Final Experiment

2024-04-23

```
setwd("/Users/naimaamraan/Desktop/experiments_and_causality")
```

```
getwd()
```

```
## [1] "/Users/naimaamraan/Desktop/experiments_and_causality"
```

```
# View the first few rows of the dataset
head(data)
```

```
## # A tibble: 6 x 16
##   `Form S/N Baseline` `Form S/N Treatment` Participant   `Order of Treatment`
##                 <dbl> <chr>                <chr>         <chr>
## 1                   1 01B                  Participant_1 2-1
## 2                   2 02A                  Participant_2 1-2
## 3                   3 03B                  Participant_3 2-1
## 4                   4 04A                  Participant_4 1-2
## 5                   5 05B                  Participant_5 2-1
## 6                   6 06A                  Participant_6 1-2
## # i 12 more variables: `Baseline Test location` <chr>,
## #   `Baseline Creativity Score` <dbl>, `Baseline Problem Solving Score` <dbl>,
## #   Treatment_Location <chr>, `Treatment Creativity Score` <dbl>,
## #   `Treatment Problem Solving Score` <dbl>,
## #   `Change in Creativity Score` <dbl>,
## #   `Change in Problem Solving Score` <dbl>, ...13 <lgl>, Treatment <chr>,
## #   `Creativity ATE` <dbl>, `Problem Solving ATE` <dbl>
```

```
# Replace spaces with underscores in column names
names(data) <- gsub(" ", "_", names(data))
```

```
head(data)
```

```
## # A tibble: 6 x 16
##   `Form_S/N_Baseline` `Form_S/N_Treatment` Participant   Order_of_Treatment
##                 <dbl> <chr>                <chr>         <chr>
## 1                   1 01B                  Participant_1 2-1
## 2                   2 02A                  Participant_2 1-2
## 3                   3 03B                  Participant_3 2-1
## 4                   4 04A                  Participant_4 1-2
## 5                   5 05B                  Participant_5 2-1
## 6                   6 06A                  Participant_6 1-2
## # i 12 more variables: Baseline_Test_location <chr>,
## #   Baseline_Creativity_Score <dbl>, Baseline_Problem_Solving_Score <dbl>,
## #   Treatment_Location <chr>, Treatment_Creativity_Score <dbl>,
## #   Treatment_Problem_Solving_Score <dbl>, Change_in_Creativity_Score <dbl>,
## #   Change_in_Problem_Solving_Score <dbl>, ...13 <lgl>, Treatment <chr>,
## #   Creativity_ATE <dbl>, Problem_Solving_ATE <dbl>
```

```r
# Convert factors to characters
data$Treatment_Location <- as.character(data$Treatment_Location)
```

```r
str(data)
```

