

# Feeling Detoxified: Expectations, Effects, and Explanations

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## Part I – The Detoxifying Ionic Foot Bath Experience

Stressed and tired, you look forward to your monthly visit at the *A New You!*\* spa. Upon arrival, you are given an information booklet about a new treatment that is being offered. It's an ionic foot bath. You are seduced by the assurances that it will leave you feeling refreshed, and opt for this treatment. The spa's technician tends to you, ensures that you are comfortable, and directs you to sit and place your feet in a bath of salt-water. She then switches on the electrical box connected to two metal rods that rest in the foot bath.

"This machine's iron electrodes ionize the water in the bath. This creates a negative bio-charge in your body and draws unwanted toxins out of special pores on the soles of your feet. You'll actually see it working," the attendant explains enthusiastically.

"Oh, right," you reply. A few minutes later, reddish-brown streaks appear in the bath water. By the time your half-hour treatment nears its end, the whole bath has a dark brown-red tinge, and bubbles cover the surface of the water, which smells faintly of chlorine. You ask the spa's attendant about the smell.

"It's from all the chlorine that we consume in our tap water. It can also be leftover in your body from swimming pools. The foot bath pulls it out of your feet. It detoxifies your body."

You leave the spa feeling refreshed. When you return home, you are intrigued. You read with interest the pamphlet that the spa provided you:

*Electricity is used in this treatment to create positive and negative ions from the water molecules in the foot bath. These ions can penetrate your body. Their positive and negative charge allows them to act as a molecular sponge to soak up and sequester particles of opposite charge. These neutralized toxins then leave the body through the surface of the feet that are in contact with water in the foot bath, leaving you cleansed and refreshed.*



### Questions

1. Why might you be tempted to believe what the pamphlet and spa attendant say? What aspects are convincing?
2. Why might you be skeptical? What are some of the problems with the explanation provided?
3. Design an easy experiment to test whether the explanations provided by the spa are accurate.

\* *Note: A New You!* is a fictional spa invented for the purpose of this case study (with a nod to Margaret Atwood's book *Year of the Flood*). The explanation for the mechanism of action of the ionic foot bath was inspired by the descriptions provided by the many companies that offer ionic foot bath services.

*Photo credit:* Public domain photo of "aqua detox" by Wikipedia user Jason7825, [http://en.wikipedia.org/wiki/File:Aqua\\_Detox.jpg](http://en.wikipedia.org/wiki/File:Aqua_Detox.jpg).

## Part II – A Proposed Chemistry of Foot Baths

After your spa foot bath, you feel refreshed. You are mentally alert, and that persistent pain in your right knee has faded considerably. Despite your skepticism about the scientific explanation behind it, you feel so fantastic that you sign up for another foot bath the following week.

Over lunch one day, you tell your friends about this experience. Your friends question your foot bath experience.

“But how does it *actually work*? How do you know it’s working? Have you tried taking your feet out and seeing what happens?”

Those questions nag at you when you visit the spa the next time. You resolve to do the experiment that your friends suggest. You are comfortably seated with your feet in the ionic foot bath. The attendant turns the machine on. However, this time, when she leaves the room, you look around cautiously and then slowly slide your feet out.

As time passes, the water slowly turns brown, the faint chlorine smell becomes detectable, and bubbles appear in the water. Hmmm. Your feet are not in the water, so obviously the bath is not drawing unwanted toxins out of your feet. Where do the chlorine smell, the reddish-brown color, and the bubbles come from?

Determined to solve the mystery, you call your friends for their help. Michael starts things off by drawing on Figure 1 as he says:

“Well, let’s start with the salty water. The most common salt is table salt, sodium chloride (NaCl), so let’s assume that’s the salt used in the foot baths. When it is dissolved in water, the two atoms in salt dissociate into their constituent ions: Na<sup>+</sup> and Cl<sup>-</sup>. There always exists a small number of water molecules (H<sub>2</sub>O) that are dissociated into H<sup>+</sup> and OH<sup>-</sup> ions. So, in other words, you have the following ions in the foot bath: H<sup>+</sup>, OH<sup>-</sup>, Na<sup>+</sup>, and Cl<sup>-</sup>.”

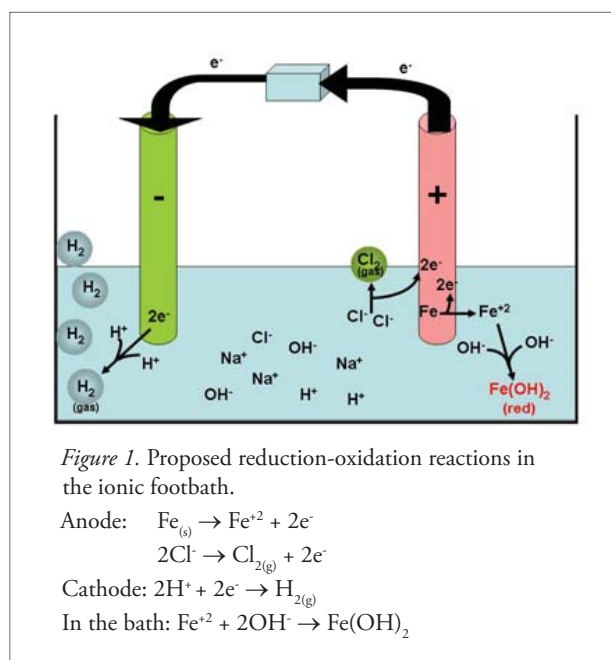
Allison, a chemistry major, thinks she holds another piece of the puzzle.

