As level

Biology

Experimenting the effects of caffeine on water daphnia

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Experiment to find out how the concentration of caffeine will affect the heart rate of water daphnia.

Hypothesis/prediction

I predict that when the water daphnia are given caffeine the higher the concentration the faster the daphnia's heart beat will be. I think this because caffeine is a stimulant that affects your heart rate keeping you awake and making you more alert. I will be counting the daphnia's heartbeat to see if the caffeine has any effect.

Information on water daphnia

Water daphnia are more commonly known as water fleas or water flies and you can buy them at most local pet shops or fishing shops as they are used to feed goldfish because they eat algae and take in all the nutrients and so are full of them.

The chief characteristic of the water fleas is that the main part of the body is enclosed in a kind of shell, with the appearance of two lids, but made of one piece. They are interesting animals for the microscopist. Because you can see through them, you can study for instance the beating of the heart and follow the course of the blood cells round part of the body. Their sizes differ from several hundred microns to more than five millimetres for the larger species. The common water flea, *Daphnia pulex* can be found in almost all sorts of eutrophic (rich in nutrients) waters. They reproduce in summer mostly parthenogenesis, that is, the eggs develop without undergoing fertilization.

At the end of the summer, some of the eggs develop into the smaller males, capable of fertilizing the eggs in females, which then develop into the so called 'winter eggs'; mostly only one or two are present in the females. These eggs can also be found in populations under stress, such as during the drying up of a pond.

Water fleas belong to the Crustacean, a large group of 'jointed limbed' animals, most of which live in water. Water fleas are placed in the order Caducean and are probably called 'fleas' because they move through the water by a sort of hopping. Water fleas are very common in fresh water; in Britain you can find about 80 different species, in The Netherlands about a 100 species. Many of them are rare. For most people, water fleas are all similar, but when we look more closely, big differences will be found in morphology and in habits.

Safety and use of apparatus

For this experiment I will need to use a very fine microscope so that I can see the water daphnia clearly. There are a couple of things that I could do to make the counting of the heartbeats a bit easier. Firstly I could use a stroboscope; this is a very expensive piece of equipment but will make it considerably easier. What it does is counts the flickering light, so if set properly when the heart beats light will shine through and the stroboscope will detect this and count it.
Secondly I could using a microscope linked up to a camera, record it for a minute then slow it down so I could then count the heart beats a lot easier as they have been slowed down.
The technique I am going to use is to count the heart beat rate by tapping a pencil in time with the beat. After a minute of counting the taps, you can say how many times per minute the heart beats. Then record this and recount again.

To time the minute I could use either a normal watch or clock and watch the hand go round once, or I could use a digital stopwatch, which will be more accurate. We will be working in pairs so one person will be counting and the other will be timing it.

Ethical issues

During the experiment it is very likely that one or more of the daphnia may die. There maybe a number of reasons for this for example: -

- Have a heart attack because they have absorbed too much caffeine
- Over heat as they're out of the water and become dehydrated
- May accidentally get squashed by a careless finger.

But just in case this happens there are a number of ways that we could replace the daphnia back into their original habitat. I could make a daphnia farm so I would breed them just in case I killed a few but this way I would be replacing the ones I squashed. The ones we have left over should be placed back into the wild so they can roam free again.

When I did the experiment I did a number of things to keep the water daphnia alive: -

- I placed ice under the slide to help keep him cool
- I started with the least amount of caffeine first so that he could slowly get used to the caffeine
- I tried to use as little as possible of the stronger solutions of caffeine so he wouldn't have a heart attack.
- Tried to make the experiment as quick as possible.

The experiment I performed needed live specimens otherwise it would not have been possible to measure the effects of caffeine on the heart. So it was necessary to use the water daphnia in this experiment.

Producing Reliable and Valid Results

The results I produced are very valid, but are not accurate. They aren't very accurate because of the method we used to collect the results. The method of tapping a pencil and someone counting them wasn't very accurate because: -

- When the daphnia's heartbeat got really fast you couldn't keep time with the rapid heartbeat.
- If you lost count while trying to count the heartbeat and still carried on counting the beats per minute wouldn't be right.

Variables

There are two main variables for this experiment; the independent variable and the dependant variable.

The Independent variable

This variable is the concentration of caffeine, which is given to the daphnia. We had 5 different amounts of caffeine to give to the water daphnia. 0%, 0.01%, 0.1%, 0.25% and 0.5%. We could not go any higher because the amount of caffeine would probably cause the daphnia to have a heart attack and die.

The Dependant Variable

This is the amount of caffeine added to the daphnia. The range varies from 0% to 0.5%. 0.5% had to be the maximum we could give the daphnia because otherwise a higher amount may have been lethal to the water daphnia. When we put the concentration on the daphnia we tried to make it a drop each time. We couldn't get it exact each time but it was very close.

Temperature

The temperature played a key part because if it was hot then the daphnia would be more dehydrated than if it was cold, meaning that its heart rate would be higher as it is trying to cool itself down by taking in more solution. But luckily it was a mild temperature so shouldn't have affected the daphnia too much.

Amount Of water

The amount of water is very important, because we tried to suck all the water out of the cotton wool on which the daphnia were placed before adding the caffeine to the daphnia. But if there was any water left on the slide with the daphnia then if would weaken the concentration of caffeine.

Different Daphnia

Daphnia are like humans, no two are the same. So in the experiment if we have more than one daphnia the results are going to be different, but this can be justified by doing 3-5 sets of results for each percentage of caffeine and taking an overall average for each concentration.

Oxygen in water

When the daphnia are in the water the oxygen levels are going to be different because the longer they are in the water the lower the oxygen levels are going to be so the harder the daphnia will find it to breathe.

Systematic errors

When performing the experiment there were a few things I tired to do to make it easier for myself. Firstly by trying to pick the bigger daphnia's because it would be easier to see them through the microscope. But this could cause errors because the daphnia are bigger so would have a slower heart beat so I would not be getting results across the whole scale just at one end.

Random errors

There are more random errors than systematic errors these are: -

- When tapping, either tapping too fast or too slow, or not in time with the daphnia's heart beat.
- When starting and stopping the stopwatch, not getting the time on exactly one minute, so either counting longer or for a shorter period of time.
- If the daphnia dies while you are counting it or has a heart attack and its heart briefly stops beating do you carry on counting or do you stop?

Significance of results/data

In the results I have collected I can tell they are along the right lines because the range is not very great, because the greater the range, the greater degree of error there is. So the more certain you are the less error there is going to be.

Presenting Data

I have decided to present my data on a line graph because it is the graph that you can see the line of best fit the easiest. This is because it goes up gradually and you can see it easily. On a pie cart you wouldn't be able to see the patterns because it is in sections and so you can only see the most popular or highest heartbeat.

For the axis I have to decided to put the independent and dependant variables because that is what we have been looking at. The two variables are the most important ones so they need to be on the graph somewhere so that I can recognise that they are important.

Conclusions

Through the results I have collected I can conclude that the more caffeine you give the water daphnia the higher their heart rate will accelerate. I can tell this through the results in the graph. As you go along the concentration of caffeine axis the higher the heart rate goes up. So this is a continuous graph because when you continue along one axis the other axis continues with it.

If I were to have any doubts about the results, they would be: -

- Me or my partner not counting the daphnia's heart beat properly
- Counting over a minute accidentally or under a minute accidentally- incorrect timing.

I couldn't put a line of best fit onto my graph. I think this is because we took an average so you can't get results all in line because you have done 3 separate experiments and the different daphnia's heart beats will be at different starting rates and will be effected differently by the caffeine.