CAN SNAILS BECOME HABITUATED TO A STIMULUS?

Purpose

- To investigate habituation of snails to a stimulus.
- To develop practical skills.

SAFETY

Wash your hands thoroughly after touching the snails and once all the equipment has been put ready for disinfection. Avoid touching your face after handling the snails.

Take care that the stimulus causes no harm to the snails.

Touching snails

Many people will have touched a snail in the garden and noticed that it immediately withdraws its eye stalks. For such a slow-moving animal this seems a very quick response. This suggests that it is important for protection and survival. A snail only withdraws when it is either inactive or threatened. When touched, it withdraws to avoid danger. Do snails become habituated to the stimulus, ceasing to withdraw with repeated stimulation? In this investigation you will collect data to find out if habituation to a touch stimulus does occur in these organisms.

1 Scientific questions and information research

Before you start the experiment you should:

Research relevant information and state what you are going to investigate. What is the hypothesis you are testing? What do you expect to happen to the response time of the snail as the number of stimuli increases? Why do you expect it to change in this way? Justify your hypothesis using your biological understanding. You may need to carry out additional research in order to do this.

2 Planning and experimental design

Read through the procedure outlined below. Use this to identify the independent and dependent variables, and any other variables that may affect the outcome of this investigation. When using living organisms, it is often difficult to keep all controlled variables the same. Which variables may be difficult to control? What type of error will be introduced to your investigation as a result of this?

What are the ethical issues that arise from the use of live snails in this investigation? How will you account for these issues and ensure the wellbeing of these organisms?

Procedure

YOU NEED	
• One giant African land snail (or a garden snail if not available) • One dampened cotton wool bud	• A suitable clean, firm surface for the snails (e.g. a plastic chopping board) • A stopwatch

A  B 

Figure 1 A giant African land snail with eye stalks A extended and B retracted.

1 Collect one giant African land snail and place it on a clean, firm surface. Wait for a few minutes until the snail has fully emerged from its shell (Figure 1A) and is used to its new surroundings.

2 Dampen a cotton wool bud with water.

3 Firmly touch the snail between the eye stalks with the dampened cotton wool bud and immediately start the stopwatch. Measure the length of time between the touch and the snail being fully emerged from its shell once again, with its eye stalks fully extended.

4 Repeat the procedure in step 3 for a total of ten touches, timing how long the snail takes to re-emerge each time.

3 Carrying out practical work safely and ethically

Record your results in a suitable table. Ensure you record results to a suitable degree of precision, and that you include the correct units.

4 Analysis and interpretation of data

Present your results in a suitable graph and identify any trends or patterns in your results.

Using your graph, state whether you think there is a positive, negative or no correlation between the number of stimulations and the time for eye stalk withdrawal.

Explain any patterns or trends in your data, supporting your ideas with evidence from the data and your biological knowledge of habituation. Relate your findings to your hypothesis.

You may see from your data that you appear to have a correlation. However, is your correlation significant? Follow the steps below to complete an appropriate statistical analysis of your data. Refer to Maths and Stats Support Sheet 12 – Spearman's rank correlation.

Evaluate the procedure used, results obtained and your conclusions.

- Write a null hypothesis that this experiment will test.
- Complete a Spearman's rank correlation test to determine if there is a statistically significant correlation between the variables. See Maths and Stats Support Sheet 12 – Spearman's rank correlation – for details on how to calculate the Spearman's rank correlation coefficient (r_s). A table with the headings below will help.

Number of times the snail has been stimulated	Rank stimulation	Time/seconds	Rank time	Difference (*D*)	D^2

- Use a table of critical values to accept or reject your null hypothesis. If your calculated r_s is greater than the critical value, then the null hypothesis is rejected. If your calculated value is less than the critical value, then the null hypothesis is accepted.
- Write a statistical conclusion for your experimental data. Make sure you include:
  - your calculated value of r_s
  - the number of pairs of data
  - the significance level
  - the critical value
  - whether the null hypothesis is being accepted or rejected.

Questions

Q1 Suggest a reason why snails may become habituated to a prodding stimulus in the wild.

