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W 4768 Experimental Research

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Pre-analysis Plan: Do the Seeds Matter? – An Experiment with Guacamole and Jalapeños

**Registration Timeline:** This pre-analysis plan is filed before treatment assignment, data collection and analysis. It provides an overview of the experiment that I plan to create and run.

**Description:** I plan to test whether there is a difference in the tasted level of spice when different parts of the jalapeño are included in guacamole. There are three parts of a jalapeño: (1) the body (outside flesh), (2) the seeds, and (3) the pith (the white inside flesh where the seeds are attached). When I make low spice guacamole, I include only the body, and discard both the seeds and the pith. When I make spicy guacamole, I include the body, seeds and pith. Sometimes, for a moderate level of spice, I remove the seeds and use only the body and pith. I have been told that both the “Spicy” and “Moderate” recipe variants are spicier than when I include the body only. However, I am not sure if there is a taste difference between the spicy and moderate versions.

**Hypothesis:** I find removing the seeds to be an annoying step in making the “Moderate” recipe. Relatively speaking, it is easier to either keep the seeds and pith or remove both entirely. Therefore, I plan to test whether there is a noticeable spice difference between my “Moderate” and “Spicy” recipes. My hypothesis is that the seeds do not make a noticeable difference to the overall spice level. As such, I will use randomization inference and a one tailed t-test to evaluate the sharp null hypothesis that there is no noticeable difference between treated guacamole (“Spicy” with jalapeño body, seeds, and pith) and control guacamole (“Moderate” with jalapeño body and pith but no seeds). I will use the low spice recipe as a baseline “pre-test” guacamole. I have not made the recipes for the same event, so I am interested in the results of this experiment.

**Recipe:** When I make guacamole, I follow a simple self-recipe:

- 3 Hass avocados (diced and mashed)
- 1/2 large Vidalia onion (diced)
- 1 medium tomato (diced) *Remove insides to prevent guacamole from becoming watery*
- 2 jalapeños (diced)
- 2 cloves of garlic (diced)
- 1 lime (squeezed for the juice)
- Mix the ingredients thoroughly in a bowl, and add salt to taste
- Variants: (1) Low Spice – remove the seeds and pith from the jalapeño, (2) Moderate Spice – remove the jalapeño seeds but keep the pith, (3) Spicy – entire jalapeño.
- Note: The recipe scales nicely for larger servings.

**Food Preparation:** I will triple the guacamole recipe to ensure that there is enough for serving. There will be three guacamole batches, a baseline pre-treatment “Low-Spice” batch with only the jalapeño body, a control “Moderate” batch with the jalapeño body and pith but no seeds, and a treatment “Spicy” batch with the jalapeño body, pith, and seeds. I will make a large bowl of guacamole and then split it into pre-treatment, treatment, and control batches that will only differ by the jalapeño parts added later. Guacamole will be prepared as follows:

- Step 1 – Prepare all the guacamole ingredients, **except the 6 jalapeños**, and mix them in large mixing bowl.
- Step 2 – Pour one third of the guacamole into each of three smaller mixing bowls. For preparation, label one bowl “low-spice,” one bowl “moderate” and one bowl “spicy.”
- Step 3 – Cut open the jalapeños, remove the seeds, and mix together in a small bowl. Remove the pith from the jalapeños, dice, and mix together in a second small bowl. Dice the jalapeño bodies and mix together in a third small bowl. *(To prevent selection on jalapeños, the guacamole batches will receive equal shares from the jalapeños).*
- Step 4 – Add 1/3 of the jalapeño body mixture to each of the spice level bowls.
- Step 5 – Add 1/3 the jalapeño pith mixture to the spicy bowl and 1/3 to the moderate bowl and discard the rest.
- Step 6 – Add 1/3 of the jalapeño seed mixture to the spicy bowl and discard the rest.
- Step 7 – Mix each batch thoroughly.
- Step 8 – Prepare servings of each guacamole using clean plastic spoons. Prepare 30 pre-treatment “Low-Spice” servings, 15 “Moderate” control servings, and 15 “Spicy” treatment servings.

**Serving:** To ensure that the experiment is blind, I will give unlabeled samples to an assistant who will serve the guacamole to the taste testers. The samples will be given to the assistant in the order designated by the randomization procedure. Each individual will receive 10 baseline servings – one for each observation. Each baseline serving will be randomly followed by a treatment/control serving. Under the complete randomization process, each individual will receive 5 treatment servings and 5 control servings.

For each observation ( $i$ ), I will follow the following steps:

- Step 1 – A tester will be asked to sip a glass of milk and a glass of water to “reset” and “clear” their palette from any residual spice flavor.
- Step 2 – An assistant will blindly give the tester a serving from the pre-treatment batch.
- Step 3 – **Baseline Score:** The tester will then score the serving using the below score chart. This score will act as a baseline covariate variable.
- Step 4 – The tester will then sip a glass of milk and a glass of water to “reset” and clear their palette.
- Step 5 – **Outcome Score:** An assistant will blindly and randomly give the tester either a treatment serving or control serving. This score will act as the potential outcome variable.
- Step 6 – The tester will then score the serving using the below chart.

