scientists who study animal behavior, know that male Bettas behave aggressively in an attempt to defend their bubble nests or their territory, but the signal that triggers the response is less understood. For example, Bettas are not known to attack goldfish. How do they know when another male Betta, and not a goldfish, has entered their territory? Is it by size, color, or fin shape? By doing the following activity, students can begin to answer this question and many others.

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Blue Fish

Animal Signals

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Betta find out

Divide students into groups of two or three and prepare the following materials for each group: one male Betta (available at pet stores for about two dollars per fish), one small fish bowl or large beaker, one small (10 x 15-cm) mirror, one set of markers, and 15 small index cards.

Bettas should be placed in a bowl or beaker of 22–25°C (room temperature) distilled water, or tap water that has been aged for 24 hours. Place the fish in the containers at least five minutes before class so that the fish have a chance to acclimate. Provide each group with a Betta and invite students to make careful observations of the Betta's behavior. For example, ask them "What color is your Betta?" and "How fast is your Betta's rate of gill movement?" Each student records his or her observations on the worksheet shown on page 17. All the student data is then compiled and distributed to the class for analysis.

Once students have established their fish's behavior in the absence of a stimulus, have them hold up a mirror against the side of the bowl for 30 seconds so that the fish can see its reflection. Record what happens. Is there any gill flaring, increase in gill movement, fanning of the fins, or a change in color? Do the responses become more or less aggressive after time? Do some behaviors appear or stop before others? How long do the behaviors last? Establish a class record sheet on the blackboard to compare group results.

Students will notice that some of the Bettas respond more aggressively than others. Have students hypothesize why this might be. Once students establish the range of the aggressive response behaviors, challenge each group to consider what triggers the Betta's behavior. Could it be the color, shape, movement, or size of the reflection in the mirror? All of these? Perhaps a combination?

Have groups share their predictions with the class and discuss how they could design an experiment to test their ideas. What materials would they need? If students have difficulty proposing a design, you may want to provide a model. For example, if one group predicts color as the stimulus, it might begin its investigation by presenting its Betta with an index card colored with a red spot (see Figure 1). Have the group hold the card in front of the Betta for 30 seconds. Ask the group how the fish responds. If the Betta does not respond, have

Figure 1. Sample color series

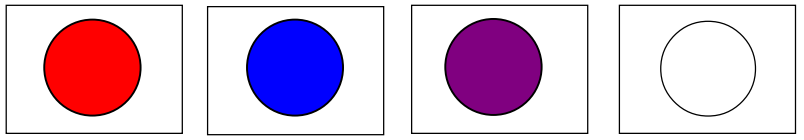


Figure 2. Sample shape series

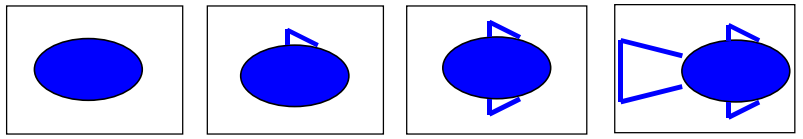
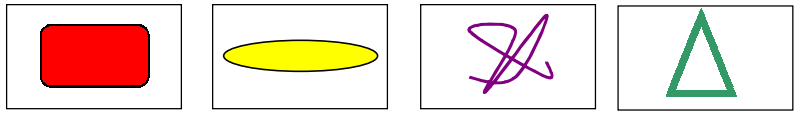


Figure 3. Student shape series



the students make more cards using other colors. After each new card is presented to the Betta, have the students record the observed behavior, wait one minute, and present a new card.

Perhaps students think the shape of the reflection stimulates the Betta's aggressive behavior. They could begin to add shapes to their cards, gradually making the picture look more and more fishlike (see Figure 2). Their choice of color would not matter as long as the same color is used on all the cards.

After students have collected their data, have the groups share their results. What conclusions can they make about what stimulates the Betta's threat displays? This is also a good time to discuss experimental design. For example, one group of my students used the card series pictured in Figure 3. When this group shared its results, several other students pointed out that they couldn't be sure if it was color or shape that the Betta responded to because the group had used cards with different colors *and* shapes. At this point, encourage students to modify their designs if their results are unclear.

After turning in their data sheets, students can individually pursue other questions that come up as a result of sharing one another's information. Students come up with an amazing array of further questions to investigate. Some questions that my students have pursued are

1. Do some fish behave more aggressively than others?
2. Does water temperature influence the tendency toward aggression?
3. Does the distance between the card and the fish matter?
4. How does the fish respond to a moving card?
5. Are there any other signals Bettas use to communicate with one another?

Students can choose to investigate Bettas or any other animal species. My purpose is to get students to think about how ethologists study animal behavior and the importance of designing appropriate tests to answer their questions. I follow up by sharing other animal behavior studies, such as those on the social behavior of wolves. For example, I discuss how tail placement communicates a wolf's standing within its pack.

After the investigations, if students express interest in taking the Bettas home, I require students to write a short essay on how they will care for the Betta and to bring a signed permission slip from home. Only after that do I provide students with a bowl and enough food for a week. Otherwise, I keep the Bettas in the classroom throughout the year and assign various students to care for the fish. This gives the students a sense of ownership of the room and encourages responsible animal care.

Gone fishing

The *National Science Education Standards* highlight the behavior of organisms as one of the fundamental concepts all students should understand.[2] After you lure your students into the world of animal behavior with this Betta activity, have them fish around for other

JENNIFER M. WANG

behaviors to investigate. For example, they might want to look into the way male peacocks use their elaborate train and how fireflies flash at night to attract mates. Or, they could examine the way wolves and other species mark their territory, and the stotting (hopping up and down) of Thompson's gazelles, which signals their ability to escape from predators.[3] Get them started today with a quick trip to the pet store.

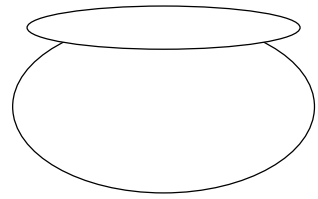
References

1. Allen, J. and P. Nicoletto. 1997. "Response of *Betta splendens* to Computer Animations of Males with Fins of Different Lengths." *Copeia* 1: 195–199.
2. National Research Council. 1996. *National science education standards*. Washington, D.C.: National Academy Press.
3. Endler, J. 1992. "Signals, Signal Conditions, and the Direction of Evolution." *The American Naturalist* 139: 125–153.

Betta behavior

Part I: Getting to know your Betta

1. What does your Betta look like?

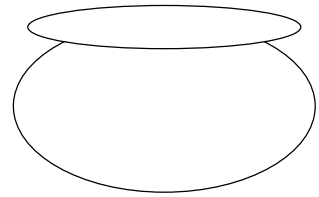


2. Carefully watch your Betta. Record everything you observe.

3. How many times does the Betta move its gills in one minute? _____

Part II: The Betta and its reflection

1. Hold a mirror up against the bowl. How does your fish respond? Record your observations below and draw what you see.



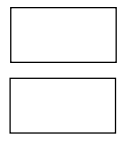
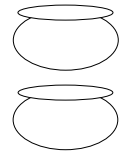
2. How many times does the Betta move its gills in one minute? _____ How does this compare with before?

3. Why do you think this is happening?

4. Share your thoughts with your group. How do your ideas compare? Do you all agree?

5. How could you test your ideas?

Part III: You be the scientist

Your signal	Fish response	What does this tell you?
		

Part IV: So that's why!

What conclusions can you make about what triggers the Betta's aggressive displays? How do these conclusions compare with what you originally thought? What did other groups find from their investigations?