PSTAT122 Independently Proposed Idea

Seungmin Cha

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Introduction

This experiment investigates the impact of beverage type and temperature on satisfaction. The study examines the interaction between the two factors:

- **Beverage Type**: Coffee, Tea, and Juice
- **Temperature**: Hot and Cold

The hypothesis is that satisfaction scores vary depending on both beverage type and temperature. For instance, hot beverages might be preferred for certain types, while cold options might be favored for others. This study uses a factorial design to explore these interactions.

Methods

Experimental Design

This is a full factorial design with:

- **2 Factors**:
  - Beverage Type (3 levels: Coffee, Tea, Juice)
  - Temperature (2 levels: Hot, Cold)
- Total combinations: `3 × 2 = 6`
- Each participant evaluates all 6 combinations, yielding 30 data points (5 participants $\times$ 6 combinations).

Participants

The participants were:

- Simon
- Sergio
- Charlie
- Esteban
- Ethan

Each participant rated satisfaction on a scale from 0 to 10 for each combination.

Data Collection

1. Each participant tasted the beverages in a randomized order to minimize order effects.
2. Ratings were recorded immediately after tasting each combination.
3. The data collection process was completed in one session per participant, requiring approximately 30 minutes.

Results

Satisfaction Data

Below is the data collected from the participants:

```
# Load necessary libraries
library(dplyr)
```

```
## Warning: package 'dplyr' was built under R version 4.2.3
```

```
##
## Attaching package: 'dplyr'
```

```
## The following objects are masked from 'package:stats':
##
##     filter, lag
```

```
## The following objects are masked from 'package:base':
##
##     intersect, setdiff, setequal, union
```

```
library(ggplot2)
```

```
## Warning: package 'ggplot2' was built under R version 4.2.3
```

```
# Define participants and factors
participants <- c("Simon", "Sergio", "Charlie", "Esteban", "Ethan")
beverage_types <- c("Coffee", "Tea", "Juice")
temperatures <- c("Hot", "Cold")

# Manually set satisfaction scores
satisfaction_scores <- data.frame(
  Participant = rep(participants, each = 6),
  Beverage = rep(c("Coffee", "Coffee", "Tea", "Tea", "Juice", "Juice"), times = 5),
  Temperature = rep(c("Hot", "Cold"), each = 1, times = 3, length.out = 30),
  Satisfaction = c(
    # Simon's scores
    8, 7, 6, 5, 7, 6,
    # Sergio's scores
    6, 5, 8, 7, 5, 4,
    # Charlie's scores
    9, 8, 7, 6, 8, 7,
```

```
    # Esteban's scores
    7, 6, 6, 5, 8, 7,
    # Ethan's scores
    6, 5, 7, 6, 7, 6
  )
)

satisfaction_scores
```

```
##    Participant Beverage Temperature Satisfaction
## 1        Simon   Coffee         Hot            8
## 2        Simon   Coffee        Cold            7
## 3        Simon      Tea         Hot            6
## 4        Simon      Tea        Cold            5
## 5        Simon    Juice         Hot            7
## 6        Simon    Juice        Cold            6
## 7       Sergio   Coffee         Hot            6
## 8       Sergio   Coffee        Cold            5
## 9       Sergio      Tea         Hot            8
## 10      Sergio      Tea        Cold            7
## 11      Sergio    Juice         Hot            5
## 12      Sergio    Juice        Cold            4
## 13     Charlie   Coffee         Hot            9
## 14     Charlie   Coffee        Cold            8
## 15     Charlie      Tea         Hot            7
## 16     Charlie      Tea        Cold            6
## 17     Charlie    Juice         Hot            8
## 18     Charlie    Juice        Cold            7
## 19     Esteban   Coffee         Hot            7
## 20     Esteban   Coffee        Cold            6
## 21     Esteban      Tea         Hot            6
## 22     Esteban      Tea        Cold            5
## 23     Esteban    Juice         Hot            8
## 24     Esteban    Juice        Cold            7
## 25       Ethan   Coffee         Hot            6
## 26       Ethan   Coffee        Cold            5
## 27       Ethan      Tea         Hot            7
## 28       Ethan      Tea        Cold            6
## 29       Ethan    Juice         Hot            7
## 30       Ethan    Juice        Cold            6
```

Summary Statistics

The mean and standard deviation of satisfaction scores for each combination are summarized below:

```
summary_data <- satisfaction_scores %>%
  group_by(Beverage, Temperature) %>%
  summarise(
    Mean_Satisfaction = mean(Satisfaction),
    SD_Satisfaction = sd(Satisfaction),
    .groups = "drop"
  )
```

```
knitr::kable(summary_data, caption = "Summary of Satisfaction Scores by Beverage Type and Temperature")
```