**Scoring:** Each taste tester will be asked to score their samples according to the following categories on a 1 to 5 scale as described below. The survey will be administered through a Google Survey. The content rating questions will be randomly ordered. The content rating questions will be followed by an overall taste rating.

**Table 1:** Ingredient Scoring Chart

Contents	1	2	3	4	5
Garlic Level	Very Weak	Weak	Balanced	Strong	Very Strong
Salt Level	Very Weak	Weak	Balanced	Strong	Very Strong
Spicy Level	Very Weak	Weak	Balanced	Strong	Very Strong
Lime Level	Very Weak	Weak	Balanced	Strong	Very Strong
Onion Level	Way Too Little	Not Enough	Balanced	Too Much	Way Too Much
Tomato Level	Way Too Little	Not Enough	Balanced	Too Much	Way Too Much
Overall	1	2	3	4	5
Overall Taste	Terrible	Poor	So-So	Good	Great

## Detailed Analysis Plan

### 1. Subjects

1. **Subjects** – The subjects are 30 guacamole taste servings ( $i$ ). A control subject is a serving from the control guacamole (the batch without seeds) and is denoted by  $d_i = 0$ . A treatment subject is a serving from the treatment guacamole (the batch with seeds) and is denoted by  $d_i = 1$ .
2. **Unit of Analysis** – Each guacamole subject will be given a spice score  $Y_i(d) \in \{1,2,3,4,5\}$  by a taste tester. The spice score for each guacamole subject is the intended potential outcome unit of analysis.
3. **Acquisition** – The guacamole subjects will be created as described in the above recipe section.
4. **Representation** – The guacamole subjects will be drawn from the guacamole batches. The batches will be mixed thoroughly to ensure flavor consistency. The above recipe is representative of how I make and serve my guacamole.

### 2. Treatment

1. **Treatment** – The treatment is the use of jalapeño body, pith, and seeds in the guacamole. A treatment sample, denoted by  $d_i = 1$ , will be drawn from the treatment batch. The control is the use of jalapeño body and pith but no seeds. A control sample, denoted by  $d_i = 0$ , will be drawn from the control batch.
2. **Procedure** – The procedure for preparing and administering the treatment and control taste servings is described above.
3. **Compliance** – Compliance will be defined as whether a guacamole sample receives a spice score. I expect each guacamole sample to receive a score from a given taste tester. Therefore, I do not expect to have any instances of non-compliance.

### 3. Randomization

1. **Procedure** - I will use complete randomization within blocks as my randomization procedure. I anticipate having three taste testers, as such, I will use complete randomization within each of the three blocks. Therefore, each individual will receive 5 control servings and 5 treatment servings.
2. **Fidelity** - To ensure my randomization procedure is followed, I am having an assistant blindly serve treatment and control samples to the taste testers. The assistant will not be given information on whether a given sample is a pre-treatment, treatment, or control serving.
3. **Code** – The R code excerpt that I will use for complete randomization within each block is given below. It also includes the code for making the random assignment table that is posted on the below page.

```
set.seed(1234567)
```

```
N = 30
```

```
n=10
```

```
m = 5
```

```
guac <- data.frame("obs"=1:N)
```

```
guac$block <- c(rep(1,10),rep(2,10),rep(3,10))
```

```
# Complete Random Assignment within each block
```

```
# Per block,  $0 < m=5 < 10$ 
```

```
guac$treatment[1:10] <- ifelse(1:n %in% sample(1:10, m), 1, 0)
```

```
guac$treatment[11:20] <- ifelse(11:20 %in% sample(11:20, m), 1, 0)
```

```
guac$treatment[21:30] <- ifelse(21:30 %in% sample(21:30, m), 1, 0)
```

```
# Show total treatment vs control
```

```
table(guac$treatment)
```

```
# Make Random Assignment Table
```

```
guac$treat_type<- "Spicy"
```

```
guac$treat_type[guac$treatment==0] <- "Moderate"
```

```
kable(guac, "html", booktabs = T) %>% kable_styling(latex_options = "striped")
```

**Table 2:** Random Assignment Table

Observation	Block	Treatment	Type
1	1	1	Spicy
2	1	0	Moderate
3	1	0	Moderate
4	1	0	Moderate
5	1	1	Spicy
6	1	1	Spicy
7	1	1	Spicy
8	1	1	Spicy
9	1	0	Moderate
10	1	0	Moderate
11	2	1	Spicy
12	2	0	Moderate
13	2	0	Moderate
14	2	1	Spicy
15	2	1	Spicy
16	2	1	Spicy
17	2	1	Spicy
18	2	0	Moderate
19	2	0	Moderate
20	2	0	Moderate
21	3	1	Spicy
22	3	0	Moderate
23	3	1	Spicy
24	3	1	Spicy
25	3	1	Spicy
26	3	0	Moderate
27	3	1	Spicy
28	3	0	Moderate
29	3	0	Moderate
30	3	0	Moderate

