The Effect of Water Type on Perception of Taste

I. Introduction

By appearance alone, tap and bottled water are indistinguishable from each other. The only way to be able to differentiate between them seems to be their taste. However, some people may prefer one over the other for reasons other than taste: there are various economic, health, and environmental issues that surround tap and bottled water.

According to the International Bottled Water Association, "the average cost per gallon of bottled water - not counting imported or sparkling waters - was $1.21 in 2013, [whereas tap water costs] $2 per every thousand gallons." Bottled water requires consumers to spend a premium price to cover for the manufacturing, but the general populace might believe that bottled water is safer to drink than tap water or that the portability and disposability of the container provide necessary convenience. This belief, combined with commercial interests that broadcast bottled water as containing more minerals and nutrients, might cause people to consciously prefer the taste of bottled water.

However, tap water actually tends to have stricter regulations than bottled water: "The EPA (regulates tap water) has tighter restrictions and inspection regimens, while the FDA (regulates bottled water) has a less stringent disclosure of consumer information." Finally, tap water is clearly more environmentally sustainable than bottled water, as bottled water creates packaging waste that ends up in landfills and oceans, requires energy use at every stage of

production, and is made up of polyethylene terephthalate (PET), a plastic that produces toxic chemicals during production. Depending on each consumer's needs and the pros and cons of tap and bottled water, this might influence what type of water the consumer might prefer.

II. Statistical Question: Does telling people whether they are drinking tap or bottled water change their perception of which one tastes better?

Hypotheses:	Definitions:
$H_0 : p_1 - p_2 = 0$	p_1 = proportion of people in the group uninformed of the source of the water that prefers bottled water over tap water
$H_a: p_1 - p_2 \neq 0$	p_2 = proportion of people in the group informed of the source of the water that prefers bottled water over tap water

III. Data Collection

We obtained tap water from the water dispenser outside the D building of our school the day of the experiment and brought Kirkland bottled water from home. Because all of the bottled waters were relatively uniform, choosing any bottle of water did not affect the results. The bottled and tap water are also visually indistinguishable from each other. We asked subjects one-by-one from our teacher's class and random passersby during one period of school (1.5 hours). We had brought a large quantity of identical, clear, plastic cups. Each cup was the same size and looked the same as its partner cup. We conducted the experiment at a desk outside the classroom, using a nearby ledge to pour water and the desk for the subject. We put the reservoir of tap water on the right side of the ledge and the bottled water (poured into the same type of clear cups as the tap water so subjects would not know which was which) on the left. One person

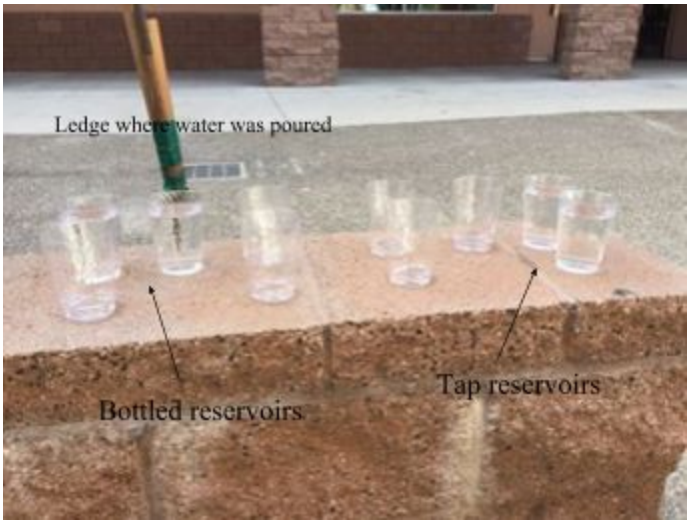
poured both cups of water for each subject, and, to maintain consistency, they poured the same amount for each cup (about 1 cm in depth).