```
## spc_tbl_ [40 x 16] (S3: spec_tbl_df/tbl_df/tbl/data.frame)
##  $ Form_S/N_Baseline              : num [1:40] 1 2 3 4 5 6 7 8 9 10 ...
##  $ Form_S/N_Treatment             : chr [1:40] "01B" "02A" "03B" "04A" ...
##  $ Participant                    : chr [1:40] "Participant_1" "Participant_2" "Participant_3" "Part
##  $ Order_of_Treatment             : chr [1:40] "2-1" "1-2" "2-1" "1-2" ...
##  $ Baseline_Test_location         : chr [1:40] "Bedroom" "Living room" "South hall classroom" "South
##  $ Baseline_Creativity_Score      : num [1:40] 4 8 6 6 10 10 10 8 6 6 ...
##  $ Baseline_Problem_Solving_Score : num [1:40] 5 10 5 5 10 10 5 5 5 10 ...
##  $ Treatment_Location             : chr [1:40] "Noisy Café" "Library" "Noisy Café" "Library" ...
##  $ Treatment_Creativity_Score     : num [1:40] 4 10 8 6 8 10 10 10 4 6 ...
##  $ Treatment_Problem_Solving_Score: num [1:40] 5 10 5 10 10 10 5 10 10 10 ...
##  $ Change_in_Creativity_Score     : num [1:40] 0 2 2 0 -2 0 0 2 -2 0 ...
##  $ Change_in_Problem_Solving_Score: num [1:40] 0 0 0 5 0 0 0 5 5 0 ...
##  $ ...13                          : logi [1:40] NA NA NA NA NA NA ...
##  $ Treatment                      : chr [1:40] "Library" "Noisy Café" NA NA ...
##  $ Creativity_ATE                 : num [1:40] 0.6 -1.7 NA NA NA NA NA NA NA NA ...
##  $ Problem_Solving_ATE            : num [1:40] -0.75 0.25 NA NA NA NA NA NA NA NA ...
##  - attr(*, "spec")=
##   .. cols(
##   ..   `Form S/N Baseline` = col_double(),
##   ..   `Form S/N Treatment` = col_character(),
##   ..   Participant = col_character(),
##   ..   `Order of Treatment` = col_character(),
##   ..   `Baseline Test location` = col_character(),
##   ..   `Baseline Creativity Score` = col_double(),
##   ..   `Baseline Problem Solving Score` = col_double(),
##   ..   Treatment_Location = col_character(),
##   ..   `Treatment Creativity Score` = col_double(),
##   ..   `Treatment Problem Solving Score` = col_double(),
##   ..   `Change in Creativity Score` = col_double(),
##   ..   `Change in Problem Solving Score` = col_double(),
##   ..   ...13 = col_logical(),
##   ..   Treatment = col_character(),
##   ..   `Creativity ATE` = col_double(),
##   ..   `Problem Solving ATE` = col_double()
##   .. )
##  - attr(*, "problems")=<externalptr>
```

```r
# Subset data for Library and Noisy Café
library_data <- subset(data, Treatment_Location == "Noisy Café")
noisy_cafe_data <- subset(data, Treatment_Location == "Library")
```

```r
print(library_data)
```

```
## # A tibble: 20 x 16
##    `Form_S/N_Baseline` `Form_S/N_Treatment` Participant   Order_of_Treatment
##                  <dbl> <chr>                <chr>         <chr>
##  1                   1 01B                  Participant_1 2-1
##  2                   3 03B                  Participant_3 2-1
##  3                   5 05B                  Participant_5 2-1
```

```
##  4                  7 07B                 Participant_7  2-1
##  5                  9 09B                 Participant_9  1-2
##  6                 11 11B                 Participant_11 2-1
##  7                 13 13B                 Participant_13 2-1
##  8                 15 15B                 Participant_15 2-1
##  9                 17 17B                 Participant_17 2-1
## 10                 19 19B                 Participant_19 2-1
## 11                 21 21B                 Participant_21 1-2
## 12                 23 23B                 Participant_23 1-2
## 13                 25 25B                 Participant_25 2-1
## 14                 27 27B                 Participant_27 2-1
## 15                 29 29B                 Participant_29 1-2
## 16                 31 31B                 Participant_31 1-2
## 17                 33 33B                 Participant_33 2-1
## 18                 35 35B                 Participant_35 2-1
## 19                 37 37B                 Participant_37 2-1
## 20                 39 39B                 Participant_39 2-1
## # i 12 more variables: Baseline_Test_location <chr>,
## #   Baseline_Creativity_Score <dbl>, Baseline_Problem_Solving_Score <dbl>,
## #   Treatment_Location <chr>, Treatment_Creativity_Score <dbl>,
## #   Treatment_Problem_Solving_Score <dbl>, Change_in_Creativity_Score <dbl>,
## #   Change_in_Problem_Solving_Score <dbl>, ...13 <lgl>, Treatment <chr>,
## #   Creativity_ATE <dbl>, Problem_Solving_ATE <dbl>
```

```
nrow(library_data)
```

```
## [1] 20
```

```
nrow(noisy_cafe_data)
```

```
## [1] 20
```

```
print(head(library_data))
```

```
## # A tibble: 6 x 16
##   `Form_S/N_Baseline` `Form_S/N_Treatment` Participant    Order_of_Treatment
##                 <dbl> <chr>                <chr>          <chr>
## 1                   1 01B                  Participant_1  2-1
## 2                   3 03B                  Participant_3  2-1
## 3                   5 05B                  Participant_5  2-1
## 4                   7 07B                  Participant_7  2-1
## 5                   9 09B                  Participant_9  1-2
## 6                  11 11B                  Participant_11 2-1
## # i 12 more variables: Baseline_Test_location <chr>,
## #   Baseline_Creativity_Score <dbl>, Baseline_Problem_Solving_Score <dbl>,
## #   Treatment_Location <chr>, Treatment_Creativity_Score <dbl>,
## #   Treatment_Problem_Solving_Score <dbl>, Change_in_Creativity_Score <dbl>,
## #   Change_in_Problem_Solving_Score <dbl>, ...13 <lgl>, Treatment <chr>,
## #   Creativity_ATE <dbl>, Problem_Solving_ATE <dbl>
```

```
print(nrow(library_data))
```

```
## [1] 20
```

```
# Load the dplyr package
library(dplyr)
```

```
##
```

```
## 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
```

```
# Create a new dataframe with switched values
switched_data <- data %>%
  mutate(Treatment_Location = ifelse(Treatment_Location == "Noisy Café", "Library",
                                     ifelse(Treatment_Location == "Library", "Noisy Café", Treatment_Lo

# Check the first few rows of the new dataframe
head(switched_data)
```

```
## # A tibble: 6 x 16
##   `Form_S/N_Baseline` `Form_S/N_Treatment` Participant   Order_of_Treatment
##                 <dbl> <chr>                <chr>         <chr>
## 1                   1 01B                  Participant_1 2-1
## 2                   2 02A                  Participant_2 1-2
## 3                   3 03B                  Participant_3 2-1
## 4                   4 04A                  Participant_4 1-2
## 5                   5 05B                  Participant_5 2-1
## 6                   6 06A                  Participant_6 1-2
## # i 12 more variables: Baseline_Test_location <chr>,
## #   Baseline_Creativity_Score <dbl>, Baseline_Problem_Solving_Score <dbl>,
## #   Treatment_Location <chr>, Treatment_Creativity_Score <dbl>,
## #   Treatment_Problem_Solving_Score <dbl>, Change_in_Creativity_Score <dbl>,
## #   Change_in_Problem_Solving_Score <dbl>, ...13 <lgl>, Treatment <chr>,
## #   Creativity_ATE <dbl>, Problem_Solving_ATE <dbl>
```

```
library(stargazer)
```

```
##
## Please cite as:

