

How Does Shampoo Affect Earthworms' Locomotion?

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January 27, 2020
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ABSTRACT

The scientists' investigation is about how shampoo impacts an earthworm's locomotion (burrowing time and sensorimotor response). The scientists know that all of the shampoos they tested contained a chemical known as methylisothiazolinone. Methylisothiazolinone has been proven to slow the connection between neurons in humans and is a suspected carcinogen because of its corrosive action on the skin. The scientists created their exposure chamber by putting a solo cup, a filter paper cut to the size of the cups, and another solo cup inside of it. Most of their supplies were bought at Walgreens and they used adult red worms. For testing sensorimotor response, the scientists used a ring of shampoo they created by squirting the shampoo out of the bottle onto the tray. The trend was all of the shampoos for both 5 minutes and 10 minutes took 20 minutes for the earthworms to burrow. All of the reactions for all of the shampoos had at least a severity of 5. All of the tests were also statistically significant. The scientists believe the burrowing time increased because of the methylisothiazolinone because it slowed the chemical signal at the synapse. They also believed that the strong reactions were caused by methylisothiazolinone because of its corrosivity. They plan to expand their investigation by testing other brands of shampoo or other forms of methylisothiazolinone.

INTRODUCTION

It isn't uncommon to be exposed to over 2,100,000 toxins each day.¹ One of those toxins is shampoo. Everyone uses shampoo almost every day. After all, the purpose of shampoo is to wash hair.² In order to use shampoo, a person places just a few ounces (depending on the length

¹ "Daily Toxin Intake: How Many Toxins Are You Accumulating" <https://nervedoctor.info/daily-toxin-intake-how-many-toxins-are-you-accumulating/>. Accessed 29 Jan. 2020.

of your hair) on wet hair, then rubs the shampoo in, and then washes it off.² But would you have ever thought that what seems to be necessary may actually have been harming you? The shampoos that were tested were Suave, Pantene, and Head and Shoulders.

One contaminant that was inside most of the shampoos was methylisothiazolinone.³ Methylisothiazolinone has been known to slow connection between neurons and cause nerve damage.³ Methylisothiazolinone is also mutagen and a possible/suspected carcinogen due to its corrosivity when it touches the skin.⁵ Another contaminant that was in most of the shampoos was SLES and SLS also known as Sodium Laureth Sulfate and Sodium Lauryl Sulfate. SLS is so harsh that it is often used as an engine degreaser.⁴ SLES can be contaminated with a chemical known as 1,4 dioxane.³ Effects of 1,4 dioxane by acute inhalation include vertigo, drowsiness, headaches, anorexia, and irritation of the eyes, nose, throat, and lungs of humans.⁴ In a deadly case of 1,4 dioxane poisoning after the individual inhaled the chemical, these effects were observed- hepatic and renal lesions and demyelination and edema of the brain.⁴ Also, ingesting formaldehyde, another possible ingredient in some of the shampoos, usually in the form of quaternium-15, can cause corrosion of the gastrointestinal tract and inflammation and ulceration of the mouth, esophagus, and stomach.⁵ Quaternium-15 can be found in these chemicals- benzalkonium chloride, benzethonium chloride, cetrimonium bromide, polyquaternium – (followed by a number, for example, polyquaternium-10).⁶ Humans expose themselves to shampoo through intentional exposure. The contaminants in shampoo and shampoo itself can be

2 "HOW TO SHAMPOO AND CONDITION YOUR HAIR – Hanz" 4 Aug. 2016, <https://www.hanzdefuko.com/blogs/products/how-to-shampoo-and-condition-your-hair>. Accessed 29 Jan. 2020.

3 "Shampoos Contain Toxins Linked To Nerve Damage - Rense." <https://rense.com/general63/nerv.htm>. Accessed 29 Jan. 2020.

4 "Behind the Label: Head and Shoulders classic clean." 1 Jul. 2008, <https://theecologist.org/2008/jul/01/behind-label-head-and-shoulders-classic-clean>. Accessed 29 Jan. 2020.

5 "Hazardous Air Pollutants | US EPA." 27 Sep. 2018, <https://www.epa.gov/haps>. Accessed 28 Jan. 2020.

6 "Quaternium-15 - Safe Cosmetics." <http://www.safecosmetics.org/get-the-facts/chemicals-of-concern/quaternium-15/>. Accessed 29 Jan. 2020.

very dangerous.⁷ Because of all these adverse effects, three scientists felt it was important to start an investigation on how shampoo impacts earthworm's locomotion (sensorimotor response and burrowing time). The three scientists decided to start the experiment because they wanted to see if shampoo affected a human's nervous system because the earthworm's nervous system and a human's nervous system are similar.⁸

Their hypothesis for burrowing time was that if the scientists expose earthworms to shampoo then burrowing time will increase because the methylisothiazolinone slows the connection between the neuron's in the earthworm's brain, making it harder for the earthworm to move and burrow.