Q2 This experiment has been shown to be less successful if the snails are handled regularly prior to the experiment. Suggest why handling prior to the experiment could affect the results of the experiment.

Q3 If a baby is shown a new object which they have never seen before, they will stare at the new object. They are fascinated. The length of time they stare at the object without breaking their gaze can be timed and recorded. The object is removed when their gaze is broken. The experiment can be repeated using the same object. With repeated exposure to the same stimulus, the baby changes its response. What would you expect to happen?

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Take care that the stimulus causes no harm to the snails and discuss any ethical issues raised.

Notes on the procedure

In this investigation students find out if habituation to a touch stimulus occurs in snails. A giant African land snail is best, but large garden snails can also be used. The Student Sheet accompanying this activity contains a procedure for this experiment, but students could be asked to plan the investigation themselves. The experiment is more reliable if snails are not handled much prior to the experiment: this avoids them becoming habituated to stimuli.

The Student Sheet directs students to develop their practical skills. They are asked to hypothesise and identify suitable variables. It is important for students to realise that many variables are difficult to control effectively in this investigation and so will introduce random error. One example of this is the force used to stimulate the snails.

This investigation is an excellent opportunity for students to consider ethical issues that arise as a result of using live animals. This may be easier for students to appreciate with the use of giant African land snails, as opposed to garden snails, as they are more unfamiliar to students.

Students present the results as a scatter graph, with the number of stimuli on the x-axis, and the time taken to re-emerge on the y-axis. Students should make a simple statement, from their results, as to whether there appears to be a positive or negative correlation, or no correlation. Students can use the data to perform a Spearman's rank correlation test: full details can be found on Maths and Stats Support Sheet 12 – Spearman's rank correlation. This should help students to appreciate the difference between looking at a graph for a correlation and showing whether or not a correlation is statistically significant.

There is a negative correlation; as the number of stimuli increases, the time taken for the snail to re-emerge decreases. Students should make reference to the data. With repeated stimulation, Ca^{2+} channels in the presynaptic membrane become less responsive. Less Ca^{2+} crosses the membrane into the presynaptic (sensory) neurone. As a result, less neurotransmitter is released into the synaptic cleft. This means that an action potential across the postsynaptic membrane is less likely. Fewer action potentials are produced in the postsynaptic motor neurone, so less of a response is observed.

Relevant comments in students' evaluations would include: the need for replication; using snails of approximately the same size and age; the need to control the size and position of the stimulation; the need to control other variables that may affect the response, such as drying out of the snail; difficulties in determining when the snail has fully extended (measuring the eye stalk length prior to stimulation may overcome this problem); effect of handling the snail prior to the experiment.

Answers

Q1 The snail learns that the stimulus is not causing harm and so it is withdrawing unnecessarily. This effect may be used in its natural habitat when faced with repetitive stimuli, such as vegetation touching the head/eye stalks.

Q2 If the snails have been handled too much prior to the experiment they may have already become habituated to this type of stimulus so further stimulations will not change the response.

Q3 The baby will look for a shorter period of time when presented with the same object. They become habituated to the object. A clip on YouTube, 'infant looking time habituation', shows the experiment.

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Wash hands thoroughly after handling the snails.

Equipment and surfaces should be disinfected with 1% Virkon™ (leave in place for 10 minutes).

Requirements per student or group of students	Notes
Giant African land snail (or large garden snail)	Giant African land snails can be purchased in some pet shops or from biological suppliers, such as Blades Biological. If purchasing giant African land snails they should be bred in this country, to reduce the chance of them having parasites. They are easy to keep in a glass or plastic aquarium tank containing several centimetres of compost; organic compost is recommended. There are several publications available about the care of land snails. If giant land snails are not available, large garden snails can be used. Snails should be kept in moist conditions before the lesson to encourage activity. If snails are still inactive they can be placed for a short time in warm water.
Cotton wool bud	
Small beaker	Any small container for water to allow the cotton wool bud to be dampened.
Board	Clean, firm surface for the snails, for example, a plastic chopping board.
Stopwatch	

Notes