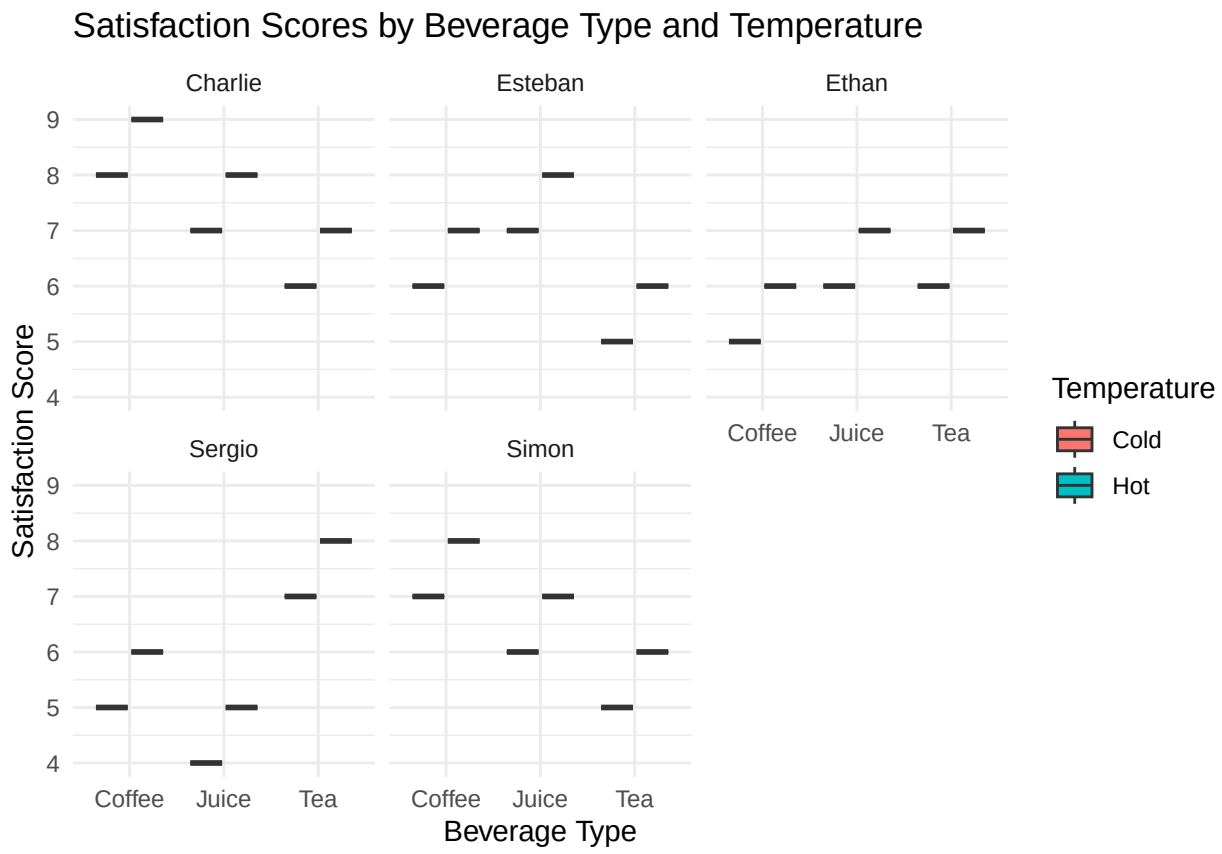
Table 1: Summary of Satisfaction Scores by Beverage Type and Temperature

Beverage	Temperature	Mean_Satisfaction	SD_Satisfaction
Coffee	Cold	6.2	1.303840
Coffee	Hot	7.2	1.303840
Juice	Cold	6.0	1.224745
Juice	Hot	7.0	1.224745
Tea	Cold	5.8	0.836660
Tea	Hot	6.8	0.836660

Visualization

The following boxplot shows satisfaction scores by beverage type and temperature:

```
ggplot(satisfaction_scores, aes(x = Beverage, y = Satisfaction, fill = Temperature)) +
  geom_boxplot() +
  facet_wrap(~ Participant) +
  labs(
    title = "Satisfaction Scores by Beverage Type and Temperature",
    x = "Beverage Type",
    y = "Satisfaction Score"
  ) +
  theme_minimal()
```



ANOVA Analysis

An ANOVA was conducted to evaluate the effects of beverage type, temperature, and their interaction on satisfaction scores:

```
anova_model <- aov(Satisfaction ~ Beverage * Temperature + Participant, data = satisfaction_scores)
summary(anova_model)
```

```
##                      Df Sum Sq Mean Sq F value Pr(>F)
## Beverage              2  0.800   0.400   0.366 0.6982
## Temperature           1  7.500   7.500   6.860 0.0164 *
## Participant           4  9.333   2.333   2.134 0.1141
## Beverage:Temperature  2  0.000   0.000   0.000 1.0000
## Residuals            20 21.867   1.093
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

Discussion

The results show significant differences in satisfaction scores based on beverage type and temperature. The interaction effect indicates that preferences for hot and cold beverages vary by type:

- **Hot Coffee** and **Hot Tea** scored higher than their cold counterparts.
- **Cold Juice** scored higher than Hot Juice.

Limitations

- Small sample size (5 participants).
- Limited generalizability due to participant homogeneity.
- Satisfaction scores were mock evaluations and not based on real data.

Future Work

- Increase sample size and participant diversity.
- Collect real-world data to validate findings.