##  Hlavac, Marek (2022). stargazer: Well-Formatted Regression and Summary Statistics Tables.

##  R package version 5.2.3. https://CRAN.R-project.org/package=stargazer
```

```
# Fit a linear model for creativity scores based on treatment location
model_creativity_location <- lm(Treatment_Creativity_Score ~ Treatment_Location, data = switched_data)

# Fit a linear model for problem-solving scores based on treatment location
model_problem_solving_location <- lm(Treatment_Problem_Solving_Score ~ Treatment_Location, data = switc

# Print the summary of the models to see the results
summary(model_creativity_location)
```

```
##
## Call:
## lm(formula = Treatment_Creativity_Score ~ Treatment_Location,
##     data = switched_data)
##
## Residuals:
```

```
##    Min     1Q Median     3Q    Max
## -5.300 -1.300 -0.050  1.575  5.200
##
## Coefficients:
##                              Estimate Std. Error t value Pr(>|t|)
## (Intercept)                    4.8000     0.5494   8.737 1.27e-10 ***
## Treatment_LocationNoisy Café   2.5000     0.7770   3.218  0.00264 **
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 2.457 on 38 degrees of freedom
## Multiple R-squared:  0.2141, Adjusted R-squared:  0.1934
## F-statistic: 10.35 on 1 and 38 DF,  p-value: 0.002643
```

```
summary(model_problem_solving_location)
```

```
##
## Call:
## lm(formula = Treatment_Problem_Solving_Score ~ Treatment_Location,
##     data = switched_data)
##
## Residuals:
##    Min     1Q Median     3Q    Max
## -2.750 -2.500  2.250  2.312  2.500
##
## Coefficients:
##                              Estimate Std. Error t value Pr(>|t|)
## (Intercept)                    7.5000     0.5721  13.110 1.12e-15 ***
## Treatment_LocationNoisy Café   0.2500     0.8091   0.309    0.759
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 2.559 on 38 degrees of freedom
## Multiple R-squared:  0.002506,   Adjusted R-squared:  -0.02374
## F-statistic: 0.09548 on 1 and 38 DF,  p-value: 0.759
```

```
# Create a formatted table
stargazer(model_creativity_location, type = "text")
```

```
##
## ===================================================
##                               Dependent variable:
##                           -------------------------
##                           Treatment_Creativity_Score
## ---------------------------------------------------
## Treatment_LocationNoisy Café          2.500***
##                                        (0.777)
##
## Constant                              4.800***
##                                        (0.549)
##
## ---------------------------------------------------
## Observations                             40
## R2                                      0.214
## Adjusted R2                             0.193
```

```
## Residual Std. Error                2.457 (df = 38)
## F Statistic                    10.353*** (df = 1; 38)
## ============================================================
## Note:                          *p<0.1; **p<0.05; ***p<0.01
```

```
stargazer(model_problem_solving_location, type = "text")
```

```
##
## ============================================================
##                                    Dependent variable:
##                                ----------------------------
##                                Treatment_Problem_Solving_Score
## ------------------------------------------------------------
## Treatment_LocationNoisy Café                0.250
##                                            (0.809)
##
## Constant                                   7.500***
##                                            (0.572)
##
## ------------------------------------------------------------
## Observations                                 40
## R2                                           0.003
## Adjusted R2                                 -0.024
## Residual Std. Error                    2.559 (df = 38)
## F Statistic                            0.095 (df = 1; 38)
## ============================================================
## Note:                                *p<0.1; **p<0.05; ***p<0.01
```

```
# Fit an ANCOVA model
# For creativity score:
ancova_creativity <- lm(Treatment_Creativity_Score ~ Treatment_Location + Baseline_Creativity_Score, da

# For problem-solving score:
ancova_problem_solving <- lm(Treatment_Problem_Solving_Score ~ Treatment_Location + Baseline_Problem_So

# Conduct the ANOVA on the linear model
anova_creativity <- anova(ancova_creativity)
anova_problem_solving <- anova(ancova_problem_solving)

# Print the ANOVA summaries
print(anova_creativity)
```

```
## Analysis of Variance Table
##
## Response: Treatment_Creativity_Score
##                          Df  Sum Sq Mean Sq F value   Pr(>F)
## Treatment_Location         1  62.500  62.500 10.1452 0.002935 **
## Baseline_Creativity_Score  1   1.459   1.459  0.2368 0.629406
## Residuals                 37 227.941   6.161
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```
print(anova_problem_solving)
```

```
## Analysis of Variance Table
##
```

