Beer Preferences for Thursday Night Football: A Blanced Incomplete Block Design Experiment

Matthew Murnane Ethan Newcomb

Abstract

Introduction

American football has immensely grown in popularity in recent years. Along with the growth of a national sport comes an increase in social gatherings and alcoholic beverage enjoyment. Weekly Thursday night football games are broadcast on national television and each Thursday, Matthew's house hosts a watch party along with his roommates. The group enjoys consuming a wide variety of beer, ranging in type and brand. This setting became ideal to test the following research question: What is the beer type that is most favored among the group of friends? Since each individual holds their own inherent biases toward beer, a Balanced Incomplete Block Design (BIBD) is a perfect experimental design. Here, the participants' preferences for beer are blocked, allowing the effects of beer type to be highlighted without the unwanted effect of the nuisance factor. The data collected will be the participants' ratings of beers, which differ in type and flavor. The "Balanced Incomplete" part of the experiment comes from the fact that alcohol impairs judgement, so the amount given to the participants should be limited.

Methods

Everything was randomized before starting the experiment. With simple R code and using a `set.seed(530)` we were able to get a correct BIBD set up.

Participants	I	II	III
1	C	B	D
2	B	C	A
3	D	A	C
4	D	B	A

We then randomized the assignments of beer types to the letters and the order of participants, using the same `set.seed(530)`.The table below is of treatment assignments and order assignments

trts	beers	rank	participants
A	Siera	1	Zach
B	Coors	2	Jon
C	Guinnes	3	Nolan
D	Pliny	4	Beni

The experiment was conducted inside of Matthew's room. Participants were blind folded before entry into the room, they were seated down and told the following:

> You will be offered three beers during the experiment. You will drink a glass of water, then taste the beer. After tasting you will rate the beer on a scale from 1 to 10. 1 meaning "I never want to drink this again", 5 meaning "this is an okay beer, and 10 meaning "I want a whole glass of this beer right now". Half points are allowed.

Results

The ratings for each participant of their three randomly assigned beers are shown in Table 3. Additionally, the mean rating of each beer type and participant are displayed. It can be observed that the beer type with the highest mean rating is Coors (Generic) at 6.17. On the other hand, Guinness (Dark) received the lowest mean rating at 4.33. The range rating between the highest and lowest mean ratings is 1.84, indicating a relatively small difference between mean ratings of beer type. Regarding participant ratings, the highest mean rating resulted from Beni at 6.5, while the lowest mean rating resulted from Zach at 3.67. The range between these two mean ratings is 2.83, indicating a relatively small difference in participant mean ratings.
There appear to be apparent outliers, such as the ratings of 8.5 or 2, which could indicate a significant block effect. However, the ANOVA table results at the end of this section will disprove that notion.

Table 3: Beer Ratings by Participant

Beers	Nolan	Jon	Beni	Zach	Row Means
Sierra(Pale_ale)	NA	5.5	7	2.5	5.00
Coors(Generic)	6	6	NA	6.5	6.17
Guinness(Dark)	5.5	3.5	4	NA	4.33
Pliny(IPA)	3	NA	8.5	2	4.50
Column Means	4.83	5	6.5	3.67	NA

Figure _____ displays a visual representation of Ratings Per Beer. It is relatively difficult to draw a conclusion from this data, given the wide range of data points and their overlapping nature.

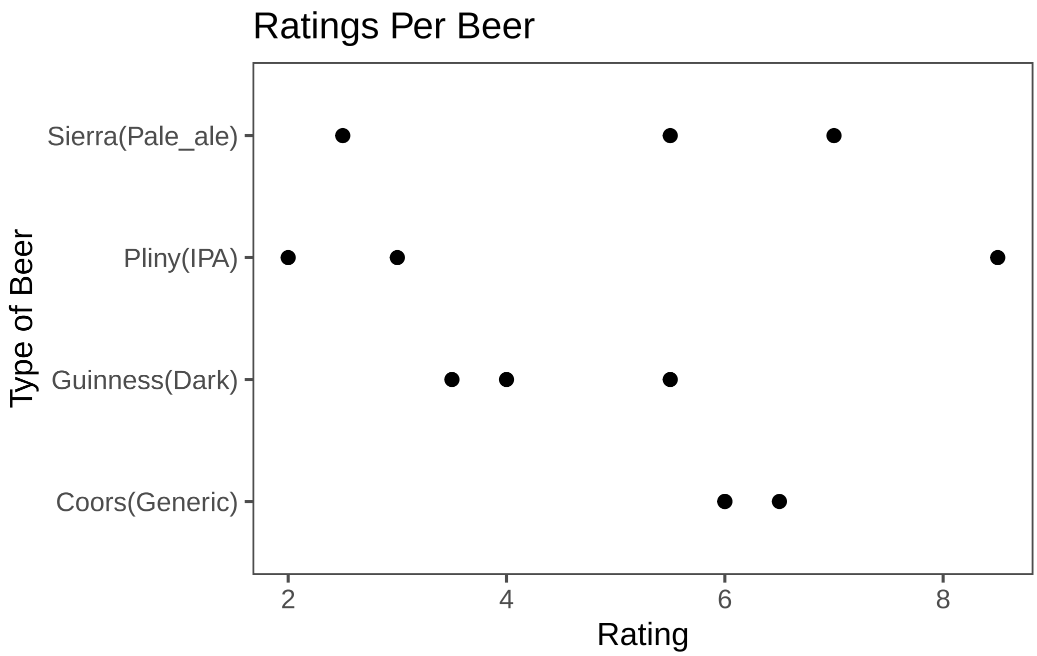

Figure _____ displays a visual representation of Ratings Per Subject. One possible trend observed in this chart is the different rating tendencies of the participants. Although the data overlaps, a potential trend could be that Beni naturally rates beers higher while Zach naturally rates them lower.