Their hypothesis for sensorimotor response was that if scientists expose earthworms to shampoo then the sensorimotor response will also be strong because the earthworm will feel the methylisothiazolinone's corrosivity when it touches the shampoo and will be irritated by that.

MATERIALS AND METHODS

Materials used to test burrowing time:

- One 12.6 oz bottle of Suave keratin-infusion shampoo
- One 3.38 oz (travel size) bottle of Pantene shampoo
- One 12.6 oz bottle of Head and Shoulders lavender-scented shampoo
- Nine 18 oz red solo cups
- Three adult red worms (Twelve worms if you want to use three different worms for each of the three trials each of the shampoos and tecontrol)
- One tray with a single dry paper towel on it
- One spray bottle filled with water
- One cup (one of the red solo cups) filled with burrowing dirt
- Four coffee filters (any size)
- Scissors
- One pen or pencil

⁷ "Why Your Shampoo May Be Hazardous To Your Health" <https://www.morroccomethod.com/blog/why-your-shampoo-may-be-hazardous-to-your-health/>. Accessed 17 Feb. 2020.

⁸ "Earthworms, Salamanders and Humans: A Pathway to New" 30 Apr. 2018, <https://ysjournal.com/earthworms-salamanders-and-humans-a-pathway-to-new-discoveries/>. Accessed 5 Mar. 2020.

- One stopwatch and one timer
- One computer or notebook to record times
- One bag of soil (so the earthworms can burrow)

(Note: The earthworms, soil, computer, tray, and spray bottle were received from Lori Voelker. While all other supplies except for the stopwatch and timer (which was a phone) were purchased at Walgreens.)

Materials used to test sensorimotor response:

- Three adult red worms (Twelve worms if you want to use three different worms for each of the three trials for each of the shampoos and the control)
- One 12.6 oz bottle of Suave keratin-infusion shampoo
- One 3.38 oz (travel size) bottle of Pantene shampoo
- One 12.6 oz bottle of Head and Shoulders lavender-scented shampoo
- One metal tray with one dry paper towel on it
- One metal tray with no paper towel on it
- One spray bottle filled with water
- One pen or pencil
- One computer or notebook to record times

(Note: The earthworms, trays, spray bottles, and computer were received from Lori Voelker while the rest of the supplies were purchased at Walgreens.)



To set up the experiment, grab all of the supplies listed above. In order to create the exposure chamber, grab one coffee filter, scissors, a pencil or pen, and 2 solo cups. Next, place the coffee filter underneath one of the solo cups and trace an outline of the bottom of the solo cup on the coffee filter. Then, use scissors to cut out the outline. Once you have the coffee filter cut, you should place the filter at the bottom of one red solo cups. Then, take the other solo cup and place it inside the cup with the filter paper. Note that you should not place it in all the way. You should leave at least $\frac{1}{2}$ an inch of the cup showing when you place it inside. You want to repeat this so in total, you have 3 exposure chambers

(one for each type of shampoo). To create the burrowing chamber, take one solo cup and fill about $\frac{2}{3}$ of it with soil. For sensorimotor response, take the tray without a paper towel. The

scientists found that it is hard to make 9 individual drops with the shampoo so they recommend to create a ring with the shampoo. Once you have the ring created, place the worm in the ring and measure the reaction. The scientists created this scale for reactions:

- 10: worm is having violent spasms or thrashing around violently, flipping over, coiling over
- 9: worm is thrashing around violently or coiling tightly
- 8: worm is is very irritated, coiling up, darting away, having slightly stronger spasms
- 7: worm is scrunching up, darting away, or have tiny convulsions
- 6: worm is darting away from the contaminant and is scrunching up
- 5: worm is darting away from the contaminant, very irritated
- 4: the earthworm touches the contaminant then turns around quickly and moves away from
- 3: earthworm avoids contaminant after touching it, tries to go around contaminant
- 2: takes a little less time to react than 1
- 1: slight reaction, the earthworm moves away from the contaminant after a few seconds
- 0: no reaction

The scientists' procedure for testing burrowing time:

Step 1: Gather all the supplies needed.

Step 2: Grab the 3 adult red worms and place them onto the tray with a paper towel on it.

Step 3: Spray the worms 1-2 times with the spray bottle to insure they stay wet. If earthworms are too dry, they can die.

Step 4: Lift the top of the exposure chamber and squirt about 1 tablespoon of the selected shampoo on the coffee filter. Only squirt that much because too much can drown the worm.