```
## Response: Treatment_Problem_Solving_Score
##                               Df  Sum Sq Mean Sq F value  Pr(>F)
## Treatment_Location             1   0.625   0.625  0.1017 0.75156
## Baseline_Problem_Solving_Score  1  21.421  21.421  3.4864 0.06981 .
## Residuals                     37 227.329   6.144
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```
# Print the detailed summaries of the models
summary(ancova_creativity)
```

```
##
## Call:
## lm(formula = Treatment_Creativity_Score ~ Treatment_Location +
##     Baseline_Creativity_Score, data = switched_data)
##
## Residuals:
##     Min      1Q  Median      3Q     Max
## -5.5704 -1.0029 -0.0828  1.5381  4.9132
##
## Coefficients:
##                               Estimate Std. Error t value Pr(>|t|)
## (Intercept)                    4.26731    1.22735   3.477  0.00131 **
## Treatment_LocationNoisy Café  2.48361    0.78562   3.161  0.00313 **
## Baseline_Creativity_Score     0.08195    0.16841   0.487  0.62941
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 2.482 on 37 degrees of freedom
## Multiple R-squared:  0.2191, Adjusted R-squared:  0.1769
## F-statistic: 5.191 on 2 and 37 DF,  p-value: 0.0103
```

```
summary(ancova_problem_solving)
```

```
##
## Call:
## lm(formula = Treatment_Problem_Solving_Score ~ Treatment_Location +
##     Baseline_Problem_Solving_Score, data = switched_data)
##
## Residuals:
##    Min     1Q Median     3Q    Max
## -3.341 -1.812  1.659  1.791  3.321
##
## Coefficients:
##                               Estimate Std. Error t value Pr(>|t|)
## (Intercept)                     5.2814     1.3111   4.028 0.000268 ***
## Treatment_LocationNoisy Café   -0.1325     0.8102  -0.164 0.870965
## Baseline_Problem_Solving_Score  0.3060     0.1639   1.867 0.069812 .
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 2.479 on 37 degrees of freedom
## Multiple R-squared:  0.0884, Adjusted R-squared:  0.03913
## F-statistic: 1.794 on 2 and 37 DF,  p-value: 0.1804
```

```r
# Create a formatted table
stargazer(ancova_creativity, type = "text")
```

```
##
## ===================================================
##                               Dependent variable:
##                           -------------------------
##                           Treatment_Creativity_Score
## ---------------------------------------------------
## Treatment_LocationNoisy Café          2.484***
##                                        (0.786)
##
## Baseline_Creativity_Score              0.082
##                                        (0.168)
##
## Constant                              4.267***
##                                        (1.227)
