

How Does the Contamination of Caffeine Affect an Earthworm's Burrowing Time?

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Abstract

This experiment was constructed to see the effects of caffeine on an adult earthworm so that it can be compared to the similar nervous system that is ours. The method used in this experiment was an exposure chamber and then a burrowing chamber. The contaminant caffeine is a nervous system stimulant that when consumed by humans can increase alertness. The scientists' hypothesis was that as the parts per million (ppm) of caffeine increased, the time taken for the adult earthworms to burrow would decrease. The hypothesis of the scientists was correct as the average speed of the burrowing time of the worm decreased from an average of the control burrowing time. This experiment is valuable to society because it helps educate caffeine consumers on what this chemical compound that they are putting into their bodies regularly could do to you.

Introduction

According to ¹Caffeine is the most popular mood altering drug in the world. This drug stimulates the Central Nervous system creating the effect of a temporary energy boost and an elevation of mood. One of the most immediate and noticeable effects you will observe once the chemical reaches the human brain is alertness. Some chemicals within Caffeine are glucuronolactone (a common ingredient in "energy" drinks) and taurine (occurs naturally in the human body, meat, and fish but is also added to "energy"

¹ "10 Interesting Facts About Caffeine | Live Science." 27 Oct. 2016, <https://www.livescience.com/56603-interesting-facts-about-caffeine.html>. Accessed 9 Feb. 2021.

drinks). The Ph level of Caffeine is 6.9, and classifies as a weak base. The chemical build up of Caffeine is 10 hydrogen atoms, 4 nitrogen atoms, and 2 oxygen atoms. Caffeine is most commonly found in tea, coffee, chocolate, many soft drinks, pain relievers, and over the counter medications. It is believed to enhance and prolong exercise performance, but it is only known to have an effect when used at a certain amount per kilogram of body weight (3-13 mg of caffeine per kilogram of body weight). Even though caffeine is thought to enhance academic performance however, according to ² Caffeine does not enhance your academic performance but only increases alertness. However Caffeine does take up to 12 hours to clear from the body and if regularly consumed, you can create a “tolerance” to the drug. Other drugs including Antibiotics (where they have weaker effects) and many more are alike in which you can build up a tolerance to, when you build up a tolerance to Caffeine however, it can prevent the “jitters” you may experience when one first tries it. According to ³ Too much caffeine can cause major health issues including irregular heartbeat and seizures. Some symptoms of an overdose on Caffeine include, dizziness, diarrhea, increased thirst, insomnia, headache, fever, and irritability. The recommended dosage for adults is 400 milligrams and for an adolescent no more than 100 milligrams. The side effects of Caffeine on a baby is unknown.

The group decided to test the effects of caffeine on an earthworm to see the effect of this drug on the burrowing time, the normal burrowing time for an earthworm is

² "CogBlog – A Cognitive Psychology Blog » Does Caffeine Help" 3 May. 2014, <https://web.colby.edu/cogblog/2014/05/03/does-caffeine-help-academic-performance/>. Accessed 9 Feb. 2021.

³ "9 Side Effects of Too Much Caffeine - Healthline." 14 Aug. 2017, <https://www.healthline.com/nutrition/caffeine-side-effects>. Accessed 9 Feb. 2021.

2.30 minutes, they also typically burrow close to the surface but at their deepest, can go down to 6.5 feet deep. The normal movement observed when watching an earthworm includes extending the body, anchoring it to the surface with setae and contracting the body muscles. The locomotion (an act or power of moving from place to place) is easily observed because of the earthworms' lack of appendages. The group suspected that the worm(s) involved in the experiment would speed up their burrowing behavior as the parts per million (ppm) of Caffeine went up. The group chose worm(s) as their subject for the experiment because earthworms have similar nervous systems to humans. One interesting fact about this experiment to keep in mind is that earthworms like coffee grounds in their composter (only a bit though!).

