Can Rachel Roggenkemper Distinguish Apple Variety by Sound?

Martin Hsu, Kirina Sirohi

I. Introduction

Rachel Roggenkemper has long claimed that due to her extensive background as an enjoyer of ASMR, she can distinguish the variety of apple just by listening to someone bite into this. We, as accomplished academics, respectfully believe that this is bullsh*t. While we fully believe in Roggenkemper's general outstanding character and overall performance, it would take either superhuman hearing or lifelong, zen-focused study of apple cultivation to develop this skill, neither of which Roggenkemper has. No human possibly could. It is simply beyond science. In fact, a 2014 study conducted by the University of Iowa suggests that human echoic memory is extremely poor, especially compared to other types of memory, such as visual or iconic memory.[1] As a result, we conducted an informal experiment to see if Roggenkemper truly has developed the unique skill of discerning variety from the sound of biting into an apple.

II. Methods and Materials

We conducted an informal double-blind, randomized, single-replicate experiment. Nine apple varieties and 1 pear were selected, listed below in alphabetical order:

- Cosmic Crisp
- Envy
- Fuji
- Gala
- Granny Smith
- Honeycrisp
- Opal
- Pear, D'Anjou
- Pink Lady
- Red Delicious

One apple or pear per variety was selected, with 10 fruits selected in total. Each apple was selected at random from the same retailer, Trader Joe's, from a group of apples of homogenous variety. One researcher was assigned to the task of biting the apple. Both Roggenkemper and the apple biter were blinded to the variety of apple by way of a physical blindfold. Before the experiment began, Roggenkemper was given a list of the possible fruit varieties in alphabetical order and was allowed to visually inspect each apple variety specimen. She was then prompted to list her familiarity with each variety on a discrete ordinal rating scale from 0-10, with 0 being not familiar, and 10 being very familiar. Informed consent was obtained from both Roggenkemper and the apple biter.

Figure 1: Image of experimental setup, with Roggenkemper on the right and designated apple biter on the left.

The apples were bit into in a randomized run order, with the apple biter blindfolded. The biter was seated approximately 2 feet away from the blindfolded Roggenkemper. Roggenkemper was allowed three guesses of the variety, in the order of which she believed most strongly was the correct apple variety. In other words, her first guess was what she believed was her strongest guess, her second guess was what she believed to be her second strongest guess, and her third and final guess was what she was believed to be her weakest guess. Between the three guesses, the guesses were made without replacement. However, she was allowed to repeat guesses between each apple. Upon request, Roggenkemper was allowed to listen to the researcher bite into the apple again, up to 3 times total. She was also permitted to request an oral listing of the apples in alphabetical order as many times as she requested.

Each apple was used as an experimental unit. The following variables were collected from each apple:

- Variety – The variety of apple.
- Guess1 – Roggenkemper's first and what she believed to be her strongest guess of the correct apple variety based on the sound of the bite.
- Guess2 – Roggenkemper's second and what she believed to be her next strongest guess of apple variety.
- Guess3 – Roggenkemper's third and what she believed to be her weakest guess of apple variety.
- RunOrder – The sequential order in which the apple was bit into. The number 1 means the apple was bit into first, and 10 meant it was bit into last, and so on.

The following secondary variables were mutated from the existing ones:

- CorrectGuess – The guess (1, 2, or 3) which Roggenkemper correctly guessed the apple variety. 0 meant she did not correctly guess the apple on any of her 3 guesses.
- TimesGuessed – The number of times the variety was listed as a guess, regardless of correctness
- TimesGuessedNoPear – The number of times the variety was listed as a guess, regardless of correctness, only for apple varieties. The pear was excluded.
- TimesGuessedG1 – The number of times the variety was guessed on Guess1, regardless of correctness
- TimesGuessedG1NoPear – The number of times the variety was guessed on Guess1, regardless of correctness, with the Pear observation excluded.
- TimesGuessedG2 – The number of times the variety was guessed on Guess2, regardless of correctness
- TimesGuessedG2NoPear – The number of times the variety was guessed on Guess2, regardless of correctness, with the Pear observation excluded.
- TimesGuessedG3 – The number of times the variety was guessed on Guess3, regardless of correctness
- TimesGuessedG3NoPear – The number of times the variety was guessed on Guess3, regardless of correctness, with the Pear observation excluded.
- AlphaOrder – The alphabetical order of the fruit variety name, based on the 10 varieties selected.
- AlphaOrderNoPear – The alphabetical order of the fruit variety name, based on the 9 apple varieties selected. The pear was excluded.

III. Descriptive Analysis

Roggenkemper correctly guessed one apple variety out of nine, Fuji, on the third guess. She correctly identified the pear on the first attempt. All other guesses were incorrect.

IV. Inferential Analysis

For reasons of clarity and conciseness, we will exclude the pear observation. By observation, it is clear that Roggenkemper can distinguish between an apple and a pear.

Because Roggenkemper was allowed 3 guesses without replacement per apple, the probability of her randomly guessing the correct variety of apple (pears excluded) within her three guesses in a given observation is as follows:

$$\text{P(correct on one of the guesses)}$$

$$= \text{P(correct 1st guess)} + \text{P(correct 2nd guess and wrong 1st guess)} + \text{P(correct 3rd guess and wrong 1st and 2nd guess)}$$

$$= \text{P(correct 1st guess)} + \text{P(correct 2nd guess} \mid \text{wrong 1st guess)P(wrong 1st guess)} + \text{P(correct 3rd guess} \mid \text{wrong 1st \& 2nd guess)P(wrong 2nd guess} \mid \text{wrong 1st guess)P(wrong 1st guess)}$$

$$= \frac{1}{9} + \frac{1}{8}\left(\frac{8}{9}\right) + \frac{1}{7}\left(\frac{7}{8}\right)\left(\frac{8}{9}\right)$$

$$= \frac{3}{9} = \frac{1}{3} \approx 0.333$$

Therefore, by the binomial distribution, given a one-sided upper-tail significance level of 0.05, we can calculate the number of varieties Roggenkemper must guess correctly to gain a significant result (given she is guessing randomly) by solving for x through the following calculation:

$$0.05 = P(X \geq x) = \sum_{i=x}^{9} \binom{9}{i} \left(\frac{1}{3}\right)^{i} \left(1 - \frac{1}{3}\right)^{9-i}$$

We use a binomial distribution since Roggenkemper is allowed to guess with replacement between each trial (but not within the three guesses for each trial).