##
## ---------------------------------------------------
## Observations                             40
## R2                                      0.219
## Adjusted R2                             0.177
## Residual Std. Error                2.482 (df = 37)
## F Statistic                      5.191** (df = 2; 37)
## ===================================================
## Note:                          *p<0.1; **p<0.05; ***p<0.01
```

```r
stargazer(ancova_problem_solving, type = "text")
```

```
##
## ===============================================================
##                                     Dependent variable:
##                                 ----------------------------
##                                 Treatment_Problem_Solving_Score
## ---------------------------------------------------------------
## Treatment_LocationNoisy Café               -0.133
##                                            (0.810)
##
## Baseline_Problem_Solving_Score              0.306*
##                                            (0.164)
##
## Constant                                   5.281***
##                                            (1.311)
##
## ---------------------------------------------------------------
## Observations                                 40
## R2                                          0.088
## Adjusted R2                                 0.039
## Residual Std. Error                    2.479 (df = 37)
## F Statistic                           1.794 (df = 2; 37)
## ===============================================================
## Note:                               *p<0.1; **p<0.05; ***p<0.01
```

```r
# 'Order of Treatment' as a factor
switched_data$Order_of_Treatment <- as.factor(switched_data$Order_of_Treatment)
```

```r
# Fit a linear model for creativity scores including the order of treatment
model_creativity_order_treatment <- lm(Treatment_Creativity_Score ~ Treatment_Location + Order_of_Treatr

# Fit a linear model for problem-solving scores including the order of treatment
model_problem_solving_order_treatment <- lm(Treatment_Problem_Solving_Score ~ Treatment_Location + Orde

# Print the summary of the models to see the results
summary(model_creativity_order_treatment)
```

```
##
## Call:
## lm(formula = Treatment_Creativity_Score ~ Treatment_Location +
##     Order_of_Treatment, data = switched_data)
##
## Residuals:
##     Min      1Q  Median      3Q     Max
## -5.5948 -1.5948 -0.1155  1.3966  5.3638
##
## Coefficients:
##                               Estimate Std. Error t value Pr(>|t|)
## (Intercept)                     5.2914     0.8362   6.328 2.26e-07 ***
## Treatment_LocationNoisy Café    2.3034     0.8204   2.808  0.00792 **
## Order_of_Treatment2-1          -0.6552     0.8373  -0.782  0.43890
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 2.47 on 37 degrees of freedom