“What you have here is a simple electrochemical cell where oxidation and reduction reactions take place. Don’t panic about the jargon: let me explain. There were two rods made of metal that were plunged into the water, and through which an electrical current was running. An electrical current means that electrons (e<sup>-</sup>) were flowing in one direction through the wires. In solution, the current is carried by migrating ions. The electrons are induced to move by a force that is provided by the power supply that the foot bath is connected to.”

“Metals conduct electricity because they have electrons that can be freed from their atoms to move to other atoms. If we follow the path of an electron through the system, it might look like this. An electron starts in the metal of one of the rods; we’ll call this rod the anode. As the anode loses electrons, the metal acquires a positive charge (because it lost some negatively-charged electrons). The electrons flow through the wire and end up in the other metal rod (the cathode), which has a negative charge (because it accepted negatively-charged electrons).”

You and Michael nod in agreement. Allison continues as she draws on Figure 1.

“The spa attendant told you the metal rods are made of iron.\* When an electrical charge is run through the cell, the anode loses electrons in the following reaction:

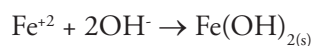


\* Note: As proposed by Lower (n.d.).



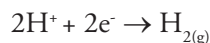
In other words, the electrode dissolves over time. While the Fe found in the electrodes cannot dissolve in water, the  $\text{Fe}^{+2}$  ions that are being created by the current are able to interact with other ions in the water.”

“In the foot bath, some of the positively charged  $\text{Fe}^{+2}$  ions react with negatively-charged  $\text{OH}^{-}$  ions to form  $\text{Fe}(\text{OH})_{2(s)}$ , which is reddish-brown in color (see Figure 2). You may also have seen flecks of rusty metal floating in the water.”



Allison continues this idea, as she adds to Figure 1.

“The negatively charged cathode attracts the positive  $\text{H}^{+}$  and  $\text{Na}^{+}$  ions in the water. Because  $\text{H}^{+}$  accepts electrons more easily than  $\text{Na}^{+}$ , the  $\text{Na}^{+}$  ions do not react at the cathode. They stay in the solution. The  $\text{H}^{+}$  ions, however, do react. They gain electrons to become hydrogen gas:



Following the same line of thought, you tentatively propose the following explanation.

“Another reaction occurs at the anode. Its positive charge attracts negatively charged ions. Thus,  $\text{Cl}^{-}$  ions are drawn to this electrode. Once they reach the anode, they donate their extra electron, and combine to form chlorine gas:



“Wow!” interjects Allison. “Did you know that chlorine gas is poisonous, and was used during World War I as a chemical weapon?”

### Questions

1. What causes the red-brown color that you saw in the foot bath? The chlorine smell? The bubbles?
2. Should you be concerned about your foot bath's production of a chemical used in warfare?
3. If simple chemistry in the foot bath (that does not involve changes to your body) can explain what you observed, then why do you feel so much better after the treatment? Think of as many possibilities as you can to explain this phenomenon.

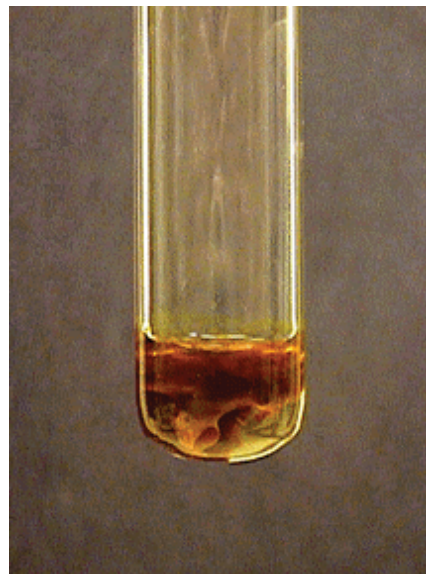


Figure 2.  $\text{Fe}(\text{OH})_2$  is a red-brown substance that forms in the bath.

Credit: Reprinted with permission of James P. Birk, Arizona State University, <http://www.public.asu.edu/~jpbirk/qual/qualanal/iron.html>.

### Part III – Feeling Better After Treatment

A few weeks go by. Despite being able to explain everything that you observed in the foot bath as a phenomenon that did not involve your body, you definitely felt better after the treatment. You wonder why.

One day over lunch, you share these concerns with Michael. He immediately becomes excited.