#### 4. Outcomes

1. **Outcomes of interest:** I am interested in whether the treatment of “jalapeño body, seeds, and pith” in guacamole is spicier than the control of “jalapeño body and pith but no seeds” in guacamole. The potential outcome measure for a treated subject  $Y_i(d = 1)$  is the taste tester scoring of a serving of the “spicy” guacamole. The potential measure for a control subject  $Y_i(d = 0)$  is the taste tester scoring of a serving of the “moderate” guacamole. As stated above, each guacamole subject will be given a spice score  $Y_i(d) \in \{1,2,3,4,5\}$  by a taste tester.
2. **Outcome Measurement:** The potential outcomes will be measured by the scoring chart listed above. Blocking and the use of a baseline score will help adjust for the fact that different testers have different baseline measures and appreciation for spice.
3. **Measurement Symmetry:** To maintain symmetry between treatment and control servings, I will implement the following procedures:
  - i. An assistant will blindly and randomly serve the testers guacamole servings.
  - ii. Testers will be asked to sip a glass of milk and water before each baseline tasting and each treatment/control tasting to reset their palettes from the spice flavor.
  - iii. Testers will wait a full minute before each baseline and or treatment/control tasting to aid in resetting their palette.
  - iv. New plastic spoons will be used to serve each testing so prevent residual spice flavor on utensils from contaminating individual servings.
  - v. Testers will be asked to grade each serving on 7 different dimensions using the above score chart. The six “placebo” scales are used to prevent the testers from focusing on only the spice flavor.

#### 5. Covariates

1. **What covariates will you use?** I will use a “pre-test” serving of the control guacamole for each observation as baseline covariate score measure. That is for each of the thirty observations a tester will (1) be given a sip of milk and water, (2) blindly taste a guacamole serving from the pre-test batch, and (3) rate the control batch. The steps will be repeated for the treatment/control servings.
2. **How will you measure them?** I will measure the “pre-test” covariate using the above scoring chart.
3. **Are your covariates measured pre-treatment? If not, how will you ensure that treatment does not affect covariate measurement?** For each observation, the “pre-test” baseline score is measured pre-treatment. Ideally, I would have 30 different taste testers – one for each observation. However, I only expect to have 3 taste testers. Each tester will each taste 10 baseline guacamole servings and randomly taste 10 treatment/control guacamole servings. To ensure that treatment status does not affect covariate measurement across observations, I am implementing the above-mentioned measurement symmetry steps (*milk and water, 1-minute wait period, clean plastic spoons, blind administration, and placebo scoring*).

## 6. Analysis

1. **Estimands** – In this experiment, I plan to estimate the average treatment effect. I want to know the average effect of treatment (guacamole with jalapeño body, seeds and pith) versus control (guacamole with jalapeño body and pith but no seeds) on spice score.
2. **Estimators? Covariate adjustment?** The main estimator of interest is the difference-in-means estimator of the treatment/control spice score with covariate adjustment using the baseline spice score. I will also report (1) the difference-in-means estimator without the baseline spice score as well as (2) the difference-in-differences estimator where I use to the baseline score to scale the outcome measure.

For fun, I will also report the difference-in-means estimator (without covariate adjustment) for the overall taste score. It will be interesting to know if one variant scores higher than another. Additionally, I will report the difference-in-means estimator for the “placebo” ingredient scores. I do not expect treatment status to affect the scores of the other ingredients.

3. **What are your hypothesis for the direction of treatment effects?** My hypothesis is that the “spicy” guacamole is not spicier than the “control” guacamole. I will use randomization inference to test the sharp null hypothesis that there is no effect of seeds for any observation. I will plan to reject my null hypothesis if the spice score of the treatment guacamole is higher than that of the control guacamole using p-value of 0.05 as my critical value.
4. **Core Assumptions** – (1) *Randomization* – I do not expect problems with my randomization strategy. I am using complete randomization and will use an assistant to serve the guacamole to ensure blindness. The assistant will not know which batch a given serving is drawn from and does not know what the experiment is designed to test. The taste testers also do not know what aspect of the guacamole is being tested. I do not expect to have any attrition, compliance, or non-interference. I expect all observations to receive a ranking.

(2) *Non-Interference* – Ideally, I would have an individual taste tester for each observation ( $i$ ) for a total of 30 taste testers. However, I will only have three taste testers. Therefore, I must assume that tasting a given guacamole serving does not affect the potential outcome spice rating of future observations. To make this assumption most plausible I am implementing the above-mentioned steps (*milk and water, 1-minute wait period, clean plastic spoons, blind administration, and placebo scoring*). To further guarantee non-interference, taste-testers will not be allowed to interact with each other during tasting.

(3) *Excludability* – I expect the excludability assumption to hold. The same procedure will be used to administer each serving. The assistant will be blind to the administration of each serving so there should be no way for subjects to know if they are receiving the treatment or control servings.