Step 5: Place 3 of the adult red worms into the exposure chamber.

Step 6: Start the timer for either 5 minutes or 10 minutes

Step 7: Once the timer is over, take the cover off of the exposure chamber and take the 3 earthworms out and place them in the burrowing chamber.

Step 8: Start the stopwatch and start to observe the worms.

Step 9: When a worm has burrowed (you cannot see it anymore), record the time on the stopwatch.

Step 10: Repeat step 9 until all earthworms have burrowed.

Step 11: Repeat steps 4-10 until all of your testing is complete.

The scientists' procedure for testing sensorimotor response:

Step 1: Gather all the supplies needed.

Step 2: Place the adult red worms on the metal tray with the paper towel on it. This insures that



the earthworms stay in one place.

Step 3: Spray the worms 1-2 times with the spray bottle to insure they stay wet. If earthworms are too dry, they can die.

Step 4: Take the one of the selected shampoo and create a small ring of shampoo on the tray with no paper towel on it.

Step 5: After the ring is created, place one of the earthworms in that ring.

Step 6: Record the severity of the reaction using the scale provided.

Step 7: After about 10 seconds, take the earthworm out of the ring and back onto the tray with the paper towel and then spray the earthworm 3-4 with the spray bottle.

Step 8: Repeat steps 4-7 until testing is complete. (Note: If the ring of shampoo has not been destroyed or contaminated, you can use it again for testing a different earthworm.)

Safety concerns that were taken were wearing safety goggles and washing hands before and after handling the earthworms. The scientists collected their data by recording the times they saw the instant burrowed and recorded in a Google spreadsheet. For sensorimotor response they recorded the severity of the reaction also on a Google spreadsheet. The scientists determined if there were any relevant statistics by calculating the t value of their data.

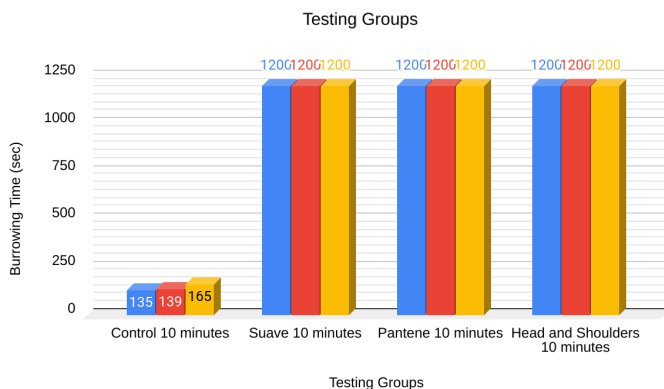
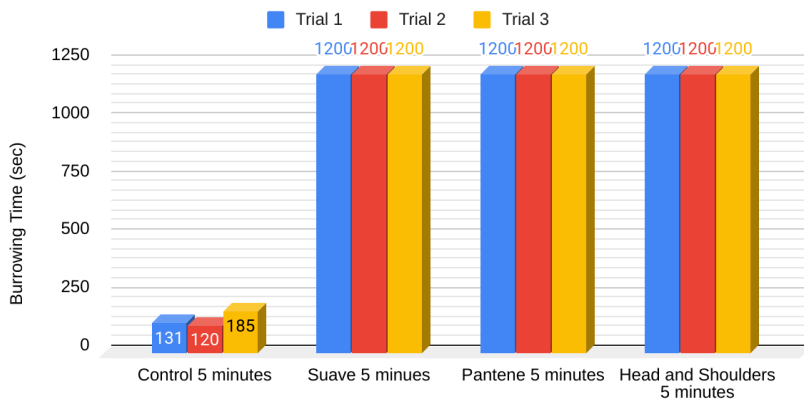
RESULTS

The scientists chose to do their experiment because they wanted to see if shampoo had any effect on the neurological system of humans. They wanted to know that because they use shampoo and they wanted to know if they were using something that was harming them. They decided to use earthworms because earthworms and humans have similar nervous systems.

The scientists thought that if they expose earthworms to shampoo, then burrowing time will increase because the methylisothiazolinone slows the connection between the neuron's in the earthworm's brain, making it harder for the earthworm to move and burrow.

They also thought that if they expose earthworms to shampoo then the sensorimotor response will be strong because the earthworm will feel the methylisothiazolinone's corrosivity when it touches the shampoo and will be irritated by that.