## Multiple R-squared:  0.2269, Adjusted R-squared:  0.1851
## F-statistic:  5.43 on 2 and 37 DF,  p-value: 0.008556
```

```r
summary(model_problem_solving_order_treatment)
```

```
##
## Call:
## lm(formula = Treatment_Problem_Solving_Score ~ Treatment_Location +
##     Order_of_Treatment, data = switched_data)
##
## Residuals:
##    Min     1Q Median     3Q    Max
## -3.556 -2.148  1.444  1.925  3.024
##
## Coefficients:
##                               Estimate Std. Error t value Pr(>|t|)
## (Intercept)                     8.5560     0.8470  10.102 3.48e-12 ***
## Treatment_LocationNoisy Café   -0.1724     0.8309  -0.208    0.837
## Order_of_Treatment2-1          -1.4080     0.8480  -1.660    0.105
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 2.501 on 37 degrees of freedom
## Multiple R-squared:  0.07167,    Adjusted R-squared:  0.02149
## F-statistic: 1.428 on 2 and 37 DF,  p-value: 0.2526
```

```r
# Create a formatted table
stargazer(model_creativity_order_treatment, type = "text")
```

```
##
## ===================================================
##                                Dependent variable:
##                            -------------------------
##                            Treatment_Creativity_Score
## ---------------------------------------------------
## Treatment_LocationNoisy Café          2.303***
##                                        (0.820)
##
## Order_of_Treatment2-1                  -0.655
##                                        (0.837)
##
## Constant                               5.291***
##                                        (0.836)
##
## ---------------------------------------------------
## Observations                             40
## R2                                      0.227
## Adjusted R2                             0.185
## Residual Std. Error                2.470 (df = 37)
## F Statistic                      5.430*** (df = 2; 37)
## ===================================================
## Note:                          *p<0.1; **p<0.05; ***p<0.01
```

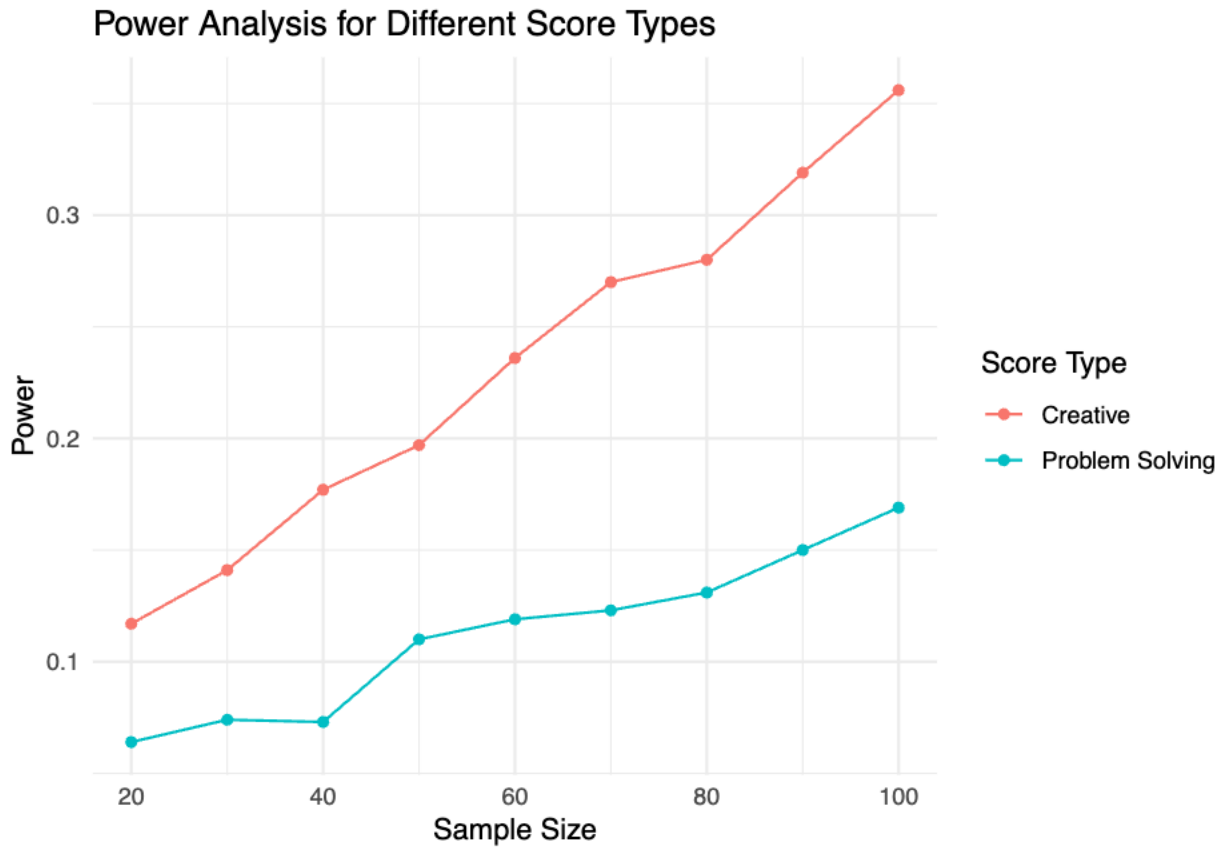
```r
stargazer(model_problem_solving_order_treatment, type = "text")
```

```