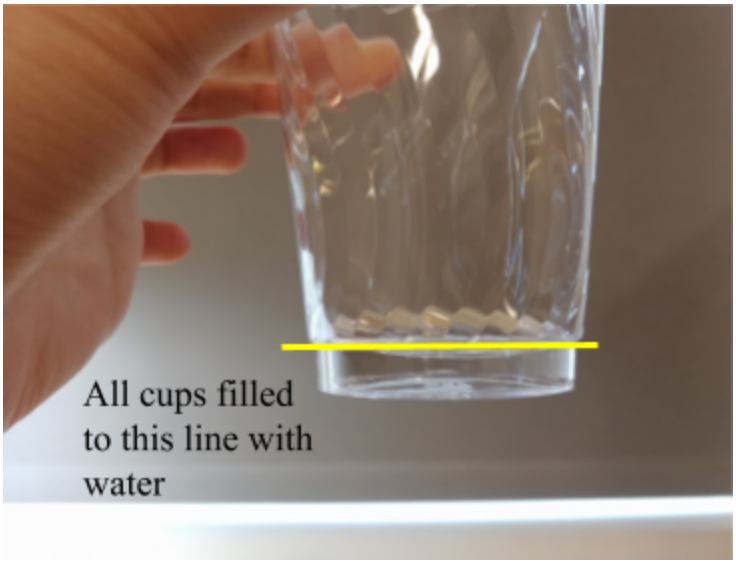
Each of the fifty volunteers were numbered 1 through 50 based on the order that they took part in the experiment. The process used to assign each subject to the treatment was carried out before the the experiment was conducted: a random number generator was used to generate 25 unique random numbers from 1 to 50, inclusive. The 25 subjects who were previously assigned these 25 numbers were then assigned to the treatment where subjects were not told which source each cup of water came from, though the researchers would know. The 25 people who corresponded with the remaining 25 numbers were assigned to the treatment where they *were* told the source of each water. Both treatment groups were informed beforehand only that they would be drinking water from two different sources, but the uninformed group would not know which respective cup was tap and one was bottled.

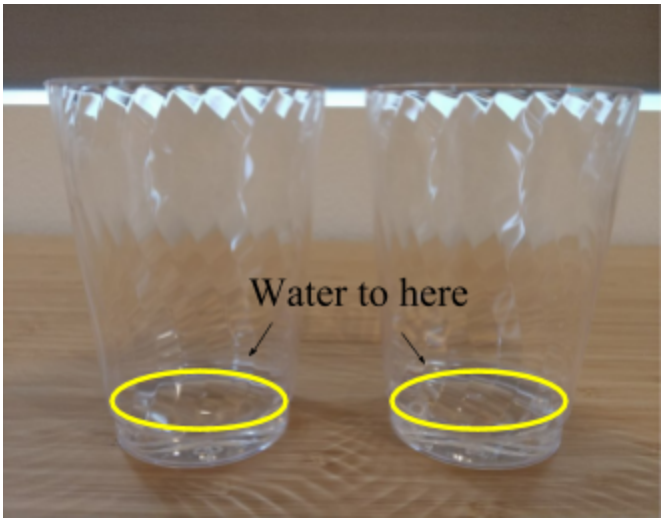
For each subject in the uninformed group, we asked the same question in the same setting, but did not tell them what was different about the waters or which was which. The person supervising the treatment flipped a coin. If it showed heads, the supervisor put the tap water on the left side of the subject. If it showed tails, the bottled water was placed on the subject's left. This way, even if participants systematically decided the first water they tried "tasted" better simply for convenience, the results would be random. The participant was then asked which water they thought tasted better—they could not say both tasted the same. Whichever cup of water (whether bottled or tap) they felt tasted better would be recorded for each subject on a spreadsheet visible only to the researchers.

This process was repeated for the informed group, but the participants were informed before they drank the water of which cup contained bottled water and which contained tap water.

