

Sam Tenney

Section 2

Homework 7

1. Perfect Cookies

a) Response Variable: Cookie diameter in inches.

Factors: Temperature of oven (370, 375, 380, 385°F), Fat ingredient (butter, margarine).

Treatments: There are eight treatment combinations of the factors and factor levels. They are as follows: 370°F-Butter, 370°F-Margarine, 375°F-Butter, 375°F-Margarine, 380°F-Butter, 380°F-Margarine, 385°F-Butter, 385°F-Margarine

b) `set.seed(1995)`

`sample(1:24, replace=FALSE`

```
## [1] 21 19 9 5 12 14 20 11 16 8 6 7 23 2 24 15 4 1 18 22
17 3 13
## [24] 10
```

Design Table

Experiment	Factor 1 Level: Temperature	Factor 2 Level: Ingredient	Replicate
1	370	Butter	1
2	370	Butter	2
3	370	Butter	3
4	370	Margarine	1
5	370	Margarine	2
6	370	Margarine	3
7	375	Butter	1
8	375	Butter	2
9	375	Butter	3
10	375	Margarine	1
11	375	Margarine	2
12	375	Margarine	3
13	380	Butter	1
14	380	Butter	2
15	380	Butter	3
16	380	Margarine	1
17	380	Margarine	2
18	380	Margarine	3
19	385	Butter	1
20	385	Butter	2
21	385	Butter	3
22	385	Margarine	1

23	385	Margarine	2
24	385	Margarine	3

#### Check Sheet

Run	Experiment	Factor 1 Level: Temperature	Factor 2 Level: Ingredient
1	21	385	Butter
2	19	385	Butter
3	9	375	Butter
4	5	370	Margarine
5	12	375	Margarine
6	14	380	Butter
7	20	385	Butter
8	11	375	Margarine
9	16	380	Margarine
10	8	375	Butter
11	6	370	Margarine
12	7	375	Butter
13	23	385	Margarine
14	2	370	Butter
15	24	385	Margarine
16	15	380	Butter
17	4	370	Margarine
18	1	370	Butter
19	18	380	Margarine
20	22	385	Margarine
21	17	380	Margarine
22	3	370	Butter
23	13	380	Butter
24	10	375	Margarine

- c) That would be faster, but it wouldn't be a randomized basic factorial design since we are choosing the order we apply the temperature treatment.
- d) That would be more expensive, and the ovens could perform differently from one another. To limit our confounding variables, it's best we use the same oven so the trials receive consistent treatments throughout the experiment.
- e) Perhaps the wait time to be put in the oven will have different effects on the cookie diameter that we wouldn't be able to account for. It's best to keep it consistent throughout the experiment.
- f) The model is  $y_{ijk} = \mu + \alpha_i + \beta_j + \gamma_{ij} + \epsilon_{ijk}$ . The variable  $y_{ijk}$  is the cookie diameter in inches for the  $k^{\text{th}}$  replicate of the  $i^{\text{th}}$  temperature (in Fahrenheit; 370, 375, 380, 385) and the  $j^{\text{th}}$  fat ingredient level (butter, margarine). The variable  $\mu$  is the grand mean of all the cookie diameters (inches). The variable  $\alpha_i$  is the treatment effect for the  $i^{\text{th}}$  temperature

(Fahrenheit) level.  $\beta_j$  is the treatment effect for the  $j^{\text{th}}$  fat ingredient level.  $\gamma_{ij}$  is the interaction effect for the  $i^{\text{th}}$  temperature level and the  $j^{\text{th}}$  fat ingredient level. The error for the  $k^{\text{th}}$  replicate with  $i^{\text{th}}$  temperature (Fahrenheit) and the  $j^{\text{th}}$  fat ingredient is represented by  $\epsilon_{ijk}$ .