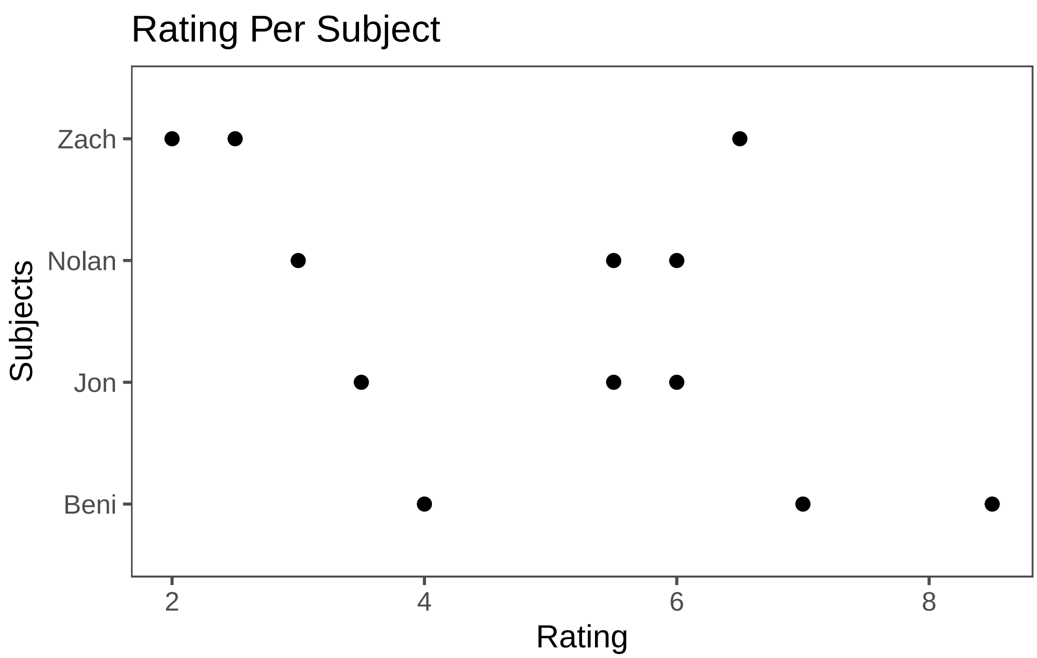

Table 4 displays the ANOVA results from the BIBD design. The p-value for the treatment (type of beer) is 0.3414684. This indicates that the effect of beer type on rating is insignificant, since it is less than 0.05. Also, the p-value for the block (participant) is 0.4001761. This indicates that the nuisance factor of participant is also insignificant, since it is less than 0.05.

*** maybe we should change “names” to participants or subjects in the ANOVA table***

Table 4: ANOVA Table for Linear Model

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
names	3	12.16667	4.055556	1.197212	0.4001761
beers	3	14.39583	4.798611	1.416564	0.3414684
Residuals	5	16.93750	3.387500	NA	NA

Conclusion

Appendix

Code Used

Libraries Used

```
library(tidyverse)
library(ggthemes)
library(tidyr)
library(knitr)
```

Data Code

```
# Data input
beers <- c("Sierra(Pale_ale)", "Coors(Generic)", "Guinness(Dark)", "Pliny(IPA)")
Nolan <- c(NA, 6, 5.5, 3)
Jon <- c(5.5, 6, 3.5, NA)
Benni <- c(7, NA, 4, 8.5)
Zach <- c(2.5, 6.5, NA, 2)

raw_data <- data.frame(beers, Nolan, Jon, Benni, Zach)

# Data Cleaning

pivoted_raw_data <- pivot_longer(raw_data,
                        cols=-beers,
                        names_to = "names",
                        values_to = "rating")

cleaned_data <- pivoted_raw_data %>%
  drop_na(rating)
```

```
#Table
col_means <- round(colMeans(raw_data[, -1], na.rm = TRUE), 2)

raw_data_with_col_means <- rbind(raw_data, c("Mean", col_means))

row_means <- round(apply(raw_data[, -1], 1, mean, na.rm = TRUE), 2)

raw_data_with_means <- cbind(raw_data_with_col_means, Row_Mean = c(row_means, NA))
```

```r
raw_data_with_means %>%
  kable(
    caption = "Beer Ratings by Participant",
    col.names = c("Beers", "Nolan", "Jon", "Beni", "Zach", "Row Means"),
    align = "c"
  )
```

Randomization Code

```r
# Computing the BIBD matrix
trts <- c("A", "B", "C", "D")
set.seed(530)
t(replicate(4, sample(trts, 3, replace = FALSE)))

# Randomly matching treatments to the letters
brands <- c("Pliny", "Coors", "Siera", "Guinnes")
shuffled_brands <- sample(brands)
assignments <- data.frame(trts, shuffled_brands)

#Randomizing the order of participants/blocks
boys <- c("Zach", "Jon", "Nolan", "Benni")
rank <- 1:4
shuffled_names <- sample(boys)
order <- data.frame(rank, shuffled_names)
```

Plots

```r
cleaned_data %>%
  ggplot(aes(x = rating,
             y = beers))+
  geom_point(size = 2)+
  theme_few()+
  ggtitle("Ratings Per Beer")+
  ylab("Type of Beer")+
  xlab("Rating")
```

```r
cleaned_data %>%
  ggplot(aes(x = rating,
             y = names))+
```

```r
  geom_point(size = 2)+
  theme_few()+
  ggtitle("Rating Per Subject")+
  xlab("Subjects")+
  ylab("Rating")
```