“We just read a landmark paper in my psychology class on a phenomenon that may shed some light on your question. In this experiment, two hundred patients with symptoms that could not be diagnosed because they had no obvious physical signs were selected for the study. They were divided into four groups.

- One group received a “positive consultation” with an empathetic doctor, but received no treatment.
- One group received a “positive consultation” with an empathetic doctor and received treatment.
- One group received a “negative consultation” with an unfriendly doctor and received no treatment
- One group received a “negative consultation” with an unfriendly doctor and received treatment.

When a treatment was provided, it was in the form of a pill containing no medicinal ingredient (a “sugar pill”). All patients were surveyed two weeks later to determine the outcome on their symptoms. I happen to have a copy of this article right here. Take a look at the results table.”

	Positive consultations		Negative consultations	
	Treated (n=50)	Not treated (n=50)	Treated (n=50)	Not treated (n=50)
<i>How much better do you feel having seen the doctor?</i>				
Completely	7 (15)	10 (21)	2 (5)	3 (6)
Much	21 (44)	18 (33)	12 (30)	10 (21)
A little	14 (29)	18 (37)	15 (38)	12 (25)
No better	6 (12)	2 (4)	11 (27)	22 (47)
<i>Have you been helped by seeing the doctor?</i>				
A lot	23 (79)	35 (73)	13 (52)	10 (30)
A little	4 (14)	10 (21)	7 (28)	10 (30)
Slightly	1 (3)	3 (6)	2 (8)	8 (24)
Not at all	1 (5)		3 (12)	5 (15)

Table 1. Effect of compassion on treatment. Note that not every patient responded to all sections of the post-doctor-visit survey.

*Credit:* Data extracted from rows 3 and 4 of Table 2 from: Thomas, K.B. (1987). Practice research: General practice consultations: Is there any point in being positive? *BMJ* 294(6581): 1200–1202.

#### Questions

1. What do the two columns of numbers for each experimental group represent (the numbers and the numbers in parentheses)?
2. How do you propose to analyze the data (i.e., how will you compare the treatment groups)? Defend why you think your method is the best way of analyzing the data.
3. Based on this table, what do you suspect that the researchers were investigating? What was their hypothesis?
4. Which group(s) is/are the control? Explain your answer.
5. Complete the following form. Repeat as many times as necessary:  
When I compare Group \_\_\_ with Group \_\_\_, I learn that \_\_\_\_\_.
6. Which of the two variables tested in this study appears to have the largest effect on improved health?
7. What can you conclude from this experiment?
8. Based on these results, propose a mechanism that might explain your improved health upon leaving the spa.

## Part IV – The Effect of Expectations

After you have absorbed the data in the table, Michael looks at you expectantly. To recap, he adds:

“Empathy is a big part of receiving an effective treatment. Feeling catered to and pampered can go a long way towards making you feel refreshed and de-stressed, independently of any form of treatment.”

Pondering these thoughts, you ask: “OK, I buy that, but is there anything else that might be at work here?”

“Well, there is the placebo effect, as it is classically defined.”

“I’ve heard about this. Isn’t it when patients are given a sugar pill and it cures them?”

“That’s one form of it. Placebos are sham treatments that mirror the experience of undergoing a treatment but do not provide the active ingredient or therapy. In other words, it’s the part of the treatment that causes an effect based on human expectations.”

“So... If I believe I am receiving a treatment that can make me feel refreshed, that’s enough to make me feel refreshed?” you ask, a bit incredulously.

“Yes! The placebo effect does not work for all conditions, but anxiety, depression, pain, swelling, and stomach ulcers all seem to respond to a placebo (Evans, 2004).”

“I guess in my situation I was feeling stressed, which is a form of anxiety, right?”

“Sure. The placebo effect is bizarre. We studied it in class. Did you know that the color of the pill, the presence of a brand name on it, the number of doses to take each day, the route of administration (e.g., orally or intravenously) all affect the size of the placebo effect (reviewed in Goldacre, 2009)? Even more striking, the effectiveness of a treatment seems to decrease as new (and, people believe, more effective) treatments become available (Moerman & Harrington, 2005). There is even evidence that the placebo effect shows differences in strength within different geographical regions, and that in recent years the strength of the placebo effect is increasing (Silberman, 2009).”

### Questions

1. Describe a situation where the placebo effect may have played a part in your response to a treatment (other than your experience at the *A New You!* spa).
2. What’s the difference between (1) conventional and (2) complementary and alternative medicine? What role does the placebo effect play in each type of therapy?
3. Propose a hypothesis to explain why the strength of the placebo effect might be increasing in recent years.
4. You were inclined to accept the spa attendant’s explanations for the foot bath on your first visit, but you felt differently during your second visit. If you had soaked your feet in the bath, should you still expect to feel better after your second treatment? Do you expect the placebo effect to work when you know it’s a placebo?
5. If the placebo effect is real, where’s the harm in letting people remain uninformed (or falsely informed) about the mechanism of action of ionic foot baths?
6. Why do people sometimes turn away from evidence-based medicine and scientifically trained experts in the treatment of their health?

### References

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