Shampoo Testing for 5 Minutes

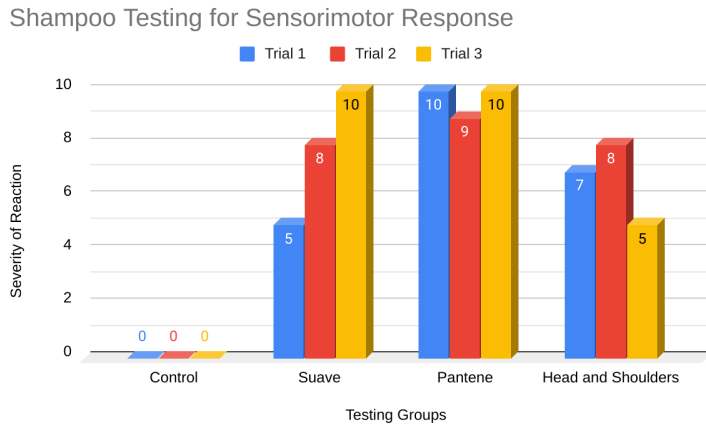


For the control group, each of the trials for 5 minutes was around 2 minutes or 120 seconds, except for the last one which was near 3 minutes or 180 seconds. For ten minutes, each of the trials for 10 minutes were around 2 minutes for burrowing time except for the last one, which was again around three minutes.

For all of the shampoos, each of the three trials for five minutes

took greater than 20 minutes for burrowing time. For all of the shampoos, all trials for 10 minutes were greater than 20 minutes.

The results of testing the sensorimotor response for Suave was that all of the reactions had a severity of 5 or above. For Head and Shoulders, all reactions also had a severity of 5 or



above. Pantene had the greatest average severity in reactions and all of the reactions for Pantene had a severity of 9 or above.

After the scientists statistically analyzed their data, they came to the conclusion that all of their tests were statistically

significant. They provided a chart for each of them here-

Testing Group	T Value	Statistical Significance
Suave 5 minutes	52.5077	Statistically Significant
Pantene 5 minutes	52.5077	Statistically Significant
Head and Shoulders 5 minutes	52.5077	Statistically Significant
Suave 10 minutes	112.0387	Statistically Significant
Pantene 10 minutes	112.0387	Statistically Significant
Head and Shoulders 10 minutes	112.0387	Statistically Significant
Suave Sensorimotor Response	5.2766	Statistically Significant
Pantene Sensorimotor Response	29.0000	Statistically Significant
Head and Shoulders Sensorimotor Response	7.5593	Statistically Significant

The results for burrowing time support the original hypothesis of the scientists. For sensorimotor response, the results also clearly support the hypothesis.

DISCUSSION

In the experiment, the data for all of the shampoos varied greatly from the control group. For each of the shampoo's trials, the data was greater than 20 minutes. For sensorimotor response, all of the reaction had at least a 5 or above in severity.

One very odd finding in the scientists' experiment was that the control which was in the exposure chamber for 10 minutes' burrowing time was very similar to the ones that were in for 5 minutes. The scientists' believe these specific results happened because the worms had become habituated to the exposure chamber. One testing error they made which could have impacted burrowing time was using unwashed cups. The scientists' used the same cups for each type of shampoo, and that could have exposed the earthworms to more shampoo than they had intended to. Unfortunately, the scientists' experiment is not adequate. They did not have enough time and didn't test enough.

The scientists' believe that they got the results they got because they believe that for the burrowing time, the methylisothiazolinone inside the shampoos did something to the earthworms. Based on their research, they know that methylisothiazolinone has been proven to slow connections between neurons in humans. They believe that when the earthworm was exposed to methylisothiazolinone and attempted to move after, the chemical signal which was supposed to be released from the nerve ending, took longer to get to the synapse. Because the connections are slower between neurons, the chemical signal takes longer to get to the synapse area from the brain.⁹

⁹ "The synapse (article) | Human biology | Khan Academy." <https://www.khanacademy.org/science/biology/human-biology/neuron-nervous-system/a/the-synapse>. Accessed 7 Mar. 2020.

However, for the sensorimotor response, they believe something different happened. From their research, they know that methylisothiazolinone is suspected carcinogen because of its corrosivity on the skin. It seems that when the earthworm comes in contact with the shampoo, it becomes very irritated with the methylisothiazolinone. The reason why Pantene had a higher average severity of reactions is most likely because Pantene had a higher concentration or amount of methylisothiazolinone.

The scientist's experiment has provided new knowledge into the field. It has brought to the spotlight how we could be damaging our bodies daily by using shampoo. It has also brought to light even more negative effects of methylisothiazolinone. Some uses of this knowledge could be that we start looking for shampoos which don't contain methylisothiazolinone. Companies could also stop producing shampoos with methylisothiazolinone. Ways that the scientists can go further with this investigation is by testing other brands of shampoo but also testing other forms of methylisothiazolinone poisoning (inhalation, intravenous injection, and injection) and see their effects.

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