##
## ===========================================================
##                                    Dependent variable:
##                                -----------------------------
##                                Treatment_Problem_Solving_Score
## -----------------------------------------------------------
## Treatment_LocationNoisy Café              -0.172
##                                           (0.831)
##
## Order_of_Treatment2-1                     -1.408
##                                           (0.848)
##
## Constant                                  8.556***
##                                           (0.847)
##
## -----------------------------------------------------------
## Observations                                40
## R2                                         0.072
## Adjusted R2                                0.021
## Residual Std. Error                   2.501 (df = 37)
## F Statistic                          1.428 (df = 2; 37)
## ===========================================================
## Note:                              *p<0.1; **p<0.05; ***p<0.01
```

```r
# Load libraries
library(ggplot2)
```

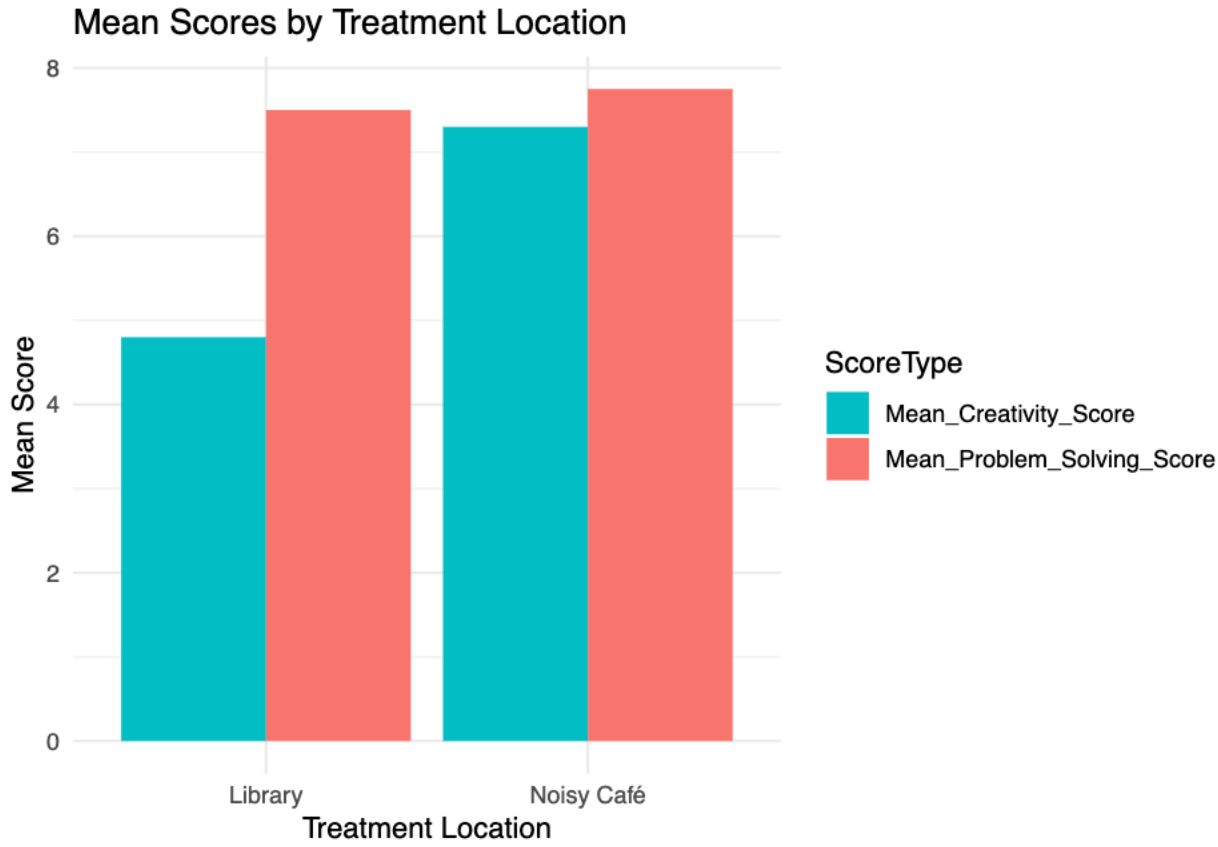
```r
library(tidyr)

# Adjusted simulation function for two types of scores
simulate_and_analyze <- function(n, mean_diff_creative, mean_diff_problem, sd_noise = 10) {

  # Here we use the same n for simplicity
  group <- rep(c("Library", "Noisy Café"), each = n)
  order <- rep(c("1-2", "2-1"), each = n)

  # Creative scores simulation
  creative_score <- ifelse(group == "Library", 50, 50 + mean_diff_creative) +
                    ifelse(order == "2-1", -0.1 * mean_diff_creative, 0) +
                    rnorm(2 * n, sd = sd_noise)

  # Problem-solving scores simulation
  problem_solving_score <- ifelse(group == "Library", 50, 50 - mean_diff_problem) +
                           ifelse(order == "2-1", 0.1 * mean_diff_problem, 0) +
                           rnorm(2 * n, sd = sd_noise)

  d_t <- data.frame(group = factor(group), order = factor(order),
                    creative_score = creative_score, problem_solving_score = problem_solving_score)

  # Analyzing both scores
  creative_model <- lm(creative_score ~ group + order, data = d_t)
  problem_solving_model <- lm(problem_solving_score ~ group + order, data = d_t)

  # Extracting p-values
  creative_significant <- ifelse(summary(creative_model)$coefficients['groupNoisy Café',4] < 0.05, 1, 0)
  problem_solving_significant <- ifelse(summary(problem_solving_model)$coefficients['groupNoisy Café',4]

  return(c(creative_significant, problem_solving_significant))
}

# Function to estimate power for both scores
estimate_power <- function(sample_sizes, mean_diff_creative, mean_diff_problem, n_simulations = 1000) {
  results <- expand.grid(SampleSize = sample_sizes, ScoreType = c("Creative", "Problem Solving"))
  results$Power <- NA

  for (i in seq(nrow(results))) {