Materials

- 2 cups (20 fluid ounces)
- 2 cups of soil
- 3 adult earthworms
- Stopwatch
- 1 large coffee filter
- Dilution tray or 4 separate cups
- 1 pipette (4 milliliter)
- 9 drops of caffeine (or amount needed for your 9-1 ratio)
- Exposure chamber (directions listed below)
- Water



Exposure and Burrowing Chambers' Directions

1. Grab one of your 2 cups (size listed above)
2. Use one of your 2 cups of soil and put in to the cup then set aside
3. Take the other cup (the empty one) and trace on a coffee filter
4. Cut out the circle of coffee filter then set aside



5. Take your first dilution (directions listed below) and using the pipette, soak the coffee filter and the soil with your first dilution of the caffeine contaminate and set the soaked filter aside
6. Take the 3 adult earthworms and set them in the empty cup
7. Cover the earthworm with the contaminated coffee filter
8. Start the timer for thirty seconds
9. After the thirty seconds is complete, place the worms in the cup of soil and time how long it takes for the worms to burrow

Dilution Directions

1. Grab your dilution tray or separate cups
2. Grab your water
3. Fill the pipette with clean water
4. Measure out 81 drops of water (or any 9-1 ratio, easiest if you use the same as listed here) into one of your cups or space in dilution tray
5. Measure 9 drops (or converted to your 9-1 ratio of choice) of caffeine into the cup or dilution space
6. This is your 1000 parts per million (ppm) of Caffeine
7. Repeat steps 3-5 but instead of using pure Caffeine (in liquid form) use the last dilution created, for example, for the 100 ppm use your 1000 ppm dilution.

Procedure

1. Now that you have your exposure and burrowing chamber made (directions shown above) make sure that you have soaked your coffee filter thoroughly
2. As shown above, place the three adult worms in the exposure chamber (1 for each trial) and start your stopwatch for thirty seconds (the exposure chamber is the empty cup and should only have the worms with a contaminated coffee filter on top of them)
3. After thirty seconds, move the earthworms to the burrowing chamber (cup of dirt)
4. Record how long it takes each worm to burrow
5. Repeat these steps but with a new diluted solution each time

Safety: Wear goggles and work with clean hands, do not personally touch the contaminant (only using the pipette). Because of the pandemic present during this experiment, the scientists were to wear masks at all times and stay socially distanced (6 ft away from each other at all times)

Results

The scientists decided on the contaminant caffeine, caffeine is a drug that when used appropriately is not harmful. An overdose of caffeine however can lead to being in the emergency room with vomiting, palpitations (a sensation that the heart is racing; often bothersome but rarely ever a sign of heart disease), high blood pressure. A big overdose on Caffeine can result in seizures and even death. It is very difficult to overdose on Caffeine but still possible. Although it doesn't seem like it, Caffeine has become a bigger health concern over the years, the emergency room visits for this reason have shot up over the years and energy drinks are not advised for kids and teens because of the health concerns with the caffeine and other stimulants included in them.

The scientists decided to use adult earthworms because both organisms shared similarities within the nervous system. The scientists started their procedure by grabbing 2 red cups (20 fluid ounces) and filling one of the cups about halfway with soil. The scientists then traced the other cup (the empty one) on a coffee filter and cut out the circle. The scientists then took their first dilution (directions for dilution shown on page 4), they filled up their pipette and soaked the coffee filter carefully, The scientists placed the three adult earthworms (or however many you use depending on how many trials you would like) in the empty cup and covered them with the contaminated coffee filter. The scientists then prepared their timers and left the worms for 30 seconds. The scientists then placed the worms in the soil and started their timers. The time was recorded precisely when each worm was completely submerged under the soil. The hypothesis was that the worm's burrowing time would speed up as the parts per million

(ppm) of the contaminant caffeine level went up. This investigation was performed in order to see the effect of caffeine on worms in comparison to us humans because our nervous system's are similar. The independent variable in this experiment was the amount of caffeine however the dependent variable was the time that the earthworms took to burrow.

