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Measuring is believing: quantifying adaptation behaviour of *Hydra*

Worksheet 2 answer sheet

What could the time periods of the movement represent in the *Hydra's* natural environment?

The time periods represent how fast/slow water movements are in the *Hydra*'s habitat. Changes in water currents that are maintained for extended times (like movements every 5 s) are likely due to environmental changes such as stronger water flow. Thus, it makes sense for the animal to adapt and elongate again, as contraction is energetically costly and prevents *Hydra* from catching prey. In contrast, movement at a time period of 30 s takes a long time to re-occur, so it is unlikely to be due to changes of flow. It may instead be due to a predator or other acute threat. The animal does react every time if the spacing of the motion is sufficiently large.

How often did the *Hydra* contract in the 2.5 min of observation time? When did these contractions occur?

The *Hydra* in the 5 s time period is theoretically only supposed to contract once, but it may contract multiple times because of differences in force or amplitude when moving the stage. However, by plotting when the contractions occur, the students can see that adaptation occurs. In the 30 s time period, the *Hydra* contract every time it is stimulated, about 5 times throughout the 2.5 min of observation time.

Did the two animals tested for each time period respond in the same way (yes/no)? Explain your answer. How many animals do you think are ideal for this experiment?

There can be some variability between the animals, but they should generally behave the same for each stimulus. If the animals behave very differently, it will be easy for students to see that they must test more animals. If they behave very similar it would be helpful to emphasise to students that we cannot draw strong conclusions from observing only 1–2 animals as those may not be representative of the population. An everyday example may be helpful here: Ask two students in the class if they like a popular book/movie. Then, falsely conclude that everyone in the class likes that book/movie. This conclusion is not representative of the entire class as more students need to be questioned. By measuring more students, we get a better representation of the distribution.

Why did we count the number of contractions to compare the different time period trials?

A smaller number of contractions indicate that the adaptation response is activated, as the *Hydra* will stop contracting to each water movement and instead elongate. A larger number of contractions means that the adaptation response is not activated and that the *Hydra* contracts regularly to each water movement.

Why would the Hydra not want to stay contracted forever?

To assist in classroom discussion, consider this example. A human muscle can contract and relax when flexed. *Hydra* contractions work similarly, with the whole *Hydra* body contracting or elongating. Contracting a muscle takes a lot of energy, which is why it is not optimal for a muscle to stay contracted forever. In addition, a contracted Hydra cannot feed, so this is not a good long-term state to be in.

Do our results support our class hypothesis? Why or why not?

The class hypothesis states that "Hydra sense and adapt to repetitive water current changes so they can respond to new acute stimuli." Because the experiments show adaptation to stimuli that happen frequent enough (5 s) but not to stimuli that are further spaced apart (30 s), they support the hypothesis.

What future experiments can you come up with to explore this topic further?

As a starting point, have the students list conditions that did not change in their experiments. Changing any one of these conditions – while fixing the time period – will lead to a new scientific question to be discovered. Students can also add onto the existing experimental setup to mimic conditions from the *Hydra*'s environment. Examples include varying the intensity of each movement with strong versus weak motion, changing the water temperature, changing the viscosity of the water, and testing higher frequencies. For each idea, encourage the students to identify the question behind their topic, and then to write a brief statement (1–2 sentences) of the experimental procedure.

How does *Hydra*'s nerve net compare to the nervous system in the human body?

Just as humans feel someone tapping on their shoulder and turn around in response, *Hydra* detect the water currents moving against their body and react accordingly. The core difference is that *Hydra* do not possess a brain, so they are still very different from humans!

While experiments on vertebrate animals are regulated by laws in many countries, no laws exist for invertebrates, such as *Hydra*. Given what you have learned about *Hydra*'s nervous system and its ability to sense and adapt to its environment, what do you think are important factors to consider when studying *Hydra* and other invertebrates?

The primary aim of this discussion question is to raise students' awareness about animal welfare. It may be useful to explain why vertebrates are protected by laws, while invertebrates are not, and to emphasise that our knowledge of animals is steadily evolving as are the relevant regulations.