    type <- results$ScoreType[i]
    mean_diff <- if(type == "Creative") mean_diff_creative else mean_diff_problem
    simulations <- replicate(n_simulations, simulate_and_analyze(results$SampleSize[i], mean_diff_creati
    results$Power[i] <- mean(simulations[if(type == "Creative") 1 else 2, ])
  }

  return(results)
}

# Parameters for simulation with different expected mean differences
sample_sizes <- seq(20, 100, by = 10)
mean_diff_creative <- 2.5  # Adjust based on your experimental design
mean_diff_problem <- 1.5   # Adjust based on your experimental design
```

```r
# Run power analysis simulation
power_results <- estimate_power(sample_sizes, mean_diff_creative, mean_diff_problem)

# Plot the results
power_results %>%
  ggplot(aes(x = SampleSize, y = Power, color = ScoreType)) +
  geom_line() +
  geom_point() +
  theme_minimal() +
  labs(title = "Power Analysis for Different Score Types",
       x = "Sample Size", y = "Power", color = "Score Type")
```

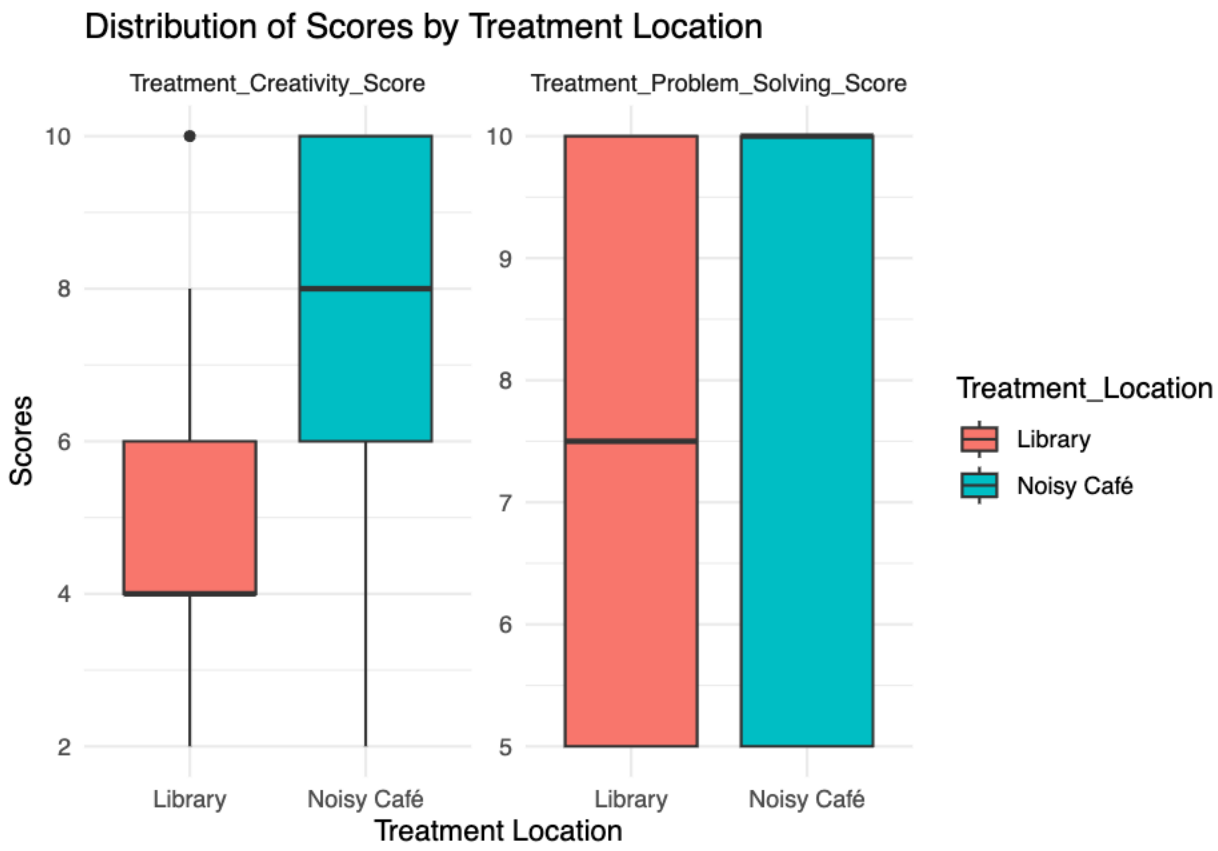



```r
# Calculate mean scores for each treatment location
library(dplyr)
library(ggplot2)

means <- switched_data %>%
  group_by(Treatment_Location) %>%
  summarise(
    Mean_Creativity_Score = mean(Treatment_Creativity_Score, na.rm = TRUE),
    Mean_Problem_Solving_Score = mean(Treatment_Problem_Solving_Score, na.rm = TRUE)
  ) %>%
  pivot_longer(cols = c(Mean_Creativity_Score, Mean_Problem_Solving_Score),
               names_to = "ScoreType",
               values_to = "MeanScore")
```

```r
# Create a bar graph of mean scores by treatment location
ggplot(means, aes(x = Treatment_Location, y = MeanScore, fill = ScoreType)) +
  geom_bar(stat = "identity", position = position_dodge()) +
  scale_fill_manual(values = c("#01bfc4", "#f7756d")) +  # Added '#' to the hex codes
  labs(title = "Mean Scores by Treatment Location", y = "Mean Score", x = "Treatment Location") +
  theme_minimal()
```




```r
# Create boxplots for each score type by treatment location
switched_data %>%
  pivot_longer(cols = c(Treatment_Creativity_Score, Treatment_Problem_Solving_Score),
               names_to = "ScoreType",
               values_to = "Score") %>%
  ggplot(aes(x = Treatment_Location, y = Score, fill = Treatment_Location)) +
  geom_boxplot() +
  facet_wrap(~ScoreType, scales = "free") +
  theme_minimal() +
  labs(title = "Distribution of Scores by Treatment Location", y = "Scores", x = "Treatment Location")
```


Distribution of Scores by Treatment Location
Treatment_Creativity_Score
Treatment_Problem_Solving_Score
Scores
10
8
6
4
2
9
7
5
Library
Noisy Café
Treatment Location
Treatment_Location
Library
Noisy Café