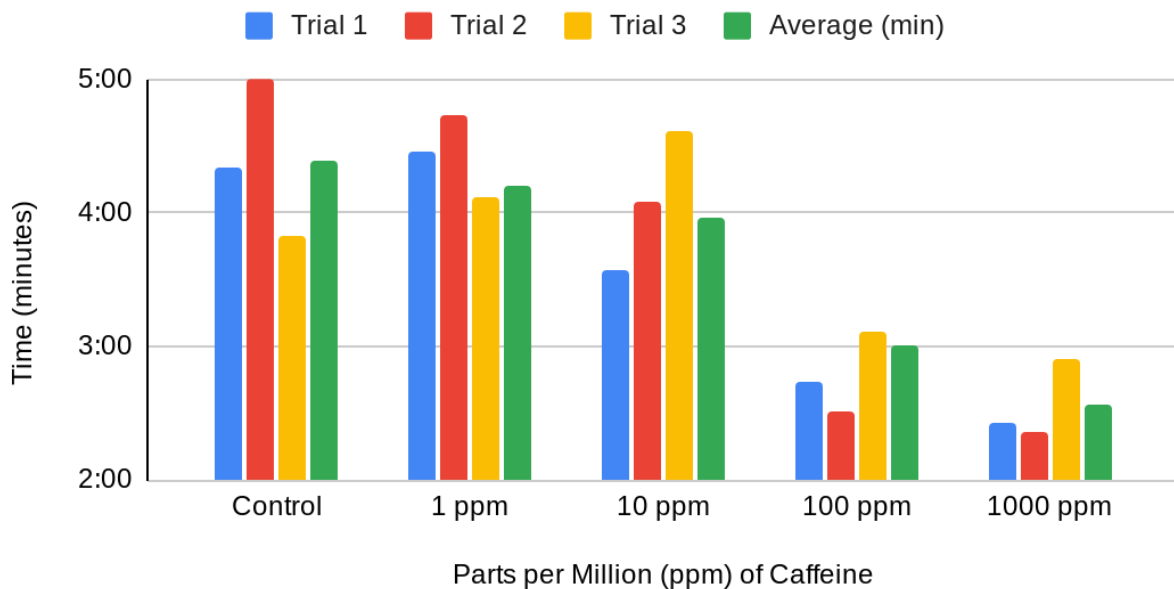
The results of the investigation were that as the parts per million (ppm) of the contaminant went up, the time that it took the adult earthworm to burrow decreased. The hypothesis of the scientists was correct.

Trial #	Parts per million (ppm)	Time (min)	Average (min)
1	control	4:20	4:23
2	control	5:00	
3	control	3:50	
1	1	4:27	4:12
2	1	4:44	
3	1	3:67	
1	10	3:34	3:58
2	10	4:05	
3	10	3:37	

1	100	2:44	3:00
2	100	2:31	
3	100	3:07	
1	1000	2:26	2:34
2	1000	2:22	
3	1000	2:54	

Time it takes Earthworms to Burrow

When exposed to Caffeine



Solution (ppm)	Mean	t-score	Statistically Significant?
1	4.26	0.0597	Not significant
10	3.92	0.5917	Not significant
100	2.6067	3.3008	significant
1000	2.34	4.2559	significant

Discussion

This investigation was performed to compare the result of caffeine on adult earthworms to what it would do to our bodies, as our nervous systems. However, because of the limitations with time, equipment, and purely human error. This experiment is not perfect for these reasons, and so neither will the results be. This experiment is valuable to society for scientific reasons, specifically being research. Like stated in the very first paragraph, caffeine is the most popular mood altering drug in the world, this means that the population summed up consumes a high amount of caffeine on a day-to-day basis. Now think of the some 7,845,846,818 people (as of 2-17-21) who live on this earth, and even though not *all* of the population consumes caffeine especially on a daily basis, There is a fair number that do. Scientists need to know what the effect of this is to people, the public needs to know what this drug's effects can do to you because so many people are consuming it regularly. Especially now that the consumption of caffeine has gone up in the 'future' of our world; teenagers and children. The work that these scientists performed could have a large impact because it could prove the highly consumed drug to be something dangerous to our health and wellbeing.

One way of advancing the effects of this experiment is to reserve more time. The scientists were limited to 4 days to complete this experiment, but if they were to have a longer period of time. They could have tested the effects of exposing the worm to the contaminant caffeine on a daily, weekly or monthly basis for a certain period of time to see the effects on it's burrowing time. This would help the community of people who drink caffeine daily, weekly or possibly even monthly to see the effects of what this

constant exposure to caffeine can do to you. Proving whether or not you merely build up a tolerance to the drug or if it has further impacts on your medical health.

From the graph (shown on page 8) you can see a slight decrease as the parts per million (ppm) of the contaminant increases. This was because the contaminant caffeine is a nervous system stimulant, so it sped up the nervous system and therefore sped up how long it took the worm to burrow.