Since x = 6 correct guesses yields a one-sided cumulative probability of about 0.04 and x = 5 correct guesses yields a one-sided cumulative probability of about 0.14, we will use 6 as the critical number of correct guesses out of 9. Therefore, if Roggenkemper guessed at least 6 varieties correctly out of 9, we could conclude that there is significant evidence that she has the ability to guess apple variety by the sound of someone biting into it.

Since Roggenkemper correctly identified 1 variety, which is less than 6 guesses, we conclude that we do not have sufficient evidence to prove that on average, she can identify the apple by the sound of someone biting into it.

By the same binomial distribution, we can postulate that if Roggenkemper were randomly guessing, the expected number of correctly guessed varieties out of 9 varieties would be calculated as follows:

$$\mu = n\pi = (9)\left(\frac{1}{3}\right) = 3$$

The number of observed correct guesses, 1 correct guess, was below this average.

V. Results

She probably can't actually guess apple variety based on sound, unfortunately.

Funding for more research is requested.

VI. Discussion

The experiment was conducted outdoors, where Roggenkemper may not have adequately heard the bite enough to distinguish between apples. Additionally, there was only one replicate per variety, which would affect the statistical power of the experiment. A better funded experiment may allow for a blocking variable of location as well as multiple replicates.

It also may be that the presence of a pear might have influenced Roggenkemper's guesses before the pear itself was bit into, which would influence the results of the analysis excluding the pear.

Finally, it could be that familiarity or reciting the apple varieties to Roggenkemper in alphabetical order upon request could have influenced her guesses, as seen in Figure 2.

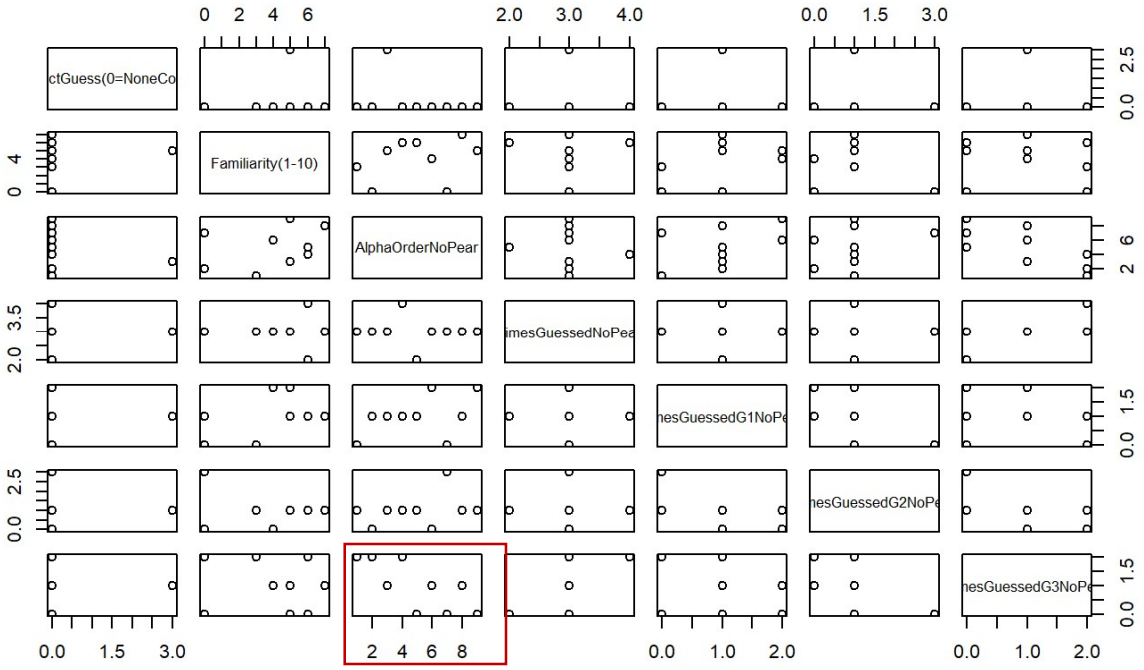

Figure 2: Scatterplot Matrix of Numerical Variables

There are few associations of significance in the Figure 1 scatterplot matrix, except for the fact that alphabetic order may be negatively correlated with the number of times a variety was guessed on the third guess. Without more replicates, these associations are inconclusive.

Roggenkemper also reported that her confidence was negatively affected by comments expressing skepticism about her ability, which originated from a certain faculty member she looked up to.

In general, due to the informal nature of this experiment, we are reluctant to draw a final conclusion, though by these results it seems clear that Roggenkemper does not have a near supernatural ability to identify apple variety by sound, as she claims.

VII. Journal Reference

1. James Bigelow, Amy Poremba. “Achilles’ Ear? Inferior Human Short-Term and Recognition Memory in the Auditory Modality.” *PLoS ONE*, 2014; 9 (2): e89914 DOI: 10.1371/journal.pone.0089914