Process:


Ledge where water was poured
Bottled reservoirs
Tap reservoirs


All cups filled
to this line with
water


Water to here

IV. Data Display

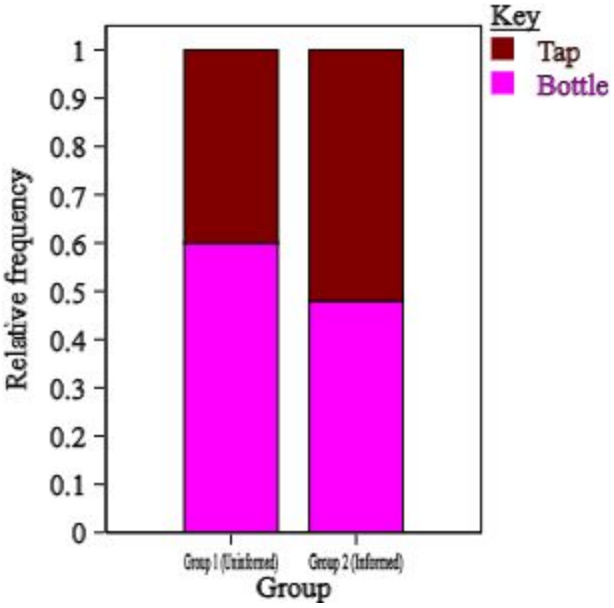
Group 1 (not informed)		Group 2 (informed)	
subject #	result (which tastes better?)	subject #	result
1 T	bottled	2 H	Bottled
3 H	tap	6 H	Bottled
4 T	bottled	7 H	Tap
5 T	Tap	11 H	Bottled
8 H	Bottled	12 T	Tap
9 H	Tap	14 T	Bottled
10 T	Bottled	17H	Bottled
13 H	Bottled	18 T	Tap
15 T	Tap	19 H	Bottled
16 H	Bottled	20 T	Tap
24 T	Bottled	21 T	Tap
25 T	Bottled	22 T	Tap
26 H	Bottled	23 H	Tap
28 T	Bottled	27 H	Tap
29 T	Tap	30 H	Bottled
34 H	Tap	31 H	Tap
35 H	Tap	32 H	Tap
36 T	Bottled	33 T	Tap
38 H	Tap	37 T	Tap
40 T	Bottled	39 T	Tap
42 H	Botted	41 H	Bottled
43 H	Bottled	44 T	Bottled
48 H	Bottled	45 T	Bottled
49 H	Tap	46 H	Bottled
50 H	Tap	47 T	Bottled

25 Randomly-generated numbers assigned to group 1

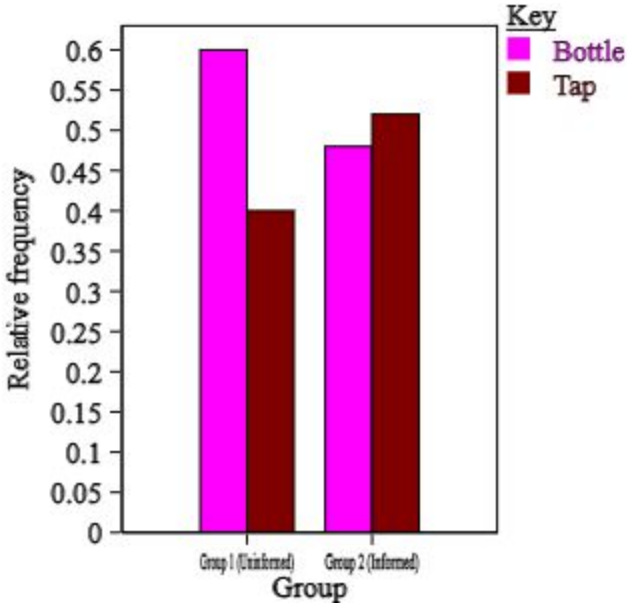
2 34 25 9 40 29 43 13 50 10 48 5
28 26 4 8 16 42 35 15 24 1 36 49 38

Two way table:

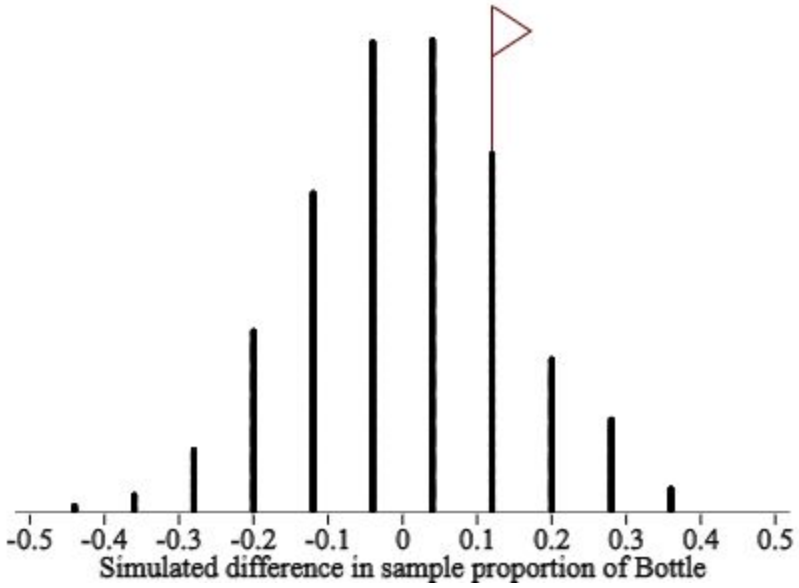
	Group 1	Group 2	TOTAL
Prefer bottled	15	12	27
Prefer tap	10	13	23
TOTAL	25	25	50
P-bottle	0.6	0.48	



Segmented bar graph



Side-by-side bar graphs



Sampling distribution of differences between proportion of uninformed group who prefer bottled water and the proportion informed group who prefer bottled water (1000 samples)

V. Data Analysis

Interestingly enough, subjects in the informed group actually said tap water tastes better in a greater proportion (0.52) than the uninformed group (0.40), which was contrary to our initial belief. The project met both random and the large counts condition, since we randomly assigned treatment groups using a random-number generator along with a coin flip, and n_1p_1, $n_1(1-p_1)$, n_2p_2, and $n_2(1-p_2)$ are all ≥ 10 (there were at least 10 responses in each category). Using a two-sample z test for a difference in proportions, we calculated a test statistic of 0.85125, which had a p value of 0.394676. We used a significance level of $\alpha = 0.05$.

$$\hat{p}c = \frac{15+12}{25+25} = \frac{27}{50} = 0.54$$

$$z = \frac{(\hat{p}_1 - \hat{p}_2) - (p_1 - p_2)}{\sqrt{\frac{\hat{p}_c(1-\hat{p}_c)}{n_1} + \frac{\hat{p}_c(1-\hat{p}_c)}{n_2}}} = \frac{(0.6-0.48) - 0}{\sqrt{\frac{0.54(0.46)}{25} + \frac{0.54(0.46)}{25}}} = 0.85125$$

$$P(z \geq 0.85125) = 0.1973$$

$$2 * 0.1973 = 0.3946267644 \text{ (two-sided test)}$$

VI. Conclusion

Because the p value of 0.3946 was greater than the significance level of $\alpha = 0.05$, we failed to reject the null hypothesis, concluding that there was insufficient evidence of a difference in the proportion of people who prefer bottled water when they are told which water they are drinking is bottled and which is tap versus when they are not informed.

VII. Reflection

While we conducted the project, data collection went relatively well. While it was difficult efficiently managing the station where we filled glasses of each type of water, volunteers who participated in the experiment were compliant and responded quickly. However, we did have confounding variables that may have affected how the water tasted to participants. For example, it is likely that many people confused temperature for taste. One such instance of this would be if a volunteer believed that colder water innately tasted better than warm water, regardless of where it was from. Because the bottled water happened to be colder than the tap water, it might have skewed the data. Thus, one potential improvement to the procedure would be cooling both types of water to the same temperature before asking people to taste. For future experiments, we could test for the placebo effect as well. An example of how this could work might be giving some randomly selected participants two types of the same water. Furthermore, we could add an option that said the two waters tasted the same. This way, if a participant already believed that, they wouldn't randomly choose one that tasted better, making the results more accurate.

VIII. Works Cited

- Livingston, Amy. "Bottled Water vs. Tap Water – Facts & 4 Reasons to Drink Tap," *Money Crashers*.
- Majd, Sanaz. "Should You Drink Tap or Bottled Water?" *Scientific American.* 21 Oct. 2015.