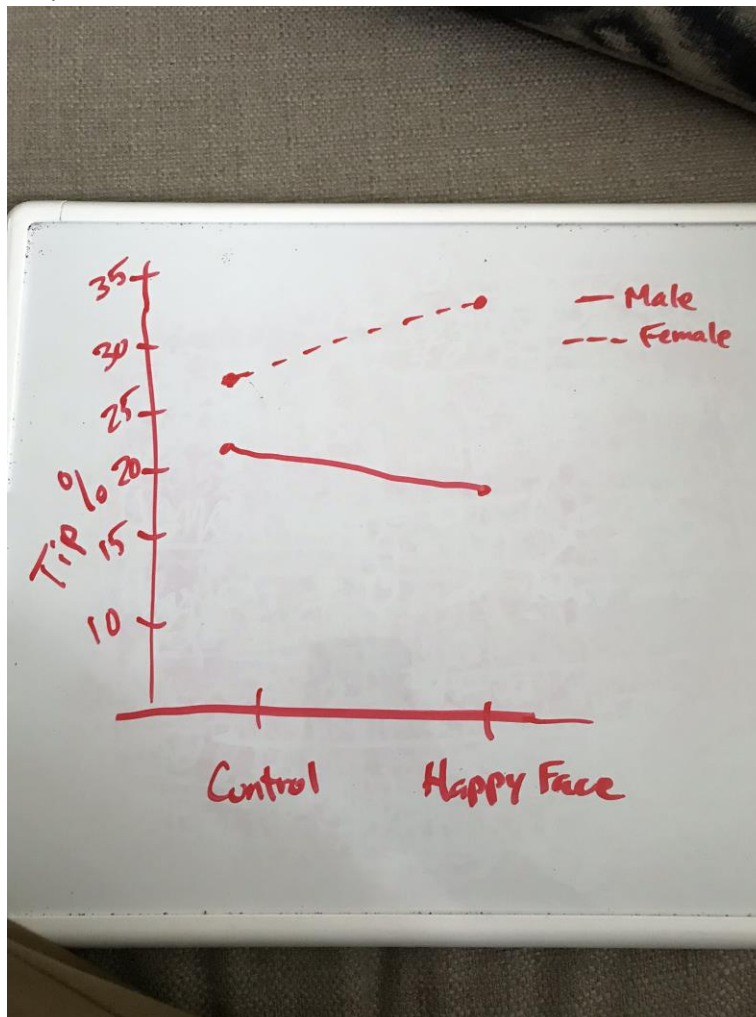
g)  $H_0: \gamma_{11} = \gamma_{12} = \dots = \gamma_{IJ} = 0$   
 $H_a$ : at least one  $\gamma_{IJ} \neq 0$

h)  $H_0: \alpha_1 = \alpha_2 = \dots = \alpha_i = 0$   
 $H_a$ : at least one  $\alpha_i \neq 0$

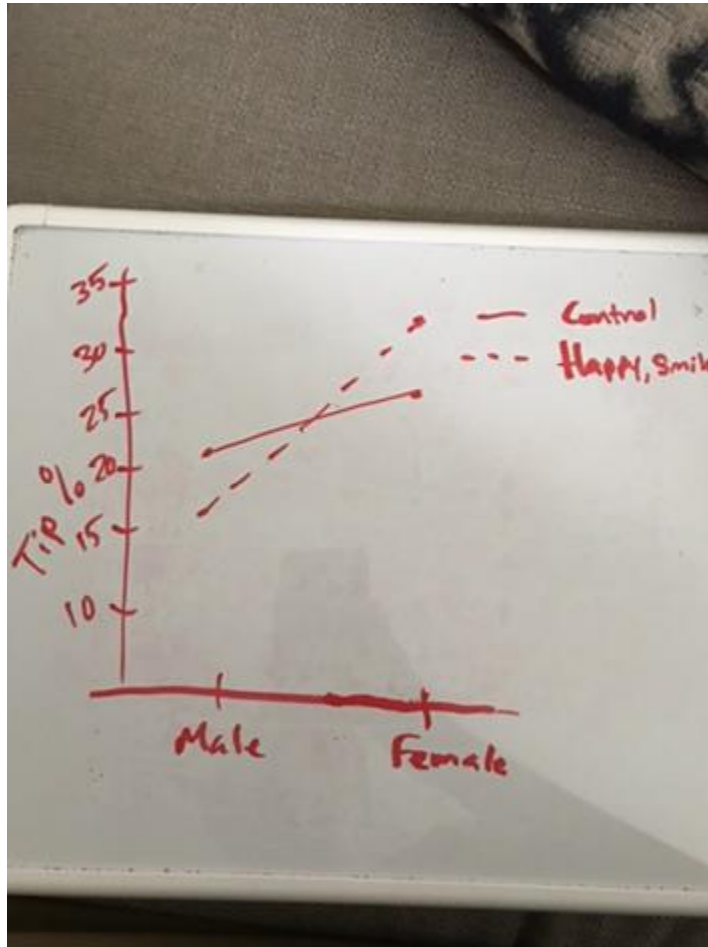
i)  $H_0: \beta_1 = \beta_2 = \dots = \beta_j = 0$   
 $H_a$ : at least one  $\beta_j \neq 0$

## 2. Receipt Personalization and Tipping Behavior

a) Graph 1



Graph 2



I prefer Graph 1 because it's easy to see that both the gender and tipping delivery have an interaction in what the tipping percentage is.

- b) When gender is held constant at male, changing the tipping delivery from the blank check to the happy, smiling face causes a slight decrease in the tipping percentage. Meanwhile, when gender is held constant at female, changing the tipping delivery from blank check to the happy, smiling face causes a slight increase in the tipping percentage.