Student

Activity 1.23 Does caffeine affect heart rate?

Purpose

- To investigate the effect of caffeine on the heart rate of *Daphnia* (water fleas).

Caffeine

Plants produce caffeine as an insecticide. Cocoa in South America, coffee in Africa and tea in Asia have all been used for hundreds of years to produce 'pick me up' drinks containing caffeine. These days, caffeine is also used as a flavour enhancer in a wide range of cola and other soft drinks. In addition, it has medicinal uses in aspirin preparations and is found in weight-loss drugs and as a stimulant in students' exam-time favourites like Pro-plus and Red Bull.

In humans, caffeine acts as a stimulant drug, causing increased amounts of stimulatory neurotransmitters to be released. At high levels of consumption caffeine has been linked to restlessness, insomnia and anxiety, causing raised stress and blood pressure. This can lead to heart and circulation problems.

Safety

If a stroboscope is used to show the Daphnia's *heart rate and you know you suffer from photosensitive epilepsy tell your teacher and take appropriate precautions.*

Procedure

Making a hypothesis

What do you think will be the effect of caffeine on the heart rate of water fleas? Write down your ideas and support your prediction by presenting biological knowledge which supports the idea. You now have an idea (hypothesis) to test.

Planning

The beating heart of a water flea can be seen through its translucent body, by placing the flea in a few drops of water in a cavity slide. A cover slip helps stop the water evaporating.

The following equipment will be available:

- Culture of *Daphnia* (water fleas)
- Cavity slides
- Dropping pipettes
- Distilled water
- Caffeine tablets
- Cotton wool
- Standard glassware (beakers, measuring cylinders, etc.)
- Stopclock
- Paper towels or filter paper
- Microscope

Produce a detailed plan for an experiment that allows you to test your hypothesis about the effect of caffeine on the heart rate of water fleas.

In your plan, make sure you include the following:

- Select suitable apparatus that will give you measurements which will validly test your hypothesis. Explain why the apparatus is suitable and how the results will let you test the hypothesis.

- Include a risk assessment, identifying any risks and explaining any safety precautions that need to be taken so as to reduce those risks.
- Comment on any ethical issues that arise from using invertebrates in the experiment and explain how these will be taken into account in the practical method used.
- Identify the dependent and independent variables and indicate how relevant variables will be controlled.
- Show how you will ensure that reliable and valid results are produced and describe what you will do to ensure that measurements are precise, accurate and repeatable.
- Identify any potential errors in readings that can be systematic (values differing from the true value by the same amount) or random (values equally likely to lie above or below the true value).

Performing the experiment

Either use the plan you have created after it has been checked by your teacher/lecturer or use a method supplied by your teacher/lecturer.

Presenting your data

Present your data in an appropriate table and graph. See the features of a good table and graph in the Maths/stats support.

If you have lots of repeated results, remember that you should work out mean values and present these in your report. This also lets you comment on the significance of your results. If the results that are used to calculate the means are very variable, this indicates errors within the experiment and any differences between the treatment means may not be significant. The range of values can be shown on the graph using bars on each point as a measure of the variation of the data. See Maths/Stats Support 10 *Standard Deviation* for details of how to work out standard error. NB: you need to make it clear what any bars on a graph are showing.

Using results to draw conclusions

In the discussion of your results you should explain any trends and patterns in your data. You should use evidence from the data when identifying patterns and trends. For example, when you identify a trend in the results you should quote some data that shows the trend. For instance, in an experiment investigating inhibition of the enzyme catalase by copper sulphate you might report that there is a steady decrease in the volume of oxygen produced with increasing copper sulphate concentration: at 0.25 M copper sulphate the mean volume of oxygen produced was 0.57 cm^3; with 2 M copper sulphate the volume of oxygen produced had fallen to 0.27 cm^3.

You should then attempt to explain any patterns and trends using your biological knowledge. Remember that the hypothesis you suggested may not be correct. In this case, the results will not show the patterns or trends that you expected. There may be a different trend or no trend at all. This is perfectly OK. You may be able to suggest an alternative explanation for the results you have obtained. Alternatively, you may still think the original hypothesis is sound but there are concerns about the experimental method used and the results obtained are not very valid, i.e. they may not be testing the hypothesis appropriately. In this case, you cannot draw valid conclusions from the results and this should be explained in your write up. A report on an experiment that does not produce the expected results is often as valuable to other researchers as a report that supports the original hypothesis. It allows other researchers to make informed decisions about the methods they will use in the future and it may allow them to suggest alternative ideas.